NEEDS ASSESSMENT ON SOIL AND WATER IN AFGHANISTAN

Future Harvest Consortium to Rebuild Agriculture in Afghanistan

Coordinated by the

International Center for Agricultural Research in the Dry Areas (ICARDA),
Aleppo, Syria

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Executive Summary

1. Two decades of war in Afghanistan had a devastating effect on its people, infrastructure, and the socio-economic structure of the country. The manmade disaster, compounded by the natural disasters like earthquakes, floods, and drought took a heavy toll on the Afghan people and their livelihood. The negative impacts of these was particularly felt in the rural Afghanistan where more than 75% of the population live and agriculture is the mainstay of theirs and the country's economy. Events of September 11, 2001, focused the attention of the international community on Afghanistan once again to rejuvenate its economy and reestablish food security in the country. Food security depends on agriculture which relies on sufficient water, functioning irrigation system, adequate rainfall, and a fertile soil.

2. The Government of Afghanistan has identified agriculture and rural development as key priority areas. Pillar 2 of the Afghan National Development Framework, NDF, outlines rehabilitation of agriculture and irrigation infrastructure as important component of its developmental strategy.

3. ICARDA was invited by USAID to coordinate and to provide quality seed and other technical assistance that will contribute to restoring agricultural productive capacity and food security in Afghanistan. ICARDA convened a Stakeholders Meeting on Restoring Food Security and Rebuilding the Agricultural Sector of Afghanistan, 20-21 January 2002 in Tashkent, Uzbekistan, which was attended by 74 participants representing 34 different organizations, including international agricultural research centers and agencies, international NGOs, U.S. universities, the U.S. private sector, and donor development agencies, together with Afghan agricultural experts.

4. ICARDA put together a team of experts on soil and water to conduct a need assessment (NA) for soil and water in Afghanistan based on the current prevailing conditions in the field in the water resources and irrigation sub-sector and soil in the country, and to appraise priority needs through the identification of irrigation and water supply projects.

5. A comprehensive questionnaire was prepared after a series of meeting with USAID, Ministry of Irrigation and Water Resources, Ministry of Rural Development and Reconstruction, ICARDA's experts in Soil and Water sector, FAO, NGOs, and the Afghan Information Management Systems (AIMS).

6. The Afghan Survey Unit, ASU was selected to conduct the field survey. An extensive training was imparted to the Afghan Survey Team, which consisted of irrigation/water supply technicians, agricultural engineering and agronomy extension service personnel. Each member of the team was made to understand all the items in the questionnaire so that the data collected should have acceptable accuracy. Three GPS units were provided to record the coordinates of the location where soil samples were to be taken. This will help in any future effort in building a GIS for soil and water in Afghanistan.

7. Survey team was dispatched to five provinces, Herat, Helmand, Ghazni, Balkh, and Baghlan to evaluate the status of irrigation systems and soil. The provinces were selected based on irrigated and rainfed areas, road accessibility and apparent security. From each province three district were picked. A total of 129 questionnaire representing 129 farmer groups were filled both from irrigated and rainfed areas. As part of the survey, 129 soil samples were obtained and shipped to Pakistan and Cornell University for analysis.

8. The main disciplines of Irrigation and Water Resources covered in this study were :

Water Resources – Irrigated Agriculture

i. Sources of Irrigation Water
   - Surface
   - Groundwater (Karezes, Springs, Tubewells)

ii Water Distribution and Water Laws

iii On-Form Water Management

iv Water Supply (Domestic and Livestock)

Water Resources – Rainfed Agriculture

i Rainfed Area

ii Groundwater (Karezes, Springs, Tubewells)

iii Water Supply (Domestic and Livestock)

iv Watershed Management and Erosion

Soils, Crop Production and Fertilizer Utilization

i Mechanisation

ii Cropping Pattern

iii Crop Production Problems

iv Nutrients,

v Quality of Fertiliser and Application

9. The survey of irrigated areas indicated that lack of water is the most importune constraint against agricultural development in the country. The condition of the conveyance system is next to water scarcity. The survey showed that canals are restricted up to eighty percent of their capacity by siltation, bank damage and vegetation growth.

10. Lack of a coordinated maintenance system because of war and lawlessness has led to the problem of conveyance. Regular desilting was not carried out for various reasons. Due to the drought conditions, the flow in the canals was reduced drastically resulting in low velocities and settling down the suspended sediment load.

11. *Mirab* is a key figure in the operations and maintenance of the irrigation system and water distribution according to the agreed arrangement. The inspection of the system and pertinent structures is carried out periodically by farmers and the *Mirab*. Although regular maintenance is scheduled to be carried out periodically when sufficient self-help

labor is available, however major repairs cannot be carried out without governmental support.

12. A semblance of a water users association exists in most parts of the areas surveyed. This makes it easier to establish a more formal and responsible WUAs in the country.

13. The survey revealed that material, skilled and unskilled labor are available in abundance. Of course high tech gates and other prefabricated parts have to be imported from the Capital City or neighboring countries.

14. Major effort is needed to improve on-farm water management. The farmers knowledge of crop water requirements is based on the *dry appearance of soil surface* or *remembrance of the time of last irrigation*. Basin irrigation is practiced widely which results in wastage of water at the expense of the lower end farmers.

15. Leveling of irrigation field results in improved crop and water use efficiency. On an average, fifty percent of farmers surveyed responded that their farms are leveled. This is indication of widespread inefficiency in irrigation. To overcome unevenness of their fields, farmers divide their fields into smaller plots.

16. Soil salinity does not seem to be widespread in the areas surveyed. In areas with salinty problem, high water table and soil were the source of salinity.

17. Despite heavy risk of flood and drought, no emergency plans are available for their monitoring, regulation, management, and mitigation. The most common method to cope with drought situation is to ration water and limit irrigated area.

18. Groundwater is an important source of irrigation water. It is tapped through springs, karezes, and wells. In all areas surveyed, karezes and springs have either dried up or the out put has reduced substantially. The reason being the war and the recent drought. In the karez-spring irrigated areas, farmers showed contempt for deep wells. They look at them as the reason behind the reduction in their karez-spring out put. Their contempt may not be misplaced because of unregulated sinking of deep and as well as shallow wells by some well to do farmers and NGOs without taking into consideration their adverse effects on the groundwater table.

19. In the provinces surveyed, the average per capita daily water consumption was about 39 liters. The main source of drinking water in the west and southwest was dug wells and in the north, shallow wells and irrigation canals. Though the majority of respondents were satisfied with their water quality, they apparently were judging it from a taste point of view rather than a public health point of view.

20. About forty to fifty percent of the respondents indicated shortage of drinking water during the drought years.

21. The percentage of farmers sharing their drinking water supply varied from 42% to 82%

22. Water rights issue is an important factor if irrigation is to improve substantially. The survey showed that farmers are using local practice and traditional laws in water distribution. The 1981 water law and its regulations regarding agricultural use can easily be updated to conform with the present strategy and organization of the government. Many aspect of the water law are in use at this time such as water user associations, the election and responsibility of the Mirabs, however, the more contentious issues of specifying the per jerib water requirement based on the current environment may prove difficult. But unless the water law is updated and enforced, agricultural improvement will be difficult to achieve.

23. Of the total 129 farmer groups surveyed, 111 belonged to irrigated farms and 18 to rainfed. In the rainfed areas with the exception of Ghazni, the rainfall was a average this year compare to 'Good" in a normal year. In Ghazni, the rainfall has been poor indicating the drought is still persisting there.

24. The cultivated land in the rainfed areas is slightly more than last year, but no where near the available cultivable land.

25. Minefield were not reported in the rainfed area as a constraint to agriculture. Again it does not mean that minefields do not exists, it is just the farmers surveyed did not see it as a constraint.

26. No rainwater harvesting and watershed management were reported in the survey. In only one instance some farmers collect water in the rock depressions for drinking and domestic use.

27. As for the water reaching the tail end of the system the response of more than sixty percent of the farmers in Herat, Ghazni, and Balkh was affirmative, while in Baghlan and Helmand it was fifty percent or lower. The lower percentage in Helmand and Baghlan could be traced to the unauthorized use of water by some powerful locales at the expense of the lower end receivers.

28. A survey of crop production practices and problems was carried out on 111 irrigated farms and 18 rainfed farms. Soil samples collected from the farms were analyzed for some basic properties and for fertility parameters. Soils were mostly in the loam to sandy loam textural classes (mean sand content 49%) and had high pH (mean 8.2) and calcium carbonate (mean 23%) content.

29. The crops most commonly grown on irrigated farms were wheat, barley, maize, munbean, cotton and melon. Farmers identified water availability as a moderately severe problem and estimated that crop yields obtained in 2002 were reduced on average to between 75 and 85% of yields obtained with normal water availability. Crop yields in 2002, and yield estimates with normal water availability, varied widely amongst farms. Wheat yields, for example, ranged from less than 1 to almost 5 t/ha in 2002. Such variability is unusual for irrigated agriculture and suggests that there are some serious constraints to productivity. Farmers ranked lack of credit as the most severe constraint,

followed by lack of water, nutrient deficiency and lack of seed. The pest-disease-weed complex of biotic constraints and seed quality were ranked as moderate problems.

30. Fertilizer use was constrained more by affordability than by availability. Nutrient inputs (fertilizer and/or animal manure) were high for the yield levels achieved and were not consistent with the apparently high frequency of nutrient deficiency. Urea and DAP were the only fertilizer sources used. Fertilizer management practices were not unreasonable, although high variability in the rates used at different application times suggests that farmers do not know what the best practice is. Relationships between nutrient inputs and crop yields were poor. Use of urea on legumes suggests that biological N fixation is not occurring or is limited.

31. Soil analyses showed that salinity was not a problem. Soil fertility status was variable for P and generally adequate for K. Available soil P levels were highest in Balkh province and lowest in Helmand province, despite the fact that P inputs were highest in the latter. Soil zinc status was low in Ghazni and Helmand provinces but was generally adequate in the other provinces. Crop yields are likely to be limited by P and Zn deficiencies in Helmand province and by Zn deficiency in Ghazni province. Poor grain fill in wheat, especially, in Balkh province, suggests boron deficiency. Analyses of soil B and organic matter status are underway.

Chapter 1

Introduction

Background

Two decades of war in Afghanistan had a devastating effect on its people, infrastructure, and the socio-economic structure of the country. The manmade catastrophe, war, compounded by the natural disasters like earthquakes, floods, and drought took a heavy toll on the Afghan people and their livelihood. The impacts of these disasters were particularly felt hard in the rural Afghanistan where more than 80% of the population live and agriculture and livestock are the mainstay of their economy.

The Government of Afghanistan has identified agriculture and rural development as key priority areas in its development strategy. Pillar 2 of the Afghan National Development Framework, NDF, outlines rehabilitation of agriculture and irrigation infrastructure as key components of its developmental strategy.

The events of September 11, 2001, and the subsequent collapse of Taliban focused the attention of the international community on Afghanistan once again. The international community decided to help Afghanistan reestablish food security in the country and rejuvenate its economy. Food security directly depends on agricultural output, which relies on sufficient water, functioning irrigation system, rainfall, and a fertile soil.

The International Center for Research in the Dry Area (ICARDA) was invited by USAID to coordinate and to provide quality seed and other technical assistance that will contribute to restoring agricultural productive capacity and food security in Afghanistan. ICARDA convened a Stakeholders Meeting on Restoring Food Security and Rebuilding the Agricultural Sector of Afghanistan, 20-21 January 2002 in Tashkent, Uzbekistan, which was attended by 74 participants representing 34 different organizations, including international agricultural research centers and agencies, international NGOs, U.S. universities, the U.S. private sector, and donor development agencies, together with Afghan agricultural experts.

The following four major thematic components were considered:

1. Seed Systems and Crop Improvement
2. Soil and Water
3. Livestock, Feed and Rangelands
4. Horticulture

As a follow up to that meeting, ICARDA put together a team of experts to conduct a need assessment for soil and water in Afghanistan based on the current condition in the field. This report presents the findings of the soil and water team.

Terms of Reference of the Soil and Water Need Assessment

Terms of reference for the needs assessment team for soils and water developed by ICARDA were as follows (See Appendix 1 for complete TOR)

Team activities;

1. Collate and analyze information available on the current state of irrigation systems, water use systems, soil fertility, availability of fertilizers and any other inputs. First priority will be given to irrigated areas of highest potential for field crops followed by other irrigated and rain-fed areas.
2. Gather information through direct interaction with NGO's and government departments and other organizations working on the soils and water sectors (e.g.. IFDC) in consultation with the ICARDA staff on the ground.
3. Prepare survey/questionnaires to assess the state of the available resources for soil and water management.
4. Identify potential partners who can conduct the surveys in collaboration with local contacts Conduct any necessary training in the use of the survey/questionnaire.
5. Develop a work plan for the survey/questionnaire with approx. dates. Agree on a timetable for preparation and delivery of the needs assessment report (tentative timetable attached).

After the surveys have been completed the team should analyze the data and prepare a report containing;

1. Information on the status of irrigation systems.
2. Identification of sites/regions where impacts of recuperation of the irrigation systems can be greatest in the short term.
3. Assess the needs and priorities for re-establishing a functional irrigated agricultural sector and tentatively identify similar needs for rain-fed systems.
4. Identification of training and capacity building needs for soil and water management specialists, NGO's and other relevant organizations.
5. Suggestions for themes for further projects of a medium to long-term nature in consultation with local authorities

Structure of the report:

A general description of soil and water is included in Chapter two. Reliance is made on the old statistics obtained from the Central Statistics Authority in the 1970s since they seem to be the more reliable ones.

Chapter Three presents the methodology of the survey. It explains the questionnaires and the data gathering processes.

Chapter Four will cover the analysis and discussion of the survey results. Chapter five includes the recommendations and Chapter six presents project ideas developed during the wrap-up workshop in Aleppo.

Chapter 2

Afghanistan

The Land

Afghanistan is located in Central Asia between 29^o 35' – 38^o 40' latitude and 60^o 31' – 74^o 55' of longitude. It is bounded by Turkmenistan, Uzbekistan and Tajikistan in the North; China to the Northeast; Pakistan to the East and South, and Iran to the West (Figure 2.1). It is convenient to divide Afghanistan into four major geographic zones: the northern plains; the central mountains; the eastern and southeastern mountains; and the southern and western lowlands. The northern plains are relatively low, about 400m asl though the altitude rises rapidly toward the foothills of the central mountain region. The climate is cold winters with about a month of freezing temperature followed spring weather with showers and a hot and dry summer with temperatures approaching 40 degree C. Mazar-e-Shareef, Kunduz, and Baghlan are the major population centers in the north

The plains of the north are separated from the rest of the country by the rugged Hindu Kush mountain range. This mountain range extends from Pamir in the northeast to the central and eastern parts of the country. In this area, even the valleys lie at around 3000 m asl. In the winter the snow line descends to about 2000 m and most of the passes on the mountains become impassible.

Afghanistan's only major forested area is located in the eastern region. The valleys in this region have traditionally been very fertile and can support the inhabitants. The southern and the western lowlands are the largest and comprise the valleys of the two major rivers, the Helmand, and the Harirud. Much of this area is between 300m to 1000m asl. It is much hotter than the rest of the country. The highway loop around the country connects all these regions to Kabul, the capital city (Figure 2.1).

Administratively, Afghanistan is divided into 32 provinces (two provinces have very recently been added). There has never been a complete census in Afghanistan. All figures on the population and its make up are guess work and approximation. The current population of Afghanistan is estimated at about 20 million with a rural population of around 16.5 million. They live in approximately 20,000 villages scattered across Afghanistan. The scatter of villages is mainly based on the availability of water.

There is a strong relationship between the amount of precipitation, length of growing season and altitude. At greater altitudes, precipitation is high and the growing seasons are shorter due to frost hazard. In the mountainous zone of the country where precipitation is sufficient, the availability of agricultural land (due to frost and rocky terrain) is a limiting factor. In the flat areas growing seasons are sufficiently long, even for double cropping, but the limiting factors are effective rainfall and irrigation water availability (ref).

Table 2.1 presents the average record of annual precipitation over a period ranging from 8 to 13 years. The data were gathered from 16 meteorological stations located in different parts of the country (the stations are not functioning at this time). The annual distribution of precipitation (Table 2.1) shows the picture of an essentially arid country.

The number of frost-free days varies from 137 in the mountains of Salang to 315 days in Jalaabad. The number of frost-free days will dictate the selection of appropriate crop for an area.

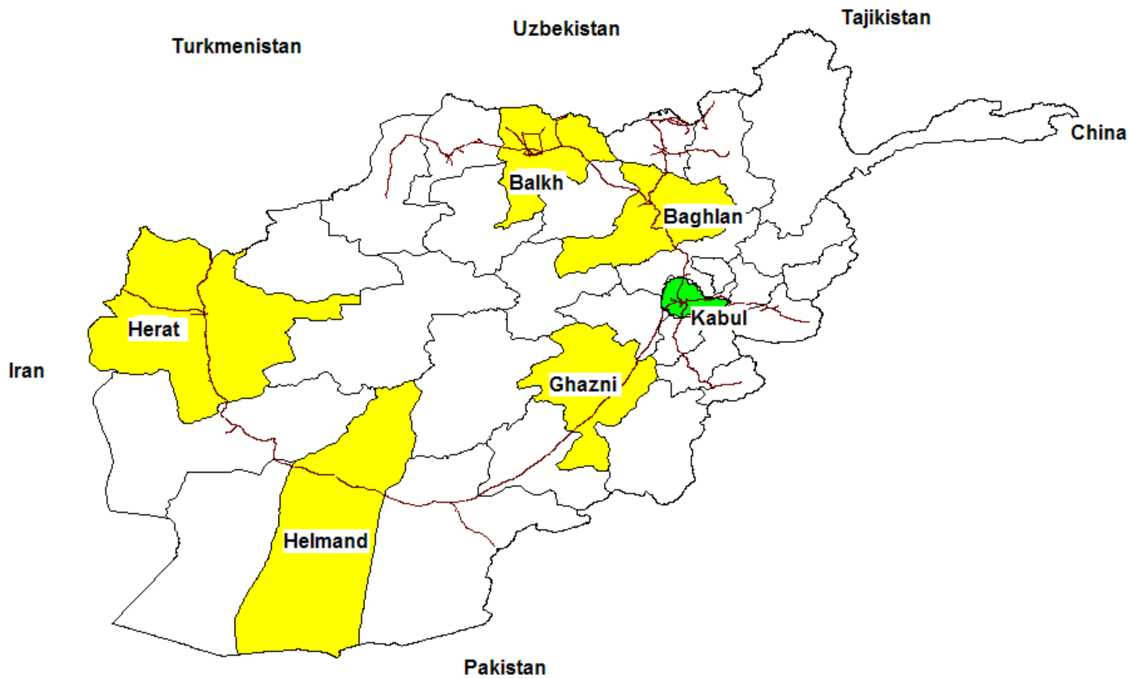


Figure 2.1: Map of Afghanistan with highway loop

Agriculture

The arable agricultural resource base of Afghanistan is about 8 million ha, which is 12 percent of the total land area. Major arable lands for permanent crops are located in the north and western parts of the country. The irrigated land is usually located in the river basins of the North, West, and the Southwest. Higher average rainfall and the presence of a number of major rivers in the north, including the *Amu* river makes it the most important agricultural region. About 40 percent and fifty percent of the irrigated and rainfed wheat area, respectively, are in this region. Despite of many years of planning (the Seven Year Plan for example) Afghanistan does not use the water from the *Amu* river as it should. Proper use of water from the Amu river will bring thousands of

Table 2.1 Climatic data for selected towns in Afghanistan

Station	Elevation (m)	Average Annual Precipitation (mm)	Years of Record	Mean Date of First and Last Killing Frost	Mean Number of Frost-free days
Faizabad	1,200	548	8	Nov 4 -Mar 24	224
Kunduz	455	371	13	Nov 27- Mar 13	258
Baghlan	510	271	13	Nov17 - Mar 12	249
Mazar-i-Shareef	378	197	13	Nov 16 - Mar 7	253
Maimana	815	376	12	Nov11-Mar 19	236
Heart	964	207	13	Nov 3 – Mar 19	228
Farah	660	75	11	Nov 20– Feb 22	270
Kandahar	1,005	180	8	Nov 20-Feb 21	271
Lashkargah	780	106	11	Nov 16 – Feb19	269
Jalalabad	566	172	13	Dec 4 - Jan 22	315
Ghazni	2,183	296	13	Oct 12 – Apr 6	188
Khost	1,146	492	9	Nov 25 – Feb13	284
Kabul	1,803	346	13	Oct 26 – Mar29	210
Jabul Seraj	1,630	510	10	Dec 6 – Feb 24	284
Salang North	3,366	1,169	11	-	-
Salang South	3,172	1,168	9	Oct 4 – May 19	137

Source: Central Statistical Office, Government of Afghanistan

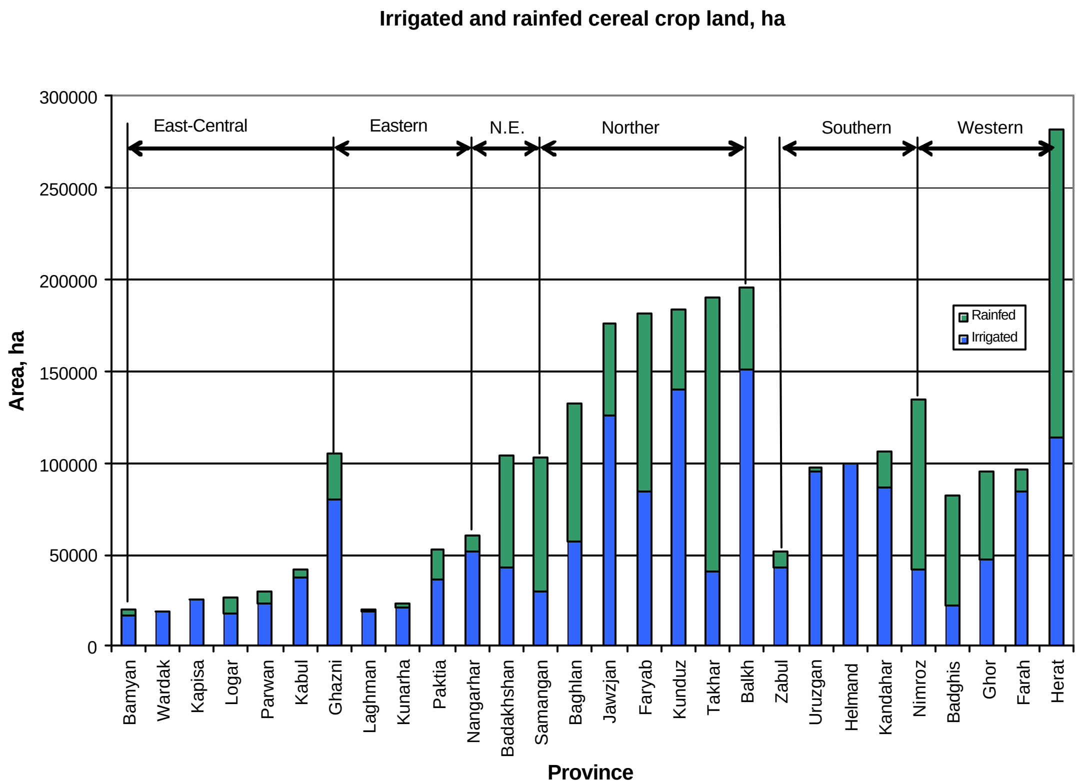


Figure 2.2: Area for irrigated and rainfed cereal crop in Afghanistan

hectares of land under irrigation in northern Afghanistan. Though there are irrigated lands in the southern and eastern parts of the country, the proportion is small. Rainfed areas are located in the north, northeast and west of the country as shown in Figure 2.2.

Cereal Crop Production and Productivity

There are roughly 3.9 million ha of cultivated land of which 1.3 million ha is rainfed and 2.6 million ha is irrigated. Up to 85% of crop foods are produced on irrigated land.

