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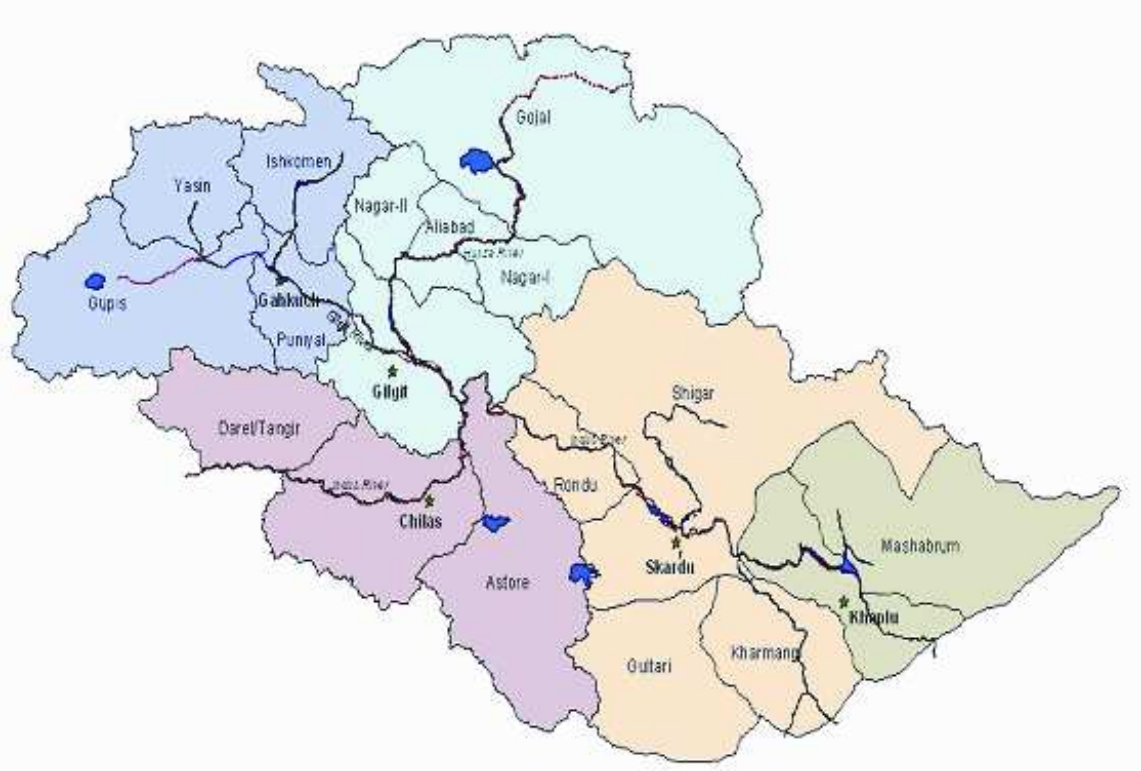
Impact Evaluation of Existing Irrigation and Agronomic Practices on Irrigation Efficiency and Crop Yields in Northern Areas of Pakistan



Edited by:

Dr. Manzoor Ahmad Malik
Engr. Muhammad Azam

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Acknowledgement

This study was undertaken as a joint effort under the PCRWR projects "Improved Water Conservation Practices for NWFP and Northern Areas of Pakistan" and "Result Oriented Short Term Research Studies to Improve Water Resources of Mountainous Areas". The study was carried out by M/s Water Engineering, Lahore, through Water Resources Research Centre, (PCRWR) Peshawar.

Khyaban-e-Johar, H-8/1, Islamabad – Pakistan
Email: pcrwr@isb.comsats.net.pk

ISBN 978-969-8469-28-3

FOREWORD

The economy of Pakistan is predominantly agrarian. Therefore optimum utilization of its land and water resources is of paramount importance. It has been observed that while preparing programmes for development of irrigated agriculture in the country, areas outside the Indus Plains are generally ignored. One such area outside the Indus Plains is the Karakoram-Himalyan region, commonly known as the Northern Areas. It mainly consists of rugged mountains and has thinly scattered land mostly located along the major drainage channels of valleys. It is with this background in mind that the current study was designed to collect relevant data to evaluate the agricultural potential of Northern Areas.

Like other parts of the country, agriculture is the main economic activity of Northern Areas as well. Almost the whole population of Northern Areas depends purely on agriculture, which is however based on traditional methods, having low outputs and yields. The current study is an effort to evaluate the impact of existing irrigation and agronomic practices on irrigation efficiency and crop yields in Northern Areas. The study has been designed to identify constraints and formulate recommendations to increase agricultural production in the area to meet the food requirements of the people of Northern Areas.

Agriculture can be developed by two methods, i.e., by extensive and intensive cultivation. Extensive cultivation deals with bringing more land under cultivation while intensive cultivation focuses on productivity enhancement. Unfortunately at the moment, both approaches are in worse condition in Northern Areas. The cultivated and cultivable land statistics of Northern Areas show that there is a great potential of improvement in terms of intensive and extensive cropping. We must therefore utilize all efforts to bring more area under cultivation and increase agricultural productivity in the already cultivated area in order to ensure the food security for the people of Northern Areas that shall ultimately reduce poverty and hunger besides reducing the dependency on import of wheat grains and other foodstuff from other parts of the country. It must be noted that Northern Areas is ideal for production of high quality crop seed free from insects and diseases by virtue of its location and latitude. However, agriculture in the area has long remained at subsistence level and per capita production has steadily declined in the face of population pressure. The area faces acute shortage of forage and food grain production. The study has come up with strategic recommendations for better water and agriculture management and definite increase in cropping intensities and increase in cropped area through introduction of best resource conservation technologies in the area. This would greatly help in improving the economic conditions of poor farmers of Northern Areas.

Dr. Muhammad Aslam Tahir
Chairman
Pakistan Council of Research in
Water Resources, Islamabad

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CHAPTER 1

INTRODUCTION TO NORTHERN AREAS

1.1 Location and Extent

Pakistan is a country of 887,714 square kilometers, roughly wedge shaped, extending from the Himalayan mountains on the Northeast to the Arabian Sea on the Southwest. It lies between 23° and 38° North latitude and 61° to 76° East longitude. Administratively, the country is divided into four provinces Sindh, Baluchistan, Punjab and N.W.F.P with capitals at Karachi, Quetta, Lahore and Peshawar respectively. The Federal Capital constitutes a separate entity, the Islamabad Capital Area. In addition, there are two Federally Administered Areas, the Northern Areas with headquarter at Gilgit and protectorate state, Azad Kashmir with Capital at Muzaffarabad.

The Northern Area is located in the extreme north of Pakistan. It extends from 34° 40´ to 37° 00´ North latitudes and 72° 30´ to 76° East longitudes. It is bounded by Afghanistan in the North, China in the North-East, occupied Kashmir in the South and Chitral district in the West. Geographically the limits of the region are well defined. Its total area is 27990 Square miles (72,496 km^2). The general land use statistics of Northern Areas is given in Table 1.1.

The entire Northern Area is predominantly mountainous and is characterized by the high mountains, containing parts of the World's greatest mountain system i.e. the Himalayas, the Karakoram and the Hindukush. The mountain system contains peaks which rank among the highest peaks of the world and include K2 (8612 m), Nanga Parbat (8126 m); Rakaposhi (7788 m) and Haramosh (7315 m).

Indus is the main river flowing through the area, which originates from western Tibet, and after flowing through Ladakh, Baltistan and Diamer districts enters N.W.F.P. Its important tributaries include Gilgit, Hunza, Ishkuman, Yasin, Shigar and Shyok Rivers which are nourished by numerous snow fields and glaciers of the area, some of which are the largest outside the polar region. An important feature of the drainage in the area is that almost all large and small streams drain into River Indus. River/stream valleys vary in size depending upon the size of the river/stream. Main River valleys are more that 64 km long and the others may vary from less than 5 km in length up to 16 km.

Due to difficult access, rugged terrain and extreme weather conditions, the development of land and water resources of the region had been slow. Agriculture has long remained at subsistence level and per capita production has steadily declined in the face of population pressure. The area faces acute shortage of forage and food grain production.

Northern Areas for administrative purposes have been divided into five districts namely Gilgit, Baltistan, Diamer, Ghizar and Ghanche (Fig. 1.1). These districts are headed by Deputy Commissioners and each district is further divided into sub-divisions, under Magistrate. The overall administration and development is through the Ministry of Kashmir and Northern Areas (KANA) while a senior officer (BPS-21) is the local Administrator and is stationed at Gilgit.

1.2 **Climate**

Due to varied and diverse topography, the climate of this region varies from subtropical temperate to dry alpine. June, July and August are the hottest months with temperatures going up to 40°C while December, January and February are the coldest months with temperature many degrees below freezing. Figs. 1.3, 1.4, 1.5 and 1.6 show the Northern Areas Drainage, Ecozones, Rainfall and Temperature. Table 1.2 gives the mean monthly minimum and maximum temperatures for various stations.

More precisely, the climate of the area is cold in winter, and hot in summer at the relatively low elevations i.e. in parts of Diamer and Gilgit. However the climate of other valleys at higher elevations e.g. Baltistan, Ghizer, Hunza, Nagar, Darel, Tangir etc is pleasant in summer and cold in winter. The rainfall in the areas is scanty and non-homogeneous. Mean annual rainfall varies from 375 mm (15 inches) in southern parts of the region to 125 mm (5 inches) in the extreme north with an average annual of 254 mm (10 inches). About 70% of the precipitation occurs during summer, while October and November are relatively dry months.

Since Northern Areas is situated on the leeward side of the summer monsoon, summers are, therefore, generally dry. However, during the winter season, the precipitation is in the form of snow on high mountains. Areas above 4300 meters remain covered with snow throughout the year. Valleys receive orographic rainfall, which varies from 50 to 175 mm per year and sometimes causes devastating damages. Table 1.3 gives the precipitation record for various stations.

Radiation is another important factor which differentiates habitants in mountainous areas through its influence on photosynthetic potential, temperature, evaporation and the water balance. This area has a high incident radiation level because of the rain shadow effect reducing the cloud cover, especially in summer, when 70% of the maximum possible sunshine hours are received (Table 1.4). The latitude determines the seasonal range in temperatures whereas the altitude reduces its mean value and increases the diurnal range. Topography adds a third cause of local variation.

Most of the sites which experience some degree of wind range from 60-100 km/day. In Northern Areas, there seems to be altitude belt between 2000 to 2500 meter, where very strong up-valley winds occur, with consistent blowing at 5-6 m/second. Owing to the aridity and temperature of the air, higher evaporation rates in the villages are anticipated.

Table 1.5 shows wind speeds at different sites. However these averages conceal the fact that often the wind is accumulated over short bursts of gusty conventional wind. Apart from its desiccating effect, wind has the following adverse effects on agricultural activities:

(i) It causes premature fruit drop. Strong winds in June can greatly reduce the apricot crop.

(ii) If accompanied by rain, it causes lodging of cereal crops and broad beans.

Up-valley winds carry aphids higher than they would normally go, transporting them across the barren inter village wastes.

1.3 Communications

Roads:

Figure 1.2 shows the Northern Area Communications. The difficult topographic conditions, frequent land slides and movement of glacier moraine greatly hamper the construction of roads in the area. The Karakoram Highway and Gilgit-Skardu roads are the most important roads, which connect major towns of the areas with rest of Pakistan. The other existing roads are all rough surfaced, narrow with poor grades and sharp curved. Most of these roads are dangerous and risky. Approximate length of existing roads of Northern Area is given in Table 1.6.

Airways:

Gilgit and Skardu have been connected with Islamabad through an air service which operates throughout the year subject to weather conditions.

1.4 Population and Society

The ethnic history of the area is complicated. The facial features of the people indicate their Mongolian and Greek origin mingled with South Asian Peoples. Sociological data collected during the reconnaissance survey indicated that village families traced their origins to ancestors from such regions as Afghanistan, Turkistan, Kazakhstan and Ladakh. Many came from neighboring areas such as Chitral and Chilas. The dominant religion is Islam and mostly belongs to Ismaili and Shia sects, the languages spoken in the area include Shina, Balti, Broskhuski, Chitrali, Urdu, Persian, Tibetan and Turki.

The population of Northern Area has more than doubled since the first Population Census in 1951. It was 650,000 in 1981 compared to 416,000 in 1972, resulting in an increase by 37.9 percent during the 1972-81 inter-census periods at an average annual growth rate of 3.8 percent. The population grew to 0.9 million in 1998. It is estimated that the current population of the area is about 1.0 million. The population has thus grown to more than double since 1972. Table 1.7 gives the population of Northern Areas and inter-census increase since 1951. The population is unevenly distributed amongst its districts. The district of Gilgit has the maximum population of 228,185 in 1981 i.e. 39.7 percent and Diamer has the minimum of 122,690 in 1981 i.e. 21.4 percent.

1.5 Geology

Geology Department of Peshawar University has done some work on the geological process and formations of the area. There are three distinct types of rocks namely:

(i) Igneous rocks: About 80% of rocks are igneous in nature. Disintegration is in active process in this type of rocks.

(ii) Sedimentary rocks: This type of rocks consists of slate, quartz, limestone and gneiss. At places these are intercalated by “Green Stone Complex” that comprise of epidorite, dolerite, basalt and hornblendic gneiss.

(iii) Meta-sedimentary rocks: Such rocks are available partly through the process of metamorphism and partly consist of distinct schistose, gneissose, quartzite and marble.

The distribution of rocks in the tract is not regular. It differs from place to place and elevation to elevation. However, the bedrock of the valleys, generally, consists of quaternary lake deposits, marine stream gravel and alluvial combinations.

The regional geology of the project area i.e. valleys of Chilas, Hunza and Ghukosh is very diverse. The region has been affected by the collision of two major continental plates, the Indian Mass and the Asiatic Mass, with a sedimentary basin sandwiched between the two. The geological set up of the Northern part of Pakistan does not produce a coherent over-view, firstly because of its complex evolutionary history as an island arc on the north western margin of the Indo-Pakistan platform and secondly due to its subsequent involvement in the interplay with the two mighty continental blocks. The resultant effect is reminiscent in its heterogeneous dominations of intermingled rocks with superimposed complex tectonics, which distinguishes it from the surrounding geological provinces. The region is underlain by a sequence of met sedimentary and igneous rocks of different ages. A group of rocks called Green Stone Complex is the major rock formation exposed in the project area.

The region is characterized entirely by rugged mountainous terrain and high relief. The Trans-Himalaya region contains four roughly parallel and accurate mountain ranges. From south to north they are: -

1. The greater Himalayas which cover Chilas, Astor and tribal territory of Darel area;
2. The Kailas Range which also forms the project area and consists of Haramosh, Rakaposhi and Masherbrum chain of mountains and runs through Baltistan, Nagir, Punial and Kohi-Ghizer; important peak in the Kailas range is Rakaposhi 7788 m (25,550 ft.) high;
3. The Karakoram range covers Northern Baltistan, Hunza, Ishkuman and Yasin; and
4. The Hindu Raj Range is the easterly extension of the Hindu Kush and is situated along the Northern borders of Gilgit and Baltistan.

All the ranges embracing most of the highest peaks are formed of granodiorite. They are remarkable for rugged nature of topography.

1.6 **Seismology**

Proper seismic evaluation of any region depends on the following factors:

(i) Accuracy and authenticity of descriptive records of earthquakes.

(ii) The network for instrumental recording of earthquakes.

(iii) Larger period of documentation for better understanding of the seismic characteristics of a region.

The number of earthquakes recorded by instruments in a given area depends upon the distribution of observation stations and sensitivity of the installed instruments. In Pakistan the network of seismicity monitoring system (Karachi, Quetta, Tarbela and Peshawar) is far from being adequate. There is no observatory in the seismically active belt of Chitral and Gilgit and same is the case with a wide active belt of Makran and Chaghai districts. These regions are sparsely populated and very little attention has been given to their development in the past and as such the need for a seismic hazard data was hardly realized. Now when major development schemes

involving sizeable engineering works are being planned and are underway, an accurate knowledge of seismicity is essential especially in the wake of recent earthquake.

Figure 1.8 shows the seismotectonic regions of Pakistan. The Karakoram Zone (Zone Number 11) is situated along a portion of the southern boundary of the Eurasian Plate. It is located north of the Indus Suture Line that marks the zone of crustal convergence between Eurasia and the Indo-Pakistan subcontinent. One feature associated with this seismotectonic zone is the Karakoram fault – a major right lateral strike split fault.

The level of modern teleseismic activity associated with this zone varies. Near the Indus suture, west of Gilgit, activity is moderate to high in number with the largest surface wave magnitudes being between 6.0 and 7.0. This activity is aligned in a north-easterly direction paralleling the large scale structural trends of the region. Else-where the level of activity is low, particularly along the Karakoram fault.

In recent historical times many large earthquakes have occurred in the mountainous northern areas and adjacent plains separating the South Asian sub-continent (Indo-Pak) from the Eurasian continent.

The seismic map of the region prepared by Pakistan Meteorological Department, Geophysical Centre, Quetta, indicates that Gilgit lies in a very active seismic zone and the seismic factor in this zone has been evaluated as "Zone of noticeable seismic danger" with acceleration values of 0.05 to 0.15 g. and to the immediate north and north-west lies the "Zone of significant seismic danger" with acceleration value of 0.15 to 0.2g.

Two devastating earthquakes occurred in the Northern Areas in near past on 28th December 1974 and 12th September, 1981 near the villages of Pattan and Sazine with magnitudes 6.1 and 5.7. Considerable loss of life and damage to the buildings was experienced in Pattan, Dubair, Darel and Tangir. Losses to the building were experienced in Naltar and Gilgit as well during the Sazine earthquake (1981). Table 1.7 shows the major earthquakes data for the Northern Areas.

1.7 **Glaciers and Glaciation**

The glaciers of Northern Areas especially Gilgit and Baltistan are disposed longitudinally or transversely. The longitudinal glaciers are remarkable for their larger length, greater volume and higher snow-line while the transverse ones are shorter in length, have lower snowline, and the position of the snow fluctuates more quickly with changes of temperature.

The important glaciers in the Kailas Range are the Harmosh group of glaciers, Rakaposhi group of glaciers and Kobar Gunge glaciers.

Most of the valleys in Gilgit and Baltistan show evidences of past glaciations. The Yasin and Ishkuman are also examples of typical glaciated valleys. They are U-shaped and have a hump like gradient. Almost all the rivers and torrential streams in the area are nourished by the numerous snow fields and glaciers of the area. Passu, Batura and Batoro glaciers are considered to be the largest outside the polar region. Unasserted accumulation of boulders, distribution of erratic, the presence of hanging valleys and lateral moraines, snow dissected by streams and the old glacial lakes can be seen all over the area. Occasionally, landslides and glacier dams have been breaking up into devastating floods affecting the Indus plain downstream.

1.8 Economy

Like other parts of the country, agriculture is the main source of economy of Northern Areas as well. Agriculture sector is based on traditional methods which lead to low level outputs and yields. The crop and livestock resources are limited. However, recent efforts for producing high-yield variety of potato and its marketing in various parts of Pakistan, is likely to boost up the agricultural production of the area.

1.9 Land Resources

The entire Northern Area comprises of about 7,250,000 ha of which only 0.95% is under farming. The area under orchards is 14% of the farmed area. The land use statistics are as under:

Table 1: *Summary of Present Land Use in Northern Areas*

S No.	*Land Use*	Area, ha	***Percent of Total Area***
	Total Geographic Area	7,249,600	100.00
1	Cultivated Area	69,480	0.96
2	Range Land	3,899,270	53.78
3	Forests	313,000	4.32
4	Mountains	2,615,120	36.07
5	Glaciers	279,200	3.90
6	Rivers, Streams and Lakes	12,800	0.17
7	Culturable Waste	60,700	0.80

1.10 Water Resources

Northern Areas are blessed with several panoramic tributaries which eventually feed the mighty Indus River. These tributaries include Shyok, Gilgit, Hunza and Astore Rivers. Northern Areas generally receive rainfall during monsoon season and snowfall in winter. The isohyetal map of the area indicates that the average annual rainfall varies from 375 mm in the south to 125 mm in the north. However, the annual mean precipitation over the entire NA is about 254 mm. This is equivalent to a volumetric amount of 14.7 BCM (11.9 MAF). Keeping in view the catchment characteristics, it has been estimated that precipitation generates about 6.6 BCM (5.36 MAF) of runoff, of which about 70% directly moves to the major tributaries of Indus River and remaining evaporates or is used in the area. The floods of Northern Areas generally cause erosion of river banks due to high velocities. Valuable tracts of land with crops and orchards get washed away.

Presently, Northern Areas have nearly 5,000 small irrigation schemes which irrigate approximately 70,000 ha of land. The annual consumption of water in this area is estimated to be about 0.84 BCM (0.68 MAF). The surplus runoff thus available is over 1.16 BCM (0.94 MAF). This flow can be utilized for exploiting more than 50% of the available land potential of 60,700 ha (culturable waste) in Northern Areas by proper conservation. Surface water potential of Northern Areas is thus as follows:

		M^3	MAF
(i)	Total Potential	$2.00x10^9$	1.62
(ii)	Existing uses	$0.84x10^9$	0.68
(iii)	Balance available for development	$1.16x10^9$	0.94

Table 1.1: *Land Use Statistics of Northern Areas (000 ha)*

S.No	***Type of Land***		***Area***	***%***
1.	Mountains/Lakes/Rivers/Glaciers		4810	66
2.	Forest: a) Protected	65 (1%)	646	9
	b) Private	219 (3%)		
	c) Social Agro/Farm	362 (5%)		
	Total Forest	646 (9%)		
3.	Rangeland		1646	23
4.	Cultivated Area		58	1
5.	Cultivable Waste		90	1
Grand total			7250	100

Source: Department of Forest NAs.