Sustaining and increasing productivity on irrigated land is essential for the overall food security of Afghanistan. The major staple crop is wheat, of which 80% is sown as a winter crop. The current drought, that began in 1997, caused the land area planted to cereal crops and total production to decrease by 25% and 47%, respectively, in the period from 1998 to 2001 (Figure 2.3). The cereal deficit was about the same as total production (~ 2 million tonnes) in 2000 and 2001. With better rainfall, and emergency seed and fertilizer distribution programs, estimated production in 2002 (http://www.usaid.gov/press/releases/2002pr020814.html) has rebounded close to that achieved in 1998 (Figure 2.3), alleviating some of the immediate food crisis.

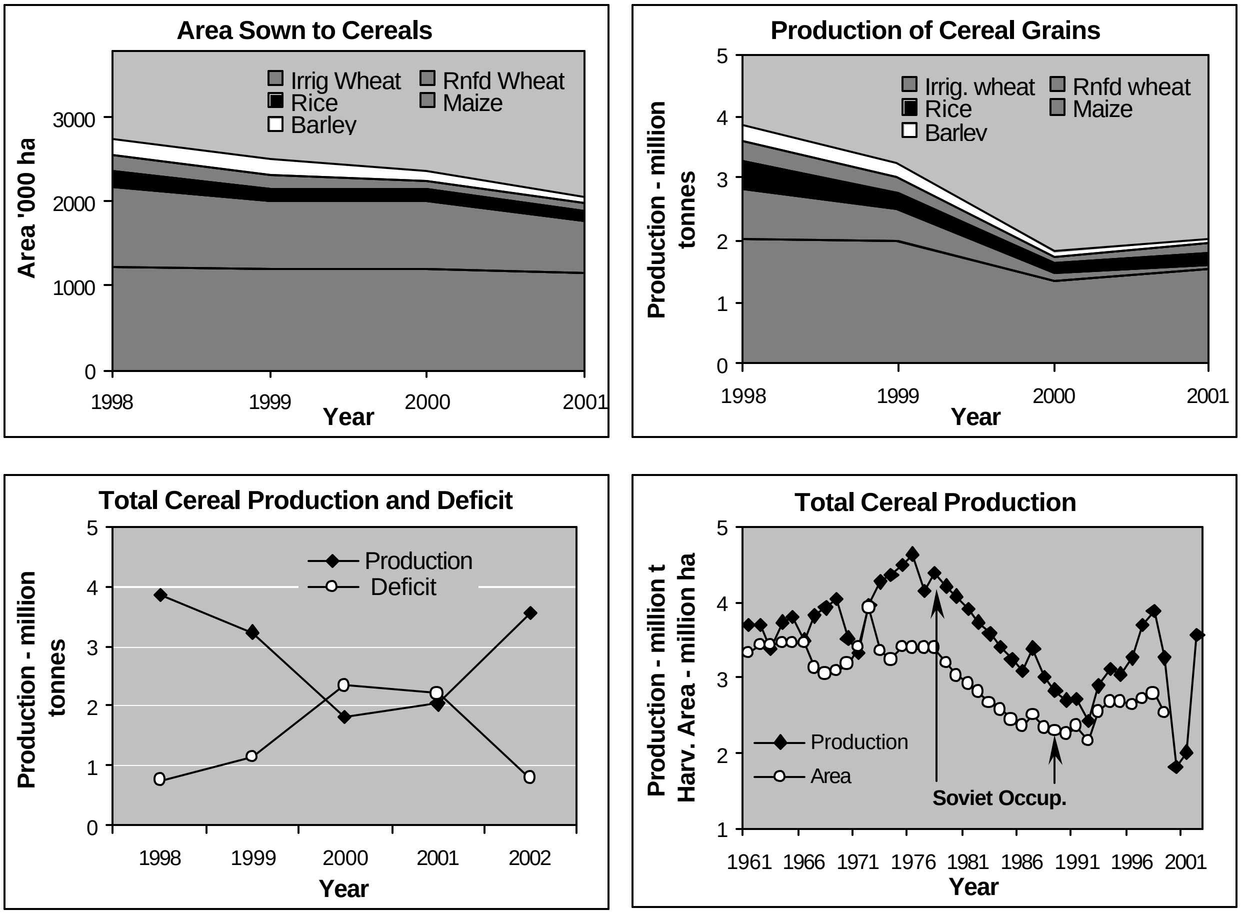


Figure 2.3. Recent and long-term trends in cereal production (data from FAO STAT and FAO, 2001)

The long-term trend in cereal production is not encouraging. The current level of production is the same as that in 1961, albeit on a smaller land area (Figure 2.3). Between 1961 and 1978, cereal production increased using essentially the same land area, indicating that productivity (yield) was also increasing during this time. With the onset of the Soviet military occupation, both the cropped area and the production of cereals decreased. Production gradually increased again in the 1990's until the onset of the drought.

Regardless of temporal trends, yields of the cereal crops are generally poor and well below achievable levels. Using 1998 data as the most recent "high productivity" year, the mean yields of selected cereal crops were:

Crop	Yield (t/ha)
Wheat	1.30 (1.65 irrigated and 0.87 rainfed)
Maize	1.65
Rice (paddy)	2.5
Barley	1.2
All pulses	1.35

While there are many possible reasons for low yields, it is clear from nutrient management trials that much higher yields of cereal crops can be achieved. From 280 on-farm fertilizer requirement trials carried out between 1970-73, Swaminathan et al. (1979) estimated that the maximum yield of irrigated wheat was 6.23 ± 0.83 t/ha. Similarly, an FAO study (1973) of crop response to fertilizer treatments carried out in ten provinces in 1969-70 achieved mean wheat yields that were mostly between 4 to 5 t/ha. Neither of these studies included nutrients other than NPK.

With NPK fertilization (120:60:30), Indian fine rice varieties that matured in 100-110 days yielded 5.9 to 8.8 t/ha compared to 5 to 6.4 t/ha for cv Barah at Baghlan and 4.1 to 7 t/ha compared to 2.5 to 5.2 t/ha for cv Pashadi at Jalalabad (Saina, 1982). Yields of coarse rice were as high as 10 and 7 t/ha at Baghlan and Jalalabad, respectively, compared to maximum yields of 4.9 and 3.8 t/ha for cv LUK. Response of rice to fertilization with Fe, Mn and Zn was found for both seedling growth and crop yield in a typical calareous silt loam soil (pH 8.3, 14% $CaCO_3$) in Nangarhar province (Das et al., 1982. Yields with micronutrients ranged from 7.5 to 8 t/ha compared to 6.8 t/ha without micronutrients.

The data, although limited, suggests that cereal crop productivity can be increased substantially with high yielding varieties, appropriate inputs and modern production technologies. A goal of doubling productivity should be easily achievable, assuming adequate water availability.

Water Resources of Afghanistan

Surface Water Resources

Although Afghanistan is located in half deserted atmosphere, it is still rich in water resources mainly due to the series of high mountains such as Hindu Kush and Baba covered by snow. Over 80 percent of the country's water resources have their origin in the Hindu Kush mountain ranges at altitudes above 2,000 m which function as a natural storage of water in form of snow during winter and thus support perennial flow in all major rivers by snowmelt during summer.

Recent estimates indicate that the country has 75 billion cubic meters (BCM) of potential water resources of which 55 BCM is surface water and 20 BCM is groundwater (FAO?). The annual volume of water used for irrigation is estimated to be 20 BCM, which is 99 percent of all the water pumped. Total groundwater extraction amounts to some 3 BCM. Approximately 15 percent of the total water volume used annually originates from alluvial groundwater aquifers and springs, and almost 85 percent from rivers and streams. Groundwater used from deep wells accounts for less than 0.5 percent. The annual per capita water availability is approximately 2500 cubic meter, which compares favorably with other countries of the region, for example, with Iran (1400 cubic meter per capita per year) and Pakistan (1200 cubic meter per capita per year). A qualitative assessment shows that Afghanistan's water resources are still largely underused, which is supported by the data presented in Table 2.2.

Table 2.2. Estimated Surface and Groundwater Balance (BCM per year)

Water Resources	Potential	Present use	Balance	Future use*	Balance
Surface Water	57	17	40	30	27
Groundwater	18	3	15	5	13
Total	75	20	55	35	40

* All existing irrigation schemes rehabilitated and managed efficiently

It is not clear, however, how much of this 'potential' resource can be accessed without bringing damage to people and ecosystem. For example, how much of the groundwater can be extracted without leading to an excessive decline in groundwater levels and reaching to a stage of 'water mining'.

Surface water quality is excellent in the upper basins of all rivers throughout the year and good in the lower basins in spite of large irrigated areas. As far as it is known, the presence of saline soils in irrigated areas is never caused by poor water quality.

Groundwater Resources

Afghanistan possesses huge reserves of groundwater. According to FAO estimates of 1996, the annual potential of the groundwater in the country is about 20 BCM. At present, only 3 BCM is being used and it is projected that in the next 10 years the annual potential may rise to 8 BCM due to increase in irrigation and domestic water supplies requirements (FAO?).

Irrigation in Afghanistan

The history of irrigated agriculture in Afghanistan goes back to more than 4,500 years ago (ancient settlement near Kandahar). Except for a few areas where rainfed agriculture can be practiced, agricultural production in most of the country is not possible without irrigation as the rainfall is either meager or unreliable. The allocation of water and land is closely related to customs and traditions of the sedentary population, and maintenance works of irrigation schemes have always been a well-defined activity in the farmers' seasonal calendar. Irrigation systems in Afghanistan can be divided into two categories: traditional irrigation systems and modern irrigation systems.

Traditional Irrigation Systems

These are centuries old systems. Water is supplied by stream flow diverted with the help of temporary weirs, which are often located in remote valleys along a stream or river and vary in size (up to 100 ha). These systems are constructed and maintained in a traditional informal manner on a communal village basis and water rights are also determined and recognized in the similar manner.

Large-scale informal surface water systems:

These systems are mainly located in the plains and along the main river valleys. Many villages can share water from such a system. According to the water laws of 1981, the amount of water needed for irrigation is determined according to the area under cultivation, the kind of crop, the irrigation regime, the water rights document, the local practices and the amount of water in its source. However, in practice water is distributed according to the local tradition and agreements between farmers, *mirab*, and the government. Each village has at least one water master (*mirab*) who delegates his authority to sub-water masters responsible for the allocation of water to different fields of the scheme.

Shallow wells (arhad) system:

Groundwater is lifted from large diameter shallow wells with the help of wheel (arhad) with animal power supplying irrigation water to the fields of an individual farmer. The size of the irrigated land does not exceed 3 ha. The total number of shallow wells in Afghanistan is 6598 that irrigate around 12060 ha of land (CSO).

Springs:

When groundwater table reaches above the ground surface, it starts flowing on the surface and form springs. There are about 5558 springs in the country, which irrigate about 188,000 ha of land. Springs are directly dependent upon the groundwater level. When the groundwater level goes down, e.g. during drought years, it results in a reduction of outflow from springs. That is why, some of the worst drought stricken areas of the country are located in region where they depend heavily on spring water for irrigation. Spring irrigation is common in the east and in the south.

Karez (qanat) systems:

Karezes (Figure 2.4) are underground galleries that tap groundwater from the aquifers of alluvial fans. Underground tunnels with gentle slopes carry water from the source to the settled areas. Karezes are usually small in dimensions but may be many kilometers in length. On average, their discharge varies between 10 l/s to 200 l/s but can in some cases reach up to 500 l/s. Karez water is used for irrigation purposes (irrigated area ranges from 10 ha to 200 ha) as well as for drinking water supply.

The technique has been used for thousands of years in Afghanistan, Iran, the Middle East and North Africa. It is one of the most economical methods of tapping groundwater for irrigation purposes. It is environmentally safe and water is drawn by use of gravity. There are 6741 karezes in the country. These karezes irrigate about 163,000 ha of land. Karez irrigation is common in the south and southwest of the country and less in the north of the country. One of the disadvantages of the karezes is that there is no mechanism to stop water from flowing during winter or when there is no need for irrigation. In each karez about 25% of total annual volume of water is wasted. Province wise distribution of different irrigation systems in Afghanistan is given in Table 2.3.

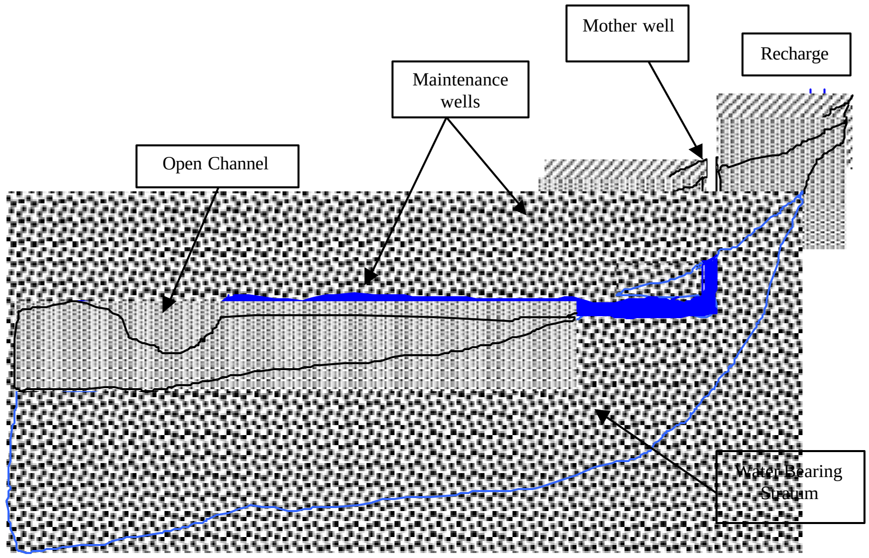


Figure 2.4: Typical Karez

Modern Irrigation Systems

Formal surface water systems without storage:

They have a permanent intake structure, which is operated and maintained by the Irrigation Department. The management of the irrigation scheme itself follows the rules of the large-scale traditional surface water schemes described above. However, the significant difference is that the regulation of water flow to the system depends on the interaction between government authorities and the village communities.

Formal surface water systems with storage:

Organized large-scale irrigation system development is a relatively recent innovation (1960-1978). However, by the late1970s five large-scale modern irrigation systems had been built and were in operation. Land tenure was different from traditional systems. Parts of the schemes were operated under the private land ownership agreements, while others were operated as State farms "owned" by the government. The government heavily subsidized these schemes and farmers were given very limited choice of crop selection or farming practices.

Formal groundwater systems:

Very little is known about the irrigation schemes supplied by groundwater from deep and shallow wells. In Khost/Paktia province, surface water irrigation schemes were supplied by some 100 deep wells until the late 1980s. In few cases, particularly in the lower reaches of large traditional schemes where water shortage is common, individual farmers undertook irrigation from shallow wells.

Cropping intensity in Afghanistan varies widely from system to system according to the scarcity of water versus land. It reaches 200 percent in the upper part of the irrigation schemes while in the lower parts up to two thirds of the command area is kept fallow each year on a rotational basis. Flood damages to the irrigated land are common, particularly in the large schemes supplied by rivers changing their course frequently due to their high sediment load and unfavorable geo-morphological conditions.

Canal Irrigation

About 85 percent of the total crops in Afghanistan are grown under irrigation. Canal irrigation is by far the most commonly used method of irrigation in Afghanistan. Canals in Afghanistan irrigate nearly 75% or 1.9 million ha of land.

As is evident from Figure 2.5, the proportion of canal-irrigated land is much greater than that of any other form of irrigation. Most of the canal-irrigated land is located in the North, West, and Southwest of the country. These canals primarily get water from snowmelt rivers in the region. At different locations along the river, small diversion structures are installed to divert water from river to the irrigation canals. These diversions are both open and gate-fitted. The traditional structures are generally loose masonry and more recently sandbags, however some newly built river diversion structures are well designed and constructed. Typical gate-fitted diversion point are shown in Figures 2.6 and 2.7. From these canals, water is diverted to small irrigation channels (watercourses).

Table 2.3 Province-wise distribution of different irrigation systems in Afghanistan

No.	Province	Canals	Springs	Karez	Wells	Mills
1	Badakhshan	212	82		54	730
2	Badghis	120	50	30		500
3	Baghlan	109	63			565
4	Balkh	250	92	3	82	912
5	Bamyan	179	137		300	651
6	Farah	312	94	352	327	260
7	Faryab	157	79	960	867	1030
8	Ghazni	818	604	1516	636	994
9	Ghor	804	570	4	263	500
10	Helmand	227	135	276	60	516
11	Heart	302	153	228	450	1302
12	Jawzjan	382	87	2	443	475
13	Kabul	177	81	321	436	616
14	Kandahar	279	258	631	252	383
15	Kapisa	285	72	49	176	638
16	Kunarha	223	67		13	681
17	Kunduz	88			55	363
18	Laghman	45	3			561
19	Logar	154	169	124	91	433

20	Nangarhar	274	210	495	15	1001
21	Nimroz	193	2	18	140	133
22	Paktia	625	392	528	800	171
23	Parwan	120	93	34		756
24	Samangan	20	73	7	271	190
25	Takhar	316	288		509	653
26	Uruzgan	363	429	84	210	1266
27	Wardak	589	519	336		822
28	Zabul	199	756	743	148	373
		7822	5558	6741	6598	17475

Source: CSO

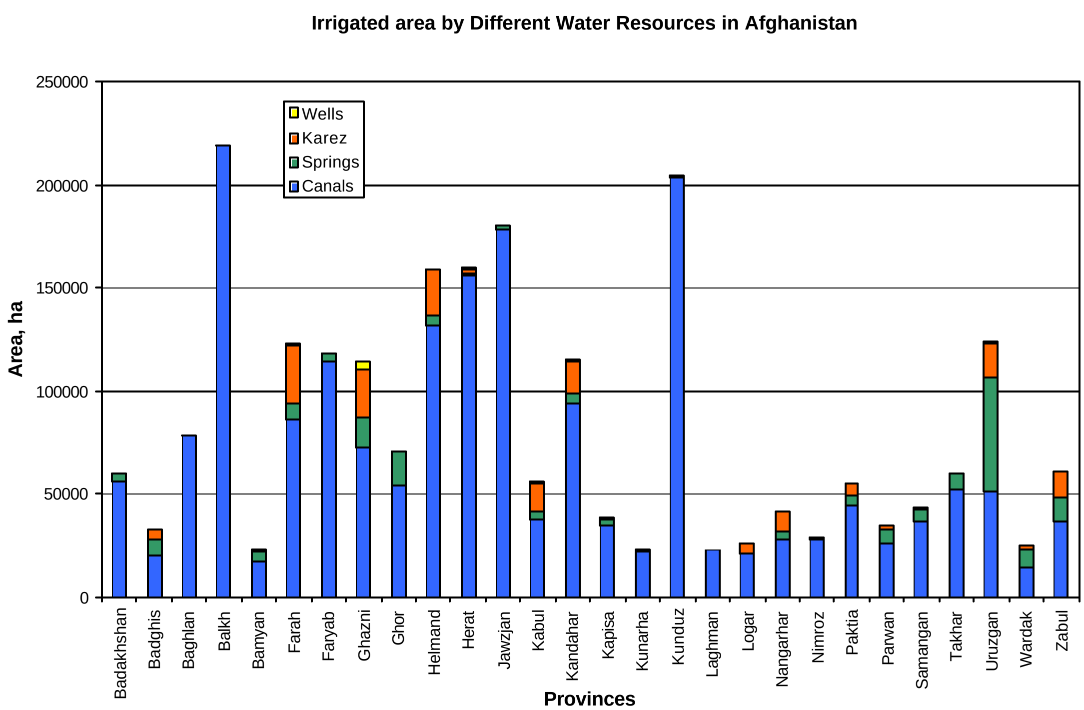


Figure 2.5. Area of irrigated land (ha); irrigated by different irrigation schemes in Afghanistan

Figure 2.6. A Diversion Structure across the Logar River

Figure 2.7. A typical gate-fitted canal intake

Soils

Calcareous soils are extensive in Afghanistan and dominate the cropland areas, with calcium carbonate ($CaCO_3$) contents ranging from 5 to 50% (FAO, 1973; Mannan, personal communication). Consequently, soil pH is generally high (around pH 8.2). The soils are classified in the entisol, inceptisol and aridisol soil orders (Figure 2.8; USDA soils classification system). Most agricultural soils are formed in alluvium or loess and do not have a calcic horizon that could restrict rooting. Such soils are classified as Torriorthents, Xerorthents and Camborthids by the USDA system or as Yermosols, Xerosols, Fluvisols and Regosols by the FAO system (FAO, 1973).

Soil fertility issues associated with calcareous soils are:

- precipitation of soluble P, initially as dicalcium phosphate then to very insoluble forms with aging
- poor availability of metal micronutrients – Zn, Fe, Mn, and Cu
- lime induced B deficiency

Communities and Rural Economy

The structure of Afghan rural society consists of numerous settlements many of which have very limited access to basic needs of life. The basic unit of Afghan life is the village. Single villages may range in size from as few as ten farming families to as many as 500. There are three officials in the village who are chosen by the villagers. The *Malik* or the head of the village, he is responsible for the dealing of the village with the government. The second is the *Mullah* who leads the religious life of affairs of the village, and the third is the *Mirab* or water master who organizes the village irrigation systems and making sure that it is operational.

Majority of the rural population is small subsistence farmers who live off small plots of land. Those who live off the land may be divided into four categories: landowners; share-farmers who receive fifty percent of the eventual crop and supply both input and labor; share-laborer who receives twenty percent of the eventual crop and supply only labor; and casual laborers who are employed irregularly.

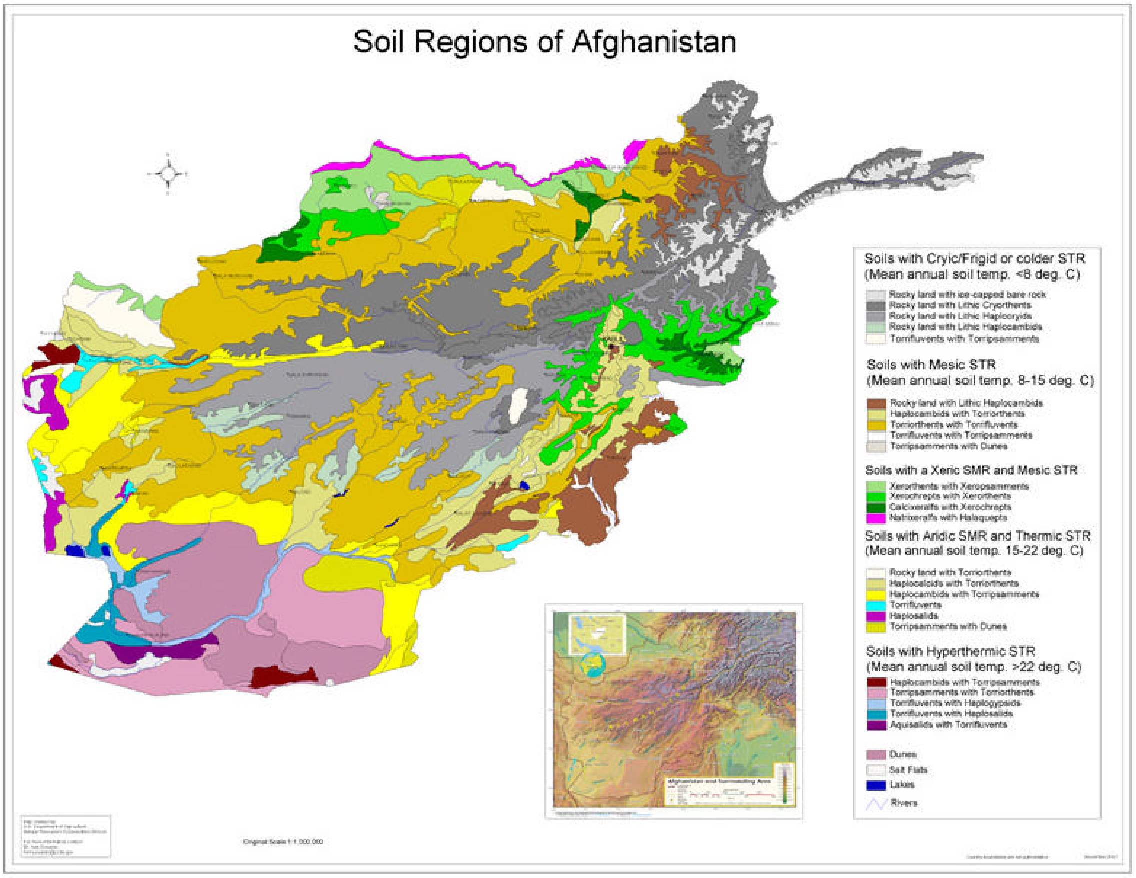


Figure 2.8 Soil regions of Afghnistan with the USDA classification system (map from NRCS:

http://www.nrcs.usda.gov/technical/worldsoils/mapindx/afghanistan-soil.html)

Although there are marked geographical differences in wealth generating capacities across the country, there is a similar cross-section to village society irrespective of location or agro-ecological zone. This cross-section covers small landholders, landowners, sharecroppers, female-headed households and landless. The vast majority of land holding falls in the range of 0.5 to 6 ha. Holding under 20 ha accounted for 60% of land ownership in 1967 and those over 100 ha for 8% (ref) Distribution of farm size in irrigated and rainfed areas is given in Table 2.5.