Table 1.2: *Mean Monthly Temperatures in Northern Areas (°C)*

Site	*Years*	*Max/ Min.*	*JAN*	*FEB*	*MAR*	*APR*	*MAY*	*JUN*	*JUL*	*AUG*	*SEP*	*OCT*	*NOV*	*DEC*	*Extreme Daily Variation*
Chilas (1260m)	27	Min Max	0.5 12.1	3.2 14.7	8.5 19.2	13.6 25.2	18.1 31.0	24.3 37.8	27.5 39.8	26.9 38.9	22.8 35.1	14.6 28.6	6.7 20.8	1.8 13.9	-6.7 47.0
Gilgit (1490M)	30	Min Max	-2.4 9.1	0.6 12.1	5.8 17.8	10.0 23.6	12.0 28.0	15.2 34.0	19.0 35.9	18.4 35.6	13.3 31.7	7.2 26.2	1.2 17.9	-1.4 11.0	-9.5 45.4
Chitral (1500m)	20	Min Max	-0.7 8.7	0.4 9.8	4.2 14.9	8.6 21.8	12.6 27.1	18.3 34.8	20.3 36.2	19.3 35.0	13.3 31.1	7.7 25.0	3.1 18.4	-0.8 11.4	-12.3 44.8
Gupis (2144m)	26	Min Max	-4.9 4.0	-2.8 6.6	2.2 12.2	7.6 18.3	11.3 22.9	16.1 29.1	19.2 32.0	17.5 31.1	13.5 26.3	7.2 20.0	1.7 13.5	-3.0 6.0	-11.2 40.3
Astore (2148m)	25	Min Max	-7.2 2.6	-5.6 4.1	-1.2 8.4	4.0 14.8	7.3 19.6	11.6 25.2	15.0 27.3	15.1 26.9	10.6 23.8	4.5 17.1	-0.6 11.0	-4.7 4.8	-15.7 35.3
Skardu (2197m)	29	Min Max	-8.0 2.6	-5.2 5.1	1.3 11.4	6.6 17.9	9.6 21.6	13.8 28.3	16.9 31.2	16.6 31.1	12.2 26.6	5.2 20.3	-1.6 11.7	-5.7 5.5	-18.5 40.0
Karimabad (2405m)	7	Min Max	-4.0 2.1	-2.6 4.3	2.4 9.0	7.2 16.1	10.6 20.2	13.9 25.8	16.4 28.5	17.2 29.4	11.5 23.8	7.7 18.1	2.6 10.7	-1.8 4.3	-6.7 37.8
Yasin (2450m)	3	Min Max	-9.7 -0.2	-7.4 2.4	-1.6 8.3	4.2 13.6	7.9 20.3	9.5 24.7	11.4 26.4	12.1 30.1	7.1 22.1	2.6 16.4	-1.9 9.8	-6.6 2.7	-15.0 36.0
Naltar (2880)	2	Min Max	-0.7 -2.8	-9.4 -1.4	-4.7 4.0	0.7 9.5	4.1 14.0	8.7 21.0	9.6 27.3	12.1 23.9	9.6 19.8	2.6 14.0	-0.4 7.0	-6.1 1.7	-15.6 32.12
Babusar (3003m)	2	Min Max	-14.7 -1.6	-10.6 -1.8	-3.0 6.0	3.6 12.6	(6.5) (15.1)	10.7 20.1	14.5 25.4	13.4 23.9	9.4 19.1	0.4 10.1	-5.4 3.4	-12.6 -4.3	- -
Misghar (3088m)	17	Min Max	-13.2 -1.1	-9.7 1.7	-5.4 7.2	-0.2 12.3	3.4 16.3	8.0 21.2	11.1 24.6	11.6 25.2	6.6 20.8	-0.1 14.0	-5.8 6.9	-10.6 0.5	-18.9 32.8

Source: Northern Areas Regional Development Plan, WAPDA, 1990

Table 1.3: *Mean Monthly Precipitation in Northern Areas (mm)*

Station			***Altitude(m)***	***JAN***	***FEB***	***MAR***	***APR***	***MAY***	***JUN***	***JUL***	***AUG***	***SEP***	***OCT***	***NOV***	***DEC***	***TOTAL***
MD	Chilas	(27)	1260	8.5	14.9	36.5	40.2	26.4	6.6	7.7	11.1	2.6	1.2	4.0	5.4	165.1
MD	Gilgit	(30)	1490	4.4	6.3	15.0	28.3	27.4	6.3	15.0	14.4	6.8	6.8	2.1	3.4	131.7
MD	Chitral	(20)	1500	35.7	66.4	107.7	95.4	48.3	3.1	7.0	5.0	9.1	15.1	19.0	31.0	442.9
MD	Gupis	(26)	2144	4.7	8.4	10.4	22.1	32.8	9.0	9.3	15.7	7.6	6.3	1.7	5.4	133.4
MD	Astor	(24)	2148	37.9	52.0	92.9	90.3	76.0	20.0	20.4	25.3	18.5	33.4	15.6	19.4	501.8
MD	Skardu	(29)	2197	20.7	23.6	40.1	26.1	29.2	7.3	12.2	11.6	6.2	7.9	5.4	11.9	202.2
W	Karimabad	(9)	2405	4.2	4.3	7.0	21.6	23.2	13.3	21.7	26.5	13.7	4.6	1.1	3.7	145.1
FAC	Yasin	(3)	2450	6.4	0	28.0	15.6	25.4	2.6	10.9	6.7	18.6	6.3	2.9	2.6	126.0
W	Naltar	(2)	2880	11.5	15.5	63.8	65.2	93.0	23.0	13.5	69.8	43.2	2.5	3.8	6.1	410.9
*(MD)	Babusar	(1)	3003	21.0	37.1	23.1	76.4	27.9	34.8	25.1	39.9	42.4	10.7	9.1	47.7	395.3
*(MD)	Misghar	(17)	3088	6.2	6.8	13.7	18.7	25.3	4.7	10.1	10.6	6.8	6.6	5.1	14.1	128.7

Source: Northern Areas Regional Development Plan, WAPDA, 1990

Note: - MD = Meteorological Department, Lahore (*in brackets – Station now not operational)
- W = WAPDA, Lahore
- Bracketed figures equal number of years of records.

Table 1.4: *Sunshine Hours*

	JAN	***FEB***	***MAR***	***APR***	***MAY***	***JUN***	***JUL***	***AUG***	***SEP***	***OCT***	***NOV***	***DEC***
Maximum Possible day (36°N)	10.1	11.9	11.9	13.1	14.0	14.5	14.3	13.5	12.4	11.3	10.3	9.8
Chilas (%)	30	36	46	51	58	70	59	62	65	66	59	39
Gilgit (%)	29	36	45	50	57	69	59	62	64	65	58	38
Gupis (%)	30	36	47	54	60	69	58	62	65	66	61	38
Astor (%)	20	27	34	46	57	69	56	59	63	62	58	31
Skardu (%)	31	37	49	58	62	70	59	62	65	66	64	38
Yasin (%)	32	29	30	37	49	66	61	56	43	43	38	28
Yasin (hours)	100	91	111	144	211	285	266	234	160	151	117	86

Source: All data abstracted from Met. Department Lahore, except Yasin (established by the FAO Project).

Table 1.5: *Winds (Meters/Second) at 2m Height*

Site	***JAN***	***FEB***	***MAR***	***APR***	***MAY***	***JUN***	***JUL***	***AUG***	***SEP***	***OCT***	***NOV***	***DEC***
Chilas	0.2	0.5	0.7	0.8	0.7	0.8	1.2	1.1	0.9	0.5	0.2	0.2
Gilgit	0.3	0.5	0.6	0.6	0.6	0.5	0.6	0.4	0.4	0.3	0.2	0.2
Gupis	0.3	0.5	0.8	10.	1.0	1.1	1.0	0.9	0.9	0.6	0.3	0.2
Skardu	0.3	0.5	0.8	1.0	1.0	1.1	1.0	0.9	0.9	0.6	0.3	0.2
Astore	0.4	0.5	0.7	0.7	0.7	0.7	0.9	0.9	0.9	0.8	0.7	0.2
Yasin	0.6	1.1	1.3	1.3	1.2	1.1	0.9	0.8	0.7	0.7	0.8	0.9
Yasin (Km/day)	54	103	108	115	100	91	72	71	64	63	72	73

Source: Met. Dept. Lahore, except Yasin (FAO)

Table 1.6: *Statement of Existing Roads of Northern Areas*

S.No	***Name/Description of Road***	***Length (kms)***
1.	Karakoram Highway (K.K.H): i. Basha Dam site to T-junction Skardu Road	 137
	ii. T-junction Skardu Road to Gilgit Bridge.	28
	iii. Gilgit Bridge to Khunjrab Pass.	266
2.	Gilgit-Skardu Road:	
	i. T-junction Skardu Road on K.K.H. to Skardu.	170
3.	Others Raods:	
	i. Poney Traks	250
	ii. Jeepable Road	2500
	iii. Metalled Road	200
	iv. Track Road	150

Source: Northern Areas Regional Development Plan, WAPDA, 1990

Table 1.7: *Population and Intercensal Increase Since 1951*

Description	***1951***	***1961***	***1972***	***1981***	***1998***	***2001***
Population (in thousand)	254	308	417	575	900	1000
Intercensal Increase (percent)		21.45	35.27	37.82	56.52	11.11
Average Annual Growth rate (percent)		1.98	2.64	3.81	3.14	2.78

Source: Northern Areas Economic Survey, 2002.

Table 1.8: *Earthquake Data*

Date	***Latitude N°***	***Longitude E°***	***Depth (Km)***	***Magnitude (Richter Scale)***
15.11.1921	36.5	70.5	215.0	7.8
7.12.1925	37.0	76.0	-	6.0
30.5.1935	29.5	66.8	-	7.5
20.8.1936	36.5	71.0		6.3
24.9.1943	36.5	74.0	120.0	6.8
29.10.1947	36.5	70.5	230.0	7.3
4.3.1949	36.5	70.5	230.0	7.5
29.1.1965	36.6	73.6	11.0	5.7
2.2.1965	37.5	73.4	33.0	5.8
14.3.1965	36.3	70.7	219.0	6.6
10.4.1965	37.6	73.4	33.0	5.5
6.4.1966	35.0	73.0	38.0	5.1
24.4.1967	37.4	72.4	31.0	5.6
21.12.1971	35.5	74.2	25.0	5.2
27.12.1971	35.1	73.1	10.0	5.4
2.4.1972	36.1	73.6	47.0	5.9
3.9.1972	3.0	73.4	36.0	6.3
4.9.1972	35.9	73.4	33.0	5.8
27.9.1972	36.1	73.4	33.0	5.7
28.12.1974	Pattan	-	-	6.1
12.9.1981	Sazin	-	-	5.7

Source: Northern Areas Regional Development Plan, WAPDA, 1990

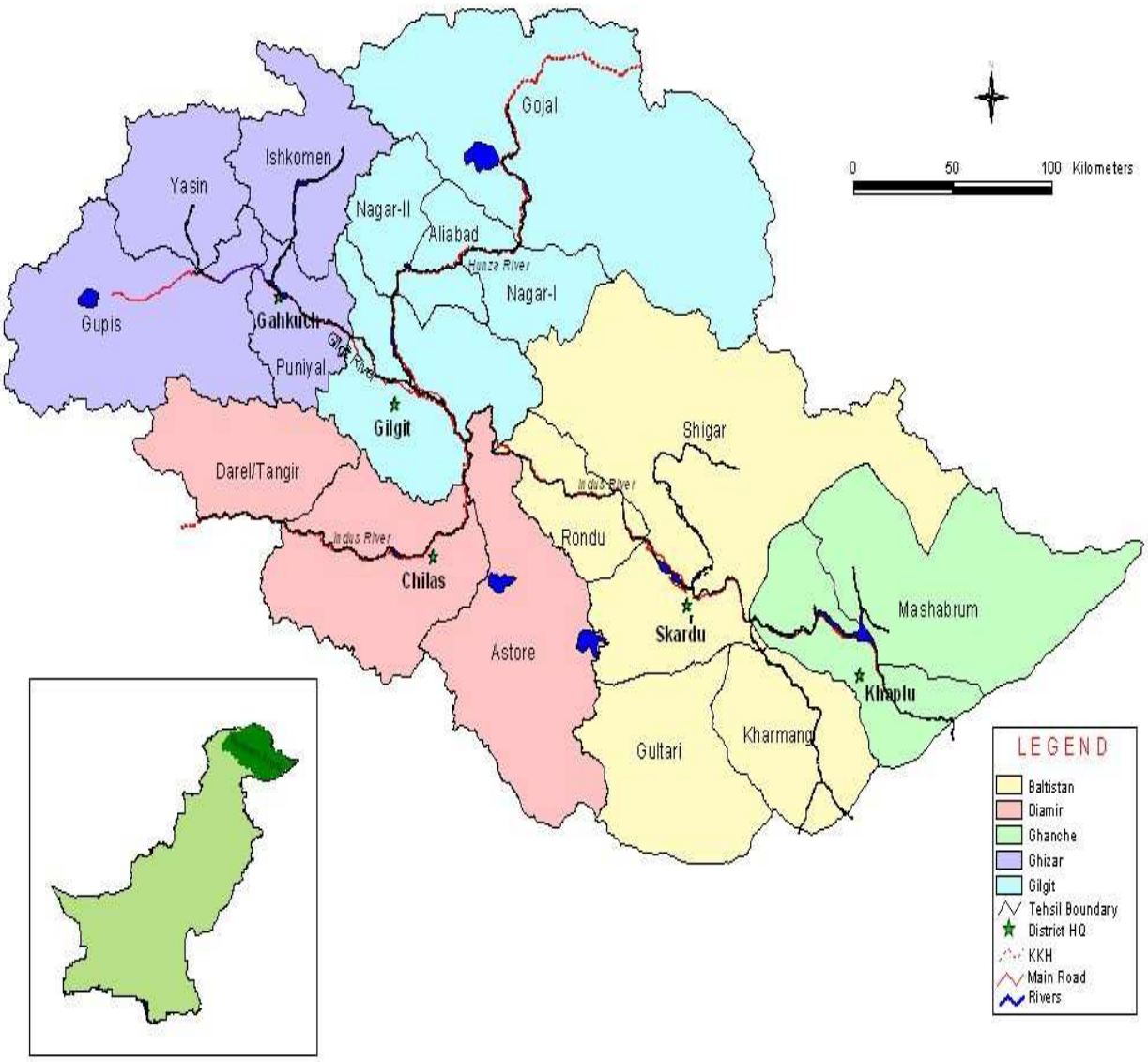


Figure 1.1: *Northern Areas Administration*

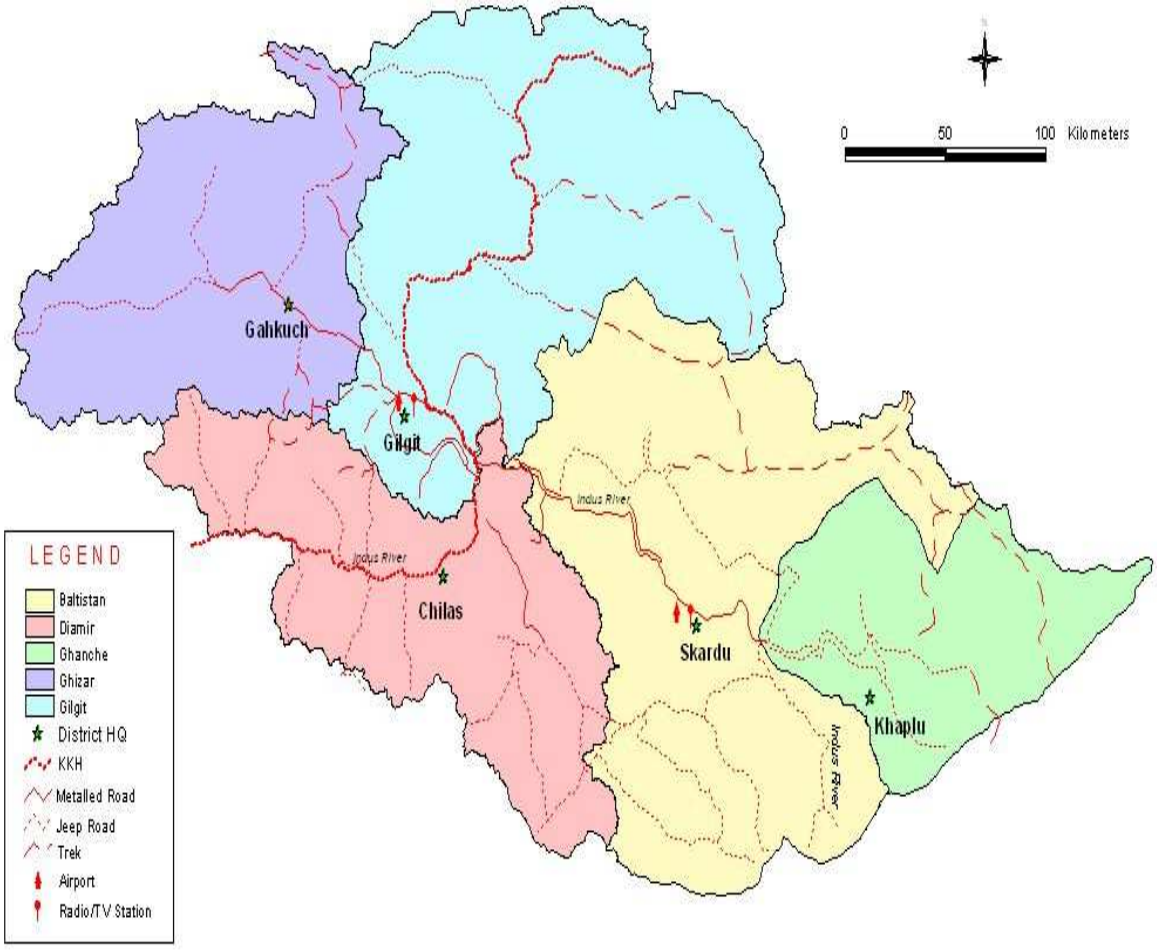


Figure 1.2: *Northern Areas Communications*

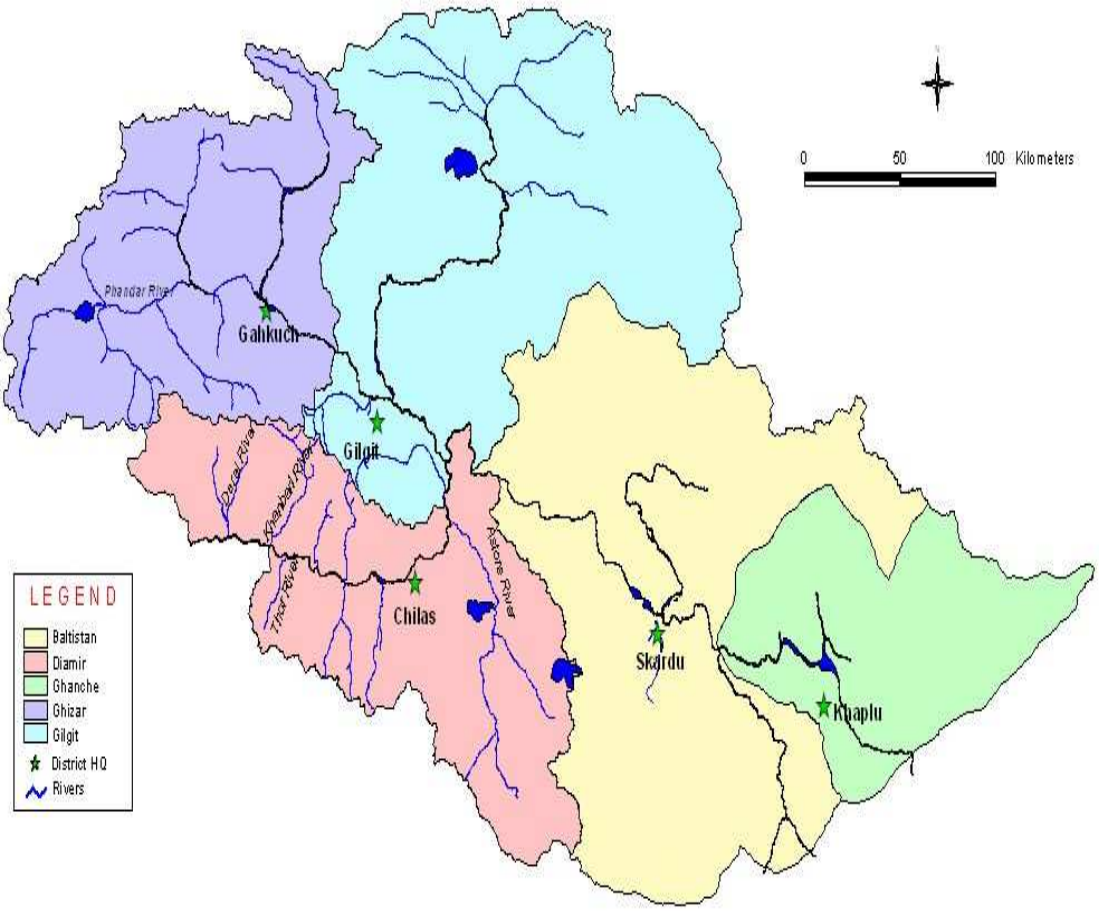


Figure 1.3: *Northern Areas Drainage*

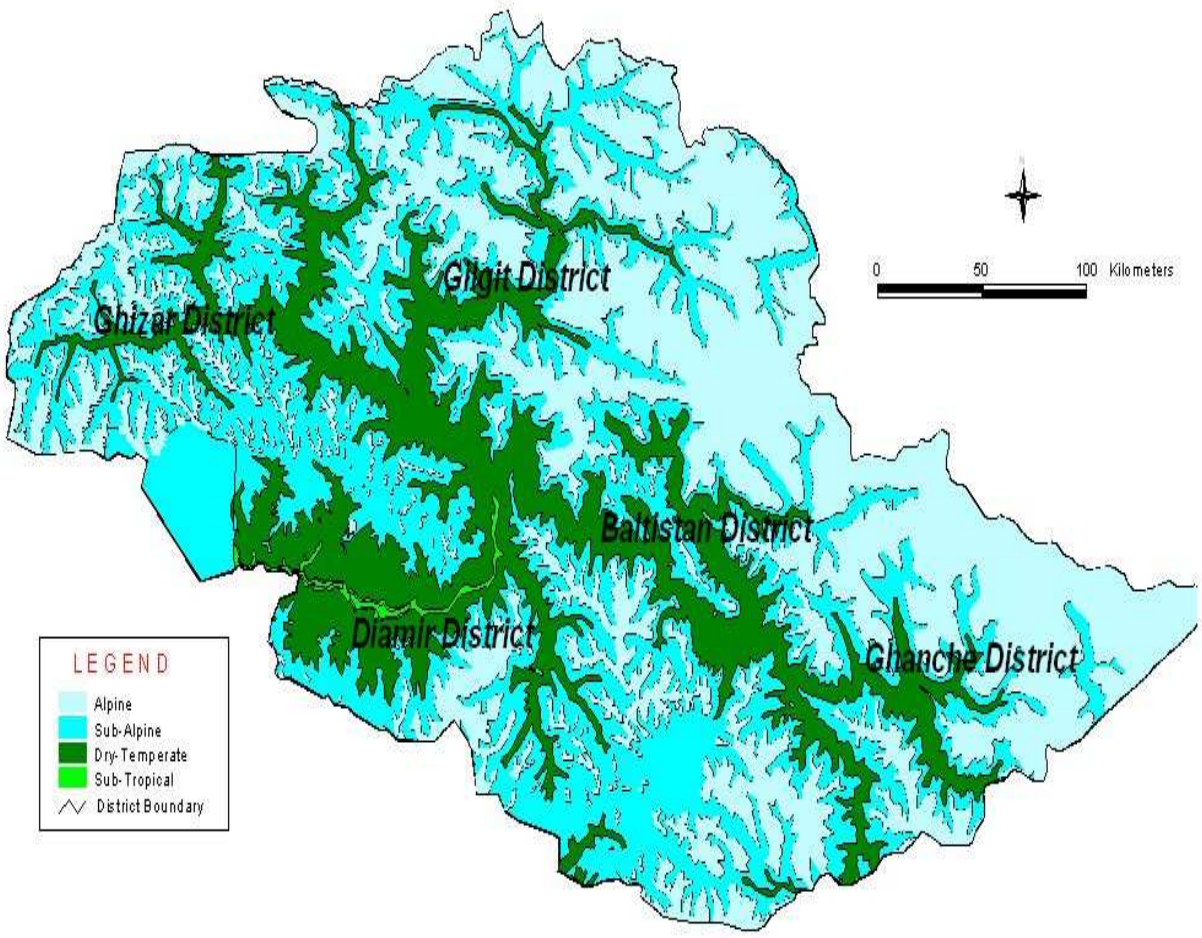


Figure 1.4: *Northern Areas Ecozones*

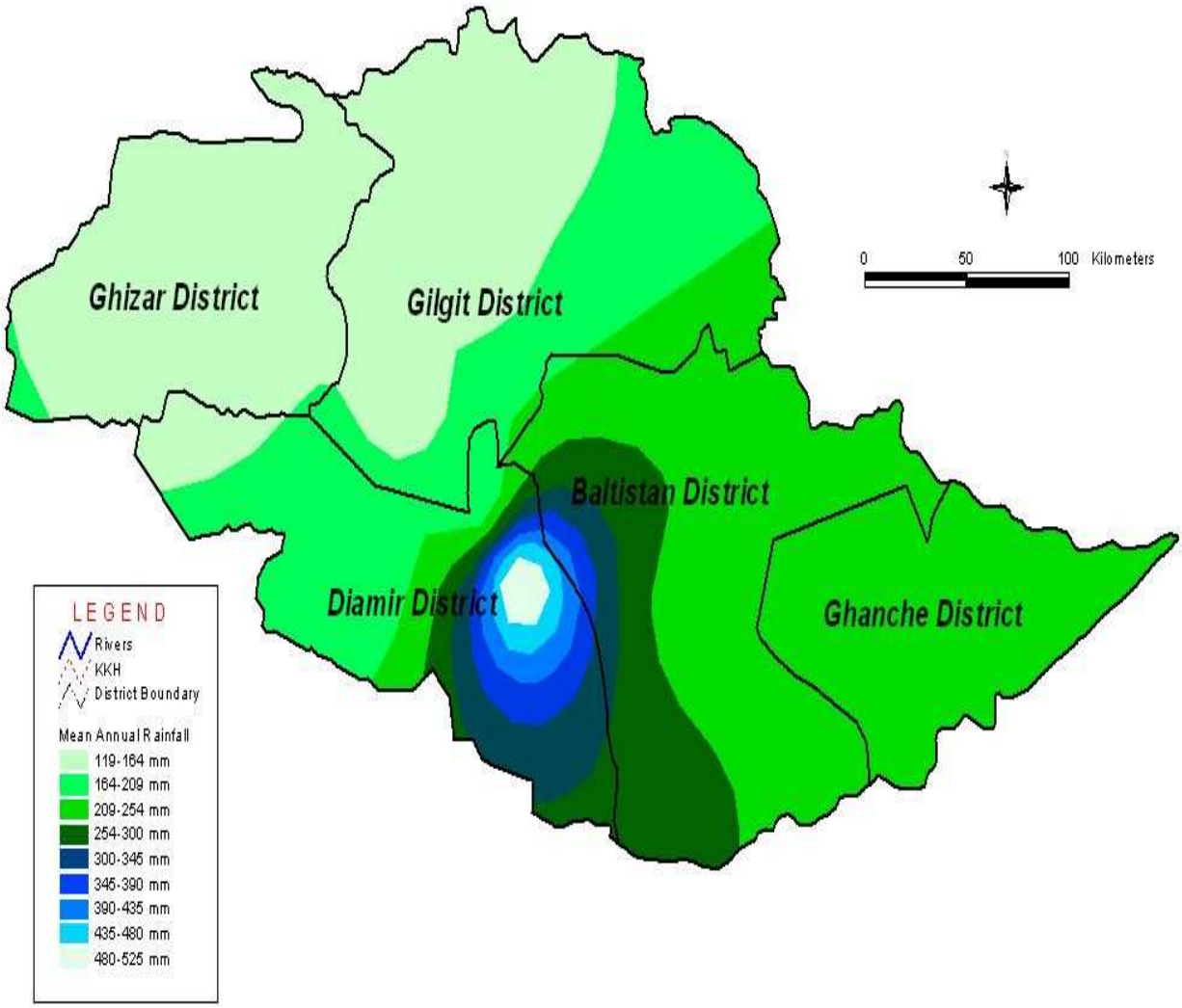


Figure 1.5: *Northern Areas Rainfall*

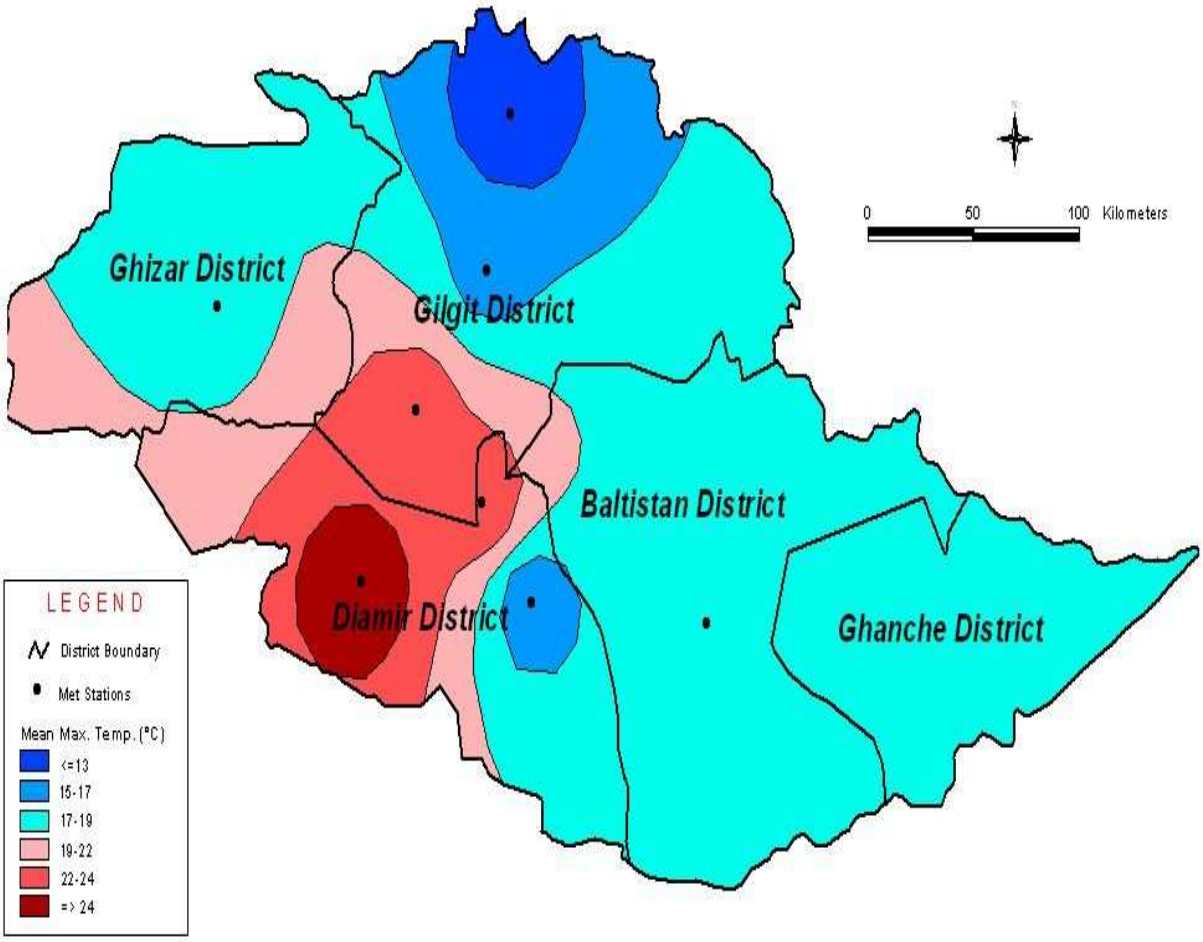


Figure 1.6: *Northern Areas Temperatures.*

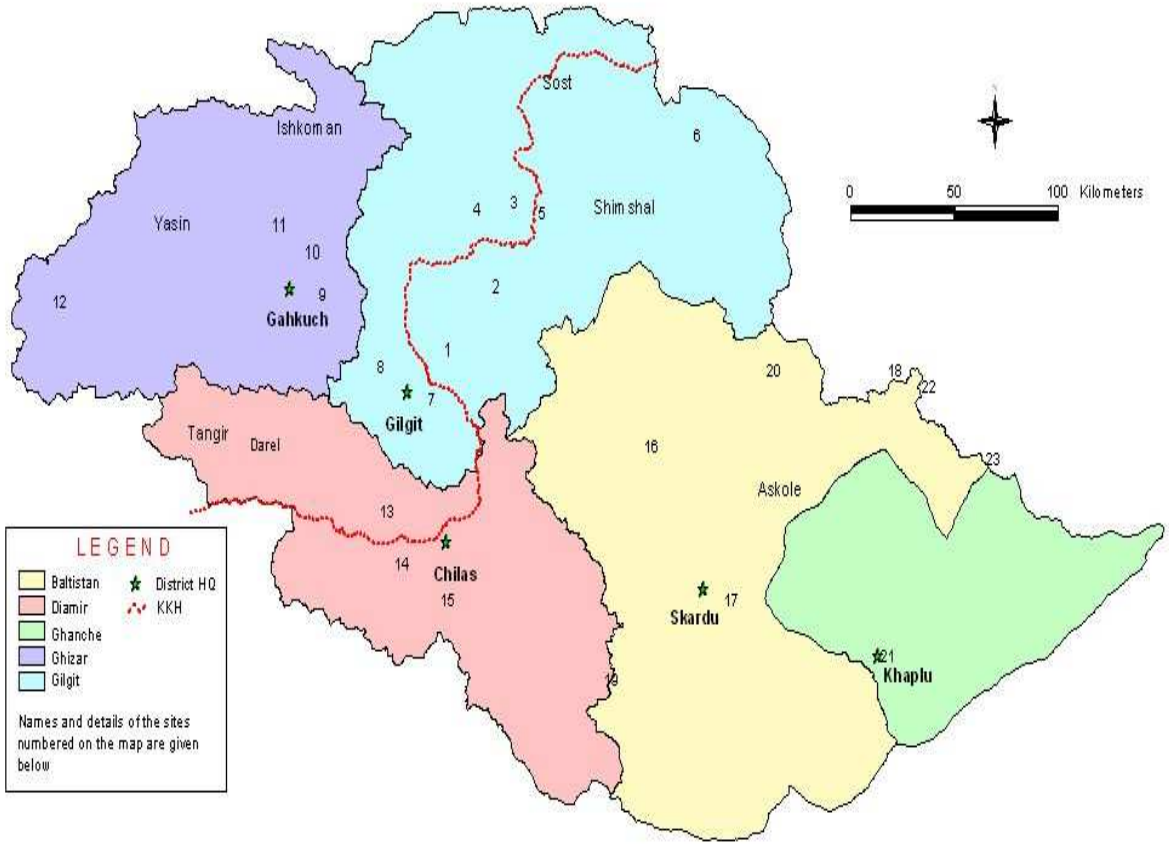


Figure 1.7: *Northern Areas Tourism*

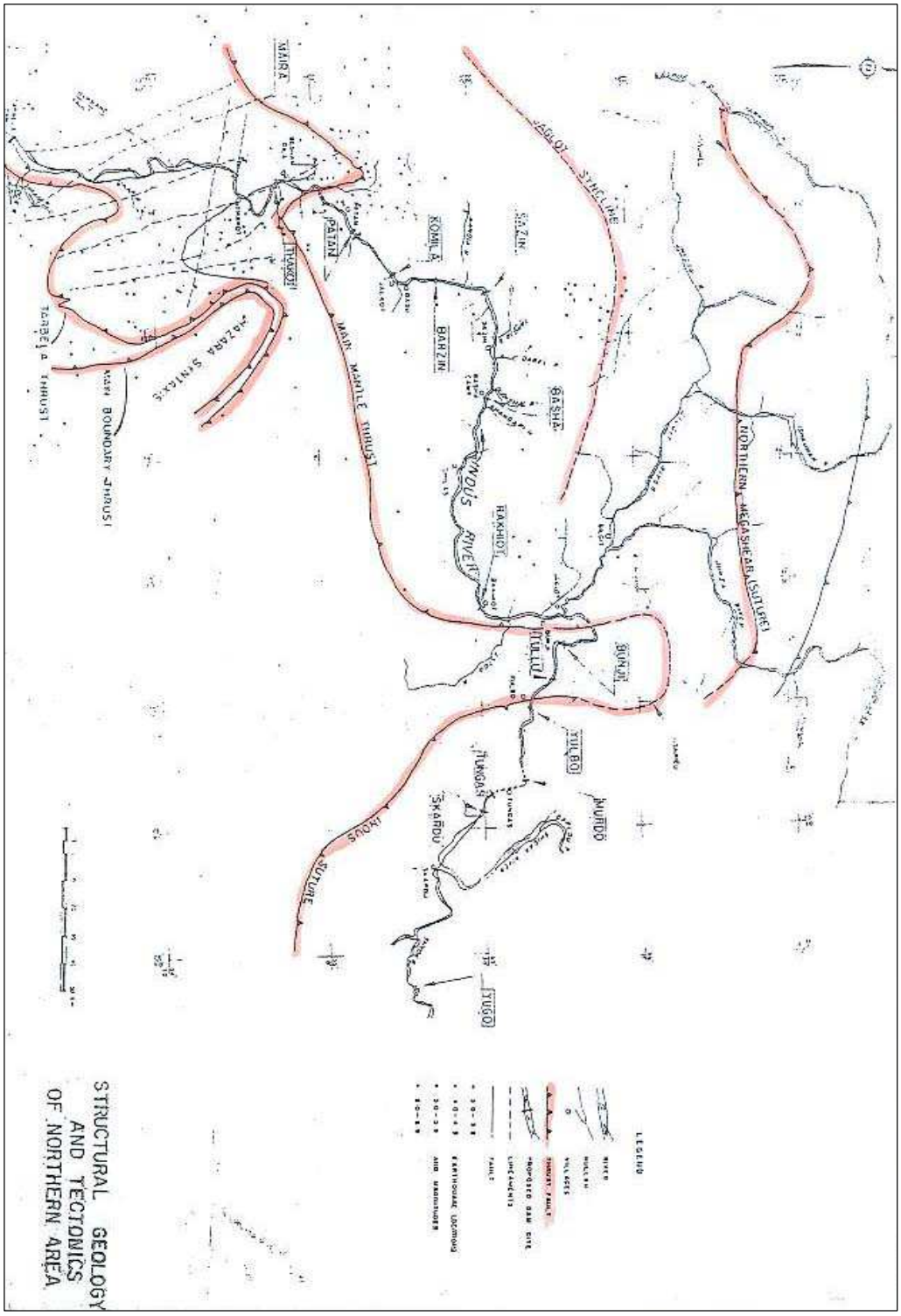
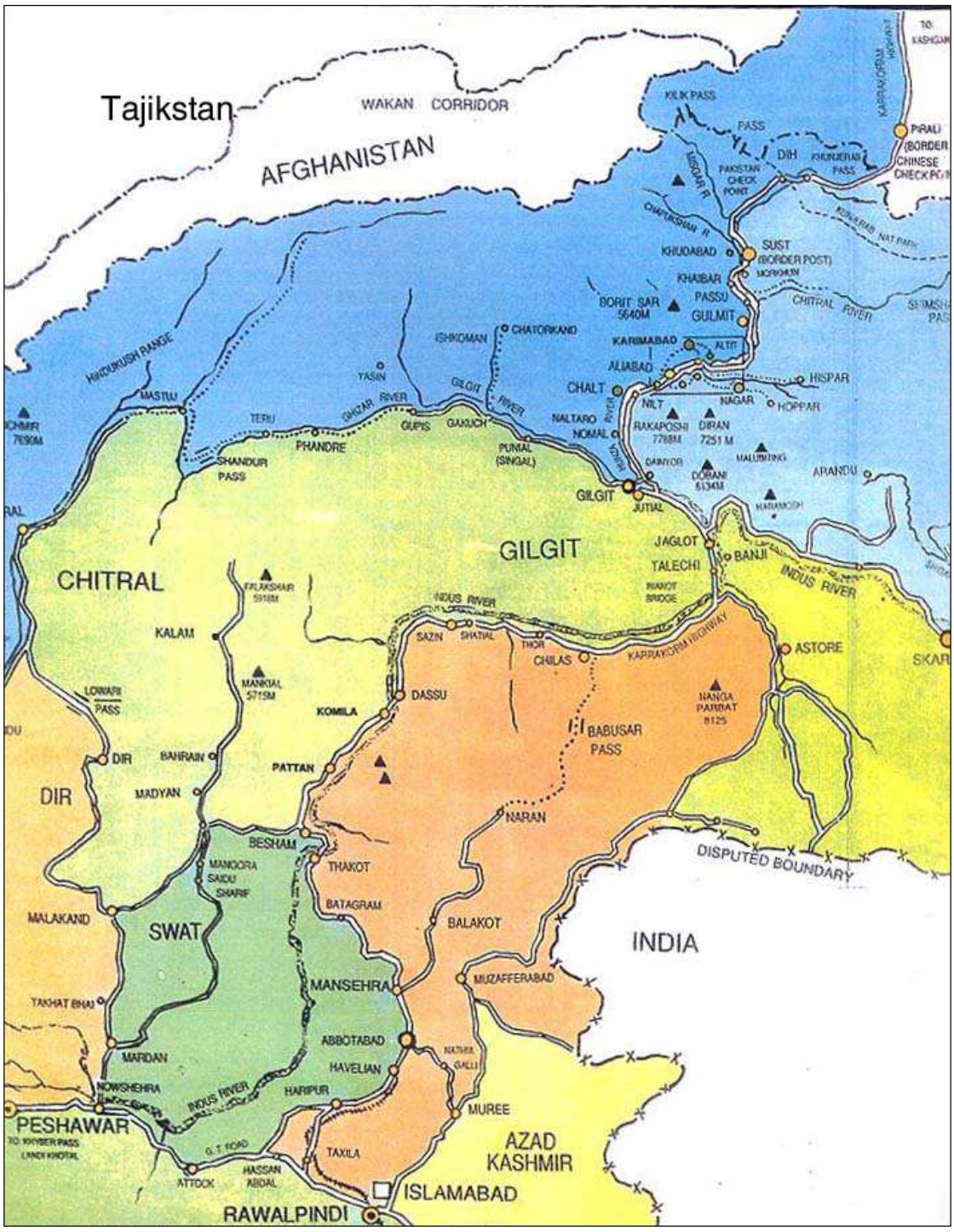


Figure 1.8: *Structural Geology and Tectonics of Northern Area*



Figurer 1.9: *Northern Areas Location Map*

CHAPTER 2

THE STUDY AREA

2.1 Location and Extent

The study area comprising valleys of Chilas, Hunza and Gakuch is located in a desolate mountainous landscape with high peaks, deep gorges, interspersed with narrow valleys. The soils formed are alluvial in nature and occur along the main rivers and the tributaries in the form of abandoned flood plains, terraces, alluvial fans and scree slope deposits. These soils are quite suitable for cropping provided irrigation water is available. Terraced fields have been built with great skill and efforts in areas, which could be irrigated from the streams coming from the side valleys. The rock fragments present in fields are collected by hand and used for the construction of field terraces. The farmers have constructed terraced fields even on very steep slopes wherever irrigation facilities could be provided.

The irrigation facilities mostly are of inundation type and consist of small channels off taking from streams and traversing several miles along the hills to supply water to few hectares of land situated mostly on terraces along river banks.

The water availability is governed by the amount and timing of snowfall. Late winter snowfall does not pack down and melts rapidly in early warm spring season causing flood, which depletes water resources for late summer irrigation. In contrast early winter snowfall followed by prolonged cool spring causes water shortage in April and May because of delayed snow melting.

2.2 Land Use / Land Cover

The land use data of the study area obtained from Soil Survey of Pakistan, Lahore and given in Table 2.1 shows that major part of the area i.e. 66.5 percent is covered by Alpine and other pastures, followed by snow being 27.4 percent; 3.6 percent is covered by forests, 1.8 percent is put to year round cropping and 0.6 percent is subject to seasonal cropping with irrigation. Maize, Wheat and Barley are the main crops grown followed by fodders. A very small area is put under vegetables, especially potatoes, oilseeds and pulses. No regular fruit orchards are grown. Fruit trees are often grown on field boundaries. Apple, Apricot, Grapes, Almond and Walnut are extensively grown in the area.

The size of the farm in the study area falls within the range of 0.40 to 10 hectares. About 99 percent of total farms are less than 5.0 hectares whereas only one percent of the farmers have more than the subsistence holding. The farms size statistics is shown in Table 2.2. The tenure position of the area is shown in the Table 2.3. Nearly 95 percent of farms are owner operated. Owner-cum-Tenants operate 4.0 percent of farm area and only 1.0 percent of cultivated land is under tenant operation.

Nearly 53 percent of farmers in the area own less than 1.0 hectare of land and support a family of about 7 to 8 members. The farmers hire local labour to develop their new land or lease out the under-developed land to other farmers in the village on mutually acceptable terms for development and exploitation. District-wise land-use in Northern Areas and District-wise land utilization statistics are shown in Table 2.4 and 2.5.

2.3 Soils

The study area is located in a desolate mountainous with high peaks and deep gorges interspersed with narrow valleys, steep slopes, bare rocks, glacial moraines, scree slopes and old river terraces are the important landscape feature of the area.In the valleys, shallow to deep stony, gravelly and/or bouldery soils are formed mainly in moraine (glacial) deposits, river terraces, alluvial fans and scree slopes deposits. Terraced fields have been built on these deposits with great skill and effort in areas which could be irrigated from the steams from the side valleys. Most of the rock fragments present in the parent material are collected by hand by the farmers and used in construction of field terraces. The farmers have constructed terraced fields even on very steep slope wherever irrigation facilities could be provided.

Generally, the hill slopes are bare without any soil cover. In cracks and crevices of rocks, often shallow soils are found or where rock scree had been deposited. Bushes and grasses grow on these soils which provide green fodder for grazing animals. These soils are formed into excellent terraces and have also stones which come from parent material. The soils are loams and sandy loams and are calcareous in nature. The soils forms are alluvial in nature and occur along the Hunza and Gilgit Rivers in the form of patches of small areas. The soil is extremely deficient in organic matter, nitrogen, phosphorus and sulphur. When the local farmers were interviewed during survey of the area it was observed that they are accustomed to manure wheat and maize with farm yard manure regularly and therefore deficiency of phosphorus and sulphur is made up.

2.4 Agriculture

Agriculture of any particular area is mainly dependent on land and water resources, climate (temperature and precipitation) and socio-economic conditions of the farmers of that area. Soil genesis, soil series, soil depth, soil type, land class and the land capability etc., are such factors which determine the most appropriate and economical use of the land resources for agriculture. Among the climatic factors, temperature is the one, which cannot be changed except in green-house technology which is highly expensive) and has a direct bearing upon the agriculture of the region. Precipitation can possibly be supplemented through artificial irrigation, wherever possible. Similarly, the socio-economic conditions of the farming community can be influenced favourably through teaching, persuasion, incentives, subsidies, grants and the development of infrastructure etc.