Table 2.4. Farm size distribution in Afghanistan

Farm size (ha)	Irrigated farms (%)	Rainfed farms (%)
<3	83	8
3-6	14	8
>6	3	84
Median	1.4 ha	6-7 ha

Source:???

It is generally accepted that families with less than 0.5 ha of irrigated land have great difficulty in earning their livings solely from agricultural production in most parts of Afghanistan. Therefore, off-farm income generating activities serve as an integral part for about 65 percent of farming families to achieve a modest living(ref) Afghan farmers use centuries old farming techniques with oxen providing the draught power. The majority of women in Afghanistan work in agriculture. They constitute a large portion of the agricultural labor force; estimates indicate that they account for over 70 percent of the labor (ref). Being an agricultural country, the future growth of Afghanistan depends on the development of agriculture and related industry.

Chapter 3

Methodology

The need was carried out in four phases.

Phase I

a. Contact Ministries, Government Organizations, International Agencies, NGOs to discuss current and past situation, and future planning, and to get information, data and reports.
b. Collection and review of data, information, previous studies, other type of available documents in the libraries inside and outside of Afghanistan and activities undertaken by NGOs.
c. Contact Afghanistan Information Management Service (AIMS) to obtain copies of maps of provinces and river valleys and find the possibility of inserting data to be collected from the selected provinces.

Phase II

a. Preparation of questionnaire on Water Resources, Soil and Crops Production and Fertilizer Utilization for:
   (i) Irrigated Agriculture
   (ii) Rainfed Agriculture
b. Preparation of Tables in Microsoft Excel for data entry and statistical analysis of the information/data to draw conclusions.
c. Selection of provinces and districts based on irrigated and rainfed areas.

Phase III

a. Training of Afghan Survey Team Survey consisting of irrigation/water supply engineers and, technicians, agricultural engineers, agronomists and extension service personnel.
b. Making the Survey Team fully understand all the items in the questionnaire so that the data collected should have acceptable accuracy,
c. Provision of selected provinces and districts, command areas and GPS units,
d. Training on the use of GPS,
e. Training on collection of Soil Samples.

Phase IV

a. Debriefing of the Survey Team
b. Check the data entry. Collate and analyze data. Draw conclusions for assessment of the situation. .
c. Preparation of final report including lessons learnt, conclusions and recommendations according to the format provided, and

d. Presentation and workshop.

Phase I: The Team Leader arrived in Kabul on 8 May 2002 and other team members joined him on 20 May 2002. During their stay in Kabul, they met the following personnel discussed the current situation and future planning for the rehabilitation and upgrading of Water Resources and Irrigation Systems, Soils, Soils Fertility and Crop Production. Available information, data and reports were collected.

Contacts

- Ministry of Agriculture
    i. General Haji Muhammad Hussain Anwary, Minister
    ii. Muhammad Qasim Qadri, Dirrector Agriculture Research Centers
- Ministry of Irrigation
    i. Pir Muhammad Azizi, Deputy Minister
    ii. Dost Muhammad Amin, Director Planning
    iii. Sultan Muhammad, Director Irrigation
    iv. Gul Bahar Haleemi, Head Hydrology Section
    v. Engr. Kareem, Head Groundwater Section
    vi. Engr. Abdus Samad, Head Irrigation Section
- Minister of Rural Rehabilitation and Development
    i. Engr. Kamaluddin Nizami, First Deputy Minister
    ii. Muhammad Musa Sharifi, Director Planning
    iii. Hayatullag Farhang, Head Construction Section
    iv. Syed Jalal, Technical Assistant
    v. Muhamnmad Ajmal, Social Services
- Afghan Association Coordination Authority (ACCA)
    i. Joma' M. Mohamadi Lead Advisor
    ii. Qasim Naimi Technical Advisor
- Food and Agriculture Organization of the UN
    i. H. Adji Ismat-Hakim OiC, FAO Affairs
    ii. Walter Klemm, Water Resources and Irrigation Consultant
    iii. Richard China, Program Manager
    iv. Sayed Sharif Shobair, Irrigation Engineer
- US Agency for International Development
    i. Dr.Raymond H. Morton, Senior Policy Advisor

- Afghanistan Information Management Service (AIMS)
    i. Joe Crowley Head Mapping Section

The following reports and documents were collected:

Reports

1. Rehabilitation Options, Desk Study,
   Report No. 01/090 IC-AFG, 16 November 2001

2. Quick Impact Project for Rehabilitation of Traditional and Formal Medium Scale Irrigation Schemes in Afghanistan,
   FAO of UN (TCIP) Mission Lead by J.H. Weatherhog, March 2002
3. Effects of Deep Wells on Groundwater Resources in Afghanistan,
   Sayed Sharif Shobair, Irrigation Engineer, FAO Afghanistan
4. Rapid Assessment of Water Sector – Afghanistan
   Report Submitted to US AID by M. Saleh Keshawarz, April 2002
5. Water and Irrigation (WRI) Project Formulation and Backstopping
   (FAO Agricultural Rehabilitation and Recovery Program)
   WRI Consultancy Mission Report No.1, By Walter Klemm
6. Natural Resources and Agriculture Sector, Medium Term Development Framework
   Multi Donor Phase II Mission, April 2002
7. Afghanistan Agricultural Strategy, by Walter Klemm
   TCP/AFG/4552, Rome January 1997
8. Current Drought Situation in Afghanistan
   by Sayed Sharif Shobair, Irrigation Engineer, FAO Afghanistan, August 2001
9. Agriculture Sector Study 1996 (Irrigation and Water Resources Report)
   By Walter H. Klemm and Sayed Sharif Shobair

Other Information:

1. "List of Irrigation Systems and Pertinent Structures" Candidate for Rehabilitation and Upgrading, Ministry of Irrigation
2. "List of Traditional Irrigation Systems and Pertinent Structures"
   Labor Intensive Rehabilitation Program, Afghan Association Coordination Authority (ACCA),
3. River valleys, roads and settlement maps of 32 provinces
4. Land cover maps of 8 provinces selected for field survey

Phase II:

Questionnaire

In a meeting with Ray Morton, a number of hypotheses were established on Water Management, Institutional Set-up and Soil Fertility, which were used to formulate questions in the questionnaire. List of hypotheses are shown in as follows:

Soil and Water Needs Assessment Team in a meeting with Ray Morton (US AID) in Kabul Hotel on 26 May 2002, developed the following hypotheses

Hypotheses for Questionnaire

1. Water is available at the source, conveyance systems are not big enough to irrigate potential area.
2. Water conveyance systems are not functioning well.
3. Water distribution is not even according to the holding, tailend farmers are not getting required quantity of water.

4. On-farm water management is poor, water use efficiencies are low and water is wasted.
5. Farmers' lack of knowledge of CWR and irrigation scheduling result in wastage of water.
6. Water policies for the distribution and delivery of irrigation water are not in place.
7. Water policies for the distribution and delivery of irrigation water are not implemented properly.
8. Better water policies and regulations are needed in order to improve on-farm water management.
9. Displacement and death have altered land use and water rights.
10. Farmers do not understand relationship between water management and soil fertility.
11. Soil fertility is generally low, but is better in irrigated areas than rainfed areas.
12. Water conservation technologies are not used in rainfed areas and farmers have limited knowledge of these technologies.
13. Crop productivity is constrained by nutrient deficiencies in addition to N (e.g. P,K,Zn,Fe,B).
14. Soil erosion is a problem in the area.
15. Soil conservation measures are not implemented in the area.
16. Soil erosion is reducing soil fertility.
17. There is a lack of trained personnel to advise farmers on soil and water management issues.

To test these hypotheses, a preliminary version of questionnaire was prepared in Kabul. On May 30, the team members returned to their bases and the then Team Leader came to Syria to finalize the questionnaire.
In series of meetings with ICARDA's experts in Soil and Water sector, the questionnaire was discussed and finalized. The main disciplines covered in the questionnaire are **:**

Water Resources – Irrigated Agriculture

- Sources of Irrigation Water
  - Surface
  - Groundwater (Karezes, Springs, Tubewells)
- Water Distribution and Water Laws
- On-Form Water Management
- Water Supply (Domestic and Livestock)

Water Resources – Rainfed Agriculture

- Rainfed Area
- Groundwater (Karezes, Springs, Tubewells)
- Water Supply (Domestic and Livestock)
- Watershed Management
- Erosion

Soils, Crop Production and Fertilizer Utilization

- Soils
- Mechanization
- Cropping Pattern
- Crop Production Problems
- Nutrients
    - Quality of Fertilizers
    - Application of Fertilizer

A copy of the completed questionnaire is included in Appendix A.

Selection of Provinces

Keeping in mind the goals stated in the Tashkent meeting "improved food security and a rejuvenated agriculture sector in Afghanistan", the following six provinces were proposed based on irrigated and rainfed areas, road accessibility and their potential for bringing about food security in Afghanistan:

North

a. Baghlan
    - Baghlan
    - Pule Khumri
    - Dahan-e-Ghori

b. Kunduz
    - Imam Sahib
    - Khanabad
    - Char Dara

c. Balkh
    - Kaldar
    - Balkh
    - Sholgara

South and West

d. Ghazni
    - Qarabagh
    - Khwajaomari
    - Andar(Band-e-Sultan Area)

e. Hilmand
    - Nahre Siraj
    - Nad Ali

- Nawan barakzayi

f. Herat

- Kushk
- Guzara
- Pashtun Zarghun

Subsequently, Kunduz, was dropped from the list and the survey was conducted in five provinces.

Afghan Survey Team

The Afghan Survey Unit (ASU) based in Peshawar, Pakistan was selected to conduct the survey. It has 15-member survey team that has experience in conducting surveys, interviews in various disciplines of agriculture, agricultural engineering and livestock. This team was hired to run the survey and collect the data and information required for Needs Assessment for Water, Soils, Crop Production and fertilizer Use.

Training

An extensive training was imparted to the Afghan Survey Team Survey, which consisted of irrigation/water supply engineers and technicians, agricultural engineers, agronomists and extension service personnel. Each member of the team was made understand all the items in the questionnaire so that the data collected should have acceptable accuracy.

Three GPS units were provided. Training on the use of GPS and collection and handling of soil samples were also given.

The Afghan Survey Team left for Jalalabad, Afghanistan on 8 July 2002. The ASU computer specialist who is in-charge of data entry and analysis is stationed in Peshawar. Later the program for data entry and methods of analysis were discussed with him.

Survey Methodology

Three survey teams each consisting of one supervisor and one enumerator conducted the survey. ASU's field coordinator, supervised the implementation of the survey.

In each province the process began by the ASU field coordinator meeting with the provincial authority (Director of Planning), briefing him of the purpose of the survey. The authority then issued introduction letters to the relevant districts. Each team was dispatched to one district and started the process by meeting the district authority and presents to him the introduction letter issued by the Director ate of Planning.

During the meeting with the district authority, cropping and irrigation systems were discussed with the responsible officers. In general, the agriculture/irrigation officer and a guard from the district headquarter accompanied the survey team to the site.

The soil and water assessment was carried out on a village basis. The survey team selected an irrigation system (canal, karez, spring, well). In the case of canal system, three villages were selected randomly from the area under the command of a particular canal. In case of the canal system, the selected villages were located in the upstream, midstream, and downstream of the canal. In small irrigation systems such as karez and spring, one village was selected randomly for interview.

Survey teams with the help of local guides collected 7-15 villagers (village elders, farmers, intellectuals, and the *mirab*) and met with them, discussed general conditions, and completed one questionnaire (when there was irrigated land only) or two questionnaire (one for irrigated and one for rain fed land).

Each group interview took 2-3 hours. The survey team worked seven days per week from 5 am to seven pm. The completed questionnaires were checked on the same day by the supervisors and field coordinator for possible corrections.

For soil sampling due to unavailability of augers, locally available tools such as shovels were used for digging and sampling. A V-shaped hole with a depth of about 15 cm was dug in the field and then a slice was taken from there. From an area of 700 to1000 sq m a total of 5 sub samples were collected and mixed in a bucket and then about 250-300 grams of soil was taken and stored in a sample bag. On the bag, the name of the province, district, village, date of sampling, GPS coordinates (latitude, longitude) and land type were recorded.

It is worth mentioning that all surveyed provinces and districts were selected by ICARDA consultants. ASU had carried out the survey in all pre selected districts. Only in Balkh province due to security reason instead of Kaldar, another district, Chimtaal was selected.

Data Entry and Analysis

Completed questionnaire and soil sample were brought to Peshawar where the data was entered into excel worksheet that were designed by the soil water team. The soil sample were shipped to NARC lab in Islamabad for tests. A portion of those soil samples were shipped to Cornell for more sophisticated tests.

Two members of the soil and water team and a representative from NARC debriefed the survey team upon their return. The data were analyzed by the team members at their home bases and a draft report was prepared for the work shop at Aleppo, Syria

Chapter 4

To determine the current status and future course of action, as discussed in Chapter 3, in line with the goals of food self-sufficiency, poverty reduction and agricultural development, a technical field survey conducted during July-August 2002 in 5 provinces of Afghanistan. The the results of that survey is presented in this chapter along with some analysis.

A. Irrigated Agriculture

1.Surface Water Irrigation

The deterioration of almost all the irrigation systems, big, medium or small, in the country first started in 1980 during foreign occupation and the second blow was during the civil war period between 1988 and 1992. The decline in the recovery in irrigated area continued over the last two decades.

Essentially nothing has been done to improve the efficiency of irrigated agriculture in the last two decades in areas of **high production potential**. This despite of spending of millions of dollars on the restoration of small-scale traditional irrigation system in some parts of the country with very little to show for it.

The decrease in agricultural production in Afghanistan can be traced to unreliable irrigation supplies, inefficient water management, negligible water management extension services and persistent use of traditional irrigation and farming methods unsuited to modern agriculture. These constraints cannot be over-come by individual or group of farmers unaided.

About 85% of all crops in Afghanistan are grown under irrigation and canal irrigation is by far the most commonly used method of irrigation. Therefore there is a growing realization of the critical role irrigated agriculture must play in Afghanistan's total development if the nation is to meet its development goals. The modernization of irrigation sector rests fundamentally upon provision of new production possibilities enabling farmers to increase per hectare yields at decreasing costs.

In order to assess the current condition of the surface water irrigation system a number of questions were asked from the farmer which are outlined as follows:

- Type of intake
- Condition of the intake
- Information of the canal system

- Condition of the canals
- Command area

Intakes

Herat province, which includes the Harirud River basin, is one of the more productive areas of the country. Canals in the two districts, Pashtoon Zarghoon and Gozara, have their source from the Harirud River. A large portion of the agricultural land in this district is canal irrigated. There is some rain fed land in the area with a very small fraction of it being planted this year. The third district in the province, Kushk is locate in a part of the province which is away from the main rivers and the source of irrigation in that district is mainly from karezes and springs.

Flow in the Harirud River this year is very low at this time of the year, however, during spring and early summer it was much better than the last three years.

The intakes for these canals are in general loose masonry, which are usually washed away during the flood season and then rebuilt by the community. A typical loose masonry diversion structure is shown in Figure 4.1.

On a rating scale of "Good", "Partly Damaged" and "Damaged", the condition of the free intakes for the systems surveyed were reported as "partly damaged". Water is distributed based on a system devised by Maulana Jami the famous sixteenth century Dari mystical poet and scholar in Heart. It is still in use and people seem to be happy with it. The draw back with the current system of distribution is it has not taken into consideration the expansion of agricultural land over the years. New land has been added to the system which during water abundant years there are no problems of shortage of water however, during drought it is the source of dispute.

Flood water courses are major cause of damage to the canal banks. There is a great need for rerouting of the flood water through flood control concrete lined channels and installation of culverts.

Some work has been done the NGOs in the area in terms of constructing concrete intakes for secondary canals, but it is not nearly enough..

In the Helmand Province, Nad-e-Ali District, the condition of the dam intakes are reportedly "Good". However, in the Nawa and Nahr-e-Saraj Districts, the condition of the intakes is reported as "Partly Damaged" to "Damaged". Widespread illegal and unauthorized tapping of the canal water is reported in the Helmand Province, which is an indication of the lawlessness in the area. In at least one instance, the survey team felt threatened.

In the Ghazni Province the condition of the dam and free intakes, in general, were reported as "Partly Damaged". Most of the installation in the Ghazni Province is government run and belongs to the Band-e-Sardeh project

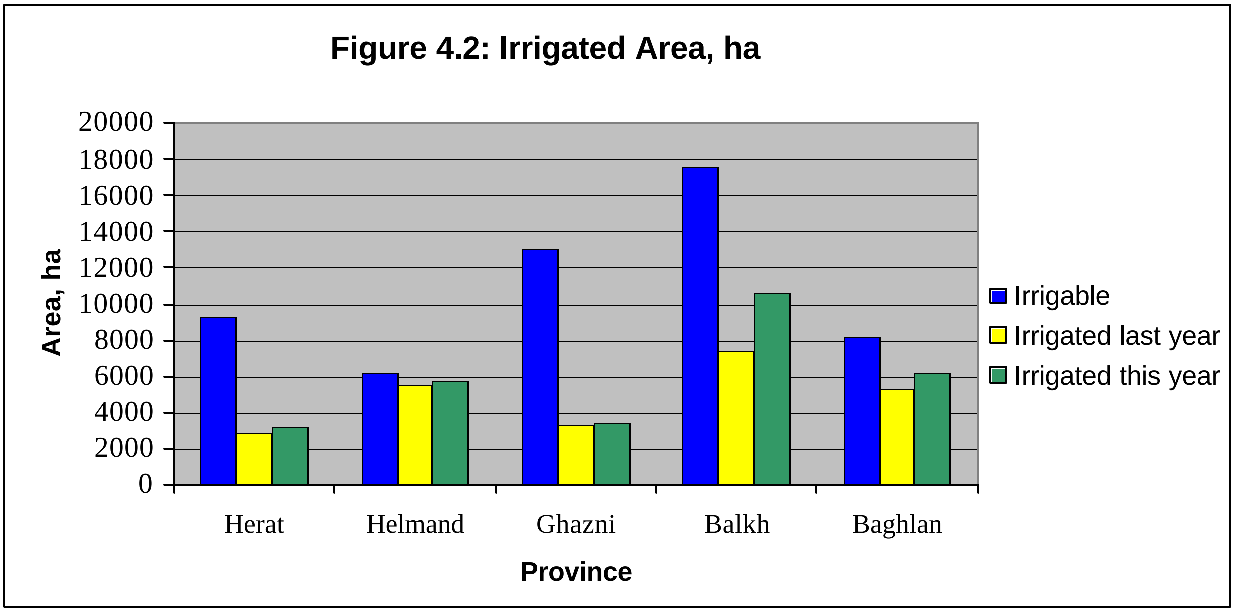
All the intakes reported in the Balkh province were free intakes and they were “Partly Damaged” to “Damaged”. The dam intakes in the Baghlan province are generally in good condition, however, the free intakes were reportedly rated as “damaged”.

Figure 4.1: Typical loose masonry water diversion structure

In general, the survey showed that the condition of intakes, especially the free intakes are in serious need of repair. This is more pronounced in high yield provinces such as Balkh, Baghlan, and Herat. It is obvious that the farmers need help in putting their systems back to working condition. The work is beyond their capability and they need help in rebuilding their system.

Figure 4.2 shows the total irrigated area, area irrigated last year, and area irrigated this year in the five provinces. In general there is a slight increase in the irrigated area this year as compared to last year. But as is evident from Figure 4.2, the current irrigated area is much lower than the irrigable area in the five the provinces. With proper water management techniques these tracks of land could be brought under irrigation.

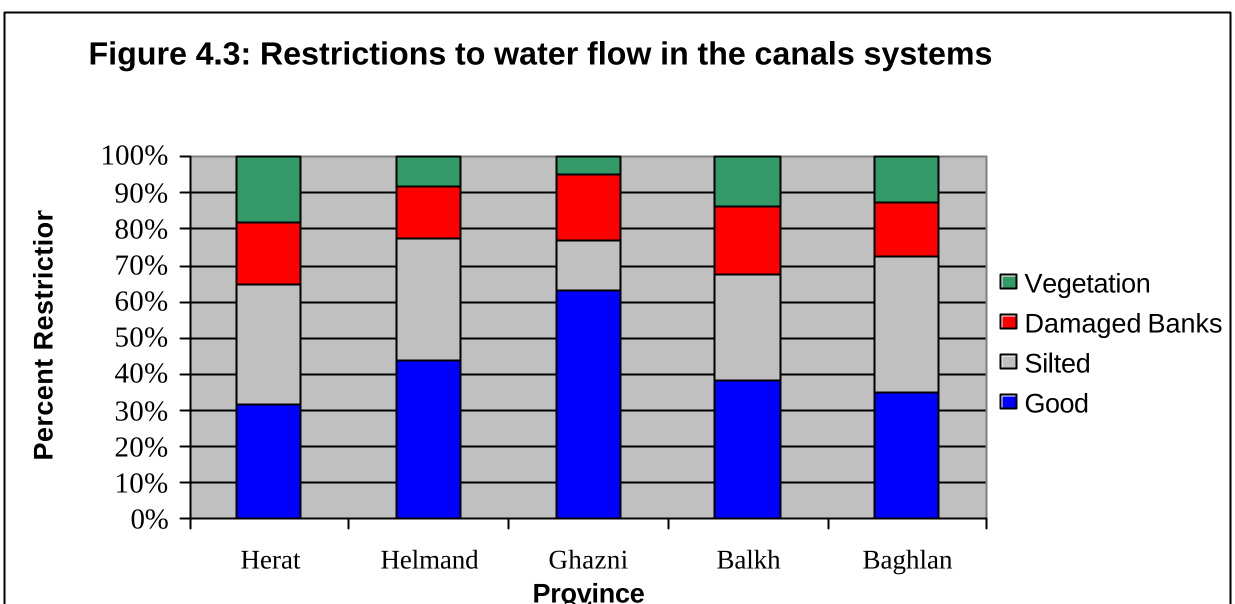
The reader should keep in mind that these areas are not the total for the province, but the total for the district in the provinces that were survey, and even at that, they may not be very accurate.



Conveyance Systems (Canals)

The survey of irrigation system in the selected districts and villages in five provinces revealed that the primary and secondary canals are restricted up to 80% of their capacity. The restrictions were siltation, banks damage, and vegetation growth. In some places the small canals disappeared all together. Regular desilting was not carried out as it should have been. Due to drought conditions, the flow in the canals was reduced drastically resulting in low velocities and excessive settling down of the suspended sediment load.

Figure 4.3 illustrates the source and amount of canal restriction in different provinces.



2. Operation and Maintenance

In Afghanistan, operation and maintenance of the traditional irrigation system has been the responsibility of the community where the irrigation system is located. Through a system known as *hashr,* members of the community contribute to the labor force required to maintain the system. Whether it is the construction of the intake or the cleaning and desilting of the conveyance system. Unfortunately, during the past two decade for reasons that were mentioned earlier, the systems have not been kept properly and a s a result the efficiency of the conveyance system has been reduce to as much as 80 percent of its original capacity.