Table 2.1: *Distribution of Land Use in Study Area*

Category		***Area***		
		Hectares '000'	*Acres '000'*	*Percent*
1.	Cultivated Area:			
	i. Year-round cropping	52.7	130.2	1.8
	ii. Seasonal Cropping	18.6	46.0	0.6
2.	Pastures	1978.1	4886.0	66.5
3.	Forests	106.6	263.3	3.6
4.	Snow	815.4	2014.1	27.4
5.	Urban Area	1.7	4.2	0.1
	Total:	2973.1	7343.8	100.0

Source: Agriculture Census, Directorate of Agriculture, Northern Areas, 2000.

Table 2.2: *Number of Farms and Farm Area by Farm Size*

Farm Size (ha)	*Average Farm Size (ha)*	
	Farm Area	*Cultivated Area*
Under 0.4	0.24	0.20
0.4 to under 1	0.65	0.53
1 to under 2	1.34	0.90
2.0 to under 3.0	2.27	1.42
3.0 to under 5.0	3.56	2.15
5.0 to under 10.0	6.03	3.16
10.0 to under 20.0	12.75	7.70
20.0 and above	20.25	11.94

Source: Agriculture Census, Directorate of Agriculture, Northern Areas, 2000.

Table 2.3: Land Tenure

Type	***Percent***
Owner Cultivated	95
Owner-cum-Tenants	4
Tenants	1
Total	100

Source: Agriculture Census, Directorate of Agriculture, Northern Areas, 2000.

Table 2.4*: District-wise land use in Northern Areas (ha)*

S.No	*District*	*Farm (Nos)*	*Farm Area (ha)*	*Cultivated Land (ha)*	*Cultivable Waste*	*Forests*	*Total*
1.	Gilgit	17573	21624	11900	18073	17028	35101
2.	Ghizer	11302	15223	7800	7896	7740	15636
3.	Diamer	16008	13583	14900	32000	249784 (218784 Private)	281744
4.	Skardu	22746	22127	15200	20859	9288	30147
5.	Ghanche	11351	25557	7900	11636	100	11736
Grand Total		78980	98114	57700	90464	283900	374364

Source: Agriculture Census, Directorate of Agriculture, Northern Areas, 2000.

Table 2.5:*District-wise Land Utilization Statistics (ha)*

S. No	***District***	***Cultivated Area***	***Cultivable Area***	***Cereal***	***Potato***	***Other Vege.***	***Fodders***	***Fruits***	***Total***
1.	Gilgit	11900	18073	10821	574	634	3679	1399	17107
2.	Ghizer	7800	7896	7000	93	376	2529	2230	12220
3.	Skardu	15200	20859	10713	521	582	3533	1400	16749
4.	Gahkuch	7900	11636	6089	525	425	3394	1100	11533
5.	Diamer	14900	32000	11202	520	530	3133	900	16285

Grand Total	57700	90464	45825	2233	2547	16268	7029	73902

Source: Agriculture Census, Directorate of Agriculture, Northern Areas, 2000.

CHAPTER 3

THE STUDY DETAILS

3.1 Scope and Objectives of Study

The Scope and Objectives of the study are:

(a) To document the existing irrigation practices being employed in Northern Areas;

(b) To select 45 farms (15 in each valley) in 3 valleys (Chilas, Ghakush, Hunza). Out of 15 farms, 5 will be large, 5 medium and 5 of small landholding. Detailed data on farm layout, source of irrigation water supply, quality of irrigation water, conveyance and application efficiencies, depth and quality of groundwater, soil type, organic matter in soil, infiltration rate, cropping pattern, crop yields, agriculture practices (seed bed preparation, sowing time, seed rate, etc.), quantity and frequency of fertilizer use, etc. would be collected.

(c) To suggest suitable irrigation practices for the area based on the field data collected.

3.2 Data Source

Agronomic data has been collected from Agriculture, Forest and Fisheries Departments, and Local Tehsil Offices, supplemented by field investigations. The selected farmers of the 45 surveyed schemes of the study area were the major and most important source of basic data. The secondary sources of data comprised of reports and publications of Census of Agriculture, Soil Survey of Pakistan, Pakistan Forest College and Research Institute, Peshawar and Agha Khan Rural Support Programme (AKRSP), Gilgit.

The available data of cropped area at the local Tehsil offices is not maintained properly and was incomplete in most of the cases, as settlement of Districts has not been done. The cropped area data was collected from respective Tehsil offices whereas the land use for the remaining area is only estimated. Sample survey indicated that even the local farmers are ignorant about the exact area owned by them or their cropped area and the survey party had to estimate this by interviewing a number of farmers of the surveyed schemes.

3.3 Selection of Farms / Sampling

As per Terms of Reference of the study, 45 farms in all, 15 each in Chilas, Gakuch and Hunza valleys were selected for data collection purposes. Out of 15 farms, 5 are large, 5 medium and 5 having small landholdings.

The farm size statistics in the study area indicates that the size of the farms range from 0.40 to 10 hectares, however about 99% of total farms are less than 5.0 hectares. Therefore, the following criteria have been adopted for classification of farms:

Farm Size	Category
Up to 0.4 hectare	Small
0.4 to 1.0 hectare	Medium

Greater than 1.0 hectare	Large

Since the farms are located in pockets in scattered remote areas, an effort has been made to select 3 to 5 farms in close vicinity to a nearby village so as to have easy access to the owners of the farms and collect relevant data from the field and interview the owners. A comprehensive Data Collection Form was designed for collection of data on each farm. A specimen of Data Collection Farm is available as Annexure I of the Report.

3.4 **Methodology**

Three field teams, one for each valley, comprising 2 members, one sub-engineer and one agricultural field assistant were constituted and one team was sent to each valley to collect farm data. The data collected comprises location of farm, approach, type of terrain, elevation, method of cultivation, total area of farm, cultivated area, uncultivated area, type of soil, type of crops grown, cropping pattern and intensities, crops yields, inputs (fertilizers, pesticides, insecticides) used, orchards/ type of trees on the farm, livestock inventory, average farm production, socio-economic aspects of the farm owner (size of family, educational level, sources of income, machinery & equipment, farm production disposal, etc.), and the irrigation and agronomic practices being used by the farmers. The irrigation data collected included source of irrigation water, flow discharge & duration, conveyance losses, application losses, irrigation efficiencies, water requirement versus availability, O & M practices, etc.

3.5 **Measurement of Flows & Losses**:

The discharge data of water channels/"Kuls" was obtained using flumes and flow meters. Water losses data was obtained using ponding and recession rate method. Average loss rate in liters/sec in 100 meters of water course over a period of 16 hours was obtained in each of the three valleys in the study area. Detailed measurements were conducted on straight channel sections under conditions of steady state flow. These losses generally account for seepage and evaporation. Losses at junctions, dead storage losses in the watercourse, and losses involved in wetting dry banks, etc. are over and above the losses considered in the study.

3.6 **Water Quality Assessment**:

The major source of irrigation in the study area is water of the rivers/tributaries drawn through "kuls" or water channels. The quality of surface waters is generally good in terms of salinity and for agriculture use. The soluble salts concentration is high in winter and low during high flow periods in summer. The data available locally from Agriculture Department and PARC as well as WAPDA was relied upon. However, random sampling for water quality was also done at few sites. The salinity of surface water ranged from 150 to 400 ppm and the water was found of good quality. Since groundwater is not being used for irrigation in the study area, this aspect was not looked into.

3.7 **Data Collection Sheets**

The data obtained from the field is enclosed in the ensuing pages.

Impact Evaluation of Existing Irrigation and Agronomic Practices on Irrigation Efficiency and Crop Yields in Northern Areas of Pakistan

DATA COLLECTION DETAILS

Gahkuch
(Name of Valley)

Gahkuch
(Name of Village)

Gilgit River Sub-Basin
(Name of River Basin/Sub Basin)

A. Sample Size and Category of Farm

No. of Farms	=	4
Total Area	=	3.1 hectares (7.6 acres)
Farm Category	=	Large/Medium/Small

B. General Description of Area

1.	Location:	Situated at 71 kms towards west of Gilgit city on the right bank of Gilgit River
2.	Approach:	One Km along metalled road from Gilgit city, then 70 Kms on a narrow metalled road along the right bank of Gilgit River looking downstream.
3.	Type of Terrain:	Sharp Slope
4.	Elevation:	2500 m
5.	Name of Village	Gahkuch
	a) Population	4500
	b) Total Area	777 hectares (1920 acres)
	c) Cultivated Area	550 hectares (1360 acres)

C. Agricultural Data

1.	Total Area of farms:	3.1 hectares (7.6 acres)
2.	Cultivated Area:	3.0 hectares (7.4 acres)
3.	Uncultivated Area:	0.08 hectare (0.2 acres)
	i) Cultivatable Area:	0.08 hectare (0.2 acres)
	ii) Non-Cultivatable Area:	-
4.	Type of Soil:	Loamy
5.	Crops grown:	Wheat, Maize, Fodder, Vegetables, Lucern and Fruits.
6.	Cropping Pattern and Intensities:	

Crops	Area (hectares)

a)	Rabi	Wheat	1.1
		Fodder	0.2
		Vegetables	0.2
		Subtotal:	1.5
b)	Kharif	Maize	1.22
		Vegetables	0.2
		Subtotal:	1.42
c)	Perennial	Lucern	0.08
		Grand Total:	3.0

d) Rabi Intensity 50 %
e) Kharif Intensity 48 %
f) Annual Intensity 98 %

7. Crop Yields:

Major Crop		Area (hectares)	Total Production (kg)	Av. Yield (kg/hectare)
i)	Wheat	1.09	1550	1418
ii)	Maize	1.21	2500	2058

8. Input used:

i) Fertilizers: Nitrophos @ 2.5-3.70 kg/hectare
ii) Pesticides Nil
iii) Insecticides: Nil

. Orchards

Type of Trees		Number of Trees
i)	Apple	6
ii)	Apricot	27
iii)	Almond	27
iv)	Ber	5
v)	Grapes	15
vi)	Peach	16
vii)	Walnut	11

10. Livestock Inventory

Bullocks	6
Cows	15
Sheep	9
Goats	3

11. Forest/Fisheries Nil

D. Socio Economic Aspects of the Farm Owner

1. Size of Family: 5 to 8 persons
2. Literacy Level: 35 %
3. Sources of Income: Agriculture
4. Method of Cultivation. Manual
5. Machinery & Equipment: Nil

6.	Disposal of Farm Production:	Difficult, being far from main city.

E. Irrigation & Agronomic Practices:

1	Feeding Channel	Gahkuch Gah
2.	Source of Water	Snow-melt and Spring
3.	Discharge and Duration	Gahkuch Gah is a seasonal Gah which remains almost dry during March-April, From June to April; discharge gradually increases and reaches maximum value of 30 cusecs.
4.	Distribution System	3 kuls of 14.16 lps each offtake from right side of Gahkuch Gah at different altitudes and supply irrigation water to the lands of Gahkuch Bala. Also there is a spring near Gahkuch Pain from which 3 No. minor kuls irrigate lands of Gakuch Pain.
5.	Conveyance Efficiency	50-60 %
6.	Application Efficiency	90 %
7.	Irrigation Efficiency	54 %
8.	Requirements Versus Availability of Water:	About 283 – 340 lps water is required to meet irrigation and domestic requirements of Gahkuch and Aish villages. Avg. shortage of water is 30 %.
9.	O& M of Irrigation Channel/System	Nominal, on self-help basis
10.	Ground Water	N.A.
11.	Existing Agronomic Practices	Primitive; Resource Conservation Technologies (RCTs) not being applied

F. Conclusion

The present cropping intensities of the village are poor because of inadequate irrigation supplies. About 81 hectares (200 acres) of cultivable land is lying barren in the village. The existing yields are low and can be increased by using additional inputs. Potatoes are damaged by Potato mildew. Local poor farmers are not in a position to purchase costly insecticides from the market. The area is very suitable for growing orchards.

Impact Evaluation of Existing Irrigation and Agronomic Practices on Irrigation Efficiency and Crop Yields in Northern Areas of Pakistan

Data Collection Details

Hunza
(Name of Valley)

Danyor
(Name of Village)

Gilgit River Sub-Basin
(Name of River Basin/Sub Basin)

A. Sample Size and Category of Farm

No. of Farms	=	8
Total Area	=	10.32 hectares (25.50 acres)
Farm Category	=	Large/Medium/Small

B. General Description of Area

1.	Location:	Situated on Karakoram Highway at about 11 kilometers towards north east of Gilgit city near the confluence of Hunza and Gilgit River
2.	Approach:	Ten kilometers along Pacca road from Gilgit city to China bridge on Gilgit River and then about one kilometer along Karakoram Highway.
3.	Type of Terrain:	Mild Slope
4.	Elevation:	1500 Meters
5.	Name of Village	Danyor
	a) Population	10,000
	b) Total Area	915 hectares (2260 acres)
	c) Cultivated Area	798 hectares (1970 acres)

C. Agricultural Data

1.	Total Area of farms:	10.32 hectares (25.50 acres)
2.	Cultivated Area:	9.11 hectares (43.0 acres)
3.	Uncultivated Area:	NIL
	i) Cultivatable Area:	N.A
	ii) Non-Cultivatable Area	N.A
4.	Type of Soil:	Loamy
5.	Crops grown:	Wheat, Maize, Fodder, Vegetables and Fruits

6. Cropping Pattern and Intensities:

	Crops	Area (ha)
a) Rabi	Wheat	8.10
	Shaftal	0.81
	Vegetable	0.20
	Subtotal:	9.11
b) Kharif	Maize	6.68
	Vegetable	0.40
	Subtotal:	7.08
c) Perennial	Orchard	1.21
	Subtotal:	1.21
	Grand Total	17.41

d) Rabi Intensity 100.0 %
e) Kharif Intensity 78 %
f) Annual Intensity 178 %

7. Crop Yields:

Major Crops	Area (hectares)	Total Production (kg)	Avg. Yield (kg/hectare)
i) Wheat	8.10	12300	1519
ii) Maize	6.68	13500	2021

8. Input used:
   i) Fertilizers: Urea / Ammonium Sulphate = 1.25 bags/hectare
   ii) Pesticides: Nitrophos + DAP= 2.5 bags/hectare
   iii) Insecticides: NIL
   NIL

9. Orchards

Type of Trees	Number of Trees
i) Apple	65
ii) Apricot	149
iii) Almond	43
iv) Cherry	26
v) Grape	39
vi) Toot	83
vii) Peach	54
viii) Walnut	12

10. Livestock Inventory

Bullocks	4
Cows	60
Sheep	44
Goats	47

11.	Forest/Fisheries	Nil

D. Socio Economic Aspects of the Farm Owner

1.	Size of Family:	8-10 persons
2.	Literacy Level:	40%
3.	Sources of Income:	Agriculture + Jobs
4.	Method of Cultivation.	Mechanized
5.	Machinery & Equipment:	Tractor/Trolleys available on rental basis.
6.	Disposal of Farm Production:	Through trolleys and pick-ups to Gilgit city.

E. Irrigation & Agronomic Practices:

1	Feeding Channel	Manugah
2.	Source of Water	Snow-Melt and Spring Water
3.	Discharge and Duration	Minimum discharge available throughout the year is about 708 lps whereas maximum discharge varies up to 2125 lps during different months of the year. Flood discharge in the rainy season is also available which is about 42480 lps.
4.	Distribution System	From the left bank of the Manugah two kuls (watercourses) having 283 lps discharge each are offtaking, with one at high elevation while the other at low elevation and both are feeding the Danyor Village. Similarly two kuls having about 14 lps discharge capacity each are offtaking from the right side of the nullah which are feeding the nearby village Sultanabad for irrigation and drinking purposes.
5.	Conveyance Efficiency	55 %
6.	Application Efficiency	90 %
7.	Irrigation Efficiency	50 %
8.	Requirements Versus Availability of Water:	Water requirement of the village is about 348 – 566 lps which is adequately being fulfilled from the existing source.
9.	O& M of Irrigation Channel/System	Through self-help basis.
10.	Ground Water	N.A.
11.	Existing Agronomic Practices	Primitive

F. Conclusion

Since the cropping intensities have already reached the maximum level, therefore there is a little chance for its further improvement. The village is surplus in food grains because of the fact that its major part is under food crops while its population is comparatively less. The present crop yields which are low, can however be increased if improved agricultural practices are adopted and additional inputs are used.

The area is very suitable for growing orchards. The main fruits grown are apricot,

apple, almond, cherry, grapes, mulberry (toot), peaches and walnuts.

Impact Evaluation of Existing Irrigation and Agronomic Practices on Irrigation Efficiency and Crop Yields in Northern Areas of Pakistan

DATA COLLECTION DETAILS

Hunza
(Name of Valley)

Barmas
(Name of Village)

Gilgit River Sub-Basin
(Name of River Basin/Sub Basin)

A. Sample Size and Category of Farm

No. of Farms	=	6
Total Area	=	2.23 hectares (5.50 acres)
Farm Category	=	Large√/Medium/Small

B. General Description of Area

1.	Location:	Situated at 3 kilometers towards west of Gilgit city, at the foothill of the mountain.
2.	Approach:	It is linked with Gilgit city by a metalled road.
3.	Type of Terrain:	Sharp Slope
4.	Elevation:	1483 meters
5.	Name of Village	Barmas
	a) Population	5000
	b) Total Area	187 hectares (461 acres)
	c) Cultivated Area	104.5 hectares (258 acres)

C. Agricultural Data

1.	Total Area of farms:	2.23 hectares (5.50 acres)
2.	Cultivated Area:	2.23 hectares (5.50 acres)
3.	Uncultivated Area:	Nil
	i) Cultivatable Area:	
	ii) Non-Cultivatable Area:	-
4.	Type of Soil:	Loamy Soil
5.	Crops grown:	Wheat, Maize, Fodder and Fruits

6. Cropping Pattern and Intensities:

	Crops	Area (hectares)
a) Rabi	Wheat	2.02
	Shaftal	0.20
	Subtotal:	2.23
b) Kharif	Maize	2.23
	Subtotal:	2.23
c) Perennial	Orchards	0.20
	Subtotal:	0.20
	Total	4.66
d) Rabi Intensity		114 %
e) Kharif Intensity		114 %
f) Annual Intensity		228 %

7. Crop Yields:

Major Crops		Area (hectares)	Total Production (kg)	Av. Yield (kg/hectare)
i)	Wheat	2.02	2650	1309
ii)	Maize	2.23	4200	1877

8. Input used:

i)	Fertilizers:	Urea @ 2.5 bags/hectare Nitrophos @ 2.5 bags/hectare
ii)	Pesticides:	Nil
iii)	Insecticides:	Nil

9. Orchards

Type of Trees		Number of Trees
i)	Apple	2
ii)	Apricot	9
iii)	Almond	5
iv)	Fig	1
v)	Grape	4
vi)	Toot	4
vii)	Pear	3
viii)	Peach	6
ix)	Pomegranate	1
x)	Walnut	2

10. Livestock Inventory

Bullocks	1

	Cows	17
	Goats	50
11.	Forest/Fisheries	Nil

D. Socio Economic Aspects of the Farm Owner

1.	Size of Family:	Avg 7 persons
2.	Literacy Level:	30 %
3.	Sources of Income:	Agriculture
4.	Method of Cultivation.	Manual
5.	Machinery & Equipment:	Nil / available on rental basis
6.	Disposal of Farm Production:	Transport is conveniently available

E. Irrigation & Agronomic Practices:

1	Feeding Channel	Barmas Gah (This channel does not feed the village for irrigation purposes).
2.	Source of Water	Seasonal rains and some snow-melt
3.	Discharge and Duration	Barmas nullah remains almost dry during the year. During rainy season some water runs into the nullah. Maximum flood discharge and snow melt is 50 cusecs which is usually available during June to August.
4.	Distribution System	The village is being irrigated from Karagh nullah through a kul having maximum discharge capacity of about 8 cusecs.
5.	Conveyance Efficiency	70 %
6.	Application Efficiency	80 %
7.	Irrigation Efficiency	56 %
8.	Requirements Versus Availability of Water:	Adequate quantity of water is available in Kargah Nullah.
9.	O& M of Irrigation Channel/System	On self-help basis
10.	Ground Water	N.A.
11.	Existing Agronomic Practices	Primitive / No RCTs.

F. Conclusion

The present cropping intensities are the maximum and cannot be increased under the present agro-climate conditions. However, the existing low yields can be improved further while adopting the improved agricultural practices.

Impact Evaluation of Existing Irrigation and Agronomic Practices on Irrigation Efficiency and Crop Yields in Northern Areas of Pakistan

DATA COLLECTION DETAILS

Chilas
(Name of Valley)

Chamograh
(Name of Village)

Gilgit River Sub-Basin
(Name of River Basin/Sub Basin)

A. Sample Size and Category of Farm

No. of Farms	=	8
Total Area	=	11.22 hectares (27.70 cares)
Farm Category	=	Large√/Medium/Small

B. General Description of Area

1. Location: Situated at 28 kilometers towards east of Gilgit city, at the foothill of the mountain along left bank of Gilgit river looking downstream near the confluence of Gilgit and Indus rivers.
2. Approach: Ten kilometers along pucca road from Gilgit city to Gilgit river bridge (China bridge); then about one kilometer along Karakoram Highway up to Danyor village where-from a Shingle jeepable road offtakes which after passing through Aushkindas and Jalalabad villages reaches Chamogarh village. This village is situated along the left bank of Gilgit River at a distance of about 17 kilometers from Karakoram Highway.
3. Type of Terrain: Sharp Slope
4. Elevation: 1304 meters
5. Name of Village: Chamograh
   a) Population: 2500
   b) Area: 430 hectares (1083 acres)
   c) Cultivated Area: 135 hectares (334 acres)

C. Agricultural Data

1. Total Area of farms: 11.22 hectares (27.70 acres)
2. Cultivated Area: 21.66 hectares (53.50 acres)

3. Uncultivated Area: 0.49 hectare (1.20 acres)
   i) Cultivatable Area: 0.49 hectare (1.20 acres)
   ii) Non-Cultivatable Area: -
4. Type of Soil: Loam
5. Crops grown: Wheat, Maize, Fodder, Vegetables, Lucern and Fruits
6. Cropping Pattern and Intensities:

	Crops	Area (hectares)
Rabi	Wheat	9.72
	Shaftal	0.61
	Vegetables	0.20
	Subtotal:	10.53
Kharif	Maize	10.53
	Vegetables	0.20
	Subtotal:	10.73
Perennial	Lucern	0.41
	Total	21.66

   d) Rabi Intensity 97 %
   e) Kharif Intensity 99 %
   f) Annual Intensity 196 %
7. Crop Yields:

Major Crops		Area (hectares)	Total Production (kg)	Av. Yield (kg/hectares)
i)	Wheat	10.53	9200	875
ii)	Maize	10.73	10500	988

8. Input used:
   i) Fertilizers: Ammonium Sulphate/Nitrate @ 2.5 bags/hectare
   Nitrophos @ 2.5 bags/hectare
   Urea @ 1.25 bags/hectare
   ii) Pesticides: Nil
   iii) Insecticides: Nil
9. Orchards

Type of Trees		Number of Trees
i)	Apple	26
ii)	Apricot	78
iii)	Almond	93
iv)	Ber	55
v)	Cherry	10
vi)	Fig	14
vii)	Grape	29
viii)	Toot	76
ix)	Pear	4
x)	Peach	17

	xi) Pomegranate	65
	xii) Walnut	8
10.	Livestock Inventory	
	Bullocks	6
	Cows	39
	Sheep	10
	Goats	53
	Donkeys	12
11.	Forest/Fisheries	Nil

D. Socio Economic Aspects of the Farm Owner

1.	Size of Family:	7-9 persons
2.	Literacy Level:	25 %
3.	Sources of Income:	Agriculture
4.	Method of Cultivation.	Manual
5.	Machinery & Equipment:	Nil
6.	Disposal of Farm Production:	Very difficult

E. Irrigation & Agronomic Practices:

1	Feeding Channel	Batkor Gah
2.	Source of Water	Spring water and snow melt
3.	Discharge and Duration	Minimum discharge available throughout the year is about 6 cusecs whereas maximum discharge varies up to 30 cusecs during different months of the year. Flood discharge in the rainy season is also available which is extremely variable.
4.	Distribution System	One kul (watercourse) having 6 cusecs discharge capacity offtakes at the upstream of Batkor nullah from its right side and supplies water to the village both for irrigation and drinking purposes.
5.	Conveyance Efficiency	80 %
6.	Application Efficiency	80 %
7.	Irrigation Efficiency	64 %
8.	Requirements Versus Availability of Water:	Average Shortage of water is 30-40 %
9.	O& M of Irrigation Channel/System	On self-help basis
10.	Ground Water	N.A.
11.	Existing Agronomic Practices	Primitive / No RCTs

F. Conclusion

The agriculture is being practiced on traditional methods which lead to low level output and yields. The average irrigation efficiency is 64%. If the entire cultivable land of the village is put under cultivation and also yields of the crops are improved by using additional inputs and modern agricultural practices, then agriculture in this area can play a

vital role in increasing the overall food production. There is a good scope for the development of orchards in the village provided marketing facilities are improved.