Mirab (water master) plays an important role in the inspection, decision making, operation, and maintenance of the irrigation system in an area. *Mirab*, in general, is an elderly, most respected person in the area and farmers listen to him and abide by his decisions. Operations of the irrigation system and water distribution according to the agreed arrangement are his responsibility. *Mirab* is elected by the farmers and he also serves as a link between the government water authority personnel and the farmers. He may have one or two assistants. *Mirab*s generally receive some compensation in the form of farm products such as wheat for the performing of their duties.

To evaluate the status of operation and maintenance, a number of questions were posed to the farmers community in the survey. These questions mainly dealt with the frequency of inspection and maintenance, who is responsible for the work, and information on the availability of skilled and unskilled labor and construction materials in the area.

The results of the survey showed that inspection of the systems and pertinent structures is carried out periodically. In the majority of the cases the farmers and the *Mirab* are the ones who inspect, schedule, and carry out the maintenance work of the system. In very few cases, mainly in the larger system built by the government, the government decides on the maintenance of the system.

The overwhelming majority of systems in Afghanistan is the traditional non-government systems managed by farmers groups. Many countries are trying to transfer the control of the irrigation systems to farmer group or WUA. Luckily, the farmer groups already exist in Afghanistan and they <u>are</u> responsible for their systems.

The survey also revealed that material, skilled and unskilled labor are available in abundance. Of course high tech gates and other prefabricated parts have to be imported from other areas. One has to keep in mind that the district chosen were all accessible through major roads. The situation may be much different in other areas.

3. On-farm water management issues

On-farm water management is as broad as agriculture itself, and, therefore, must be studied as an entire system including physical, organizational, economic, and legal factors. Farmers do not have one or more discrete problems but they are concerned with the management of a complex system. For example, poor physical farm delivery systems resulting in high losses of water might be related to legal factors, social organizational factors, design factors and lack of knowledge. Likewise, farmers' low irrigation application efficiencies and under-irrigation or over-irrigation may be related to water availability, un-level fields, lack of information regarding actual crop water requirements and inadequate extension services. Such factors likely have a high degree of interdependence and interaction on any farm system.

To achieve the goal of increased crop production, increased quantities of water alone are not sufficient. Many irrigation projects and improvement programs have failed to benefit farmers due to the lack of complementary inputs and conditions necessary for increased crop production. Therefore it is necessary to examine the availability and utilization of water and other inputs and services provided to the farmers.

The construction of physical improvements will provide the 'hardware' for improving water management and consequently food production. However, the proper utilization of the physical facilities is required in order to actually realize the benefits that can result from improved water management. The primary purpose for improving water management is to grow more food. The heart of this food growth process is the plant environment, particularly the plant root zone. Here, most of the agricultural inputs such as seeds, cropping cultural practices, and water come together, along with climatic conditions, to determine crop yields. The role of improved water management is to provide the proper quantities of water to the root zone at the appropriate time to maximize crop production. The first step, then, becomes defining the proper quantities and timing of water for various combinations of crops and soils. The next step is to effectively apply the water delivered to each field to maximize crop production and avoid over-irrigation.

Before addressing the issues faced by the farming community in Afghanistan, it is important to have complete understanding of how these systems work and what are the major problems that need to be further studied. The technologies for solving most engineering and physical irrigation problems are known, but very little is known about the processes and mechanisms of transferring these technologies to the farmers. Still less is known about the complex interactions of physical, social, economic, and legal constraints on farmers. In order to understand the present irrigation practices of the farmers in Afghanistan, following questions were asked in a comprehensive survey of five provinces.

- Do they have exact knowledge of their crop water requirements? If yes, what?
- Are their fields leveled? If not what measures they take to ensure uniform application of irrigation water over the field.
- Do they have salinity problem? If yes, what are the reasons and how they tackle this problem?
- What strategies they adopt to cope with the less water availability?
- Do extension people have knowledge of crop water requirements?
- How they manage drought?

- What are the main reasons for not irrigating the total command area?
- Do they know relationship between water management and soil fertility?
- Do they have any emergency plans for drought and floods?
- Why rain-fed areas are not irrigated?
- Do they experience water and/or wind erosion problems?
- Do they use any water harvesting techniques in the rain-fed areas?
- Do they take any soil conservation measures?

This study is an attempt to identify some of the pieces and to solve parts of the puzzle. The program involves problem identification and applied and adaptive research methods to discover wide range of relevant solutions at the farm level. Major activities include intensive field survey to document the extent, magnitude and nature of problems at the farm irrigation system level. Water budgeting and return flow problems related to water-logging and salinity, crop water use, irrigation scheduling, water-soil-plant interactions and evaluation of improved irrigation methods on level fields are subjects that have been investigated. Farmers perceptions on different on-farm water management issues and the recommendations for improving present irrigation and cultural practices to enhance crop productivity are discussed separately for irrigated and rain-fed areas. The results presented are based on the analysis of the field survey data.

To determine exactly what is the reason as why all the command area is not irrigated, the most common response was "Insufficient Water". The overwhelming majority of response belonged to this category. "Inadequate System" in Herat, Helmand, and Balkh was of concern to some farmers. However, it was not a concern to Baghlan and Helmand farmers. "Insufficient System" was not a major constraint in Herat, Ghazni. But farmers in Balkh and Baghlan showed some concern about their system sufficiency. "Minefields" was not considered a constraint to irrigation in any of the provinces surveyed. This was a surprise to the surveyors and to the soil and water team. Obviously more surveys are needed to make a definite conclusion as to the presence or lack of minefields in the irrigated areas. "Poor Water Management" is not a big factor in Herat in Ghazni, however, for the farmers in Helmand, Balkh, and Baghlan it is a concern and it is generally related to security in the area and the equitable distribution of water to the farmers.

Farmers' Knowledge about Crop Water Requirements

The primary focus of this section is to learn about farmers' attitude and level of knowledge about certain irrigation practices and soil-water-plant relationships. This will provide some idea of ***'where they are'*** and ***'what'*** might be required to help them improve their knowledge and consequently their irrigation behavior.

In order to apply irrigation water more efficiently, an irrigator must have some knowledge of soil-water-plant relationships. The farmer must know generally about the penetration of water and plant root systems into the soil, crop water requirements, critical stages of the crop growth, and varying water requirements at each growing stage of the crop. Although these questions were not directly asked in the field survey, informal talks with the farmers suggest that their knowledge about crop water requirements and irrigation management issues is also very limited. The lack of this information could be a reason for farmers to apply more or less water than is required for optimum crop growth.

Farmers' present irrigation practices in Afghanistan are aimed at applying maximum water for maximum crop production. Irrigation practices today are characterized by the necessity to irrigate "by all means" leaving little room for proper irrigation system management. Farmers usually do not have sufficient knowledge of irrigation scheduling. Therefore present irrigation practices of farmers include a tendency to over-irrigation whereas opposite should be accomplished. Irrigation practices witnessed in the field are based on the maximum amount of water a farmer can capture. In traditional as well as in modern irrigation schemes the dominant irrigation method is basin/border irrigation for cereals and furrow irrigation for vegetables.

Farmers is Afghanistan usually do not plan their irrigation in advance. Their decision mainly depends on visual plant stress indicators and the instant availability of water in the canal system. Interestingly, more than 90 percent of the respondents reported that they have sufficient knowledge of crop water requirements. However, when they were asked to explain it. Their answers were mainly related to their past experiences and what they have learned from their forefathers. From the survey results, it appears that farmers do not have any adequate method of deciding about the timing of irrigation. The two important criteria mainly used for deciding the timing of irrigation are *'dry appearances of the soil surface'* and *'remembrance of the time of last irrigation'*. This is to be expected given the absence of on-farm water management extension or advisory services. Although it is not explicitly clear from the survey results, but we suspect that much of the over and under-irrigation being practices in the fields is a result of the limited knowledge of the farmers and other constraints. This is because some crop plants, such as maize and cotton, do indicate to a certain degree of soil moisture deficit while the others are at wilting point before stress signs are visible.

The amount of water applied for individual irrigation has no relevance with the actual crop water requirement. In many cases, farmers open the field inlet from one end and allow the water to completely fill the basin and over flow into the next field. Different perceptions exist to decide when to stop irrigation for a particularly field. Most common are *'when water reaches the far end of the field'*, *'when water cover all the high spots of the field'* and *'when a certain depth of water is applied to the field'*. Farmers also do not have any concept of a 'usual' or 'optimum' depth of irrigation application. The farmers' perception about a good irrigation is the amount of water or delta ponded in the basin when irrigation is completed. This method does not include infiltration rate during irrigation, soil moisture deficiency, the roughness of the soil profile (fallow or cropped), and the slope or level of the field. Due to neglect of these important factors, the applied amount of irrigation is likely to be more than double the required amount of water for a particular crop. Farmers' response to the number of irrigations for a particular crop differs greatly. Their decision depends on the availability of water. Farmers having access to groundwater tend to apply more water than those fully dependent on the canal water supplies.

Leveling of farmer fields is generally poor. Fields with low and high spots (un-level fields) present many problems to individual farmers as well as to the system as a whole. By the time many farmers have applied the amount of water to completely fill their fields to cover all the high spots, soil moisture requirements have been exceeded. Some areas of the field receive excess water while the others receive too little. This un-even distribution of water in the field produces patches of low and high infiltration rates, which in turn produces patches of low and high salinity within the same field. In the fields where nitrogen fertilizer has been applied, it is expected that much of the nitrogen is leached and lost before giving any benefit to the crop. Actually over-irrigation of fields can be viewed as a triple menace because it creates water-logging and salinity problems, leaches expensive nitrates, and reduces the quality of groundwater by mixing with salts and nitrates-all resulting reduction in the crop yields.

Above discussion revealed that the farmers are wasting large amounts of irrigation water due to poor water management practices. On the other hand, a majority of the farmers reported that the main reason for not irrigating the full command areas, is insufficient availability of irrigation water. This clearly demonstrates the need to educate farmers regarding improved water management practices and water saving strategies. The amount of water saved by adapting these improved techniques, could be used to bring more areas under irrigation. Due to diminishing resources of water in Afghanistan, farmers need to learn how to apply the right amount of water at the right time. Farmers, by applying excessive irrigation to crops, can decrease their crop yields. Proper leveling of fields is therefore an essential prerequisite to achieving high irrigation application efficiencies.

Farmers' Knowledge about Irrigation Application Efficiency

Water management in Afghanistan is primarily irrigation water management because at present the annual water used for irrigation is about 99 percent of the all water used. Nearly, 90 percent of the irrigation systems in Afghanistan, covering about 2.3 million ha, are traditional schemes developed by farmers and also operated and maintained by farmers according to traditional communal customs and practices. Afghan farmers use centuries old farming techniques with oxen providing the draught power. While agriculture is the basis of economy, little knowledge on new irrigation techniques and cultural practices is available to the farmers, and institutional credit facilities are almost absent.

The overall irrigation application efficiency in Afghanistan is only about 25 to 30 per cent for both modern and traditional irrigation schemes due to the following reasons:

- high conveyance losses in traditional schemes with earth canals,
- high operation losses in modern schemes with lined conveyance canals,
- high on-farm distribution losses (over-irrigation, poorly levelled land) in both traditional and modern schemes.

Additionally, there is usually a waste of irrigation water in traditional schemes during the first half of the growing season due to unregulated flood water entering the conveyance canal, and a shortage of water during the second half when river flow decreases to its annual minimum.

Due to low irrigation application efficiencies, crop yields are very low and productivity levels are low even from regional standards. There are roughly 2.6 million ha irrigated land. This irrigated area produces almost 85 percent of all agricultural productions. In 1978, the total area (irrigated and rain fed) under cereal crops was about 3.4 million ha. The total production was 4.15 million tons of which 2.65 million tons was wheat. Table 1 gives the details of cultivated area, production and yields of major cereal crops in 1978. Present drought conditions and lack of inputs have caused further reduction in crop yields e.g. average yield of wheat was about 1.1 tons/ha in 1978 as compared to 0.8 tons/ha of today. By promoting improved on-farm water management practices and technology transfer, production potential of these lands can be improved substantially even under low and variable rainfall regimes.

Table 1. Cultivated area, production and yields of cereal crops in Afghanistan in 1978.

Crops	Area		Production	Yield
	Million ha	Percentage of total	Million tons	Tons/ha
Wheat	2.35	69.3	2.65	1.13
Maize	0.48	14.2	0.76	1.58
Rice	0.21	6.2	0.40	1.91
Barley	0.31	9.1	0.30	0.97
Other cereals	0.04	0.1	0.04	0.81
Total	3.39	100	4.15	1.22

Source:

After water reaches a farmer's field, the primary goal is to apply it as uniformly as possible over the field in order that depth of water applied will match the soil moisture depletion in the crop root zone. The irrigation method commonly used in Afghanistan is basin type and the farmers apply water mostly by guesswork. Factors that influence the application of irrigation water for crops include: field levelness, farm size, soil moisture depletion, crop rooting depth and leaching requirements. Climatic regions and associated type of crop cultivated may influence farmers' application efficiencies. Generally, water supply situation provides the strongest influence over farmers' field application practices. Where more water is available, more is applied and more is wasted through over-irrigation.

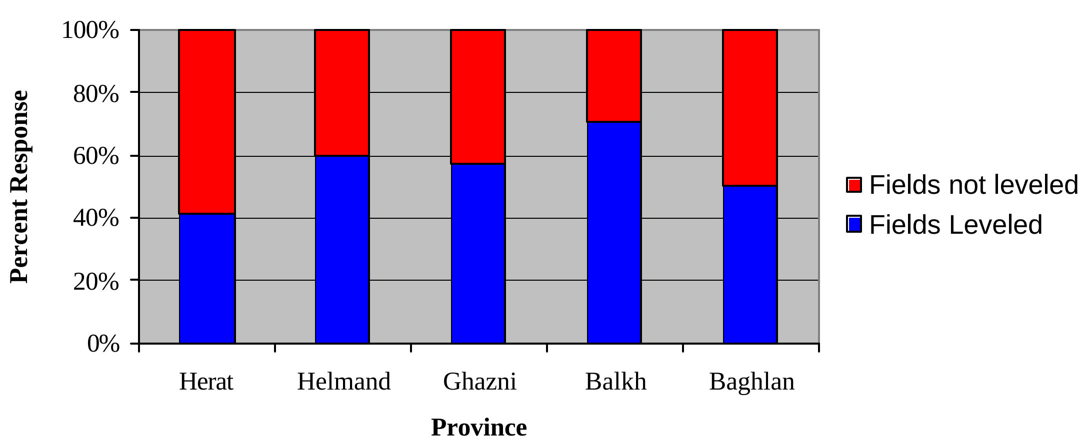
Since water delivered to a given farm is a function of discharge and delivery efficiency, the further from the source of the supply the greater the conveyance losses. As a result, tail end farmers usually have greater water constraints. However, it is believed that application efficiencies of tail end farmers are much higher than the head end farmers. This tends to suggest that tail end farmers are more careful in the application of water or that they do not just have the water to waste. The main reason for high application efficiencies of tail end farmers are basically due to large number of under-irrigations, which they apply to bring more area under cultivation. This under-irrigation usually causes salinity problems due to insufficient leaching of salts from the root zone.

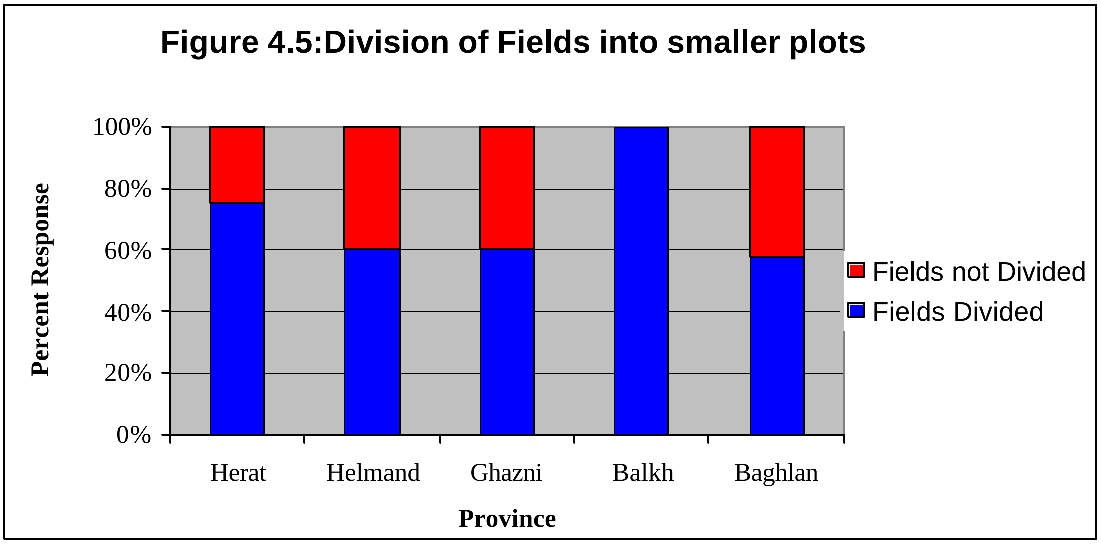
Farmers' Knowledge about Levelling of Irrigation Fields

During the survey, about 40 to 60 percent farmers were of the view that their fields are leveled as shown in Figure 4.4. Farmers do attempt to level their fields with the traditional leveling equipment's. The farmer, without engineering help, simply tries to remember the high spots while irrigating and then later uses the bullock powered traditional wooden equipment's in an attempt to make high and low spots equal. This is also done by few farmers who are really concerned about their field application efficiencies. Majority of farmers reported that they divide their irrigation fields into several smaller units to ensure uniform application of water.

The choice of a farmer to level his fields is also dependent on water supply situation and location of his land in the command area. When water supplies are adequate, farmers have less incentive to level their fields. Farmers with good water supplies usually attempt to compensate for un-level fields by applying more water. Farmers located at the tail end of the watercourses and usually constraint about limited water supplies are more concerned in leveling their fields to get maximum benefit of their water turns.

Figure 4.4: Levelness of Agricultural Fields





Land leveling not only provides conditions for improved crop yields, but also is a mean to achieve improved field design and consequent reduction of land devoted to field channels and bunds. Land leveling is, therefore, a mean for increasing the area of land cultivation as well as to provide more uniform water distribution. Land leveling studies conducted elsewhere under similar environmental conditions have shown a direct relationship between field levelness and water saving and crop yields. Evaluation of several fields after precision land leveling in various parts of Pakistani Punjab have shown that there is a saving of from one-third to one-half the water on precision leveled fields as compared to traditional un-level fields. These studies have also related land leveling to improved crop yields (Table 4.1).

Table 4.1. Relationship between levelness and crop yields (Kg/acres).

Crop	Estimated leveling standard		
	Poor	Fair	Good
Rice	280	520	1280
Cotton	240	280	440
Wheat	240	560	560
Sugarcane	12000	21,200	22,400

Source:

The most widely used method of applying irrigation water to fields in Afghanistan is to continue irrigation until the basin is completely covered with water. Farmers attempt to cover all high spots of the field. It is, therefore, important that fields are almost dead level to ensure good seed germination, crop emergence, and adequate moisture throughout the growing season for good crop yields. Advocates of land leveling report many other benefits from precision land leveling such as increased uniformity of crop stand, improved germination of seed, reductions in nitrate leaching, improved field application efficiencies, saving of water, reduction in salinity and water-logging problems. Under traditional leveling of fields, large land area is wasted by field channels, bunds, and other small structures needed to control water at junctions and outlets and inlets to the fields. With improved field design achieved through precision land leveling these problems could be reduced to minimum. Such changes should also take place with the rehabilitation of existing deteriorated channel systems. In a land-scarce agricultural economy, any fertile land saved has high economic value.

Farmers' Knowledge about Salinity Problems

As already described in this report that farmers having greater access to water tend to over-irrigate their fields. In many irrigation areas around the world, these irrigation practices of farmers have resulted in waterlogging and consequently salinity problems. Salinity problem also result from under-irrigation of crops. Farmers confronted with scarce irrigation water supplies attempt to maximize their cropped area by thinly spreading water over their fields. The point of economic diminishing returns is difficult to isolate because it varies with type of crop, the variety, and the use of other inputs. Evidently, farmers find through trial and error the degree of under-watering that is best for their traditional practices.

Incidences of soil salinity are not widespread in Afghanistan. More than 60 percent of the respondents reported that their soils are not salt-affected. High water table conditions and soil were was reported as reasons for the development of salinity in irrigated lands. Most of the soil salinity is considered to be inherent, as it was produced during the process of soil formation. Soil salinity within the irrigation fields is highly variable. This is mainly due to inequity of canal water supplies between up-stream and down-stream users, which limits the chances of proper leaching at all fields. The distribution of water in the field is also not uniform due to inadequate land leveling and irrigation application practices. This un-even distribution of irrigation water produces patches of low and high infiltration rates, which in turn produces patches of low and high salinity within the same field.

The farming community in Afghanistan is not very aware of the strategies to overcome soil salinity problems. During the survey, only 25 percent of the farmers responded that they use leaching and drainage as the potential solutions to solve salinity problems. Growing of salt tolerant crops in salt-affected areas is not a common practice as the knowledge and availability of salt tolerant crops is very limited.

Farmers' Knowledge about Flood and Drought Management

Afghanistan has a history of repeated floods and droughts and will continue to experience it. Flood damages to the irrigated areas are common, particularly in large schemes supplied by rivers changing their course frequently due to their high sediment load and unfavorable geo-morphological conditions. Floods usually occur in spring and early summer. The sources of spring floods are heavy rains and melting of snow on mountains. These floods are more continuous and appear in early April to June in Afghanistan.

Last four years of continuous drought have taken a heavy toll on Afghanistan's economy and increased vulnerability and hardship for many predominantly rural communities. There have been widespread damages to biological potential of land, extinction of livestock and problems for human life due to non-availability of water.

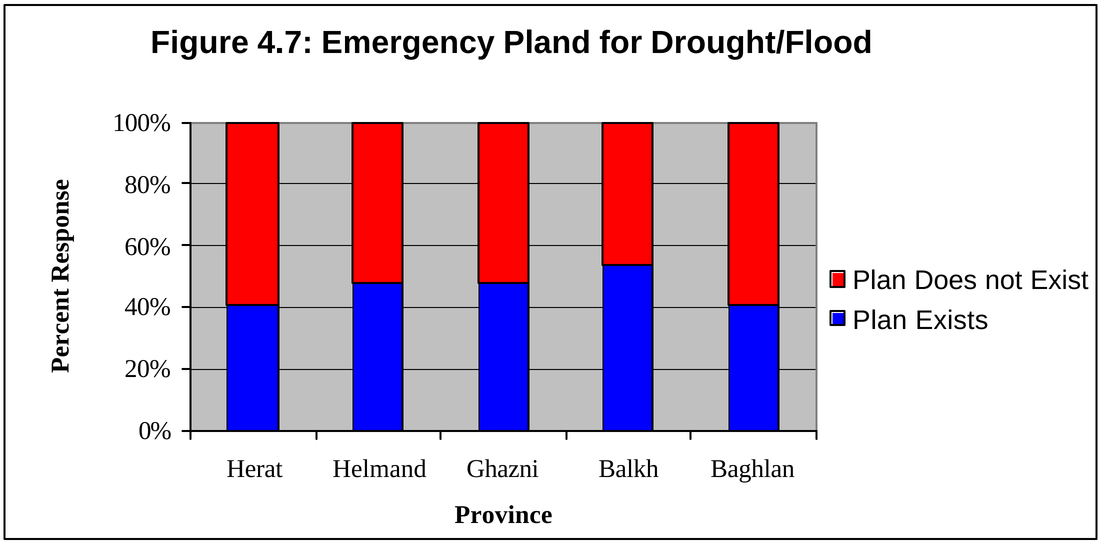
There seems to be a four to five year frequency for a minor drought and a thirty year for a major drought The impact of drought on surface water resources varied greatly by height of river above mean sea level. The rivers with main discharge forming basin above 4000 m asl. have enough water in the upper and middle reaches but in the lower parts shortage of water is seen. In the rivers where discharge forming basin is below 3000 m asl. An acute shortage of water is seen. All valleys and low land plains with an altitude lower than 2000 m asl., which also include rain-fed areas, are affected by drought very seriously.

The natural tendency of human being is to forget natural disaster like earthquake, floods, and droughts very quickly. It is not very common to think about the next disaster and make contingency plans. Afghanistan for sure in not an exception.

As shown in Figure 4.7. Despite heavy risks of floods and droughts, no emergency plans are available for their monitoring, regulation, management and mitigation. About 60 percent of the respondents reported that there are no emergency plans for the management and mitigation of floods and droughts. The survey results indicate that the most common method to cope with the drought situation is to limit the irrigated area, which ultimately reduces the crop production and threatens the food security. Next in the importance is the rationing of water supply among different communities.

The concept of sharing water shortages is not very common within the farming community. Almost all the respondents were unaware of the improved water management techniques that can be adopted to use scarce available water resources for optimizing crop production rather than maximizing crop production. These way farmers do not need to decrease their irrigated areas. Studies done elsewhere under similar conditions has shown that adaptation of water conservation strategies can save up to 25 percent of the water resources without compromising on crop yields. The water saved through conservation measures can be used to bring more areas under irrigation.

Farmers of these areas should also be encouraged to use water efficient irrigation application techniques such as sprinkler and drip irrigation systems. These systems are particularly suitable for steep slope areas where land development costs are high. The sprinkler irrigation for crops and drip irrigation for fruits/forests plants provides an alternate option for farming and resource conservation in these areas. Therefore, there is a need to introduce these systems with operations that are cost effective and adaptable to farmers, crops and physical local conditions. Now a days small and cost-effective pressurized irrigation systems are available. Considering the costs involved in the land development, the investments required for the installation of these systems is feasible.



4. Groundwater

Groundwater is extracted through springs, karezes, and wells. When groundwater table crosses the ground surface, water seeps from underground and flows on the surface and form springs. Close to 183,000 ha of land is irrigated by springs in Afghanistan. The largest portion of spring-irrigated land is located in the Uruzgan province in the southwest. Springs are directly dependent upon the groundwater level. When the groundwater level goes down, e.g. during drought years, the results is a reduction of outflow from springs. That is why some of the worst drought-stricken areas of the country are located in region where they depend heavily on spring water for irrigation. Spring irrigation is common in the east, west, and in the south. It is not as common in the north of the country.

Karezes are underground galleries that tap groundwater in the aquifers of alluvial fans. Underground tunnels with gentle slopes carry water from the source to the settled areas as shown in Figure 4.8. Techniques for retrieving water through karez have been used for thousands of years in Afghanistan, Iran, the Middle East and North Africa. Karez is one of the most economical methods of tapping groundwater for irrigation purposes. It is environmentally safe and the water is drawn by utilizing of gravity. There is always the temptation to replace karezes by tubewells. However, by doing that an ancient technology which brings groundwater to the surface through the force of gravity will be killed.

The total area of karez-irrigated land is estimated at 163,000 ha, slightly less than spring-irrigated land. Karez irrigation is common in the south and southwest of the country, but less so in the north of the country.

Another form of extraction of groundwater is through dug wells or *arhads*. Animal power (donkey, horses, oxen) is used to rotate the *arhad* wheel which is equipped with buckets reaching the water in the well and by rotating the wheel, water is drawn from the well and emptied in the stream. About 16,000 ha of land is irrigated by well water.

There has not been any concerted effort to exploit water through modern technology mainly because of high initial and maintenance costs. Perhaps this is an excellent way of preventing groundwater over exploitation and mining. The downside is that during the drought years when most of the karezes and spring dry out, without tubewells, it is impossible to use groundwater for irrigation purposes.

The potential groundwater resources of Afghanistan as estimated by FAO, 1997 is about 18,000 million m^3, from which 3,000 million m^3 is currently being used. With an estimated future use of 5,000 million m^3, the groundwater balance in the country is about 13,000 million m^3. Groundwater is common in the alluvial deposit of all major rivers. which makes conjunctive use of surface and groundwater and attractive proposition to boosting agricultural products and increase cropping intensity in the river basins of the north, west, and south west of the country.

In the province surveyed the contribution of groundwater to irrigation varied widely from province to province. Figure 4.9 shows contribution of different source of irrigation water in those provinces.

Provinces, which relied on groundwater for their source of irrigation water, were particularly hit hard by the last three years of drought. Ghazni is an example. The general lowering of groundwater table in these provinces has resulted in the drying up of springs and karezes. Use of tube wells a supplementary source of water by a few well to do (less poor) farmers has become a source of resentment toward tube wells by the general public. They blame the existence of tube wells as the primary cause of drying up of their springs and karezes.

To know the condition of karezes let us walk through the village of Gaja in Herat. There are three karezes in Gaja. One of the karezes has dried up during the drought. The second karez has 20 wells and water output has decreased by about 75%. The third karez is the Gaja karez and has 60 wells. Most of the wells are destroyed by flood. These three karezes join together in the bed of a river and uses the river bed for a bout 2 km. Flooding destroy the water course and the villagers are desperate for some permanent solution. As a result of drought people have made a storage dam which they can collect water in a small reservoir and use it on a turn basis. Perhaps this is the hard way of learning about water conservation because in normal years there were no need for storing water.

The drought of the past three years has been particularly hard on the agriculture that was dependent upon groundwater extracted through springs and karezes. The questionnaire was designed to gather information on the extent of groundwater use through karez, spring, and wells. Questions were designed so that to gather information on the number of each source in the area, the command area for each source and the effect of the drought on the source

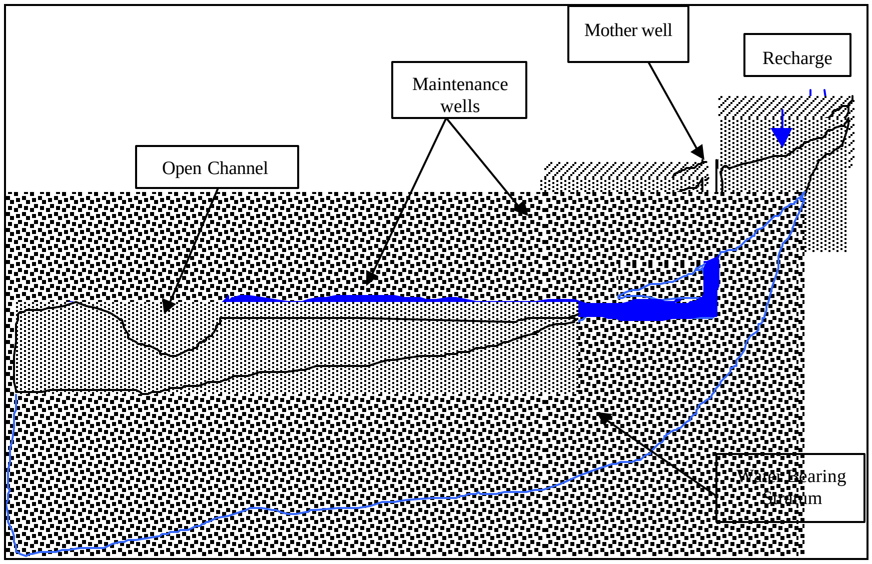
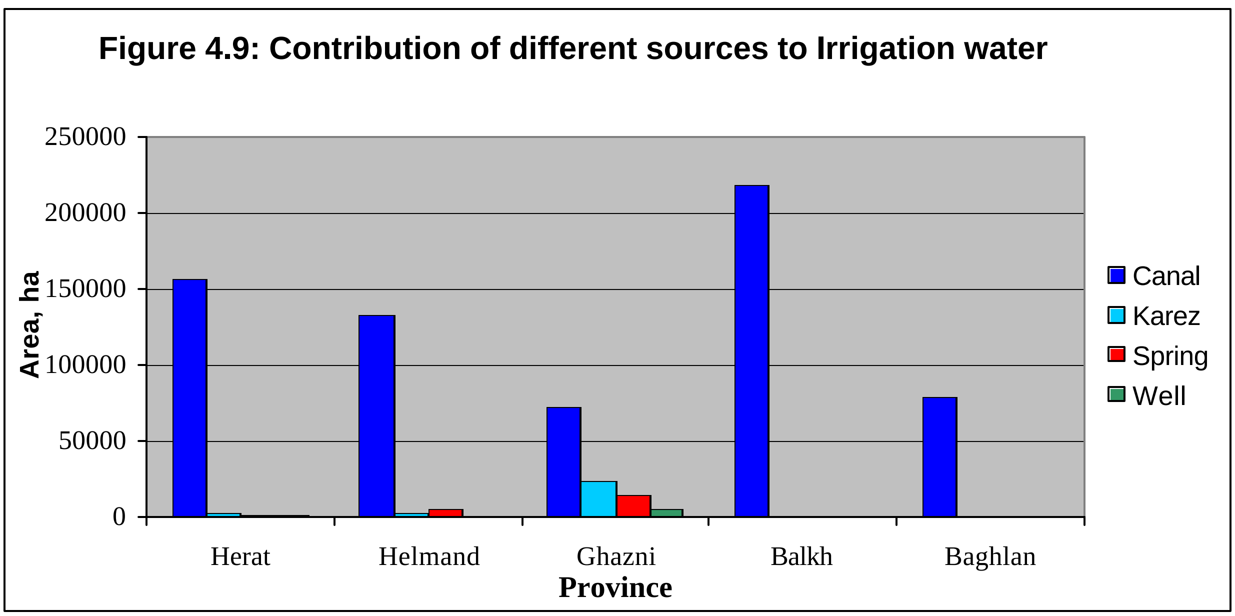
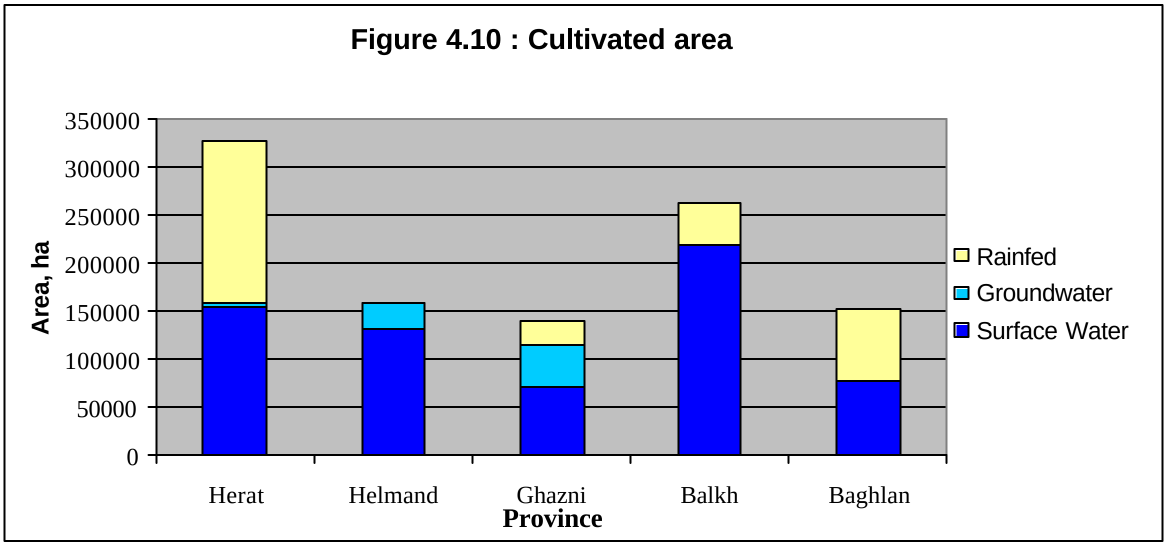


Figure 4.8: Typical Karez



Source: CSO

In the 17 villages that were survey in Herat, a total of 1710 ha of land is irrigated by 11 karezes as shown in Table 4.2.. On average, each karez irrigates 155 ha of land. Almost a 100 percent of the karezes are owned and maintained by the community. The intermediate wells and above ground water course of some of these karezes are located along the flood course creating problems for the community in maintaining the karez functional. Most of the karezes in the districts surveyed are perennial karezes which their water could be stored during winter as a water conservation measure. The contribution of springs and tube well to irrigation in the villages surveyed in Herat is insignificant, 80 ha and 20 ha, receptively.



Source: CSO

In the Helmand province, in the twenty-six villages, there is only one community owned karez reported which is responsible for irrigating about 70 ha of land. There are no springs reported, however, there is substantial use of tubewells reported. This is an indication of conjunctive use of surface water and groundwater in the area. These tube wells are installed without any permit or consent of the authority. Though it was not part of the questionnaire, the increased number of tube wells is the result of increased perceived wealth from poppy cultivation.

Table 4.2. Groundwater Statistics in the provinces surveyed

Province	No. Villages Surveyed	Karezes		Springs		Tubewells	
		No	Area , ha	No.	Area , ha	No.	Area , ha
Herat	17	11	1710	1	80	1	20
Helmand	26	1	70	0	0	300	3356
Ghazni	21	51	7395	2	4000	314	1427
Balkh	24	0	0	2	2140	9	294
Baghlan	22	0	0	0	0	0	0

From the five provinces surveyed, Ghazni heavily relies on groundwater. In the 21 villages surveyed, there are 51 karezes and two springs responsible for 7395 and 4000 ha of land receptively. In addition there are 314 tube wells that provide water to 1427 ha of land. Ironically, the general public do not have a positive attitude toward tub wells mainly because they are owned and operated by a few wealthy individuals and they are thought, and rightly so in some cases, to be responsible for the general decline of water table in the area.

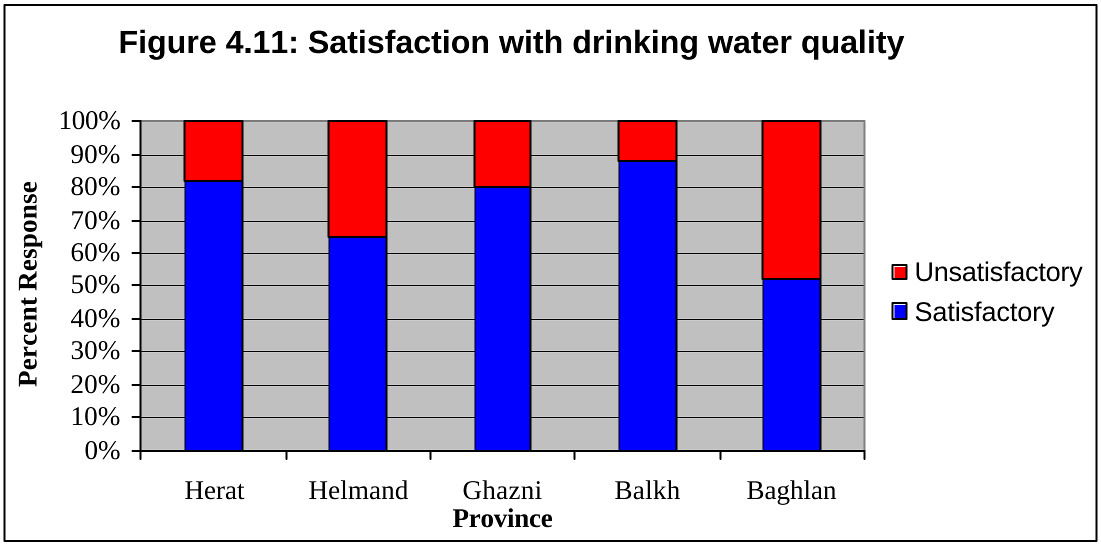
5. Water Supply

Water is the key to life in Afghanistan. The same source generally provide water for irrigation, animal, human consumption, and personal hygiene. More fortunate villages have independent source of water, springs, or karezes, which are usually quite clean and reliable. Others must share water from streams, canals, and rivers. The water flows through the village in open multipurpose canals, generally, the canal water polluted even before it enters the village, and that if they are not when they enter, they are when they leave. The least fortunate villages do not have a regular supply of water. In these villages water flows for a specified amount of time on a given day when it irrigates the fields is used to wash clothes, and is stored in small reservoirs know as *howz*. *Howz* water is polluted. Some villages have shallow wells to tap groundwater. The water from these wells is usually less polluted than the *hawz* water. In areas where people do not have access to groundwater and surface water, they harvest rainwater in rock depressions and use them for all household needs and drinking purposes. These areas were particularly hit hardest and large number of population was forced to migrate to IDP camps. Chemtal, in Balkh was such an area.

The survey indicated that the estimated average per capita daily water consumption for the five province is about 38 liters. The main source of domestic water supply in the western, south, and south western provinces is well water and that is mainly through the work of NGOs in the last two decade which were concentrated in those regions of Afghanistan. In Balkh and Baghlan however, the source of domestic water supply is shallow wells and canals. I recall what the Minister of Irrigation in the AIA government who was from Baghlan told me once that their drinking water always tasted like sugar beats because the source of their drinking water was the same canal that was used to discharge the effluent from the Baghlan Sugar Factory. This is not an uncommon situation in Afghanistan.

Drinking water quality

The survey contained a question to indicate the degree of satisfaction of the villagers as to the quality of drinking water. The reader should keep in mind that the question of water quality measures only the quality as far as the taste is concerned. There is no water purification activity going on at this time in Afghanistan so the water quality question is a qualitative (taste) test of water and nothing else. At best it measures the quality as brackishness vs. good taste or as the minister of irrigation, AIA pointed out the taste of sugar beats in water. It should be kept in mind that water quality in Afghanistan at this time is a major source of disease among the population. As to the quality of water, more than eighty percent of those surveyed were satisfied with their quality of water in Herat, Ghazni, and Balkh. The satisfaction dropped considerably in Helmand 65 percent and Baghlan 52 percent. In Helmand water logging and salinity have had adverse effect on the land and groundwater. In Baghlan, however, canals form a major source of domestic water and these are, in general, polluted. Figure 4.11 summarizes the findings on the domestic water data.

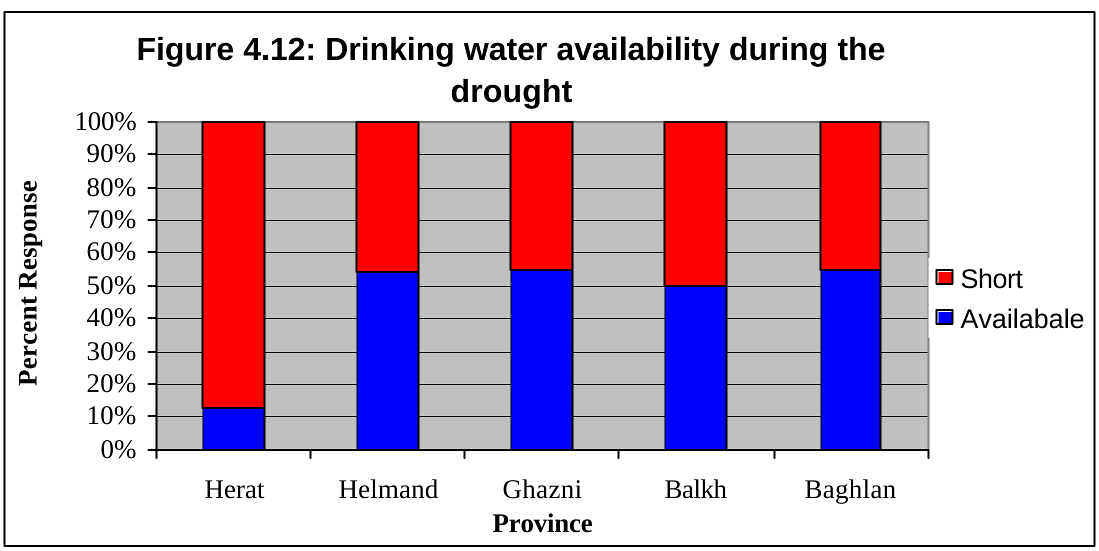


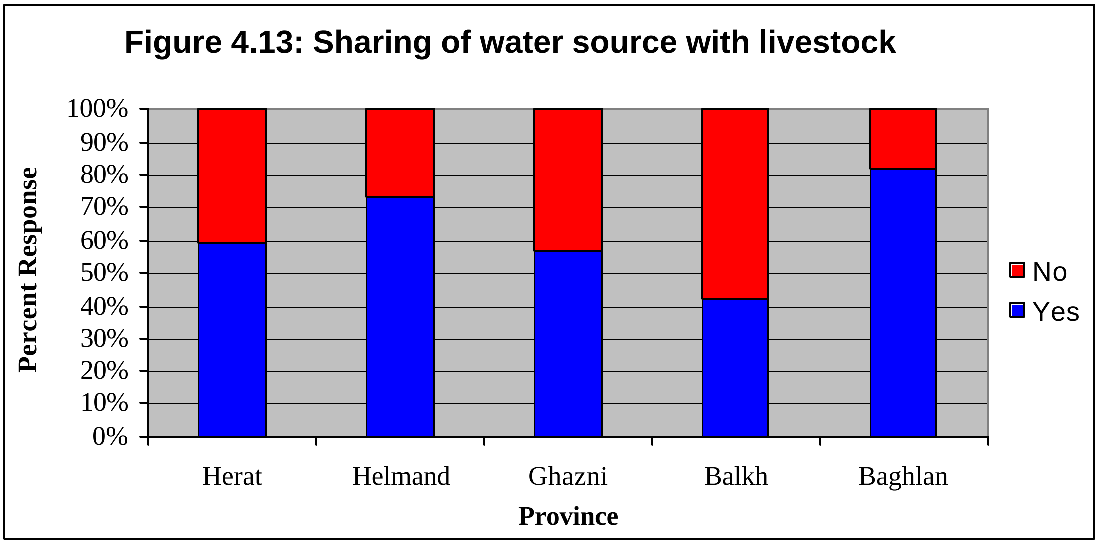
Drinking water availability during the drought

Forty five to fifty percent of the respondents faced shortage of drinking water during the drought years in Helmand, Ghazni, Balkh, and Baghlan. The shortage was more severe in Herat where more than eighty percent of the respondents faced shortage of water during the drought years.

Sharing of water with livestock

Figure 4.13 shows the percentage of respondents sharing their drinking water source with their livestock. It varies from province to province ranging from 42% in Balkh to 82% in Baghlan. This question was included in the survey at the request of the livestock group.





6. Water Law

Water rights perhaps is the most serious constraint to agricultural development in Afghanistan. The traditional system, still in force, results in inequitable water distribution favoring land near upstream of the canals at the expense of the farmers at the tail end of the canal. The distribution is easy to manage, however, it discouraged land owner at the top end of the system from making improvements to the system because the feel that they will not benefit from the improvement and usually, theses are the more influential people in the village.

The traditional water distribution has been developed over the years and it my not be very easy to change. The Afghanistan Government instituted the 1981 Water law to impart some improvement in the water rights. However it needs updating and revision before it is ready to be enforced. A copy of the 1981 law is provided in Appendix 3. It may not be the official translation.

The water law is in seven chapters. Chapter one includes issue such as ownership of water which belongs to the public and is preserved by the government (Articles 2), drinking water and water for other living requirements has been given priority over other uses (Article 5), and use of water shall be free of charge (Article 6). Provision is included to charge fee to cover maintenance cost of irrigation systems (Article 8).

Chapter two deals mainly with assigning authority and responsibility to the Ministry of Water and Electricity (Article 10*) which is split under the new organizational chart of the government. The water part of the Ministry of Water and Electricity has been shifted to the Ministry of Irrigation and Water Resources. A further complication is that the in the National Development Framework (NDF), the responsibility of water resources and management is assigned to a yet to be established government entity.* Article 11, directs the same ministry to establish offices responsible for the construction of irrigation systems *which again is contrary to what is envisioned in the NDF and that is to contract these activities to the private sector.* Permission has to be obtained before building next to a water source or sinking a deep water well (Article 14). The government has been giver the authority to restrict water use during inclement weather affecting water resource (Article 16).

Chapter three is about use of water in agriculture. It deals with water rights, water distribution, water user associations, *Mirab*, and tax break for converting their dry cropping land to irrigated land.

Chapter four deals with drinking water and using water for transportation. It also gives permission to use water for fire engines from all sources and as much as required.