Impact Evaluation of Existing Irrigation and Agronomic Practices on Irrigation Efficiency and Crop Yields in Northern Areas of Pakistan

DATA COLLECTION DETAILS

Hunza
(Name of Valley)

Sinakkar
(Name of Village)

Gilgit River Sub-Basin
(Name of River Basin/Sub Basin)

A. Sample Size and Category of Farm

No. of Farms	=	7
Total Area	=	3.48 hectares (8.6 acres)
Farm Category	=	Large/Medium/Small√

B. General Description of Area

1.	Location:	Situated at 29 kilometers towards north east of Gilgit city.
2.	Approach:	Ten kilometers along metalled Gilgit Road from Gilgit city to China bridge on Gilgit river, then about one kilometer along Karakoram Highway up to Danyor village where from a single jeepable road offtakes which after passing through Danyor and Aushkindas villages is further bifurcated; out of which one goes straight to Sinakkar village while the other turns to right side and leads to Jalalabad and Chamogarh villages. The overall distance along kacha road beyond Karakoram Highway is 18 kilometers.
3.	Type of Terrain:	Sharp Slope
4.	Elevation:	1943 meters
5.	Name of Village	Sinakkar
	a) Population	1200
	b) Total Area	115.8 hectares (286 acres)
	c) Cultivated Area	45.34 hectares (112 acres)
	a. Cultivable	30.36 hectares (75 acres)
	b. Non-Cultivatable	19.84 hectares (49 acres)

C. Agricultural Data

1.	Total Area of farms:	3.48 hectares (8.6 acres)
2.	Cultivated Area:	4.96 hectares (12.25 acres)
3.	Uncultivated Area:	0.04 hectare (0.1 acres)
	i) Cultivatable Area:	0.04 hectare (0.1 acres)
	ii) Non-Cultivatable Area	Nil

4. Type of Soil: Loamy Soil
5. Crops grown: Wheat, Maize, Fodder and Vegetables
6. Cropping Pattern and Intensities:

	Crops	Area (hectares)
a) Rabi	Wheat	2.23
	Vegetable	0.20
	Subtotal:	2.43
b) Kharif	Maize	1.32
	Vegetables	0.20
	Subtotal:	1.52
c) Perennial	Lucern	0.61
	Orchard	0.40
	Subtotal:	1.01
	Total	4.96
d) Rabi Intensity		100 %
e) Kharif Intensity		72 %
f) Annual Intensity		172 %

7. Crop Yields:

Major Crops		Area (hectares)	Total Production (kg)	Av. Yield (kg/hectare)
i)	Wheat	2.23	3500	1571
ii)	Maize	1.315	2200	1680

8. Input used:
   - i) Fertilizers: Ammonium nitrate @ 2.5 bags/hectare; Nitrophos @ 0.62 bag/hectare
   - ii) Pesticides: Nil
   - iii) Insecticides: Nil
9. Orchards

Type of Trees		Number of Trees
i)	Apple	27
ii)	Apricot	165
iii)	Almond	3
iv)	Ber	8
v)	Fig	1
vi)	Grapes	58
vii)	Toot	7
viii)	Pear	7
ix)	Pomegranate	7
x)	Walnut	14

10. Livestock Inventory

Bullocks	6
Cows	17
Sheep	83
Goats	88

	Donkey	1
11.	Forest/Fisheries	Nil

D. Socio Economic Aspects of the Farm Owner

1.	Size of Family:	6-8 persons
2.	Literacy Level:	30 %
3.	Sources of Income:	Agriculture
4.	Method of Cultivation.	Manual
5.	Machinery & Equipment:	Nil
6.	Disposal of Farm Production:	Difficult due to poor means of communication

E. Irrigation & Agronomic Practices:

1	Feeding Channel	Bagrote Gah
2.	Source of Water	Snow-melt and spring
3.	Discharge and Duration	Although sufficient discharge is available in Bagrote nullah throughout the year, yet the village at present is not fed through this source of water. Minimum discharge coming to the village through the spring is about 1 cusec which is available from April to November. The supply increases during April and May which again decreases during June to November and ultimately freezes due to high altitude.
4.	Distribution System	The water coming from the spring is first of all stored in the tank from where it is distributed to the houses for drinking purposes. The surplus water is used for irrigation purposes.
5.	Conveyance Efficiency	70 %
6.	Application Efficiency	80 %
7.	Irrigation Efficiency	56 %
8.	Requirements Versus Availability of Water:	There is severe shortage of irrigation water. About 5 cusecs of water is at least required for the village both for irrigation and domestic purposes.
9.	O& M of Irrigation Channel/ System	Nominal, on self-help basis.
10.	Ground Water	N.A.
11.	Existing Agronomic Practices	Primitive; No RCTs

F Conclusion

The average irrigation efficiency on the farms is 56% with poor land and soil management. The annual cropping intensity is 172% which is satisfactory.

The village being located at high altitude has so many problems and apparently the standard of living of the villagers is very poor. If the water shortage problem of the village is solved then most of the cultivable land of the village cold be brought under cultivation and thus food shortage problem of the village would be solved and ultimately financial status of the villager would be upgraded.

The area is slightly deficit in food grains due to low yield per hectare and limited area under food crops. The present low yield can be improved by using additional inputs and adopting modern agricultural practices. The cropping pattern and intensities show that cropping intensities have reached the maximum level and cannot be increased further under

the present agro-climatic conditions. The area is very suitable for growing orchards. The main fruits of the area are apple, apricot, grapes and walnuts. Crop and fruit production can be increased further if the marketing facilities are improved. Moreover, agricultural extension services need improvement for increased crop production.

Impact Evaluation of Existing Irrigation and Agronomic Practices on Irrigation Efficiency and Crop Yields in Northern Areas of Pakistan

DATA COLLECTION DETAILS

Chilas
(Name of Valley)

Parri
(Name of Village)

Gilgit River Sub-Basin
(Name of River Basin/Sub Basin)

A. Sample Size and Category of Farm

No. of Farms	=	8
Total Area	=	7.77 hectares (19.20 acres)
Farm Category	=	Large/Medium√/Small

B. General Description of Area

1.	Location:	Situated on Karakoram Highway about 29 kilometers towards east of Gilgit City on right bank of Gilgit river looking downstream
2.	Approach:	Ten kilometers along Gilgit-Karakoram link metalled road and then 19 kilometers along main Karakoran Highway towards Chilas where the village Parri is located on both sides of the main road.
3.	Type of Terrain:	Mild Slope
4.	Elevation:	1300 meters
5.	Name of Village	Parri
	a) Population	2000
	b) Total Area	775 hectares (1913 acres)
	c) Cultivated Area	276 hectares (682 acres)
	d) Uncultivated Area	498 hectares (1231 acres)
	i. Cultivable Area	405 hectares (1000 acres)
	ii. Non-Cultivable Area	94 hectares (231 acres)

C. Agricultural Data

1.	Total Area of farms:	7.77 hectares (19.2 acres)
2.	Cultivated Area:	7.29 hectares (18.0 acres)
3.	Uncultivated Area:	0.49 hectare (1.20 acres)
	i) Cultivatable Area:	0.49 hectare (1.20 acres)
	ii) Non-Cultivatable Area:	-
4.	Type of Soil:	Loamy Soil
5.	Crops grown:	Wheat, Maize, Fodder and Vegetables

6. Cropping Pattern and Intensities:

	Crops	Area (hectares)
a) Rabi	Wheat	5.26
	Shaftal	0.51
	Vegetable	0.10
	Subtotal:	5.87
b) Kharif	Maize	5.26
	Subtotal:	5.26
c) Perennial	Lucern	2.02
	Total	13.00

d) Rabi Intensity 100 %
e) Kharif Intensity 92 %
f) Annual Intensity 192 %

7. Crop Yields:

Major Crops		Area (hectares)	Total Production (kg)	Av. Yield (kg/hectare)
i)	Wheat	5.26	5500	1050
ii)	Maize	5.26	6300	1198

8. Input used:

i) Fertilizers: Urea @ 3.0 bags/hectare
DAP/Nitrophos @ 2.5 bag/hectare
ii) Pesticides: Nil
iii) Insecticides: Nil

9. Orchards

Type of Trees		Number of Trees
i)	Apple	10
ii)	Apricot	192
iii)	Almond	96
iv)	Ber	200
v)	Fig	9
vi)	Grape	23
vii)	Toot	162
viii)	Pear	3
ix)	Peach	18
x)	Pomegranate	6
xi)	Walnut	11

10. Livestock Inventory

Bullocks	11
Cows	45
Sheep	73
Goats	112

11. Forest/Fisheries Nil

D. Socio Economic Aspects of the Farm Owner

1. Size of Family: 7-9 persons

2.	Literacy Level:	35 %
3.	Sources of Income:	Agriculture + Jobs
4.	Method of Cultivation.	Manual
5.	Machinery & Equipment:	Nil
6.	Disposal of Farm Production:	Vans/ Pick-ups are always available for haulage purposes.

E. Irrigation & Agronomic Practices:

1	Feeding Channel	Sai Nullah
2.	Source of Water	Snow-melt and spring
3.	Discharge and Duration	The main Sai Nullah which is flowing on the back side of the mountain pertaining to the village, has at least 200 cusecs discharge which gradually rises to 1000 cusecs during snow melt period (i.e.) April to August.
4.	Distribution System	The present irrigation is being done through a kul (Watercourse) having 5 cusecs discharge capacity and offtaking from Sai Nullah. This kul as reported was constructed during 1914 and is the longest kul of northern area with a length of about 18 kilometers. This kul is being maintained by NAPWD personnel with the cooperation of local people. At about 11 kilometers, the kul has a sharp fall of about 91.5 meter and at this location the kul after coming down at lower level goes back towards Parri village along front side of the mountain and irrigates its cultivated lands.
5.	Conveyance Efficiency	80 %
6.	Application Efficiency	85 %
7.	Irrigation Efficiency	68 %
8.	Requirements Versus Availability of Water:	Availability of water through the existing kul is inadequate and is short by 40 %.
9.	O& M of Irrigation Channel/System	Through NAPWD
10.	Ground Water	N.A.
11.	Existing Agronomic Practices	Primitive / No RCTs

F. Conclusion

Due to inadequate irrigation water supply at present, a vast area of cultivable land of the village is lying uncultivated. The entire land could be brought under cultivation resulting in higher crop production which would be quite enough even to meet the food requirements of the surrounding areas which are suffering from food shortage problem.

The area is surplus in food grins as the population of the village is less as compared to the area under cultivation. The crop yields of the village are also poor which can be increased by using additional inputs and adopting modern agricultural practices. The cropping intensities have reached the maximum level which cannot be increased under the present climatic conditions.

Impact Evaluation of Existing Irrigation and Agronomic Practices on Irrigation Efficiency and Crop Yields in Northern Areas of Pakistan

DATA COLLECTION DETAILS

Hunza
(Name of Valley)

Henzal (Bala & Pain)
(Name of Village)

Gilgit River Sub-Basin
(Name of River Basin/Sub Basin)

A. Sample Size and Category of Farm

No. of Farms	=	6
Total Area	=	6.52 hectares (16.10 acres)
Farm Category	=	Large/Medium/Small

B. General Description of Area

1.	Location:	Situated at 16 kilometers towards north west of Gilgit city on the Gilgit-Gupis Road.
2.	Approach:	A narrow shingle jeepable road leads to the village along right bank of Gilgit River looking downstream.
3.	Type of Terrain:	Mild Slope
4.	Elevation:	1500 meters
5.	Name of Village	Henzal (Bala & Pain)
	a) Population	1200
	b) Total Area	91.1 hectares (225 acres)
	c) Cultivated Area	79.75 hectares (197 acres)
	d) Non-Cultivated Area	11.33 hectares (28 acres)

C. Agricultural Data

1.	Total Area of farms:	6.52 hectares (16.1 acres)
2.	Cultivated Area:	7.70 hectares (19 acres)
3.	Uncultivated Area:	2.27 hectares (5.6 acres)
	i) Cultivatable Area:	2.27 hectares (5.6 acres)
	ii) Non-Cultivatable Area:	-
4.	Type of Soil:	Loamy
5.	Crops grown:	Wheat, Maize, Fodder, Vegetables and Fruits.

6. Cropping Pattern and Intensities:

	Crops	Area (hectares)
a) Rabi	Wheat	3.04
	Shaftal	0.40
	Vegetables	0.20
	Subtotal:	3.64
b) Kharif	Maize	3.24
	Vegetables	0.20
	Subtotal:	3.44
c) Perennial	Orchard	
	Lucern	0.41
		0.20
	Subtotal:	0.61
	Total	7.70

d) Rabi Intensity 68 %
e) Kharif Intensity 67 %
f) Annual Intensity 135 %

7. Crop Yields:

Major Crops	Area (hectares)	Total Production (kg)	Av. Yield (kg/hectare)
i) Wheat	3.04	6500	2139
ii) Maize	3.24	7550	2344

8. Input used:

i) Fertilizers: Urea @ 3.0 bags/hectare
Nitrophos @ 2.5 bags/hectare
ii) Pesticides: Nil
iii) Insecticides: Nil

9. Orchards

Type of Trees	Number of Trees
i) Apple	6
ii) Apricot	99
iii) Almond	34
iv) Fig	9
v) Grape	9
vi) Toot	26
vii) Peach	20
viii) Pomegranate	38
ix) Walnut	15

10. Livestock Inventory

Bullocks	7
Cows	28
Goats	11
Donkeys	3

11.	Forest/Fisheries	Nil

D. Socio Economic Aspects of the Farm Owner

1.	Size of Family:	6-8 Persons
2.	Literacy Level:	30 %
3.	Sources of Income:	Agriculture + Jobs
4.	Method of Cultivation.	Manual
5.	Machinery & Equipment:	Nil
6.	Disposal of Farm Production:	The area being located on the main Gilgit-Gupis road is well connected with transport facilities.

E. Irrigation & Agronomic Practices:

1	Feeding Channel	Hilter Nullah
2.	Source of Water	Spring
3.	Discharge and Duration	Four cusecs discharge is available throughout the year.
4.	Distribution System	One kul having discharge capacity of about five cusecs offtakes from Hilter Nullah. It bifurcates into two branches, one supplies water to upper Henzal while the other to the Lower Henzal. Full supply of irrigation water is given for eight hours to upper Henzal and remaining sixteen hours to Henzal Lower.
5.	Conveyance Efficiency	70 %
6.	Application Efficiency	75 %
7.	Irrigation Efficiency	52 %
8.	Requirements Versus Availability of Water:	About 7 cusecs water is required
9.	O& M of Irrigation Channel/System	Nominal, on self-help basis
10.	Ground Water	-
11.	Existing Agronomic Practices	Primitive / No RCTs

F. Conclusion

Irrigation distribution system has been improved with the help of Agha Khan Foundation. The cropping intensity on the farm is only 135% which can be improved.

The area is surplus in foood grains on account of more area under cultivation as compared to population. The present crop yields are quite adequate and cannot be increased further. The present cropping intensities are also adequate and cannot be increased under the present agro-climatic conditions.

The area is very ideal for growing orchards. The main fruits grown in the area are apricot, almond, mulberry (toot), peach, pomegranate and walnut. There is a good scope for development of orchards because of marketing facilities available at Gilgit which is located quite close to the area.

Impact Evaluation of Existing Irrigation and Agronomic Practices on Irrigation Efficiency and Crop Yields in Northern Areas of Pakistan

DATA COLLECTION DETAILS

Chilas
(Name of Valley)

Sakwar
(Name of Village)

Gilgit River Sub-Basin
(Name of River Basin/Sub Basin)

A. Sample Size and Category of Farm

No. of Farms	=	8
Total Area	=	5.18 hectares (12.80 acres)
Farm Category	=	Large/Medium/Small√

B. General Description of Area

1.	Location:	Situated on main Gilgit Road linking Gilgit city with Karakoram Highway and is Ten kilometers towards south east of Gilgit city.
2.	Approach:	The scheme is linked with Gilgit city through a Ten kilometers metalled road.
3.	Type of Terrain:	Mild Slope
4.	Elevation:	1500 meters
5.	Name of Village	Sakwar
	a) Population	2000
	b) Total Area	577.33 hectares (1426 acres)
	c) Cultivated Area	145.75 hectares (360 acres)
	d) Uncultivated Area	431.60 hectares (1066 acres)
	i) Cultivable	283.40 hectares (700 acres)
	ii) Non-Cultivable	148.20 hectares (366 acres)

C. Agricultural Data

1.	Total Area of farms:	5.18 hectares (12.8 acres)
2.	Cultivated Area:	5.06 hectares (12.5 acres)
3.	Uncultivated Area:	0.12 hectare (0.3 acres)
	i) Cultivatable Area:	5.18 hectare (12.8 acres)
	ii) Non-Cultivatable Area:	-
4.	Type of Soil:	Sandy Loam
5.	Crops grown:	Wheat, Maize, Fodder and Vegetables.
6.	Cropping Pattern and Intensities:	

	Crops	Area (hectares)
a) Rabi	Wheat	3.04

		Shaftal	0.40
		Vegetable	0.20

		Subtotal:	3.64
	b) Kharif	Maize	3.24
		Vegetable	0.20

		Subtotal:	3.44
	c) Perennial	Orchard	1.42

		Total	8.50

d) Rabi Intensity 98 %
e) Kharif Intensity 98 %
f) Annual Intensity 196 %

7. Crop Yields:

Major Crops		Area (hectares)	Total Production (kg)	Av. Yield (kg/hectare)
i)	Wheat	3.04	1900	618
ii)	Maize	3.24	4500	1383

8. Input used:
   i) Fertilizers: Urea @ 1.25 bags/hectare
      Nitrophos @ 3.70 bags/hectare
   ii) Pesticides: Nil
   iii) Insecticides: Nil
9. Orchards

Type of Trees		Number of Trees
i)	Apple	3
ii)	Apricot	565
iii)	Almond	10
iv)	Fig	9
v)	Grape	15
vi)	Toot	23
vii)	Pear	6
viii)	Peach	19
ix)	Pomegranate	44
x)	Walnut	7

10. Livestock Inventory

Bullocks	3
Cows	16
Sheep	3
Goats	4

11. Forest/Fisheries Nil

D. Socio Economic Aspects of the Farm Owner

1. Size of Family: 6-8 persons
2. Literacy Level: 35 %
3. Sources of Income: Agriculture + Jobs
4. Method of Cultivation. Manual
5. Machinery & Equipment: Nil

6.	Disposal of Farm Production:	Transport facilities for haulage are slightly inadequate.

E. Irrigation & Agronomic Practices:

1	Feeding Channel	Sakwar Gah
2.	Source of Water	Snow-melt
3.	Discharge and Duration	Minimum discharge of about 5 cusecs is available during April-May. During June-August, discharge rises up to 15 cusecs. From August onward the supply is decreased and in winter months, no water is available. The maximum flood discharge of nullah is about 100 cusecs.
4.	Distribution System	At present, the supply of water from the nullah to the village is through a pipe of 10 cm (4 inch) dia having overall length of 2000 meters.
5.	Conveyance Efficiency	70 %
6.	Application Efficiency	80 %
7.	Irrigation Efficiency	56 %
8.	Requirements Versus Availability of Water:	Present supplies are inadequate for irrigation purposes because the water is not available throughout the year.
9.	O& M of Irrigation Channel/System	Nil
10.	Ground Water	-
11.	Existing Agronomic Practices	Primitive/No RCTs

F. Conclusion

The cropping intensity in the area is 196% which shows good land management. About 283 hectare (700 acres) cultivable area in the village is lying wasted due to non-perennial supply of water from the existing source of water. This land can be brought under cultivation and will prove very helpful in increasing the overall food production of the area.

Although the crop yields of the village are very poor, even then this village is self-sufficient in food grains production. The crop yields can be increased by increasing irrigation supplies, using additional inputs, providing insecticides at reasonable rates and adopting improved agricultural practices. The present cropping intensities of the area have reached the maximum level and cannot be increased under the present agro-climatic conditions.