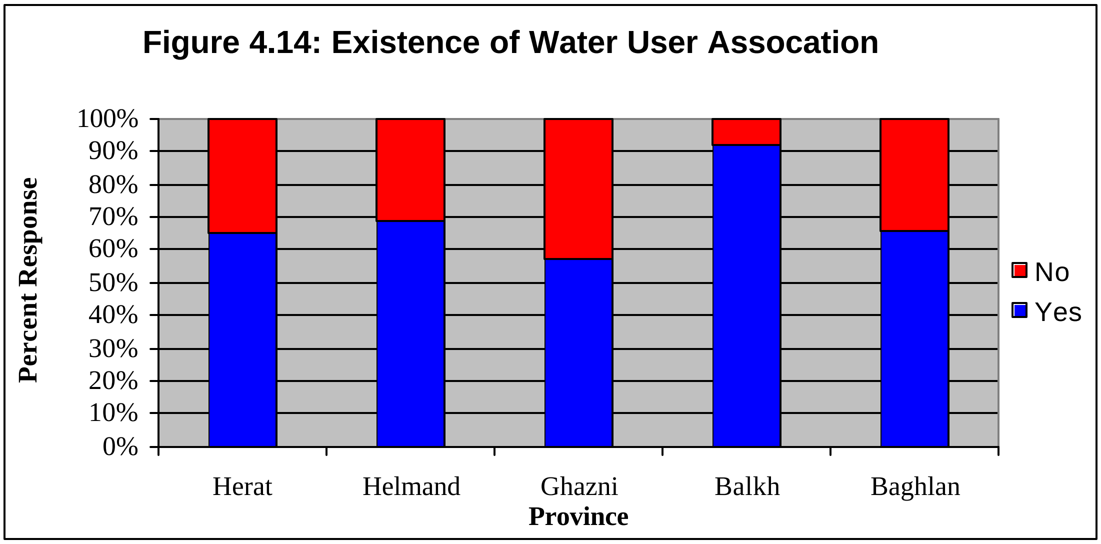
Chapter five is about water pollution issues.

Chapter six addresses dispute resolution arising from water distribution.

Chapter seven calls for special regulation for the use of water in agriculture. These regulations are in Four chapters and thirty nine articles.

The survey included some questions to see if some parts of the water law are followed.
In response to the question of the existence of Water Users Associations WUA, the "yes" response ranged from 57% in Ghazni to 92 % in Balkh as shown in Figure 4.14. This is significant because a majority of the farmers are familiar with and are part of WUA. These WAU, however very informal meet, as needed, to decide on important issues pertaining the irrigation system. In many countries, the main difficulty lies in the education of farmers to be part of WAU like the one in Indonesia.

In all five provinces surveyed, there is a water distribution schedule that is followed by the farmers The scheduled is made either by the government or the *Mirab*. In Herat, in 70% of the cases, the government makes the schedule and as mentioned earlier, the schedule was made in the sixteenth century and is still followed. It is maintained in the ministry of Agriculture office in Herat and the *Mirab*s follow that formula in water distribution. In the Helmand Province because of the existence of public irrigation system, the government, the *Mirab*, or both make the schedule. The same thing is true with Baghlan and Balkh. It is interesting to note that the government has an active role in the water distribution, even if the system is a traditional system run by the farmers.
In response to the question of "Is *Mirab* elected", in the overwhelming majority of case the answer was yes. The *Mirab*, in general, receives compensation in kind for his services. In the majority of the villages surveyed the *Mirab* also settles deputes between frames.



Water Allocation:

The basis of water allocation in Herat is the traditional and local practice that has been in existence for centuries. These allocations are in general based on the area to be irrigated. However, the upstream user has the priority in the allocation. Dispute over water allocation in normal times is rare. It is only in some areas because of the heavy handed operation of some local commanders, especially in Helmand and Baghlan where dispute have been surfaced. *Mirab* in cooperation with local government authority are generally the ones who settle the dispute.

Water Reaches Tail end

The response varied from a low of 27% in Baghlan to a high of 98% in Ghazni, the rest in between as depicted in Figure 4.15. In Baghlan, it seems that unauthorized diversion of water in the upstream area had caused the shortage of water at the bottom of the system.

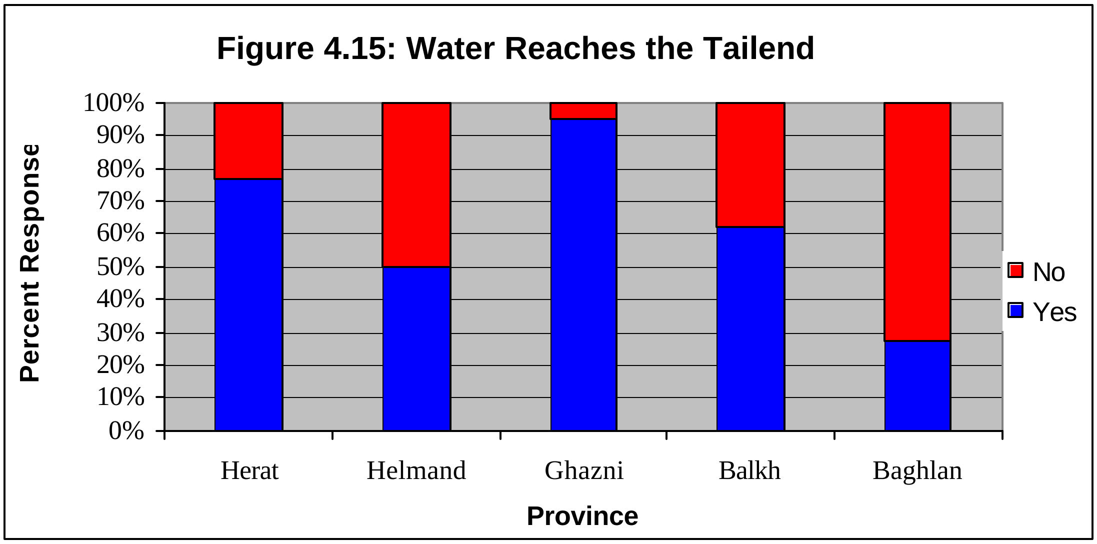
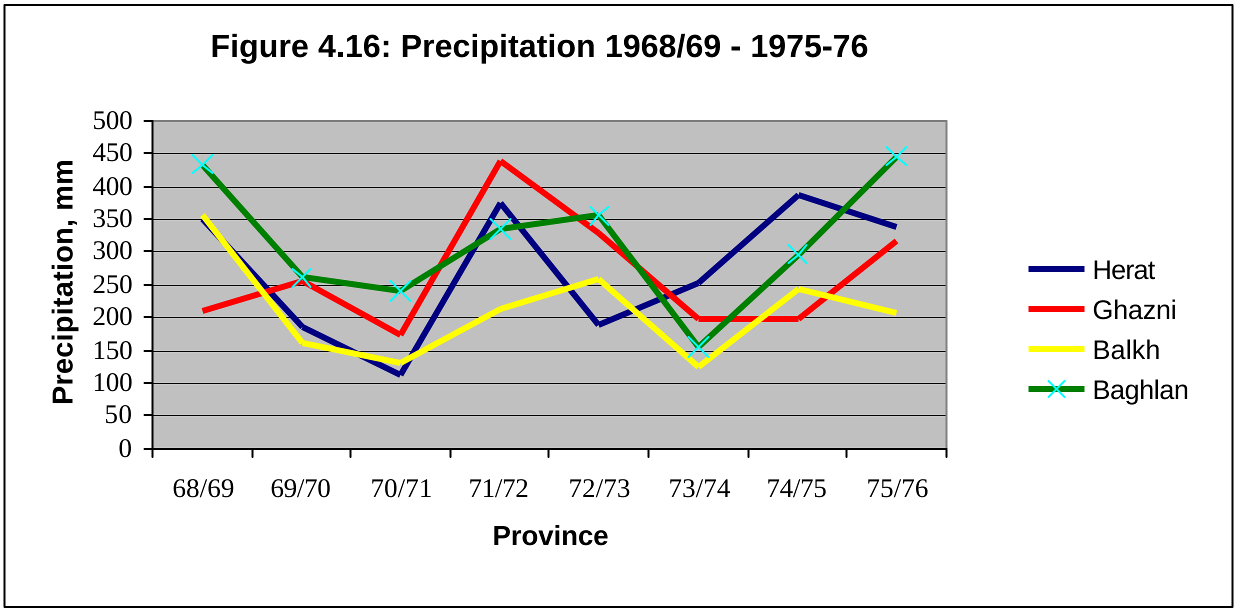


Figure 4.15: Water Reaches the Tailend
Percent Response
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Herat
Helmand
Ghazni
Balkh
Baghlan
Province
No
Yes

B. Rainfed Agriculture

Afghanistan is predominantly an agrarian society with 80 percent of the population living in rural areas, and directly dependent on natural resources for livelihoods (small scale farming, pastures and forest products). Since rainfall is scanty and highly variable over most of the country where topography and soils are suitable for agriculture, there are only few areas where rain fed crops can provide a reliable basis for livelihoods. There are roughly 3.9 million ha of cultivated land in Afghanistan of which about 1.3 million ha are rainfed. Although irrigated area produces more than 85 percent of all agricultural products, the contribution from the rainfed areas is of significant importance in meeting the food and fiber requirements of large population living in these areas.

Figure 4.16 shows the annual precipitation in the selected provinces from 1968/1969 to 1975/1976. The statistics for the Helmand could not be located. As is seen from the



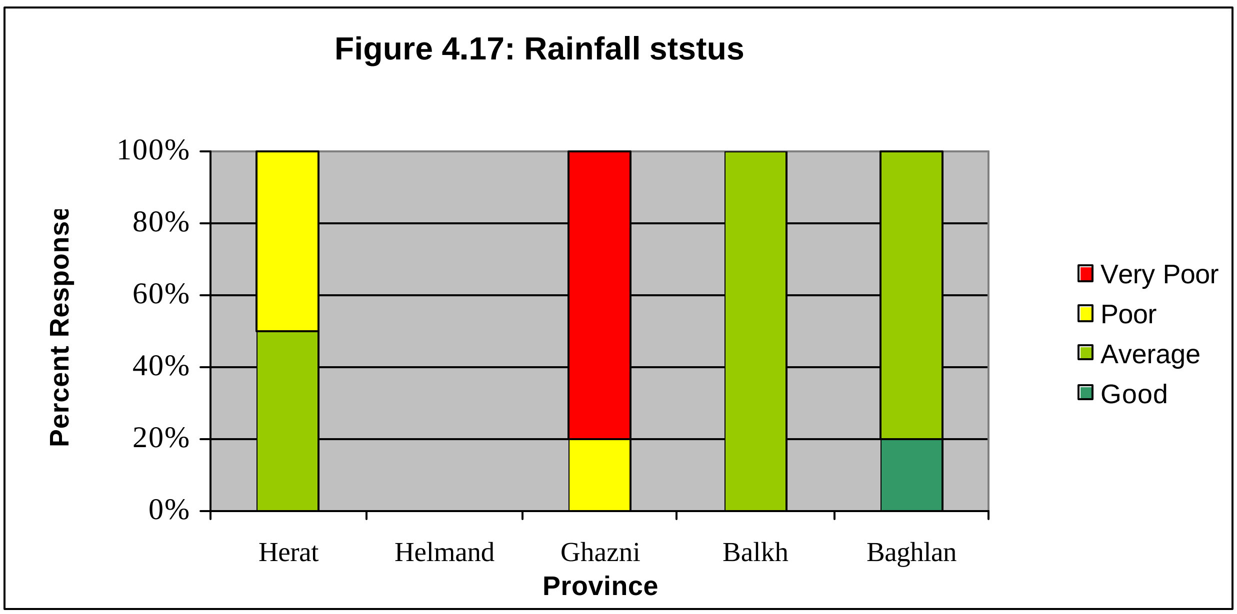
Source: CSO

precipitation chart, the every three to four years of good rainfall is followed by two to three years of low rainfall which results in low yield in the rainfed areas. Judging from the trend, and the input from the farmers about this years rainfall, for the exception of Ghazni, we may be in a cycle of increased rainfall in Afghanistan for the next three to four years. This is an opportunity to devise plans to cope for the inevitable drought in the next cycle.

The major rainfed areas are located in the northern, southern and eastern parts of the country. In rainfed areas, the water availability for irrigation is mainly a function of effective rainfall and groundwater resources - which in turn depends on the amount and distribution of precipitation. The recent succession of dry years has reduced the annually cultivated rainfed area to less than 0.5 million ha. Currently, rainfed cereal production has fallen to about 0.6 tons/ha, which is 10 percent lower than the expected production in a normal year (ref). As a result, food security is becoming a major challenge particularly in the northern parts of the country where rainfed agriculture is widely practiced.

The rainfed areas are more vulnerable to drought conditions. Due to the climatic conditions prevailing in Afghanistan, frequency of droughts is high and will remain high. As a consequence, rainfed areas are the first and most severely hit. However, as the survey showed, no emergency plans exist for the management and mitigation of droughts and the drought of last four years has played havoc with the lives of people living the rainfed areas.

In the province surveyed, the amount of rainfall generally is rated “good”. The feeling about rainfall this year varied from province to province. In Herat, was “average” to “poor”, in Ghazni, it was “poor” to “very poor”, and in Balkh and Baghlan it was rated as “average”. These responses are depicted graphically in Figure 4.17.



Not all of the available land is cultivated in the rainfed area. This has been particularly true during the recent drought years. Figure 4.18 shows the area under cultivation in the province surveyed. It appears that large tracks of land is left fallow in each province. It is the goal of the government to produce at least half of the country’s cereal needs from rainfed farming. The land is certainly there.

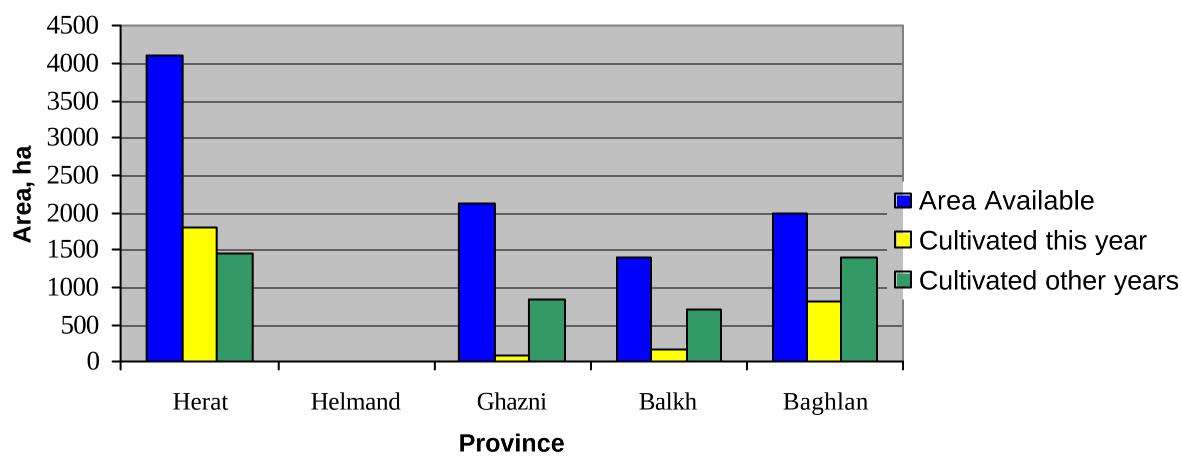
In response to the question “Is it possible to bring more area under cultivation?” The answer was an overwhelming “yes”, 94 %. Minefields again, as was in the case of irrigated agriculture, did not seem to be a constraint in the rainfed agricultural lands. More survey is needed an order to come up with a definite conclusion as to the presence of mines in those areas. The reader should be aware that the size of the sample is small and does not cover the whole province. Therefore, when it comes to minefields, we have to be careful not rush to judgment.

Can the rainfed area be irrigated? The soil and water survey has shown that no rainwater harvesting techniques are used in the rainfed areas of Afghanistan. The small amount of rainfall stored in village ponds is only enough to meet the drinking water or livestock demands and are not sufficient to support irrigation. The main reason reported by farmers for not storing rainwater for irrigation is the lack of storage facilities and technical guidance to build such storage. Farmers think that by improving present storage and installing new systems, more areas can be brought under irrigation. During the survey farmers did not report any water or soil erosion problems.

Rainwater Harvesting

The improvement and expanded use of water harvesting (the capture and diversion of rainfall to fields for irrigation) is an ancient practice but has been recently for rain-fed agriculture. Successful water harvesting captures part of the rainfall and stored it in the plant root zone to enhance growth as in the case of micro-catchments; or when stored in small surface and subsurface reservoirs it can be used for supplemental irrigation and other productive uses. Water harvesting can also provide broader environmental benefits through the reduced soil erosion and improved vegetative cover in the degraded lands.

Figure 4.18: Rainfed cultivated land area, ha



A range of technologies is available for water harvesting and artificially recharging the groundwater aquifers. The most common water harvesting structures that are in use in various parts of Africa and Asia are check dams, percolation tanks, village tanks and roof water harvesting. The selection of a particular technology for a specific area depends on geo-morphological and socio-cultural conditions of that area. The construction of village tanks is a community activity and therefore requires the involvement and willingness of all farmers. In areas where water is stored in relatively less hotter months but used in hotter months, a large percentage of water stored in surface reservoirs is lost in evaporation. In these regions, the construction of check dams to store water underground is more appropriate technology. Thus, not only the water, which is otherwise lost in runoff, is saved, but also the loss of water through evaporation is prevented. The amount of water saved through prevention of this evaporation is quite high during the drought years. The check dams are usually built in series along the river course. In areas where groundwater tables are deep, as in case of many areas of Afghanistan, recharge tubewells built in conjunction with check dams are the most effective solution.

Roof water harvesting appears to be the best alternative for households in both rural and urban areas for domestic water security where private water sources are absent and other public water systems fail to supply water. Roof water harvesting systems can also supplement existing public water systems and reduce the stress on them. The most ideal condition for adoption of roof water harvesting systems is that the area having reasonably high rainfall and the housing stock has sufficient per capita roof area. The amount of water that can be made available through roof water harvesting technique is directly proportion to the total quantum of rainfall, the runoff coefficient of the roof and the per capita roof area.

Rooftop water harvesting will be physically most feasible for the rural households in the areas, which face acute drinking water scarcity due to poor natural storage of water resulting from the steep terrain. The production of infrastructure for rainwater harvesting is very high when compared to the almost free water available from public water systems. Hence, many a rural household will find it unaffordable. In view of this, subsidies from the Government will be essential for large-scale adoption of rooftop water harvesting in rural areas.

These water conservation and water harvesting initiatives have proved very successful in India and parts of Pakistan. They have contributed significantly in addressing the local groundwater scarcity problems and helped farmers achieve water security for protecting their crops. When these activities are taken up at a larger scale, more systematic and scientific planning is needed to assess their impacts on the overall water balance at the regional/basin level, more specifically the impact of storage on environment. While in good rainfall years, the local water harvesting structures could capture the excessive runoff that otherwise would flow over the large reservoirs, in low rainfall years they could possibly reduce the inflow into these reservoirs. Therefore, local water conservation activities should be a part of planning of water resources management activities in the river basin. This is necessary for the integration of local water conservation activities and large-scale interventions at the basin level.

Watershed Management

Watershed is defined as the area including all barren land, plant cover and rangeland in which all the small streams run into a main stream of water and make a natural drainage area. In general way, we can say that it is an area of land that drains into particular receiving water body (e.g., river, lake, stream, bay). It is separated from other systems by ridge-top boundaries. It includes not only the waterway itself but also the entire land area that drains to it. For example, the watershed of a lake would include not only the streams entering into that lake but also the land area that drains into those streams and eventually to the lake.

Watershed management is the management of all land, plant cover and water to best advantage and benefit of the population affected or living within the watershed area. It can be defined as the process of formulating and carrying out a specific course of action involving manipulation of the natural system or watershed to achieve specified objectives, without adversely affecting land, water and vegetation resource base. It essentially relates to soil and water conservation in the watershed which means proper land use, protecting lands from all forms of deterioration, building and maintaining soil fertility, conserving water for farm use, proper management of water for drainage, flood protection, sediment reduction and increasing productivity from all land uses.

The main reasons for resource degradation in Afghanistan are soil and water erosion, declining of groundwater tables, overgrazing, deforestation, plant nutrients deficiency, improper crop rotations, floods, droughts and economic pressures.

The problems in a watershed are usually intricate and interlinked. Therefore, no single and isolated solution can work effectively. A holistic and integrated approach is needed to tackle the problems. It essentially requires the setting of goals, preparing plans, collaborating with different institutions and stakeholders and above all effective implementation of the proposed management options.

The first step towards the solution is to identify the problems in a particular watershed. What are the causes behind those problems and what are more prevalent problems endangering the watershed resources. For example, the problem of reservoir sedimentation could be due to excessive soil erosion by heavy rainfall and/or steep topography of the area or due to extensive deforestation by the local communities. The experience across the globe show that stakeholders' involvement and public participation is necessary for the successful watershed management. The identification of key institutions involved and specification of their role in watershed management requires better understanding and integration among the stakeholders. All the actors such as farmers, general public, industry, and government institutions etc should be taken into account while planning and implementing the protective measures. The multiple solutions could be suggested to tackle a range of problems. The choice of the best option has to be made considering the technical and institutional capacity and recourses for watershed as well as concerns of the people and environment.

For example the problems of large-sale deforestation, soil erosion, overgrazing, inappropriate land use and seasonal migration can be tackled by adopting the following measures.

- Development of an integrated approach to the problems based on community needs;
- Protecting aforestation on community land;
- Distribution of seedlings to encourage planting on private land;
- Soil and water conservation;
- Pasture improvement through planting pasture grasses;

- Water harvesting;
- Distribution of subsidized fuel and energy saving devices;
- Integration of land-use innovations with measures to improve community livelihoods;
- Promotion of alternative income generating activities to reduce poverty and discourage seasonal migration;

The best management practices should include a well-integrated approach combining the micro and macro scale measures. The construction of check dams at suitable location would help in controlling the floods and soil erosion. The water thus stored during the rainfall periods would also help in cultivating the crops in dry periods. Experience has shown that construction of check dams in upper catchments helped reducing land degradation sedimentation load and the local community to improve crop production and natural landscape beauty of these regions. In middle and lower reaches check dams can be used to recharge the depleting groundwater resources.

Rainwater harvesting by developing community ponds and small tanks at local levels can store rainwater for domestic and other uses. This will reduce the excessive drainage and enhance the beneficial use of water. This would reduce the pressure on groundwater resources as well. The problems of groundwater water depletion problems can be addressed by taking artificial recharge measures. The delay action dams, tanks and groundwater wells are the potential options.

The land erosion can be controlled through proper land cover through the plantation of suitable grasses and mulching. Enhancing vegetation along the slopes can protect the steep slope areas. The pasturelands can be protected through a community involvement, improving vegetation along rangelands and better livestock management.

Improving the agricultural practices in terms of devising suitable cropping patterns, irrigation practices and agricultural inputs including optimum water and fertilizer/pesticide use will help in better watershed management. The rational use of fertilizers will reduce the pollution of groundwater resources. The reuse of animal and plant waste will reduce stream pollution.

The other options could include the restriction on the excessive woodcutting, groundwater rationing and overgrazing etc. The proper legislation should be drafted to clearly define the restriction and penalties in case of violation. The incentives and compensation should also be provided for the people of problematic areas.

For the environmental sustainability, the identification of key issues such as protection of agro-biodiversity, fish and wildlife habitat and endangered species in a watershed should be carried out. The range of corrective measures such as allocating minimum downstream discharges to protect downstream fisheries and aquaculture should be adopted. The better licensing policies for fisheries and hunting should be implemented to protect wild life and endangered species.

The education and awareness programs should be initiated to increase the understanding among the local communities. This can be done through mass media campaigns and involvement government/non government organizations.

Water-related problems in rain-fed agriculture in the water scarce tropics are often related to the intensity of rainfall with large spatial and temporal variations, rather than to low cumulative volumes of rainfall. Mitigating intra-seasonal dry spells is a key to improved water productivity in rain-fed agriculture. There are three major avenues to achieve this:

- Maximize plant water availability (maximizing rainfall infiltration and reducing unproductive losses (soil evaporation). Mulching techniques usually proves very effective in reducing the soil evaporation rates.
- Maximize the capacity of plants for uptake of water (timeliness of operation, crop management, soil fertility management). Appropriate sowing and harvesting dates, irrigation applications at the critical growth stages of crops and optimizing irrigation depths are few examples of better management.
- Bridge crop water deficits during dry spells through supplemental irrigation.

For rain-fed areas, slightly different approach is needed to improve on-farm water management and ensure sustainability of agriculture. The range of water management measures essential for the rain-fed areas are briefly discussed below.

- Develop new large and small storages in rain-fed areas to store as much of rainwater as possible. This can be done by reducing runoff and managing floods in a better way. Special attention should be given to control un-necessary evaporation losses from these storages.

- Improve system efficiencies: by reducing water losses at all levels of the irrigation system. Improve irrigation scheduling of different crops and restrict irrigation at critical growth stages of the crop to mitigate the effects of dry spell and ensure reasonably good yields. Farmers should be encouraged to adopt high application efficiency systems as sprinkler and drip irrigation.

- Conserve water at all levels: This include the adaptation of resource conservation technologies such as precision land leveling, zero tillage and bed and furrow planting techniques. These techniques have been very successful in saving considerable amounts of irrigation water.

- Exact crop water requirements for different crops under different agro-climatic conditions should be calculated. These calculations should be based on the optimization of water resources rather than maximizing the crop yields.

- Regular monitoring of groundwater levels and quality. Conjunctive use of surface and groundwater should be managed in a way that does not pose threats to the sustainability of groundwater resources.

- Develop new water efficient crop varieties. Related to this is the adoption of appropriate cropping patterns for rain-fed areas.

- Promote saline agriculture for the best possible use of land degraded by salinity and potential use of saline groundwater resources.

- Improve the management of upper catchments by reducing deforestation and better rangeland and watershed management.

- Determine and ensure environmental uses of water by region or river basin scale. Protect water uses by agro-biodiversity, fish and wild life habitats.

- Initiate recharge programs to manage depleting groundwater aquifers through delay action dams, rainwater harvesting and other artificial recharge programs.

- Impose restriction over the use of surface and groundwater by limiting the uses by different categories of agricultural, industrial and domestic users etc.

- Integrate the institutions directly managing the water resources with all other inter-related institutions.

- Launch mass media campaigns to aware and educate people about drought and water resources management.

For the sustainability of rain-fed agriculture, research is needed to address the following issues:

- What institutional arrangements are needed to integrate rain-fed agricultural technologies and practices?
  - How to coordinate communities in the design and management of surface runoff to enhance rain-fed agriculture?
  - What are the appropriate mixes of technologies and practices and scales of replication that both benefit local users and have minimum impact on environment and downstream water users?
  - Development and adaptation of risk-management tools such as rainfall forecasting.

- Where are the most appropriate fits for different interventions in different agro-ecological and hydrodynamic zones?

Groundwater

In the area surveyed, there is no groundwater use in to supplement rainwater. The attitude of the farmers when asked about the possible potential groundwater exploitation was generally negative. The negative feeling about groundwater exploitation stems from their fear of losing water in their karezes and springs in case there is groundwater development projects. Their fear is well placed if the groundwater exploitation through uncontrolled sinking of deep wells in the vicinity of Karezes and springs continues.

The source of drinking water for the majority of farmers in the rainfed areas is groundwater tapped by karez, spring, well. In some cases the land is close to the village where people have access to canal water for domestic use. The per capita average daily water was reported as 27 liters. Groundwater quality in the Herat province was acceptable while in parts of Ghazni, Balkh, and Baghlan it was unacceptable. The survey showed that none of the farmers ever had to pay for water.

C. Soil and Crop Survey

SURVEY OF FARMERS

1. Irrigation Status of Farms

Between 23 and 27 farms were surveyed in each province, with the majority being irrigated (table 1). Only 18 of the 129 farms surveyed were rainfed.

Table 1. Irrigation status of farms

Province	Number of Farms	
	Irrigated	Rainfed
Ghazni	21	5
Helmand	26	0
Heart	17	6
Baghlan	22	5
Balkh	25	2

2. Soil Texture and Depth

Farmers were asked to characterize their soils using a local system as stony, silt or sand. Soils from the irrigated areas were characterized as predominantly silty in texture with only a few sandy soils (figure 1). However, the average sand content of samples collected from irrigated farms was 49% (section B I). The limited number of soils from rainfed farms (18) were more variable in texture (figure 1). The sand content of samples from Herat, Ghazni and Balkh provinces was higher (mean 67%) than the irrigated soils but samples from Baghlan had lower sand contents (mean 38%) that were comparable to soils from irrigated farms (mean 41%). Soil depth was > 15cm on all of the irrigated farms, whereas it was < 15 cm on 3 of 18 rainfed farms.

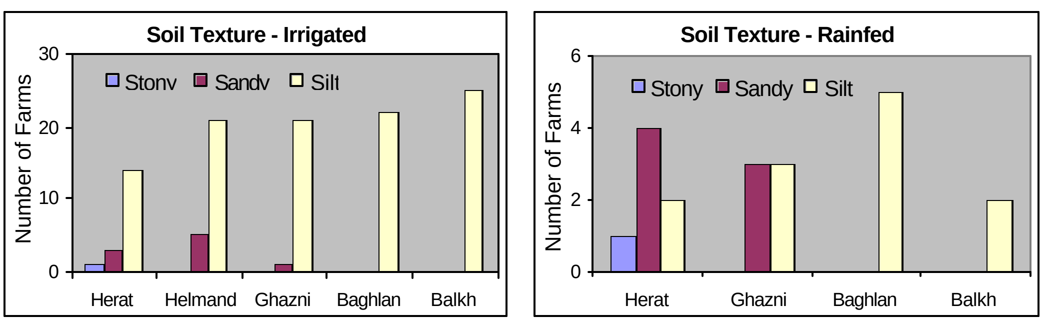


Figure 1. Farmer characterization of soil texture

3. Mechanization

Tractors, both owned and rented, are widely used for land preparation on irrigated farms (table 2). The greatest ownership of tractors is in Helmand. Animals are also widely used in Herat, Baghlan and Balkh provinces. Some manual land preparation is carried out in all provinces. Despite the widespread availability of tractors, sowing and harvest of crops is exclusively by manual labor. Threshing of grain crops is generally mechanical, with some still done by hand. Ownership of threshers is greatest in Baghlan and Balkh provinces *(ask survey team to check Helmand data)*

Table 2. Mechanization on irrigated farms

Land Preparation	-------------------- **Number of Farms** -------------				
	Ghazni (n=21)*	**Helmand** (n=26)	**Herat** (n=17)	**Baghlan** (n=22)	**Balkh** (n=25)
Manual	9	8	8	6	10
Animal - Own	7	1	15	15	21
- Rent	0	0	0	0	0
Tractor - Own	3	17	3	12	10
- Rent	11	9	11	10	9
Threshing					
Manual	9	7	9	1	12
Thresher - Own	2	0	2	11	13
- Rent	14	26	14	11	11

* total number of farms

4. Cropping Patterns and Crop Yields

Irrigated Farms

The frequency with which crops were grown on irrigated farms in the five provinces in normal water availability years is shown in table 3. Minor crops not shown were cumin seed,

Table 3. Crops grown on irrigated farms

Crop	------------ **Percent of Farmers Growing Crop** -----				
	Helmand (n=26)	**Herat** (n=17)	**Ghazni** (n=21)	**Baghlan** (n=22)	**Balkh** (n=25)
Wheat	100	100	100	100	100
Barley	12	71	67	45	68
Mungbean	100	47	24	77	56
Cotton	73	24	0	50	80
Maize	100	24	57	50	60

Forage Legumes[1]	31	35	86	32	28
Melons[2]	46	24	10	77	60
Potato	0	29	81	23	0
Bean	42	18	24	9	0
Flax seed	0	0	0	41	4
Chickpea	0	41	0	5	16
Rice	0	41	0	23	12
Sesame	0	18	0	18	24
Millet	0	18	0	0	16
Vegetable[3]	8	18	10	5	12
Mustard	0	0	19	0	0
Peanut	27	0	0	0	0

[1]alfalfa and clover
[2]melon and watermelon
[3]includes onion and tomato, excludes bean

coriander and tobacco. Wheat was grown on all farms and barley and maize were other common cereal crops. Mungbean was a widely grown grain legume and forage legumes (alfalfa and clover) were also grown, especially in Ghanzi province. Maize, mungbean and wheat were grown on all farms surveyed in Helmand province. Cotton was a common crop, except in Ghazni province where it was not grown. Melons/water melons were widely grown, except in Ghazni province, and this crop is presumably a cash crop. Potato was most frequently grown in Ghazni province, flax seed in Baghlan province, and chickpea and rice in Herat province.

Farmers were asked to provide data on crop yields in 2002 and also for years with normal water availability. Comparisons between the two values for six of the major crops grown on irrigated farms (figure 2) indicated that yields were reduced in 2002. This result is consistent

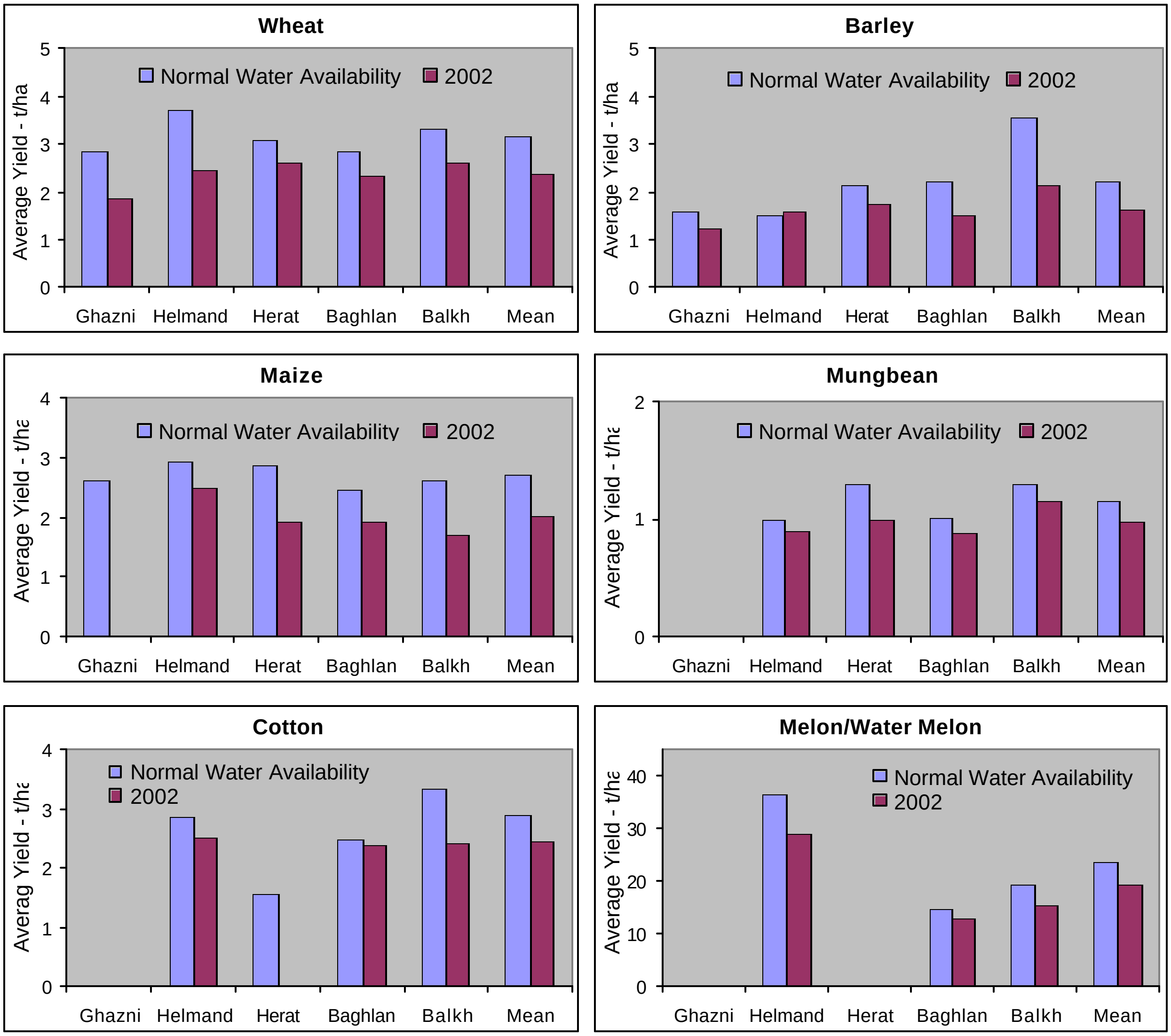


Figure 2. Farmer estimated crop yields with normal water availability and in 2002 for irrigated Farms

with farmer identification of water availability as a major constraint to productivity in 2002 (section VI) and results from the irrigation survey (section __). Overall yields (mean of province averages) in 2002 were reduced to 75% for wheat, 78% for barley, 74% for maize, 85% for mungbean, 86% for cotton and 82% for melons/water melons compared to yields with normal water availability.

A striking feature of the crop yields is their high variability (figure 3). In 2002, yields of

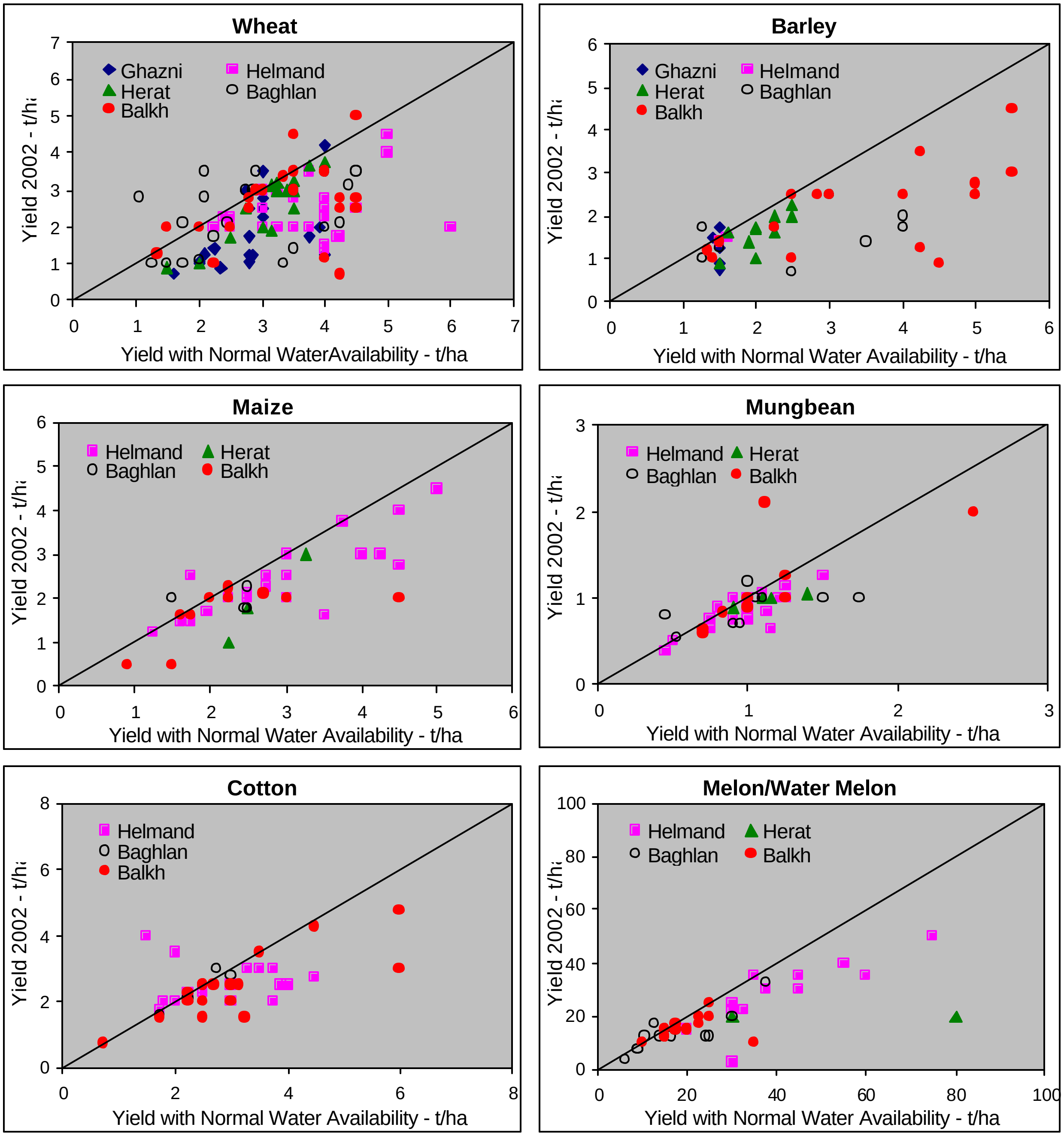


Figure 3. Relationships between farmer estimated crop yields in years with normal water availability and 2002 for irrigated farms

wheat, barley, maize and cotton ranged from <1 t/ha to about 5 t/ha, yields of mungbean ranged from 0.5 to 2.4 t/ha and yields of melon range from 2.5 to 50 t/ha. Such high variability in yields is unexpected for irrigated agriculture and suggests that constraints to productivity are widespread for all of these crops.

Rainfed Farms

The number of rainfed farms surveyed was too low to adequately characterize cropping patterns or crop yields. With this caveat, wheat, barley and chickpea were the major crops grown (table 4). Flax seed was grown in Baghlan and Balkh provinces and cumin seed and sesame were grown in Ghazni province. Crop yields were also reduced in 2002 compared to

Table 4. Crops grown on rainfed farms

Crop	-- Number of Farmers Growing Crop -- Ghazni (n=5)	Herat (n=6)	Baghlan (n=5)	Balkh (n=2)	Overall %
Wheat	5	6	5	2	100
Barley	5	6	5	2	100
Chickpea	3	6	4	1	78
Melon	2	0	2	1	28
Flax seed	0	0	5	2	39
Cumin seed	2	0	0	0	11
Sesame	2	0	0	0	11
Cotton	0	0	0	1	6

years with normal water availability (figure 4). Overall mean yields of wheat, barley and chickpea were reduced to 54%, 60% and 44% compared to yields obtained with normal water availability. Crop yields were also highly variable but this is expected for rainfed agriculture where precipitation can also be highly variable.

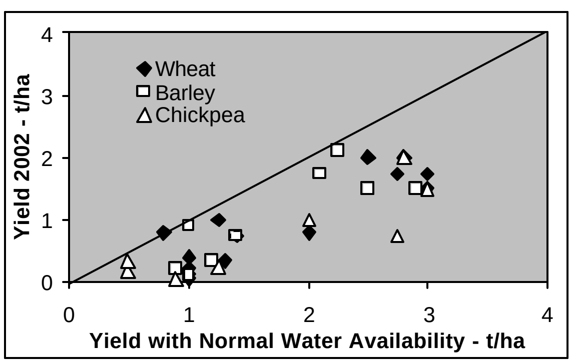


Figure 4. Relationships between farmer estimated crop yields in years with normal water availability and 2002 for rainfed farms

5. Crop Production Constraints

Farmers were asked to rank a series of constraints to crop productivity on a scale of zero to 3, representing no, slight, moderate and severe constraints. Lack of credit was listed by farmers as the most severe constraint to productivity for all crops. For the six most commonly grown irrigated crops, lack of water and seed together with nutrient deficiencies were moderate to severe constraints. The pest/disease complex (insects, diseases and weeds) were generally slight to moderate constraints. Poor seed quality approached the moderate constraint category for wheat but was less of a constraint for other crops.

Poor grain fill, which is typically a symptom of boron deficiency, was just greater than a slight constraint overall. However, 20 and 19 out of the 107 farmers listed it as a severe and moderate constraint, respectively. It was most frequently cited as a problem (5 slight, 8 moderate and 6 severe out of 25 farms) in Balkh province. Soil crusting, which was considered to be a constraint by Afghan scientists, was not considered to be much of a constraint by farmers.

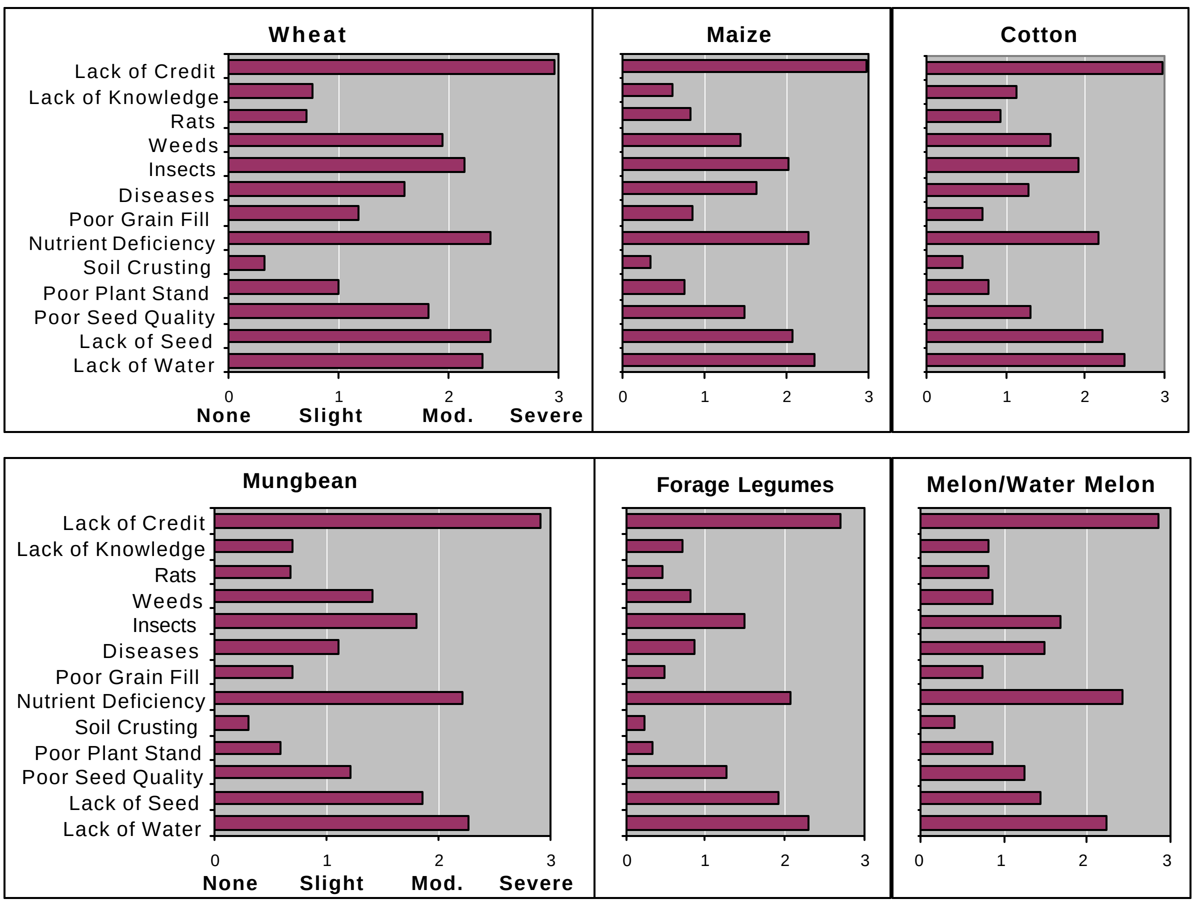


Figure 5. Severity of crop production constraints on irrigated farms

6. Nutrient Use - General

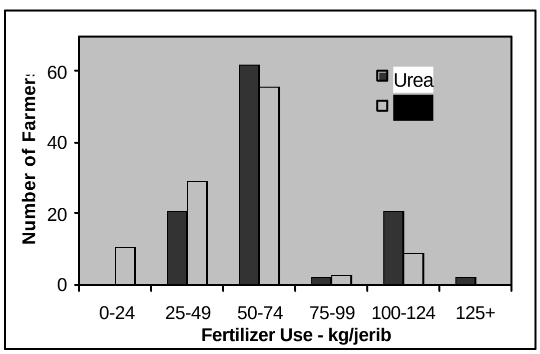
Fertilizer and animal manure were essentially used on all irrigated farms. Only 20% of the farmers used night soil. Urea and DAP were the only types of fertilizer used. Use of fertilizer was limited by what farmers could afford rather than by availability. Fertilizer application rates varied widely between farmers, and frequently was at rates less than recommended levels. Fertilizer supply would have to increase in parts of Balkh, Baghlan, Ghazni and Herat provinces before farmers could apply recommended rates. Farmers obtained recommendations on application rates mostly from neighbors or friends, and from unspecified sources. About 25% of the farmers were able to give a recommendation from the Ministry of Agriculture.