Impact Evaluation of Existing Irrigation and Agronomic Practices on Irrigation Efficiency and Crop Yields in Northern Areas of Pakistan

DATA COLLECTION DETAILS

Gakuch
(Name of Valley)

Gulmuti
(Name of Village)

Gilgit River Sub-Basin
(Name of River Basin/Sub Basin)

A. Sample Size and Category of Farm

No. of Farms	=	2
Total Area	=	2.15 hectares (5.30 acres)
Farm Category	=	Large√/Medium/Small

B. General Description of Area

1.	Location:	The village is situated on the right bank of Gilgit River looking downstream at a distance of about 60 kilometers towards west of Gilgit city.
2.	Approach:	One kilometer along metalled road from Gilgit city towards Basin Village; then 59 kilometers along right bank of Gilgit River on a narrow shingle road.
3.	Type of Terrain:	Sharp Slope
4.	Elevation:	2057 meters
5.	Name of Village	Gulmuti
	a) Population	2000
	b) Total Area	133.60 hectares (330 acres)
	c) Cultivated Area	72.87 hectares (180 acres)
	d) Uncultivated Area	60.73 hectares (150 acres)
	i) Cultivable	24.30 hectares (60 acres)
	ii) Non-Cultivable	36.44 hectares (90 acres)

C. Agricultural Data

1.	Total Area of farms:	2.15 hectares (5.3 acres)
2.	Cultivated Area:	2.87 hectares (7.1 acres)
3.	Uncultivated Area:	0.57 hectare (1.4 acres)
	i) Cultivatable Area:	
	ii) Non-Cultivatable Area	0.57 hectare (1.4 acres)
4.	Type of Soil:	Loamy Soil

5. Crops grown: Wheat, Barley, Maize, Fodder, Vegetables and Lucern.

6. Cropping Pattern and Intensities:

	Crops	Area (hectares)
a) Rabi	Wheat	0.41
	Barley	0.41
	Fodder	0.28
	Vegetables	0.20
	Subtotal:	1.30
b) Kharif	Maize	1.10
	Vegetables	0.20
	Subtotal:	1.30
c) Perennial	Lucern	0.28
	Total	2.87

d) Rabi Intensity 76 %
e) Kharif Intensity 71 %
f) Annual Intensity 147 %

7 Crop Yields:

Major Crops		Area (hectares)	Total Production (kg)	Av. Yield (kg/hectare)
i)	Wheat	0.40	750	1852
ii)	Barley	0.40	700	1729
iii)	Maize	1.10	2100	1927

8. Input used:

i) Fertilizers: Nitrophos @ 2.5 bags/hectare
Urea @ 0.62 bag/hectare
ii) Pesticides: Nil
iii) Insecticides: Nil

9. Orchards

Type of Trees		Number of Trees
i)	Apple	7
ii)	Apricot	68
iii)	Almond	17
iv)	Cherry	2
v)	Fig	2
vi)	Grape	52
vii)	Toot	10
viii)	Pear	3
ix)	Peach	12
x)	Pomegranate	6
xi)	Walnut	9

10. Livestock Inventory

Bullocks	3
Cows	16

	Sheep	3
	Goats	40
	Donkey	1
11.	Forest/Fisheries	Nil

D. Socio Economic Aspects of the Farm Owner

1.	Size of Family:	6-9 persons
2.	Literacy Level:	30 %
3.	Sources of Income:	Agriculture
4.	Method of Cultivation.	Manual
5.	Machinery & Equipment:	Nil
6.	Disposal of Farm Production:	Consumed Locally

E. Irrigation & Agronomic Practices:

1	Feeding Channel	Gulmuti Gah
2.	Source of Water	Spring and snow-melt
3.	Discharge and Duration	Minimum discharge of about 4 cusecs (spring water) is available during the period from March to May; whereas maximum discharge varies up to 50 cusecs and is available during the remaining part of the year. This variation is due to snow melt condition.
4.	Distribution System	At present eight kuls (watercourses) are offtaking from the right side of Gulmuti Gah at different altitudes and have variable discharge which ranges from 0.25 cusecs to 0.5 cusecs. All these kuls are being used for irrigation purposes. On the left side of the nullah, two kuls having discharge capacity of about 0.25 cusecs each are also offtaking and supplying irrigation water to the left part of the village.
5.	Conveyance Efficiency	60 %
6.	Application Efficiency	70 %
7.	Irrigation Efficiency	42 %
8.	Requirements Versus Availability of Water:	Adequate water is available
9.	O& M of Irrigation Channel/System	Nominal, on self-help basis
10.	Ground Water	-
11.	Existing Agronomic Practices	Primitive/ No extension services.

F. Conclusion

The present cropping intensities have reached the maximum values and cannot be increased further on account of the present agro-climatic conditions of the area. The

present crop yields are low which can, however be increased further by using additional inputs and adopting proper plant protection measures.

The area is very suitable for growing orchards. The main fruit are apples, apricots, almonds, grapes, peaches and walnuts. For the increase of present fruit production, the improvement in marketing facilities is necessary for the area.

Impact Evaluation of Existing Irrigation and Agronomic Practices on Irrigation Efficiency and Crop Yields in Northern Areas of Pakistan

DATA COLLECTION DETAILS

Gakuch
(Name of Valley)

Singal
(Name of Village)

Gilgit River Sub-Basin
(Name of River Basin/Sub Basin)

A. Sample Size and Category of Farm

No. of Farms	=	4
Total Area	=	4.82 hectares (11.9 acres)
Farm Category	=	Large/Medium√/Small

B. General Description of Area

1.	Location:	Situated at 54 kilometers towards west of Gilgit city on the right bank of Gilgit River looking downstream.
2.	Approach:	One kilometer along metalled road from Gilgit city towards Basin Village; then 53 kilometers on a narrow shingle jeepable road which leads to the village along the right bank of Gilgit River looking downstream.
3.	Type of Terrain:	Mild Slope
4.	Elevation:	2042 meters
5.	Name of Village	Singal
	a) Population	3000
	b) Total Area	279.40 hectares (690 acres)
	c) Cultivated Area	194.33 hectares (480 acres)
	d) Un-Cultivated Area	85.02 hectares (210 acres)
	i) Cultivable	36.44 hectares (90 acres)
	ii) Non-Cultivable	48.58 hectares (120 acres)

C. Agricultural Data

1.	Total Area of farms:	4.82 hectares (11.9 acres)
2.	Cultivated Area:	4.74 hectares (11.7 acres)
3.	Uncultivated Area:	1.90 hectares (4.7 acres)
	i) Cultivatable Area:	1.90 hectares (4.7 acres)
	ii) Non-Cultivatable Area:	-
4.	Type of Soil:	Loamy Soil

5. Crops grown: Wheat, Barley, Maize, Fodder, Vegetables, Lucern and Fruits.

6. Cropping Pattern and Intensities:

	Crops	Area (hectares)
a) Rabi	Wheat	1.10
	Barley	0.40
	Fodder	0.40
	Vegetables	0.20
	Subtotal:	2.11
b) Kharif	Maize	1.62
	Vegetables	0.20
	Subtotal:	1.82
c) Perennial	Lucern	0.41
	Fruits	0.40
	Subtotal:	0.81
	Total	4.74
d) Rabi Intensity	60 %	
e) Kharif Intensity	54 %	
f) Annual Intensity	114 %	

7. Crop Yields:

Major Crops		Area (hectares)	Total Production (kg)	Av. Yield (kg/hectare)
i)	Wheat	1.10	2400	2193
ii)	Barley	0.40	600	1482
iii)	Maize	1.62	4200	2594

8. Input used

Fertilizers:	Nitrophos @ 2.50 bags/hectare
Pesticides:	-
Insecticides:	-

9. Orchards

Type of Trees		Number of Trees
i)	Apple	10
ii)	Apricot	30
iii)	Almond	24
iv)	Cherry	2
v)	Grape	23
vi)	Toot	7
vii)	Pear	1
viii)	Peach	17
ix)		1
x)	Pomegranate	5

	xi) Walnut	12
10.	Livestock Inventory	
	Bullocks	6
	Cows	18
	Sheep	6
	Goats	20
11.	Forest/Fisheries	

D. Socio Economic Aspects of the Farm Owner

1.	Size of Family:	6-8 persons
2.	Literacy Level:	40 %
3.	Sources of Income:	Agriculture + Jobs
4.	Method of Cultivation.	Manual
5.	Machinery & Equipment:	Nil
6.	Disposal of Farm Production:	Inadequate transport facilities

E. Irrigation & Agronomic Practices:

1	Feeding Channel	Singal Gah
2.	Source of Water	Spring and snow melt
3.	Discharge and Duration	Minimum discharge of Singal Nullah is about 10 cusecs during the month of March and April which is available throughout the year. The maximum discharge which varies up to 200 cusecs, is available from July to August
4.	Distribution System	Two kuls (watercourses) having almost similar discharges of about two cusec each are offtaking from the right side of Singal Gah. These kuls are supplying irrigation water to the lands of main Singal village. Whereas another minor kul having 1.0 cusec maximum discharge is offtaking from the left side of Singal Gah and is meeting the irrigation and domestic water requirements of Thing Das; an adjoining village of Singal village.
5.	Conveyance Efficiency	60 %
6.	Application Efficiency	80 %
7.	Irrigation Efficiency	48 %
8.	Requirements Versus Availability of Water:	Adequate water is available.
9.	O& M of Irrigation Channel/System	Nominal, on self-help basis.
10.	Ground Water	-
11.	Existing Agronomic Practices	Primitive / No RCTs

F. CONCLUSION

The present cropping intensities are low because of poor irrigation system of the village. The watercourses of this village are quite lengthy and poorly maintained which need improvement, so that, water wastage could be controlled. Wheat and maize crops are

oftenly damaged by white grubs and cut-worms. The pesticides in the area are very costly and the poor farmers are not in a position to purchase them at higher rates from the market. It is therefore, suggested that these pesticides should be made available at the subsidized dates. The area is very ideal for fruit growing. The main fruit grown are apple, apricot, almond, grapes, peach and walnut.

Impact Evaluation of Existing Irrigation and Agronomic Practices on Irrigation Efficiency and Crop Yields in Northern Areas of Pakistan

DATA COLLECTION DETAILS

Gakuch
(Name of Valley)

Gich
(Name of Village)

Gilgit River Sub-Basin
(Name of River Basin/Sub Basin)

A. Sample Size and Category of Farm

No. of Farms	=	6
Total Area	=	2.35 hectares (5.8 acres)
Farm Category	=	Large/Medium/Small√

B. General Description of Area

1.	Location:	Situated at 51 kilometers towards west of Gilgit city on the right bank of Gilgit River looking downstream.
2.	Approach:	One kilometer along metalled road from Gilgit city and thereafter 50 kilometers on a narrow jeepable shingle road which leads to the village along right bank of Gilgit River.
3.	Type of Terrain:	Sharp Slope
4.	Elevation:	2012 meters
5.	Name of Village	Gich
	e) Population	
	f) Total Area	233 hectares (575 acres)
	g) Cultivated Area	142 hectare (350 acres)
	h) Un-cultivated Area	91 hectares (225 acres)

C. Agricultural Data

1.	Total Area of farms:	2.35 hectares (5.8 acres)
2.	Cultivated Area:	2.35 hectares (5.8 acres)
3.	Uncultivated Area:	0.68 hectares (1.65 acres)
	i) Cultivatable Area:	
	ii) Non-Cultivatable Area:	0.68 hectares (1.65 acres)
4.	Type of Soil:	Loamy Soil
5.	Crops grown:	Wheat, Maize, Lucern and Fruits.

6. Cropping Pattern and Intensities:

	Crops	Area (hectares)
a) Rabi	Wheat	1.08

b) Kharif	Maize		1.07
c) Perennial	Lucern		0.20
	Total		2.35
d) Rabi Intensity		54 %	
e) Kharif Intensity		54 %	
f) Annual Intensity		118 %	

7. Crop Yields:

Major Crops		Area (hectare)	Total Production (kg)	Av. Yield (kg/hectare)
i)	Wheat	1.07	2150	2000
ii)	Maize	1.07	2600	2421

8. Input used:

i)	Fertilizers:	Nitrophos @ 2.5 bags/hectare Ammonium Nitrate @ 3.70 bags/hectare
ii)	Pesticides:	-
iii)	Insecticides:	-

9. Orchards

Type of Trees		Number of Trees
i)	Apple	4
ii)	Apricot	71
iii)	Almond	3
iv)	Fig	2
v)	Grapes	27
vi)	Toot	10
vii)	Peach	7
viii)	Pomegranate	2
ix)	Walnut	8

10. Livestock Inventory

Bullocks	6
Cows	18
Sheep	4
Goats	18
Donkey	1

11. Forest/Fisheries — Nil

D. Socio Economic Aspects of the Farm Owner

1.	Size of Family:	6-8 persons
2.	Literacy Level:	30 %
3.	Sources of Income:	Agriculture
4.	Method of Cultivation.	Manual
5.	Machinery & Equipment:	Nil
6.	Disposal of Farm Production:	Adequate transport for haulage is not available.

E. Irrigation & Agronomic Practices:

1	Feeding Channel	Gich Gah
2.	Source of Water	Spring and snow-melt

3.	Discharge and Duration	Minimum discharge (spring water) of Gich Gah during the months of February and March is about 1.0 cusecs whereas maximum discharge (snow-melt) which varies from 5 to 10 cusecs is available during the period from May to October.
4.	Distribution System	From the right side of Gich Gah, three kuls having similar discharge of about 0.50 cusecs are offtaking at different altitudes. All these kuls are supplying irrigation water to the lands located on right side of Gich Gah. While on the left side of Gich Gah, three kuls having similar discharge of 0.25 cusecs are offtaking which are fulfilling the irrigation and domestic requirement of the village population, situated on the left side of the Gah.
5.	Conveyance Efficiency	50 %
6.	Application Efficiency	80 %
7.	Irrigation Efficiency	40 %
8.	Requirements Versus Availability of Water:	There is shortage of water during the January to March.
9.	O& M of Irrigation Channel/System	Nominal, on self-help basis
10.	Ground Water	-
11.	Existing Agronomic Practices	Primitive, No RCTs.

F. Conclusion

The irrigation efficiency (40%) and cropping intensity (118%) are both low with poor land and soil management.

Since the entire cultivable land of the village has already been brought under cultivation; therefore, there is little scope for its further development.

The village is surplus in food grains because of the fact that its major part is under food crops while its population is comparatively less. The present crop yields are low which can however be increased if improved agricultural practices are adopted and additional inputs are used. The present cropping intensities indicate the maximum level and cannot be increased further due to present agro-climatic conditions. The area is very suitable for growing orchards.

3.8 Data Analysis and Conclusions / Broad Inferences

The selected farms were physically visited by the survey teams and all important data and features of the farms were recorded. The compiled data has been analyzed. The irrigated agricultural development in mountainous topography is entirely different from that in the plains. The small patches of cultivable land are located here and there either at foot of hills or in the form of abandoned terraces of the nearby streams. The nearby source of water is generally at a much lower level than the land, making gravity irrigation difficult. Every one of the several valleys seems to have its own peculiar development needs. The agricultural economy of the region is not up to the mark and the income from agriculture is insufficient for most families to maintain even a subsistence level of consumption. An estimated 90% of the region's population makes its living from subsistence farming. The average household has more than 8 members having 2 to 3 kanals of land of which only 60% is suitable for annual crops and owns small number of livestock and fruit trees. Many sectors of the farm economy have a level of productivity that is much lower than the other parts of the country. The agricultural economy of the region should be exposed to all kinds of radical changes and accelerated growth which has been experienced in similar terrains in other parts of the World where modern irrigated agriculture is practiced. This appraisal is indicated by analysis of the factors involved in agricultural development including the resource base, existing development, infrastructure, demand for agricultural products and farmers attitudes and incentives. In this region, the obvious constraints to the development of modern agricultural economy are water factors and the scarcity of virgin land.

Leveling and clearing of virgin land, wherever available, for cultivation, alleviation of water supply deficiencies through diversion structures, small storages, lift irrigation schemes, and application of fertilizers, selected seeds, pesticides and modern technology can trigger a revolution in agriculture production of the area and bring it equal to other parts of Pakistan. This will also improve the living conditions of the people in this region.

The required level and rate of water resource development can only be achieved through a massive works program which ultimately must serve all of the irrigated lands available here and there in the region. It is also necessary to fill up the gap between agricultural productions and demand to save the government money spent on subsidies.

3.8.1 Irrigation Supplies

The irrigation water used for agriculture in the study area is mostly obtained from river / tributary channels which mostly receive snow melt water from glaciers and springs. Most of the cultivated area lies in the valleys along the banks of rivers and their tributaries and is generally at much higher level than the adjoining river. To command these higher areas, the farmers dig water channels upstream of the area at high altitude and divert water from the river / tributaries for irrigating their lands. The entire area under cultivation, at present, is irrigated from one source or the other however, the water supply is inadequate and untimely. The quantum of water available also varies from village to village due to a number of reasons.

Firstly, water availability is governed by the amount and timing of snowfall. For instance, if snowfall comes late in winter it does not pack down. It melts rapidly

during early warm season in spring which causes flooding and depletes water resources for late summer irrigation. In contrast if there is little snow and it falls early in the winter and is followed by prolonged cool spring, water shortage will occur in channels due to delayed snow melting in April and May.

Secondly, the relative height of a village together with its degree of exposure to sun determines the rate of warming up in spring and ultimately the corresponding crop water requirements. Thus the crop water demand may not coincide with altitude and its degree of exposure to sun. This indicates that a village located in a valley at an altitude of 1500 m and exposed to sun will have an early high water demand that could not be adequately met from high altitude glaciers and snow covers which are exposed to sun. In fact interaction of four parameters such as quantum and timing of snowfall, temperature which is affected by altitude, particular season, and aspect of source determine the water supply situation.

For channel building and maintaining, village organization exists with accepted rules and regulations. Irrespective of the size of landholding, all families contribute equal share for up-keep of the irrigation channel. There is strong social pressure for maintaining this activity and any family unable to supply their labour quota pays a fee for employment of labour in this place.

3.8.2 **Crop Husbandry**

Cereal crops are mostly cultivated in the area. Wheat is the main staple food crop. However, in certain parts, maize is also used for human consumption in place of wheat. These grain crops are also supplemented by panicum (sorghum) and millet (Bajra) in villages at higher altitudes. Buck-wheat is used in place of wheat in parts of Hunza Valley. Wheat flour is often mixed with other cereals used for human consumption in order to make them more palatable.

Double cropping system (wheat followed by maize) is generally practiced throughout the valley up to 1850 meter height. However, above 2300 meter altitude single cropping (wheat or maize) is in vogue. There is a transitional zone between 1850 to 2300 meter where double cropping becomes marginal.

3.8.3 **Cropping Pattern and Intensities**

The cropping pattern of study area shows that wheat and maize are the major rabi and kharif crops. The cropping pattern of the area depends upon altitude. In areas of lower elevation double cropping in practiced, while in areas of higher elevation, single cropping is in vogue. In many villages, single as well as double cropping is followed on account of variation in the altitude of the cultivated land. Generally, double cropping is practiced up to an elevation of 2000 m. Maize is cultivated just after wheat harvest or after harvesting of rabi fodders i.e. shaftal or berseem.

In single cropping zone, either wheat or maize is grown. At higher elevations, the growing season shortens and sowing of wheat is carried out in November instead of March (Punial villages). In the marginal double cropping zone, barley substitutes for wheat and maize crop is cultivated after harvest of barley in July. In Hunza area, Panicum and Millets are grown as early maturing crops in place of barley then maize is sown after its' harvest. The data shows that wheat, barley and maize are cultivated in major parts of the area followed by fodder and vegetables. Orchards are also grown on a sizeable area. Area under oilseeds, pulses and other crops is negligible.

The computed rabi and kharif cropping intensities are 90 and 75 percent respectively and annual intensity is 165 percent.

3.8.4 **Crop Yields and Production**

The yields of crops grown in the area are very low. No authentic data regarding crop yields are available. The crop yields have been estimated through interviews of the farmers and adjusted in consultation with Agriculture Department.

The estimated yield data of wheat and maize collected from schemes of Gilgit River Basin and Hunza River Basin during reconnaissance survey have been described. The crop yields relate to selected farmers. The average yield of wheat in Gilgit River and Hunza River Basins is 1976 kilograms and 2075 kilograms per hectare with an average of 2025 kilograms per hectare. The yield varies at each farm and village. Yields are generally poor on account of lack of regular irrigation supplies, poor extension services, obsolete agronomic practices, non-availability and inadequate inputs (Improved Seeds, Fertilizer and Pesticides) are the major constraints in the achievement of high crop yields in the area.

3.8.5 **Need for Research, Surveys and Monitoring**

Priority must be given to research and surveys in those fields which contribute to social and economic development. However, there is also scope for valuable basic research and monitoring of physical and biological conditions. These areas are unique among the world's mountains regions, in scale, climate, glaciations, erosion, geology and tectonics, life zones and history and as such these have the scope for scientific research of singular national and international interest. Since basic information is limited in scope and aerial coverage, surveys of geology, hydrology, soils, forests, medicinal herbs, fisheries and game populations can help increase the knowledge of the resource base substantially. An essential prelude to wide-spread introduction of new technology and economic practices needs detailed survey of existing land use, and a thorough investigation of the economic, social and medical conditions among the varied sub-cultures of the region. This information will be of unusual interest, and assist the ideological and practical dialogue that must take place between the people of Northern Areas and government agencies charged with assisting their development.

There are some severe constraints to development in mountain areas, which the scientific communities should investigate and keep close watch over. The work must proceed with due regard to the very fragile environments. Small disturbances in mountainous areas can produce large, irreversible changes because of the effects of steep slopes, and large variations in climate and hydrology. Likewise, established mountain economies are highly specialized. Any change in these economies, in their health care, technology and education must be approached with a full sense of the risks from carelessness and failure. During change, mountain populations are unusually prone to the impact of natural extremes, e.g. floods, avalanches, landslides, earthquakes or droughts. Such economies, on past evidence, are really able to restore pervious patterns of survival if new ones fail. In fact, attempts at "development" and the impact of modern conditions in most tropical and sub-tropical high mountains has been that tale of lost resources, environmental destruction and social chaos.

Vast uninhabited tracts in Karakoram-Himalyan region (Northern Areas of Pakistan) supply important resources, notably the bulk of the water for the river Indus. An investment is needed in the specialized equipment for work in such areas, simply to obtain elementary kinds of data on the physical environment; otherwise resource planning in these areas will continue to work blindly. It must also be recognized that most of the planners and scientists caught up in the attempt to develop mountainous

areas have been trained and brought up in places quite remote from them, normally in the plains. Before the more sophisticated work of science and development can be properly undertaken, investment will be necessary in developing the awareness of mountain conditions among planners and scientists; and in educating local personnel to take part in programmes and surveys. Finally the kinds of equipment and back-up gear required for effective research in high mountain regions is not that normally purchased by our Universities and Laboratories, so to involve the larger scientific community investment here is also essential.

3.8.6 **Strategy for Development of Irrigated Agriculture in Northern Areas**

The region is rugged and heavily mountainous, since it forms the interception of four of the World's highest mountain ranges – the Himalaya, Karakoram, Pamir and Hindukush. Much of the area is above 1200 meters (4000 feet) and settled farming communities exist up to altitudes of just above 2750 meters (9000 feet). Agricultural production is based essentially on irrigation with a water supply from springs, streams and rivers that are fed by snowmelt from areas higher up the mountain ranges. The Region being outside the influence of the monsoon receives very little rainfall, which varies form 50 to 170 mm per year. The climate can be best described as arid continental Mediterranean. The area has subsistence mixed farming economy and the inhabitants are well adapted to altitudinal zoning of resources, where diversity of ecozones are situated in close proximity to one another.

It is imperative that the development strategies should be self-reliant and based on local conditions and should have the participation and support of the local people.

Two stages of development are contemplated for the Northern Areas. The first stage, which involves immediate development of available land and water resources by the most expeditious and economic means and exploiting to the utmost all existing facilities and works. The second stage is discussed herein only in the context of future development i.e. the future requirements for water supplies; the physical works and costs associated with the development of these supplies and the probable timing of construction works.

The objective of the strategy is to foment rapid growth of irrigated agriculture to close the gap in agricultural production and demand and to impart sufficient momentum to the economy to over-ride minor constraints. Development needs, rather than conservation criteria, will dominant planning policy. The growth of production will tend to hinge more on increased productivity through the use of fertilizers, selected seeds, pesticides and improved technology.

Among the actions that might help to maintain a good environment and to improve the living conditions of the people are forest plantation of fast growing trees for fuel, timber and livestock forage; construction of micro-hydropower plants for lift irrigation and for supplying electricity to individual villages; development of more efficient ways to use energy for small industries, cooking, heating, and hay-drying; increasing food supplies and diversifying diets by encouraging farmers to grow vegetables; raising farm incomes by enhancing orchards of fruit and nut trees and by introducing small volume, high-value agricultural produce such as honey bees; silk culture, medicinal plants, spices and fragrances; improving livestock productivity by controlled breeding and by maintaining livestock in confinement rather that under free-grazing conditions; construction of such non-conventional means of

transportation as ropeways and foot bridges, encouragement of tourism; village electrification from local power stations; development of village and small town industries, such as tin industry and fruit preservation industry, dairying and production of cheese and butter; local wood and leather handicrafts; public health and nutrition services, provision of domestic water supplies and of water for irrigation; education and training to provide the people with economically useable skills. In all these activities, improvements in roads and communications are likely to be centrally important.

Many of these actions are interdependent or complementary in the sense that they will reinforce each other. Maintaining livestock in confinement will require availability of hay, crop residues, or forage from fast growing trees. This change in the mode of livestock management could increase the quantity of fertilizer nitrogen from animal sources, because it would conserve the nitrogen excreted in the urine. At the same time it could eliminate soil erosion resulting from over-grazing. Public health and nutrition services will lower infant and child mortality. Forest plantations of fast growing trees should ultimately lower the cost of fuel.

Electrification either form central power plants or local hydro power plants could provide power for pumping domestic water supplies to high altitude villages and for pumping irrigation water from numerous perennial streams to the less erasable lower terraces which have been cultivated for many years. If double cropping could be carried out in these lower terraces, the pressure to expand agricultural lands further to uphill slopes to meet the needs of growing local population should be diminished.

With each of these possible initiatives are associated a set of research issues. In the first place, there are numerous questions of technical feasibility and adaptation to the local conditions in Northern Areas. Secondly, there is a range of socio-economic questions that need to be answered, including the costs and benefits of particular innovations and their acceptability in the socio-cultural milieu. Finally, in view of the potential importance of complementariness between many possible activities, different kinds of technological and organization packages should be devised to meet the twin needs of improving the mountain environments and the standard of living of their dwellers. It is likely that balanced strategies may have to be devised for each locality. Some of these research projects are underway in some national institutions. It is important that these activities and new initiatives should be closely monitored.

CHAPTER 4

DEVELOPMENT NEEDS AND CONSTRAINTS

4.1 General

Snow covered mountains and deep valleys with snow or glacier fed streams are that constitute Northern Areas of Pakistan and harbour great potentials of natural resources, that need exploitation, to afford better living to the common masses. It has subsistence mixed farming economy. The inhabitants are well adapted to altitudinal zoning of resources, where diversity of econzones are situated in close proximity to one another. From the summer snowline at about 4575 meters (15000 feet) down to the valley bottoms, the vegetation varies from alpine meadow, various types of woodland and shrub to gradation of semi-desert vegetation. The inhabitants use the lowest zone for crop growing which contains land primarily on fans and terraces. This land is used to produce food with the water resources derived from snowfields at higher altitude. The intermediate zone is utilized mainly for livestock husbandry and obtaining firewood.

4.2 Development Needs

The development of the upland areas is not only imperative for the benefit of local people but also has long-term national implication. The environmental degradation occurring in the hilly northern region (Upper Indus Basin) incurs measurable and significant costs such as:

- Poor land management in the catchment area causes serious problem of erosion resulting in siltation of dams and reservoirs downstream. Even if land treatment in the mountainous region could only increase life of dams downstream for a period of five to ten years by checking siltation, the economic gains for the country would be substantial.
- Reduction in concentration time resulting in higher flood peaks and flood damages causing increased protection cost.
- Improved development may trigger development of trade, transport and communication between Pakistan and the neighboring countries e.g. China, Afghanistan and Central Asian States.

The regional development is to provide appropriate physical facilities to promote the development of land and water resources at a rate commensurate with the needs and the resources of the area. It may be emphasized that the ultimate objective of development is the creation of a viable economy. Accordingly, exploitation of land and water resources and the hydro-power is expected to result in more than simple self-sufficiency in food and fiber. It will also help maintain a good environment and to improve the living conditions of the people and to remove a basic barrier to development of a viable economy. Food shortage has been a great problem in the Northern Areas since long. As a result, the prices of commodities are extremely high and have to be subsidized by the Government.

The area is situated in an arid region and is not benefitted by monsoons. Thus there is a great deficiency of irrigation water as a whole. Such dearth of irrigation water is considered to be the main cause for low production in agriculture. To overcome this problem, the extension workers are required to demonstrate the effects of mulching on the crops and barani farming techniques. Local grasses, leaf mass of

broad-leaved trees, straw of wheat, barley and rice etc. are spread on the cultivated fields and mixed with pebbles to reduce surface evaporation and allow soil moisture to be utilized by plants for longer durations. Northern Areas of Pakistan, which was once called as the “roof of the world”, are at present the California of Pakistan in terms of fruit production. The climate is so suited to fruit development that concentrated efforts are a must to bring round the primitive farmers to accelerate the patronization of horticulture on priority basis.

There is a great scarcity of cultivated land. Only 2 % to 3 % of total area is under cultivation. To overcome the problems of food shortage in the area and to supplement food production, there is a need for:

- Creation of cultivated land out of the waste land potential situated in and outside sub-valleys of the area;
- Terracing of land and construction of small dams/diversion structures and retaining walls;
- Construction, maintenance and development of gravity flow channels;
- Supply of electricity/introduction of diesel pumps for lift irrigation;
- Improvement and modification of existing irrigation channels and watercourses.
- Provision of land leveling facilities to the farmers.
- Enhancing Irrigation efficiencies through different techniques.

The engineering works entail heavy expenditure, and are beyond the capacity of the poor farmers. Therefore, dozers may be made available to them on much-subsidized rates for terracing of land and for bringing more land under cultivation. Priority should be given to places where-ever some plain pieces of land is available. Although there are many shortcomings in the farming society in way of cultivation but the preparation of land, method of sowing, weeding, timely application of specific fertilizers, pesticides and water requirements, use of improved seeds and availing better time of sowing and harvesting are avenues that need immediate attention.

There is a great need for the demonstration of improved varieties of wheat, maize, barley and oil seeds to the farmers. No practice else can convince the farmer better to go for a higher yielding variety than the silent tone of demonstrating a variety of crop that has marked significance to the one in the neighborhood. It is suggested that higher yielding wheat variety, drought resistant varieties and those that require less period for maturity should be tried in experimental demonstration. Similarly, a sense of orchards establishment should also be created in their minds.

No proper record of agricultural production and fruit production has been maintained in the area. No data is collected, transmitted, grouped and analyzed at a particular cell for future evaluation of the mini-projects, which are called the “cutting edge” of development. It needs to be recorded in by the Planning and Development Deptt. Gilgit.

Quick development has now-a-days been decided in the general policy of the country to be achieved through integrated efforts of various disciplines. The new concept of Integrated Rural Development Programme has taken an appreciable start towards modernizing the farming community in Northern Areas. This is a concentrated effort with modern spirit of approach towards specific problem.

4.3 Problems and Constraints

The present situation of resource utilization and land-use in the Northern Area is very weak. Improper manipulation of the ecosystem has created many problems. Intensified slope cultivation, excessive rate of timber extraction and over-grazing are denuding upland slopes, enhancing landslides, road and settlement damages, weakening natural controls of water flow, and accelerating floods and siltation in low-lands drained by the Indus and its tributaries. Underlying these problems are strong economic and social factors which limit opportunities to find or implement more beneficial methods of environmental use. Economic pressures force people of mountainous area to exploit natural resources at the expense of future consequences. Rate of exploitation exceeds the regulatory capacities of government and traditional institutions. Cultural values discourage the scientific activities and popular attitudes upon which the developments of such capacities depend.

The constraints lie broadly in the areas of:

a) Natural resources
b) Human and social problems
c) Scientific data and information

The major natural resource constraints are:

a) Improper land-use and scarcity of cultivated land and water
b) Erosion
c) Deforestation
d) Natural disasters

The critical human and social constraints are:

a) Weak infrastructure
b) Increasing population
c) Lack of public awareness, participation and support
d) Lack of effective natural resources management, organization and legislation.

4.3.1 Improper Land Use and Scarcity of Cultivated Land and Water

Mountain ecosystems are unusually sensitive to quite small disturbances and the consequences are often irreversible. This is especially true of the Karakoram Himalayan region (Northern Areas) with great relief and steep slopes. The area has been prone to sudden, rapid and irreversible loss of soils because of disturbances of slope and vegetation cover through overgrazing and clean cutting of forests. Urgent local needs have brought into cultivation the areas on steep slopes resulting from the cutting of forests and overgrazing of rangelands, completely disturbing the land use balance. This has enhanced erosion by water and wind several fold, putting great strain on the land resources of Northern Areas.

Problems faced by agriculturists, are both natural and organizational. In the first case, the terrain of the tract is such that correct agricultural practices are limited to the minimum and there is a great scarcity of cultivated land. Further the areas fall in the rain shadowed geographical unit and is unaffected by monsoon, so the utter deficiency of natural water exists which poses one of the greatest problems in this regard. Such dearth of irrigation water is considered to be the problem number one for

low production in agriculture.

4.3.2 Erosion

It is now taking place on a massive scale, making it critical to immediately carry out research on its causes and possible control mechanisms. It is obvious that the recent increase of erosion is, in part, due to population increase and to consequent intensification of land use, but erosion is also caused by road building, due to heavy blasting for the construction of K.K.H. and Gilgit-Skardu road; excessive heavy traffic; inappropriate agricultural practices, use of firewood, increased forest exploitation, etc.

4.3.3 Deforestation

Deforestation has increased with the growth of population and ensuing demand of fuel wood for cooking and warmth. This has adversely affected the soil stabilities, water regime, landscape appearance and wildlife habitat. Actually the forest in the tract are state owned and have been declared as protected under Forest Act, 1927, but the forests are un-demarcated and open to encroachment from all sides. The people are enjoying the right of free grazing and grass cutting without any restriction. For consumption of timber, the locals are granted permits by the Forest Department on token price.

4.3.4 Natural Disasters

Karakoram-Himalayan region (Northern Areas) form one of the most active seismic zones of the world and though the number of large earthquakes within the region has been much less than adjacent areas of Indian Himalayas and Hindukush as well as Baluchistan, yet some serious incidents have occurred during the last two centuries causing large landslides. Occasionally, landslides and glacier dams have been breaking up into devastating floods affecting the Indus plain downstream.

4.3.5 Infrastructure

A major constraint in the way of progress of the region has been the poor and primitive means of transport and communication. The total jeepable road network is about 4000 km, which hardly serves a fringe of the population. Most villages can be approached only by tracks. During winter, a large part of the region becomes inaccessible because of blockade by snow and ice. As a result the prices of commodities are extremely high in the area and have to be subsidized by the government. Consequently, the bulk of the financial budget of the area goes in subsidies rather than actual development work.

4.3.6 Population Pressure and Migration

The impact of population pressure in the area cannot be assessed by considering population growth and population density. The major concern is with the population density and with the population resource ratio and population-resource use system, which shows clear imbalance. This can be witnessed by the damage done to the life support system, by deforestation, utilization of marginal lands, erosion and lack of economic opportunities. As a result, large scale migration is taking place from these areas into lowland cities of Pakistan. Such migration consists of the young and physically fit members of families leaving behind the old and the least fit.

4.3.7 **Lack of Public Awareness, Participation and Support**

Neither the people of Pakistan are adequately informed of the seriousness of watershed management problems in Northern Areas and the tremendous importance of the land/water resources of the region to national welfare, nor the people within the areas are aware of the potential of their land. Moreover, there is a surprisingly low level of awareness amongst the decision makers of the full dimensions of the problems of environmental deterioration in mountainous areas and its consequential impact on the adjacent lowlands.

4.3.8 **Lack of Effective Management**

A major impediment in the development of the region is an ecologically sound development organization. The government departments working in the area at present are not effectively coordinated. Government policies have neither been streamlined nor have the administrative procedures for comprehensive planning for resource conservation and development. Many development schemes involving considerable investment have been planned and launched to serve a single or dual purpose without consideration of other important uses and elements of regional planning. Agencies performing developmental work in the area are critically short of professionally trained and experienced personnel because of the un-attractiveness of the area. Therefore, they are unable to plan and implement projects effectively. There is no arrangement to train technical and professional staff to work in the mountain environment. The Agha Khan Rural Support Programme (AKRSP) model introduced recently should be formally institutionalized.

4.3.9 **Lack of Scientific Data**

There is a gross deficiency of even elementary scientific data for decision makers, planners, and administrators. The area has neither been fully covered by aerial inventory nor mapped completely at a suitable (1:50,000) scale. In addition, information on meteorology, soil, flora, fauna and socio-economic conditions is scanty.

CHAPTER 5

RECOMMENDATIONS

An effort has been made in this chapter to frame recommendations to promote irrigated agriculture in the Northern Areas of Pakistan at a rate commensurate with the needs and the resource of the region. It may be emphasized that the ultimate objective of this agricultural development is the creation of a viable economy and making the region self-sufficient in food and fiber. Exploitation of the water and land resources of the Northern Area is expected to result in more than simple self-sufficiency in food and fruit production for local consumption and export to other parts of the country. Thus, it will also remove a basic barrier to development of a viable economy.

5.1 Development Approach

The agriculture sector is based on traditional methods of operation, which lead to a low-level equilibrium situation, not capable of promoting modern agriculture or indefinitely accommodating population growth. In fact, the present population is already in excess of what can be supported with inadequate social services, traditional methods and resources. The crop and livestock resources being used in the present farming systems have essentially been evolved and retained to be compatible with the inputs of traditional resources and skills.

The development strategy for the area is based upon three central concepts which in turn, are drawn largely from the experience of successful irrigated agriculture in similar areas lying in other parts of the world like China, Europe and Asia.

i. The carefully planned and phased introduction of certain few but essential ingredients into a traditional or subsistence irrigation system will improve the food production substantially. These essentials are irrigation water supply, improved seeds, fertilizers and modern technology of using agricultural machinery. Given these ingredients at proper time and in the right proportions will give an excellent result and growth; without them, no appreciable change can occur.

ii. Secondly, the evolution of modern irrigated agriculture in this kind of terrain invariably involves several distinct stages of water resources development. Each stage, in turn, commonly exhibits temporary over development of water resources. In this contrary situation land resources, rather than water, are overdeveloped.

iii. Thirdly, in view of a large extent of a very difficult terrain and absence of sizeable contiguous cultivable land and irrigation water, it is not possible to plan a truly ultimate development programme and even if it were, such a program would always be prohibitively costly in relation to contemporary values. Therefore, for development planning “village” should be considered as development unit. The problems of mountainous Karakoram-Himalayan region cannot be solved by the costly technical methods used in the more productive lowlands in Pakistan. Greater reliance must be placed on understanding natural processes of environmental control. This ecological tendency, if exploited by suitable programs and organizational designs, can help to produce a coordinated model with operational value.

The role of research, extension and input supply system is extremely important in improving the efficiency of production through supply of knowledge, methods and material inputs. In Northern Areas, the agricultural research and extension system is incomplete and fragmented. There is no effective support organization to provide the improved seed and planting material, fertilizers, chemicals and the equipment, which farmers need and wish to purchase to boost up the food production. A co-operative effort is needed amongst various agencies and small farmers to work collectively on the methods and approaches for rational management of resources and planning.

5.2 Identification of Development Schemes

Based on the office desk studies and field reconnaissance surveys, following actions are required to be taken to identify potential schemes and determine priorities to boost up the agricultural production capabilities in Northern Areas;

- Identification of potential sites/schemes.
- Land and soil resources inventory of the area and thereby preparation of soil and land capability map of the area.
- Classification and reorganization of soil families as one of the variable for all agronomic trials and development of a package of technology for the soil families on the farms.
- Preparation of an Agro-ecological zone map of the area on the basis of soil-crop-climate interaction; and to develop techniques for efficient use of water for major soil families of the area by improving soil-moisture conservation practices.
- Improving irrigation efficiencies, water control and measurement at farm level to develop irrigation water requirements for different crops and to study the feasibility and adoption of high efficiency irrigation system.

The idea behind doing the above said exercise is to develop crop varieties suited to different ecological zones. For this purpose, improved varieties of cereals, food legumes and vegetables crop from the down country shall be obtained. Similarly, supply of quality seed of selected varieties and adequate quantity of fertilizers and pesticides along with necessary equipment for carrying out plant protection effectively is a must to augment the food production. In addition to above, standardization of fruit production technologies and supply of pedigree fruit plants of the high yielding varieties and introduction of improved orchard management practices is needed ensuring better outlet for the farm production through establishment of market infrastructure especially for fruits.

Several agencies like Northern Areas Public Works Department (NAPWD); Agriculture Department and Agha Khan Foundation etc. are working to develop irrigation in this region by constructing small and low cost irrigation channels and other allied structures. It would be appropriate to describe in brief the working strategy of different agencies and government departments working in this area and the approach adopted by them to achieve the objectives to promote equitable and sustainable improvements in agriculture production and the agricultural economy of the area to boost up the living standard of its inhabitants.

Northern Areas Works organization (NAWO) replaced NAPWD in July, 1976 and charged with the responsibility of executing development work in this remote area beset by poor communication network. In 1986, NAWO has again been renamed as NAPWD. The decision of change over was largely in accordance with the expirations of the public. NAPWD is headed by a Director General (Brigadier) equivalent to the

rank of Chief Engineer assisted by Lt. Cols. and Majors. Local talent in the form of Civil Engineers (XEN and SDO), Sub-engineers, Supervisors and the work charged staff continued to constitute the basic hardcore of the new organization. The organization, though under ministry of Defense and Army Oriented, remained predominantly civil, for the reason, military component comprised of no more that one percent of the total strength.

Northern Areas Works Organizations (NAWO) introduced new constructional techniques on war footing with the result a profusion of facilities like roads, suspension bridges, residential and non-residential accommodations, hydro-power stations, irrigation water channels, schools and hospitals have been added and a marked change is now discernable in the entire Northern Areas. PWD in different forms with changed nomenclatures is responsible for the development and maintenance of all types of works in Northern Areas.

There is an Agriculture Department headed by the Director Agriculture at Gilgit. Junior staff like Agriculture officers, Plant Protection Officers and Field Assistants is available for the guidance, help, advisory and practical services to the Zamindars.

An office of Agricultural Engineer has also been established recently at Gilgit. Following facilities are supposed to be provided to the cultivators by the Department:

i. Provision of tractors, threshers and Maize Sheller at nominal hire charges.

ii. Supply and spray of pesticides; the sprayer is provided free while only 5% of the cost of pesticides is charged at present.

iii. Seeds and manure is supplied at the same rates as at Rawalpindi. For this purpose, stocks are maintained at Gilgit and at other villages with the Fields Assistants.

iv. Fruit nurseries are maintained by the Department for supplying fruit plants to the cultivators at nominal rates.

v. Advisory services by the officers and field staff are provided free.

The Agha Khan Rural Support Programme (AKRSP) is a private, non-profit company, established in 1982-83 in Gilgit by the Agha Khan Foundation of Pakistan. AKRSP's specific objectives have been formulated to complement and supplement the activities of Government Departments and other development agencies. Foremost among the specific objective is the creation and support of broad-based, village level organization that can mature into self-sustaining development institutions in the villages and to develop a strategy for optimal long-term use of natural resources at a high level of productivity. This approach of AKRSP to achieve its objectives is the outcome from the experiences of agricultural co-operative movements in Europe and Asia including Scandinavia, Germany, Japan and South Korea and is perhaps the best-suited technique for the development in high-mountain valleys of Northern Area. The most essential feature of this approach is the insistence that small farmers work collectively to overcome the handicaps of their subsistence holding and organize themselves into broad-based, multipurpose co-operatives. The second principle of AKRSP'S approach is that productive physical infrastructure projects should usually precede other development efforts. This principle is simply recognition of the importance that farmers everywhere attach to improvements in their individual and

jointly managed stocks of physical capital. Since it usually induces broad-based village participation so essential to the success of any development effort therefore, the third principle is that an administrative, or supportive, infrastructure be created to provide villagers with agricultural inputs and sound advice on the use of these inputs.

Village planning, as the name implies, consists of the identification and implementation of a sequence of profitable projects with in a village. The contents of a village plan may vary from one location to another. In Gilgit district, a village plan might include the development of new land opened up by an irrigation channel; plantation of forests and orchards on common lands; enclosure of existing individual orchards and marketing of agricultural products. The mechanism through whish AKRSP implements its development programmes at the village level is the village organization. The village organization is a mass coalition of all those residents of a village whose common economic interest is best served by organizing as an interest group. In short, the village organization is AKRSP's executing agency for all village level projects.

5.3 Manner of Implementation

In general, the major thrust areas which need special attention and appropriate action for the development of Northern Areas are enumerated below:

i. Land and soil management and development;
ii. Water Management
iii. Crop production and protection;
iv. Fruit production, protection and processing;
v. Hydro-power generation for lift irrigation, local use and for development of small industries for processing and packing of fruits etc. and for lift irrigation;
vi. Livestock production and protection;
vii. Range management, fodder and forage production; and
viii. Forest management.

The objective of development is to ensure rapid growth of irrigated agriculture to close the gap in production and demand in the region. To achieve the objective, it is plausible that the Government of Pakistan should take up construction of only major and multipurpose schemes and leave the smaller schemes to be implemented by the villagers themselves through village organization/village co-operatives on the pattern of AKRSP system of implementation.

The new approach of development has certain definite goals divided into "short" and "long" term programmes in accordance with the priorities attached to each of them.

i. Short Term:

- Formation of farmers co-operatives/village organizations.
- Preparation of production plans with emphasis on optimum cropping patterns.
- Establishment of model farms.
- Improving irrigation efficiencies, water control, and measurement at farm level.
- Supply of agricultural inputs.
- Development of a package of technology for all soil families of the

farm.
- Providing credit to farmers.
- Providing storage and marketing facilities.
- Organization and training of farmers in modern production technologies.
- Imparting social education.
- Establishment of research facilities.
- Introduction and testing of indigenous and exotic grasses, legumes and shrubs in various range ecological zones.

ii. **Long-term:**

- Transforming farmers associations into service production social co-operatives.
- Establishment of training institutions for farmers and farm leaders.
- Establishment of local or feeder markets at Markaz.
- Encouraging of savings for increased farm investments.
- Introduction of mixed farm enterprises.
- Preparing and executing low-cost housing and storage facilities.
- Developing agro-service sector at the Markaz.
- Encouraging the undertaking of cottage industry projects.
- Setting-up of agro-allied industries and preservation plants.
- Establishing vertical and horizontal co-ordination from project to national level through establishment of market infrastructure especially for fruits.
- Research to evolve a complete set of soil conservation practices for each situation of slope, soil and crop/vegetation/trees.
- Research to develop techniques for efficient use of water for major soil families of the area.
- Research to develop irrigation water requirements for different crops.

5.4 Horizons of Development

5.4.1 Land Development

Most of the uncultivable lands of the Region in its natural state prior to its development have varying proportion of coarse rock fragments of gravel scattered not only on the surface but also throughout the sub-soils. The surface is uneven and slope varies from about 2% to 60 %. Their clay content varies from 0-20%. The land use statistics reported under present status indicate that there are about 8100 hectares (20,000 acres) of land in the study area which the Revenue Department have classified as culturable waste within the irrigation development schemes. This land can be gradually developed and brought under cultivation.

Most of the land presently under irrigation has passed through the process of physical modification and biological rehabilitation over a long period of time. Development of culturable wasteland is a lengthy and tiresome operation and the cost involved is also very high. Experimental Research Station at Jaglot should conduct experiments for speeding up the land development techniques for culturable waste area and also to determine how to get high return from newly developed lands in the shortest possible time.

It will be difficult task for the government to undertake the development of culturable waste land on its own, the owner of the undeveloped land should arrange manpower assistance through village co-operative organizations. However, during survey a general impression was observed among the local people that the work involved is of such a nature, that manual and bullock power is already insufficient and cannot cope with it. Mechanical power is required to perform this difficult job. The mechanical power can be provided to the farmers through some suitable government agencies.

5.4.2 **Land Consolidations**

Fragmentation of holdings into small pieces is a very serious problem of the region. The farm statistics show that only 1.7 % of the farmers have more than the subsistence holding covering 11 % of the total farmed area.

Northern Region is an unsettled area so far with regards to land consolidation/settlements. The Administration of the Region has taken up in hand the settlement work in Gilgit District. It would be appropriate if the consolidation of holdings is also taken up simultaneously along with the settlement work in other districts also.

5.4.3 **Contour Farming and Terracing**

Before the development work of culturable wasteland is started it would be desirable that area should be contemplated in order to facilitate irrigations of the developed land to avoid wastage of irrigation water.

5.4.4 **Erosion Control**

Both wind and water erosion occurs in the basins. Strong wind carries away fine silt particles from the surface layer and coarse sand particles are left behind on the barren or uncultivated/uncropped fields. This not only reduces fertility of the soil but also hampers the water holding capacity of soil. Water causes rill erosion along with the edges of the nullah especially when there are heavy rains in the catchment area. To control both wind and water erosion, afforestation should be done. For the check of wind erosion, plantation should be raised all along the boundaries of the area under cultivation, and crop/grass cover should be maintained on the uncultivated land. To control rill erosion, willow/popular and Russain olive tree and thorny bushes should be grown along the river bank and boundaries of terraces adjoining the nullahs.

5.4.5 **Improvement of Water Channels**

The watercourses (kuls) in the area are not well designed. The existing water channels should be modified in order to save water losses. The development and maintenance of irrigation channels should be done on scientific lines in order to improve the water conveyance efficiencies.

5.4.6 **Cropping Pattern and Intensities**

In the Northern Region, as already reported under present situation, there are two distinct cropping zones. The zones are based on the altitude of the schemes. At high altitude temperature remains low, therefore, growth period of the crops prolongs to some extent which affects the cultivation of two crops in the normal growing period of the year. Minor adjustment in the cropping calendar should be made to raise

two crops in the zone above 23,00 m as well, keeping in mind the availability of early maturing varieties of cereal crops. Moreover, size of holdings in the region is small one and small size of holdings is conducive for attaining higher cropping intensities.

An appropriate cropping pattern and intensities plan has been taken for future and presented in Fig. 6.1. The perennial crops have been considered twice while calculating the annual cropping intensity. The vegetables will be incorporated in the orchards.

Factors taken into consideration in the preparation of future cropping pattern include:

(i) Plenty of irrigation water is available in Nullas during summer. How to regulate the flow from Nullas into irrigation channels is the fundamental problem to be solved to assure the crop consumptive use requirement of water for the designed intensity.

(ii) Climatically area is most suited for the growing of deciduous fruits; therefore, maximum possible area has been allocated for fruit production. Fruit cultivation will also serve as cash crop.

(iii) According to the information supplied by the Civil Administration of the region, 25% of the total food demand is imported from outside. The adequate water supply, judicious use of fertilizer and introduction of new high yielding varieties of cereals will boost up food grain production considerably in the area. In addition, development of culturable waste land with the introduction of development irrigation schemes will also enhance food production, in the area.

(iv) Because of hilly tract, there is generally fodder shortage and it becomes acute in winter due to inclement and lengthy season, therefore, more area is required for fodder production. The vetch crop is recommended for cultivation as it can better withstand low temperature and can survive well under the prevailing conditions in winter. Fodder yields will also go up considerably with likely water supply along with recommended use of chemical fertilizer. Development of pastures as proposed under range land management will also help in minimizing the problem of fodder shortage.

(v) The potato produced in the plains is mostly infested with diseases and cannot be used as seed for raising the next crop. Pakistan has to import disease free potato seed from abroad and government has to spend a large amount of hard earned exchange on this account. The climatic conditions in the Northern area are such that disease free potato seed can be produced there. The cold and dry weather conditions in the area are not conducive for the development of diseases, which attack potato crop in the plains. Therefore, it is proposed to increase the area under potato crop. It will also serve as a cash crop for farmers.

Generally, agriculture output is increased by two methods: intensive and Extensive Agriculture, that is, either by increasing available cultivated area, or by increasing the productivity of existing cultivated land. The former can be achieved by providing Irrigation to barren land and the latter mostly by more intensive applications of agricultural inputs. Both the components will add to the production capabilities of the area.

5.5 Increase in Cropped Area

Increase in cropped area is possible by developing the culturable waste area.

5.6 Crop Yields and Production

The yields of crops grown in the area are very low. The estimated present crop yields in the area are shown in Table 6.2. The crop yields can significantly be increased through improved water management, certified seeds, improved crop varieties, use of adequate fertilizers, plant protection and other agronomic practices. The impact of these factors on crop yields increase is shown in Table 6.3. The estimated future crop yields of Northern Areas are shown in Table 6.4.

5.7 Use of Fertilizers

To make up the depleted soil nutrients and to obtain higher return per unit of land, addition of organic, applications of artificial chemical fertilizer is very essential. Organic matter is replenished to some extent by the addition of Farm Yard Manure (FYM) and fallen leaves of fruit trees and other plantation raised for the control of wind and water erosion. However, requirement of macro nutrients such as nitrogen, phosphorus and potassium are not fully met with. One of the major reasons for this short-coming is the non-availability of this input at the door step of the farmers. The supply of these fertilizers is handicapped by the absence of jeepable link roads in the area. Non-availability of credit facility to the smaller farmers is also impeding the use of this input. These impediments should be eliminated to enhance the use of artificial fertilizer. The present use of synthetic fertilizers to crops in the area is very insignificant in contrast to its requirements. The recommended application rate of artificial fertilizer to different crops and their total requirement is reported in Table 6.3.

5.8 Cultivation of Improved Varieties

Genetic Improvement in seed and their immunity against diseases and pests can contribute to an increase in output by 15 to 20%. The seed of improved varieties of wheat and maize, the major food crops, grown in the region are available. However, with the exception of very few farmers, cultivation of improved crop varieties has not been adopted, because production of straw per unit area is less and its digestibility is inferior to local varieties under cultivation. However these short-comings can be overcome. There will be significant increase in yield per unit of cropped area with the cultivation of improved varieties. This will permit to reduce to some extent area under wheat which can be spared for fodder production to compensate fodder shortage. Treatment of straw with 4% solution of urea can improve its digestibility to the desired extent.

The agriculture extension staff should make extensive propaganda for the cultivation of improved varieties and can lay out demonstration plots at suitable places to popularize them.

The well established Village Organizations (VO) under the Agha Khan Rural Support Programme (AKRSP) with commendable performance should be used for seed multiplication of the improved varieties. These selected VOs should be given proper training and the crop for seed should be grown, harvested and stored under the guidance of the Agriculture Department. A higher price for the seed of improved varieties produced by the trained growers should be guaranteed. It is advisable to proceed cautiously in the beginning so that guaranteed seed produced is used by other

farmers for sowing their crops.

5.9. Plant Protection

One of the principal impediments which can effect the agricultural production of the area is the prevalence of insects, pests and diseases. The arid climatic conditions and lengthy severe winter season in the region restrict the growth and multiplication of majority of the insect pests and diseases to great extent.

Major insect pests and diseases prevalent in the area have been reported under the present conditions. The introduction of irrigation schemes, intensification of the cropping and use of chemical fertilizer will give impetus to the spread of the reported plant diseases. If necessary steps to control diseases are not adopted with the start of the development proposals these maladies may affect the production potential of the area by 20%. At present farmers are not adopting disease control measures.

The agriculture extension advisory services should propagate intensively the necessity of adopting the disease control measures. Farmers should be educated regarding the identification of disease and life cycle of the insect pests. Insecticides and spray machinery should be provided to the farmers at the subsidized rate initially. While recommending the control of insect pest and diseases emphasis must be placed on cultural practices such as crop rotation and destruction of plant residue through mechanical means. Seed treatment with fungicides before sowing, and growing of disease-resistant varieties should also be advocated.

5.10 Scientific Cultural Practices

All the steps starting from preparatory tillage, including seed bed preparation, methods of sowing, quantum of water to be applied and time of irrigation to a crop, nature and quantity of fertilizer to be applied, its method and time of application, harvesting and threshing methods (to minimize losses during these operations) and how to store produce in order to save it from the attack of insects during storage should be taken care of properly. These cultural practices have a great bearing on the performance of the crops.

5.11 Agricultural Research and Extension Services

The agricultural output can be considerably increased through effective agriculture extension programme and by ensuring adequate supply of physical inputs. It is, therefore, imperative that competent and trained staff should be posted to achieve the desired results. The staff should be provided with adequate transport facilities. Most of the farms surveyed reported little or no contact with the extension services. At present extension services in the area are very inadequate and ill organized.

A Directorate General of Agriculture should be established in the region and each district should be controlled by a Director of Agriculture. Specialists in the field of Agronomy, Horticulture and Plant Protection should be attached with the Deputy Director at the district headquarter. The training and visit Programme like the programme in the Punjab should be introduced in the region as well in order to improve the technical know-how of the farmers. Following facilities are supposed to be provided to the cultivators by the departments.

(i) Provision of tractors, threshers and maize shellers at nominal hire

charges.

(ii) Supply and spray of pesticides: The sprayer is provided free while only 5-10 % of the cost of pesticides should be charged from the farmer.

(iii) Seeds and manure should be supplied at the same rates as at Rawalpindi. For this purpose, stocks should be maintained with the field assistants in each village.

(iv) Fruit nurseries should be maintained by the Department for supplying fruit plants to the cultivators at nominal rates.

(v) Advisory services by the officers and field staff should be provided free.

Agriculture Research Station Jaglot established in 1984 by Pakistan Government has been converted into Agriculture Research Institute for Northern Area, and is working under the control of Pakistan Agriculture Research Council (PARC). The Pakistan Agriculture Research Council should plan to set up its sub-station at Chilas, Skardu, Hunza, Gupis, Ghakush and other strategic locations.

5.12 **Fruit Development and Preservation**

There exists no commercial orchard in the area like other parts of Pakistan. Fruit trees are scattered throughout the cropped area and in residential compounds. Modern concept of orchard management covers growing of fruits intensively as a cash crop. This involves high cost, which cannot be sustained by the local farmers. However, the type and quantum of various fruits produced in the area indicate that there is enormous scope of fruit production along with the improvement in its quality and output per unit area.

Nurseries of improved varieties of various fruits are being established in the area, which is a step in the right direction. A field guide to improve nursery management need to be prepared and distributed among the fruit growers. In order to demonstrate recommended system of planting, small orchards would be established in various schemes.

Fruit picking, processing and drying falls within the domain of female and children activities. Their performance in handling of fruits can be enhanced significantly by imparting them proper training in handling of fruits at harvest stage. The crude method of sun drying fruits for preservation needs to be replaced with the newly developed techniques of fruit drying by chemical dehydrates. The male members need to be trained in the handling of fruit seeding, their grading, new propagation techniques, pruning of trees and the correct identifications and treatment of pests and diseases which attack fruit plant.

5.13 **Live Stock**

5.13.1 **Farming Power**

Introduction of mechanical cultivation in the area is not practicable because size of holding in majority of the cases is small and natural slope is abnormal. This permits the establishment of small plots only in the terraces and cultivation with tractor of small plots with boundary stone wall will not be feasible. Because of small holdings, maintaining a tractor will not be an economical proposition for individual farmers. However, tractor can be had on co-operative basis for development of culturable waste land, haulage of produce for marketing purposes. The prevailing

conditions in the area permit only the development of bullock force for farming purpose. The stocks of the local breed are small ones and physically very weak. At present, local breeds of cattle are being improved by crossing with Red Sindhi, Sahiwal and New Jersey Breeds. Yak is a hardy and well-built animal. It is being tried with the help of Government of China. Local Yaks could be improved at the breeding farms, which should to be established at Government level to meet the farming power and milk requirement of the area.

5.13.2 **Fodder and Forage Supply**

In order to improve fodder supply, area under fodder crops has to be increased in the cropping pattern and cultivation of vetch new fodder crop which can better withstand the inclement winter conditions have to be advocated to meet fodder shortage.

Grazing or lopping of early winter sown cereals can be helpful in meeting the fodder shortage at the close of winter season. It is for this reason that sowing of all wheat crops has been proposed in the month of October/November. The grazing or lopping should not go beyond the end of February.

Malva Verticillata: In the Northern Areas 'Sonchal' (Malva Verticillata) is the most common leafy vegetable. In trans-hamalayan Nepal that is an arid zone like Gilgit, this vegetable is cut and dried as fodder for Yaks in winter season. It is also an important fodder in the Central Asian states. Its estimated return per hectare is in the range of 20- 85 tons of fresh matter. Its digestibility is also very good. This vegetable is well adapted to the region and the potentials of this crop should be examined by PARC.

5.13.3 **Treatment of Wheat Straw**

It has already been reported that under present conditions the digestibility of wheat straw of improved high yielding varieties is not good one, in comparison to the straw of local varieties being cultivated at present. That is why the farmers are reluctant to adopt the cultivations of new recommended varieties. Digestibility of wheat straw can be improved by treating the wheat straw with 4% urea solution. Farmers should be given training in urea straw treatment. This treatment makes the straw more palatable and improves its digestibility. With the improvement of straw digestibility of recommended varieties, farmers will readily adopt their cultivation as it will not add to the fodder shortage problem being faced by cultivators of the area.

5.13.4 **Milk and Meat Production**

The fodder supply position could improve substantially as reported earlier which in turn will help improve the physical conditions of the livestock. Amelioration in health of animals will go a long way in enhancing their productive capacity of both milk and meat. As the climatic conditions are favourable for the development of poultry, poultry breeding farms should be set up in the area by the Animal Husbandry Department. Farmers specially women folk should be trained in poultry keeping and the success of this project will be helpful in eliminating meat shortage in the area.

5.14 **Range Management**

The primary objective of the range management in the area should be to provide firewood for fuel and forage for livestock. Arable lands are very much limited. Large scale production of fodder from these lands will not be feasible as this will result

in the proportionate decrease in the grain production to meet the requirements of the human population. While on the other hand vast areas (over 50% of the land resources) are potentially fit for forage production, which are also presently used as rangelands. These lands need their management on the modern scientific lines that can substantially increase firewood and the forage production.

Rangelands are the greatest gift of nature of the people of the area. There is no range management organization in the area inspite of the fact that rangelands provide the biggest land use in the area. There are no trained personnel in range sciences. Setting up of a range management organization and training of personnel is required for management of these vast rangelands.

For the benefit of the people a planned use of rangelands is needed. Range management practices cannot be suggested without underlining the objectives of management. The following objectives of management are suggested:

(i) The productivity of range lands should be increased by the application of modern scientific techniques.

(ii) The range vegetation should be protected from grazing for critical periods, when there is fodder shortage.

(iii) The livestock should utilize the whole range in a uniform manner.

(iv) The cutting of forest plantation for firewood should be regularized.

5.15 **Conclusions**

The major restraints to the development of Northern Areas in general are scarcity of plain land and water factor; insufficient, poorly timed and unreliable irrigation supplies and inadequate infrastructures, communication and transportation facilities and inadequate use of fertilizer and pesticides. Modern technology is needed for water resources development, operation and management to meet the requirement of different phases of agricultural activities. Shortage of agricultural extension facilities and the difficulties due to remoteness and the topographically imposed isolation and local variation in growing conditions imposed by climate which are different from rest of the country have also restricted its development. The remoteness restricts transportation access to markets and better prices.

In removing these restraints, the provision of requisite infrastructures and on-farm management will provide the initial impetus and the essential requirements for the improvement of agribusiness and fruit production/preservation in the Northern Area. With the additional water supplies, new cultivable waste land will be brought under cultivation and cropping intensities and yields will increase greatly, creating an environment favorable for rapid increase in food production, to meet the demands of both producers and consumers. However, optimum increases in production cannot be attained with the inadequate inputs and primitive equipment and the relatively inefficient practices now commonly in use.

Upon the elimination of the restraints imposed by water factors, cultivators could be encouraged to increase other inputs and adopt modern practices in places where it is practicable. First there will be a rapid increase in the demand for and use of commercial fertilizers, pesticides and improved seed varieties, whose yield potentials are much higher than the seed varieties presently in common use. Simultaneously, simple changes in farm operations and water management practices by adequate and timely irrigation supplies could be adopted.

Since the cultivation at most of the places is in the form of terraces, draft animals will be in greater demand and mechanization of operations will spread on large holdings and at places with wider fields. Increased yields will require improved harvesting practices, which in turn will require new and more efficient equipment. Facilities for crop and fruit storage and preservation/processing shall be needed. Better markets and marketing facilities will be in demand. Similarly better farms-to-market roads and transportation facilities will be necessary. The existing roads are all rough surfaced, narrow with poor grades and sharp curves. Most of these roads are dangerous and risky. The difficult topographic conditions, frequent land slides and movement of glacier morain greatly hamper the construction of roads in the area. Anyhow, these improvements, which will require the co-operative efforts of farmers, villagers, businessmen and the Government, will greatly stimulate the agricultural economy.

Most of these developments require capital investment. There is an extreme shortage of investment and working capital throughout the Northern Area. It is not possible to raise the production and management level without the availability of credit and loans and saving facilities. The shortage of credit facilities also affects the use of improved seed, fertilizers and other farm inputs. The lack of credit facilities, especially for fruit processing and packaging is one of the reasons for wastage of fruits in abundant quantities. The Agricultural Development Bank and other financial agencies must establish procedures which will encourage the farmers to borrow needed capital for necessary equipment and facilities. More facilities must be established to assist the cultivator in buying supplies and in marketing his produce efficiently and equitably. Village co-operatives and farmer-controlled co-operatives can supply the necessary production inputs such as improved seeds, fertilizer, pesticides and implements and provide storage facilities and processing plants. With increase in marketable surplus, the importance of processing of fruits and vegetables into convenient and storable forms will increase as quality control and grading will be necessary. An expanded and improved transportation system is another need associated with increasing crop and fruit production.

The role of research, extension and input supply system is extremely important in improving the efficiency of production through supply of knowledge, methods and material inputs. There is no effective support organization at all in the Northern Areas to provide the improved seed and the planting material, fertilizers and chemicals and the equipment, which farmers need and wish to purchase. An effective educational programme will be necessary to teach the farmers and the villagers how best to make the changes necessary for rapid and full development of agriculture. Thus, an efficient, well-trained agricultural extension service can contribute greatly to agricultural progress and evolution. Dissemination of technical know-how and training of farmers in modern production technologies is a must to promote development in the area.

There is a lack of suitable livestock production systems including new breeds and animal mixes, pest and disease control and animal care, livestock feed, field operations, housing and produce handling in the area. Establishment of veterinary hospitals, efficient disease investigation facilities and monitoring of related data regarding disease are of economic and prophylactic importance and require due attention.

Establishment of research facilities in the field of agricultural production and the field of animal/poultry feeds preparation, utilizing the locally produced ingredients, analysis of such feeds and forages, testing of such formula for efficiency and

economics and their demonstration to the farmers for cattle, sheep, goat and poultry production is needed. In view of extreme shortage of fodder for animals, introduction and testing of indigenous and exotic grasses, legumes and shrubs in various range ecological zones is required. Agronomic and other cultural trails of promising forages to develop package of technology is also needed.

Research is also needed to develop irrigation water requirements for different crops and to study the feasibility and adaptation of high efficiency irrigation system for the development of crop varieties suited to different ecological zones keeping in view the requirements of the major agro-ecological zones of Northern Areas.

Farmers have developed many wrong notions through hereditary practices and limited communications. It is therefore vital for agricultural development that good research should be produced by trained people and that the knowledge gained and substances obtained from the research be given to the farmers in an effective way.

Holdings are generally small and fragmented. Prices tend to fluctuate widely to the disadvantage of small farmers. Credit is often not available to majority of small farmers. In view of this, establishment of agro-based industries should be encouraged in the rural areas and the price incentive is necessary for the farmers. Government should ensure the national and international average prices to the farmers for exported items. Storage, processing, and marketing facilities should be provided, ensuring better outlet for the farm production through the establishment of market infrastructure especially for fruits.

We should no longer regard farming as a day-to-day family occupation. It has become a business and must be treated like any other modern business, if it is to fulfill its task, and the farmer must be treated as manager, entrepreneur, and business oriented skilled farm worker. He must be provided incentives equivalent to a businessman. The prices of farm products must have clear incentives for farmers, because when farmer gets more money, it is but natural that he will put more inputs to the farm, in the form of fertilizers, pesticides, farm machinery hours, labour and his managerial abilities, to produce more. Thus after every production cycle, there will be more output from the flow resources of the farm, which have unlimited production potential.

Table 5.1: *Estimated Present Crop Yield for Northern Areas*

Sr. No	*Crops*	*Yield (kg/hectare)*	*Yield (Mds/Acre)*
1.	Wheat and Barley	1581	16
2.	Maize	1778	18
3.	Potato	19240	200
4.	Pulses	593	6
5.	Lucern	20748	210
6.	Rabi Fodder	27664	280
7.	Kharif Fodder	27170	275
8.	Vegetables	6916	70
9.	Fruits	7904	80
10.	Sugarcane	59280	600
11.	Oilseeds	593	6.0
12.	Rice	2470	25.0

Table 5.2: *Crop Yield Increase Potential*

S.No		*Percent Increase above current levels*

	Factor	*Wheat*	*Rice*	*Cotton*	*Sugarcane*
1.	Improved Water Management	20	10	10	10
2.	Drainage and Salinity Control	10	10	15	10
3.	Certified Seeds, Improved Varieties	15	25	15	10
4.	Fertilizer	45	40	20	30
5.	Plant Protection	15	15	30	10
6.	Other Cultural Practices	30	40	80	15
	Total:	135	140	170	85
1.	Current National Average	15.6	16.7	2.8	405
2.	Potential	37	40	7.5	750

Source: Leading Farmers Survey, Master Planning & Review Division, Wapda, 1987.

Table 5.3: *Estimated Future Crop Yields of Northern Areas*

Name of the Crop	*Yield (kg/hectare)*	*Yield (Mds/Acre Yield*
Wheat + Barley	3162	32
Maize	3557	36
Potato	39520	400
Lucern	56810	575
Rabi Fodder	55328	560
Kharif Fodder	53352	540
Vegetable + Fruit	14820	150
Miscellaneous (Oilseeds, Pulses)	1186	12

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