Surprisingly, urea was sometimes added to legume crops grown on irrigated farms. Most notable was its use by 11 of 26 farmers growing mungbean and 6 of 8 growing clover in Helmand province; by 8 of 18 farmers growing clover in Ghazni province; and by 6 of 7 farmers growing chickpea in Herat province. The yield response of legumes to N inputs and the need for rhizobium innoculum, Mo and P should be assessed.

Fertilizer was only used on 2 of 18 rainfed farms and then at low rates. Lack of water (so no economic benefit), cost and lack of credit were the main reasons for the lack of fertilizer use.

7. Nutrient Use and Responses - Irrigated Wheat 2002

Almost all farmers used urea and DAP fertilizers on wheat. The most common rate was 50 kg/jerib (250 kg/ha) for both fertilizer sources (figure 6). About 20 and 10 % of farmers used rates of 100 kg/jerib for urea and DAP, respectively. The highest rates of



fertilizer

Figure 6. Frequency distribution of fertilizer rates used on wheat in 2002

were used in Helmand province (200 kg N/ha and 55 kg P/ha) and the lowest rates were used in Ghazni province (85 kg N/ha and 25 kg P/ha; figure 7). The mean wheat yield in Ghazni province of 1.86 t/ha reflected the lower fertilizer use compared to the other provinces where mean wheat yield was 2.45-2.60 t/ha. The higher rates of fertilizer use in

Helmand province did not result in higher yields compared to Balkh, Baghlan and Herat provinces (figure 7). Analysis of soils collected from the farms showed that available P (Olsen) was especially low in Helmand province (section B) despite P inputs that were equal to, or higher than, those in the other provinces.

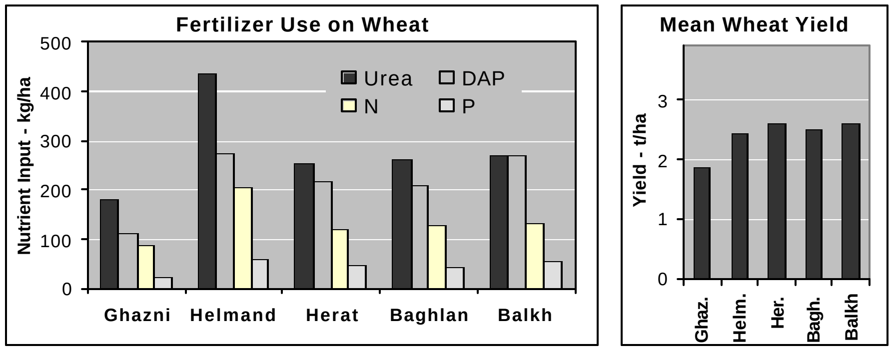


Figure 7. Fertilizer use and mean wheat yield in 2002

Sixty-six of one hundred and seven farmers (62%) used animal manure in combination with urea and DAP fertilizers. Only 4 of 107 used night soil. Low rates of animal manure (<10 t/ha fresh weight) were used more frequently in Ghazni and Balkh provinces, while high rates (15-20 t/ha fresh weight) were used more frequently in Helmand and Herat provinces (figure 8). The majority of the farmers used between 5 and 20 t/ha fresh weight (figure 8). The nutrient value of the manure is unknown; it is likely to be variable but should supply some P and micronutrients as well as N.

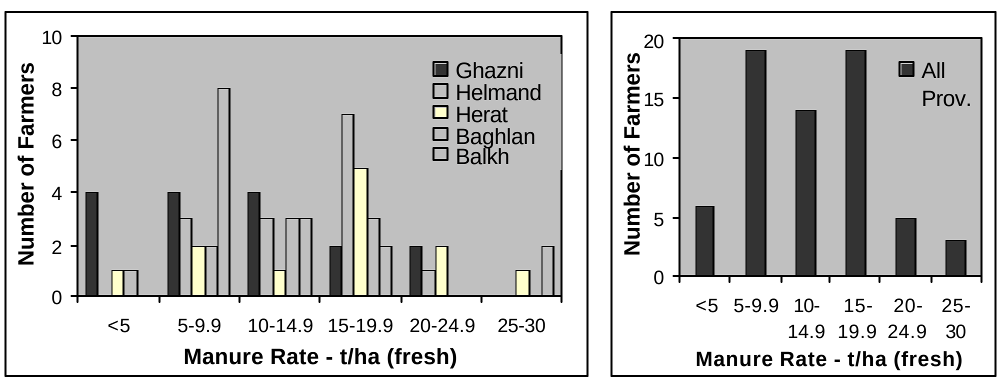


Figure 8. Use of animal manure (calculated as fresh weight based on data in bar/jerib and assuming 30 kg/bar)

There was no relationship between nutrient input and wheat yield where fertilizer was the only external nutrient source (figure 9). Weak, but significant, yield response to nutrient inputs was found where combinations of inorganic and organic (animal manure) nutrients were used, or where all of the data were pooled (figure 9). The best relationship was obtained where the input of animal manure was multiplied by a factor of 0.25 on a bar/jerib basis (factor of 0.0083 on a t/ha fresh weight basis). Using animal manure increased wheat yield somewhat in three of five provinces compared to yields where fertilizer was used alone (figure 9).

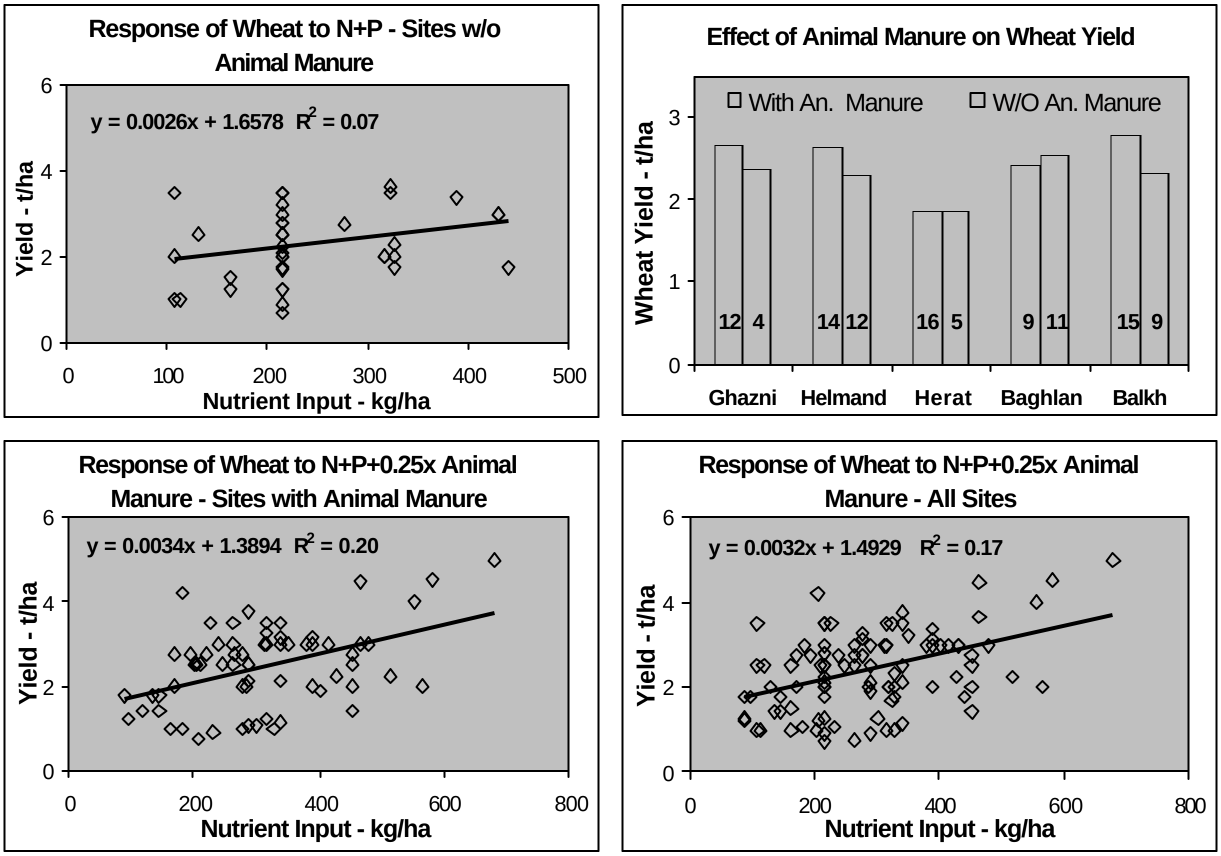


Figure 9. Response of wheat to nutrient inputs in 2002; numbers within bars on upper right panel are the numbers of farms

Possible reasons for poor response to nutrient inputs include:

- failure to supply a nutrient (e.g. Zn and B) or adequate amounts of a nutrient (e.g. P),
- poor quality fertilizers (e.g. is there P in the DAP???)
- leaching of N - a likely problem with flood irrigation of generally light to medium textured soils,
- unbalanced nutrient ratios,
- production problems not related to nutrients (e.g. weed, pest and disease pressure).

Analysis of soils (section B) indicated that both P and Zn could be limiting productivity in Helmand province and Zn in Ghazni province.

Overall, nutrient inputs are high considering the relatively low mean yields achieved (1.9-2.6 t/ha) and it is clear that farmers are not benefiting from nutrient inputs to the extent that they should be.

8. Nitrogen Application Practices on Irrigated Wheat

All farmers who used DAP applied this at planting, which is recommended practice. Most farmers also added urea at planting and subsequently at tillering and flowering. The distribution of N rates between planting, tillering and flowering varied widely (table 4), suggesting that farmers were not sure of the best practice. No addition of N at planting or amounts above 50 kg N/ha (number 2 on the scale in table 4) are probably inappropriate and it is probably hard to justify total inputs much above 100 kg N/ha (number 4 on the scale in table 4).

Table 4. Distribution of N inputs to irrigated wheat between planting, tillering and flowering.

---------------------- **Province** ----------------------				
Ghazni	Helmand	Herat	Baghlan	Balkh
1-2-2 [1]	2-4-4	2-4-0	2-2-0	5-4-0
1-1-1	2-4-4	2-2-0	1-2-0	1-1-1
1-2-2	2-6-6	2-1-1	4-1-1	2-2-0
1-2-0	2-4-4	2-2-0	2-2-0	1-1-1
1-1-1	2-4-4	2-2-2	2-2-0	1-2-2
1-2-0	1-2-2	4-4-0	2-2-0	2-4-0
1-2-0	2-4-2	2-2-0	5-2-2	1-2-2
0-2-1	1-4-4	2-2-2	1-2-0	2-2-0
1-2-1	2-4-4	2-4-1	2-2-2	1-2-0
0-2-0	4-2-0	2-2-2	2-2-2	1-2-0
1-0.5-0.5	2-2-0	2-2-2	0-2-2	2-2-2
2-2-1	4-2-1	1-2-2	3-4-0	4-4-4
1-1-0	2-1-1	1-4-2	2-2-2	2-2-0
1-1-0	2-2-0	1-1-1	2-2-2	2-2-2
2-2-2	2-2-2	1-2-2	1-2-2	2-2-2
0-2-2	2-2-2	1-2-2	2-2-2	2-1-1
1-2-2	2-2-2	1-2-2	0-0-0	2-4-0
2-2-0	3-2-2		0-0-0	2-2-0
1-0.5-0.5	2-2-2		0-2-2	2-2-0
1-1-1	2-4-4		1-2-0	2-2-1
1-1-0.5	2-2-0		1-2-2	4-4-0
	2-2-2		1-4-0	2-2-0
	5-2-2			5-4-0
	1-2-0			
	4-4-0			
	5-2-2			

[1] Numbers refer to amounts of N added sequentially at planting, tillering and flowering stages in increments of 25 kg N/ha (1 = 25, 2 = 50, etc). Intermediate values were rounded to the nearest unit.

D. SOIL PROPERTIES

Soils were sampled from all 129 farms surveyed. A representative field was selected and a composite sample of surface soil (nominally 0-15 cm) was collected by sampling from 3-5 spots in the field. Sampling was done with a spade and so was not precise. Samples were analyzed at NARC (Islambad, Pakistan) for pH, EC, $CaCO_3$ and sand contents, available P (Olsen), available K (pH 7 NH_4OAc) and available Zn (DTPA). Analysis of organic C, total N and available B (hot water extractable) was done at Cornell University (Ithaca, New York).

1. Soil Texture, Carbonate Content and Salinity

Soils were all calcareous and consequently soil pH (1:1 soil:water) was uniformally high, with a mean value of 8.2, and a range from 7.5 to 8.8. The mean calcium carbonate content was 23%, with a range from 3 to 42%. Carbonate content was lowest in Ghazni province and highest in Balkh province (figure 10). Sand content of soils was also quite high, with a mean of 45% and a range from 26-85% (figure 10). This would place soils in the loam to sandy loam textural classes. A negative linear relationship between $CaCO_3$ and sand content ($R^2 = 0.44$-0.53) existed in Helmand, Herat and Ghazni provinces but the relationship was less clear in Baghlan and Balkh provinces. An overall relationship may be found if sand content is measured on a carbonate free basis.

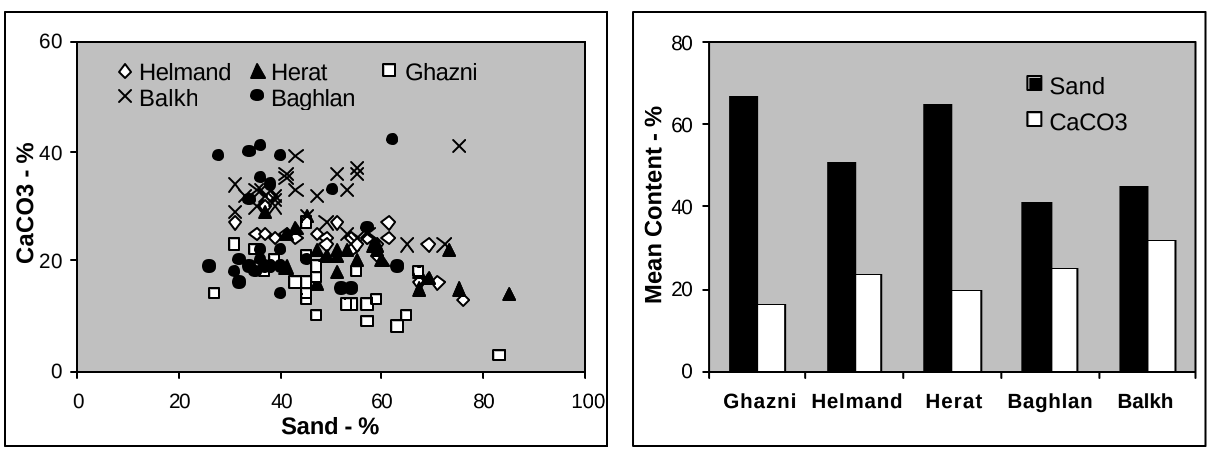


Figure 10. Calcium carbonate and sand content of soils

Soil salinity was generally low. Electrical conductivity was above 4 ds/m in only one of the soils tested and only 10 of the 129 samples had values >1 ds/m. Mean EC values ranged between 0.4-0.7 ds/m for the five provinces.

2. Soil Fertility Status

Assessment of available P (Olsen) in soil samples from irrigated fields indicates that P deficiency is fairly widespread. Using a critical value of 10 mg/kg (ref), 46 % of the soils are deficient in P (figure 11). Phosphorus deficiency is especially high in Helmand where 23 of 26 samples were below 10 mg/kg. The best soil P status was in Balkh where 18 of 25 samples were above 10 mg/kg. Limited samples from rainfed farms showed that soil P status was poor in Herat but suprisingly good in Balkh, Baghlan and Ghazni (figure 11). Available soil K status (pH 7 NH_4OAc extractable) was generally adequate *(add values and critical level).*

Two thirds of the irrigated soils in Ghazni and half of the soils in Helmand had levels of DTPA Zn below the critical level of 0.5 mg/kg soil. In contrast, soil Zn status was generally adequate in Herat, Baghlan and Balkh provinces. Zinc status in soils from rainfed farms was generally low, except for Balkh province.

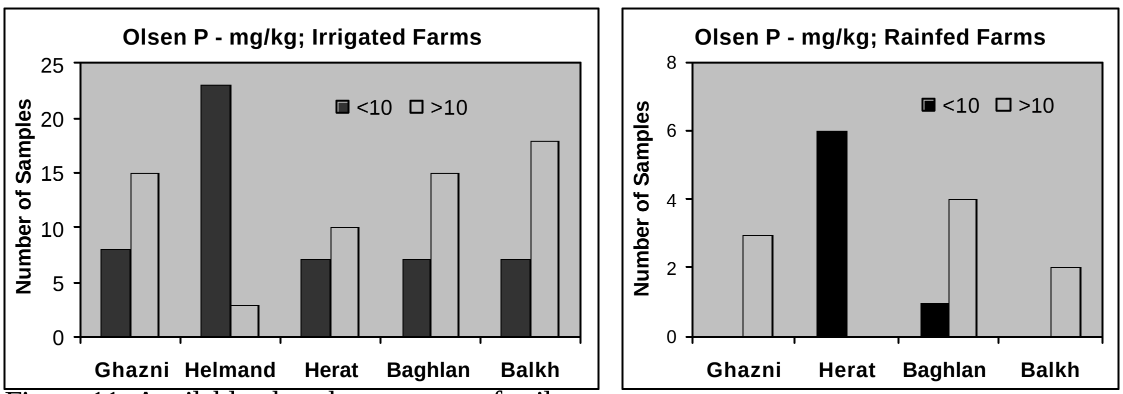


Figure 11. Available phosphorus status of soils

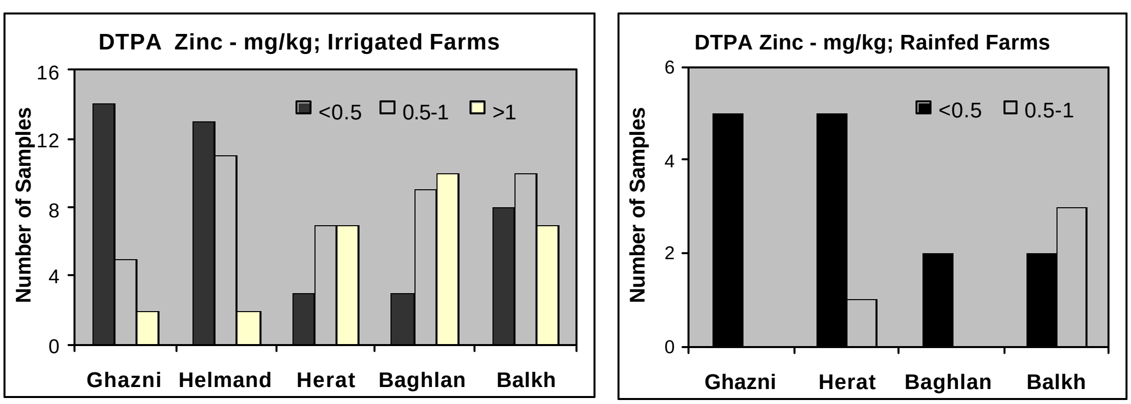


Figure 12. Available zinc status of soils

Add soil organic C and N and hot water extractable B

Chapter 5

Recommendations for water

The problems of water resources management in Afghanistan are complex and a straightforward solution seems impossible. In order to increase agricultural production and sustainability of irrigated agriculture, the overall strategy should be to increase the water capital and make better use of water. Government must take lead in putting in place the coordination mechanism providing effective oversight. For quick recovery of water sector, increase in crop production and improvement in water use efficiency and environmental sustainability, following steps may be identified:

- For the formulation of strategy for the rehabilitation of irrigation systems, a comprehensive database and information systems should be established. This is absolutely necessary for the accurate and up to date assessment and spatial locations of the rehabilitation work must be undertaken. The data gathered during this assessment could be used to create a GIS for irrigation and soil in Afghanistan.
- Without water in the farm, we can not improve agricultural productivity. The constraint that stood up over and over again in this assessment was shortage of water on the farm. Not only was this true during drought years, but during normal years too. Rehabilitation of irrigation systems should be given a priority. All systems within the basin or sub-basin should be systematically surveyed and assessed before priorities are selected. This is necessary to ensure that traditional water rights and allocations are preserved and upstream and downstream impacts and conflicts are minimized and mitigated. This process should be completed with the consultation and participation of local communities (i.e. *mirabs* and farmers). Priority should be given to areas with the high potential to contribute to food security.

- Given the country's variable climatic conditions and vulnerability to drought, water availability for agriculture is likely to be a subject of debate both for rainfed as well as for irrigated agriculture. Therefore, the conservation efficient use of water must be the foundation for a fully productive agriculture sector. Farmers should be encouraged to use water harvesting and watershed management, including more water storage structures both small and large. Farmers should be introduced and trained in the use of modern water saving technologies and crop varieties, which have proven successful in other arid environments similar to Afghanistan. Pilot projects should be established to demonstrate effective water harvesting and watershed management techniques.

- Although Afghanistan has limited water resources, it does not make efficient use of what is available. Farmers are ignorant of actual crop water requirements and irrigation-scheduling practices are still largely based on the maximum amount of water a farmer can capture. Therefore, present irrigation practices of farmers include a tendency to over-irrigate, whereas the opposite should be accomplished. To address this very important issue, research studies focusing on the revision of irrigation planning based on maximum water saving should be initiated.

- Increasing demand for water has put enormous pressure on the groundwater resources. Consumption of groundwater is presently 3 BCM and it is projected that in next 10 years it will reach up to 10 BCM due to increase in domestic and irrigation supply demands. Due to this excessive use coupled with the successive drought, groundwater tables in different parts of Afghanistan have declined to the extent that about 60-70 percent of traditional groundwater irrigation systems (i.e. Karezes) have dried up. This over-exploitation of the resource has caused devastating impacts on drinking water supplies for urban and rural population. For the preservation of this future resource, the government needs to develop appropriate policies to effectively manage and monitor groundwater development and use. Steps should be taken for the revision and enforcement of 1981 water laws. Communities should be directly involved in the campaign of artificially recharging the aquifers and in the conjunctive use and management of surface and groundwater resources. A basin-wide groundwater evaluation should be undertaken so that the groundwater reserves are determined.
- Afghanistan has a history of drought of varying severity and will continue to experience it in the coming times. Traditional coping and mitigating strategies have been broken down under growing population pressures and the collapse of the rural economy. For poverty alleviation, farmers should be provided with the opportunities to generate off-farm incomes. Traditionally, the main sources of off-farm income have been hired labour, forest products and small-scale enterprises like carpet weaving, bee keeping, skin processing, handicrafts, and silk worm farming depending on the region of the country.
- Appropriate institutional arrangements should be made for proper coordination of different ministries and line agencies involved in the management of water resources. The roles and responsibilities of these organizations should be clearly defined to avoid overlapping and to ensure effective management of water resources at all levels.
- An enormous amount of technical expertise has been lost in the water sector over the past 20 years. This loss of human capital should be replaced as quickly as possible if the sector has to recover its former status, reduce dependency on external expertise and enable citizens to revive their potential. Therefore, a strategy should be developed to create training opportunities for farmers, quality sector managers and technical staff.
- Colleges of Engineering and Agriculture in Kabul and other provinces can take the lead in training irrigation engineers, agriculturists, and agronomists. They should be helped in their curricula, teachers training, and establishing and/or re-equipping their laboratories.

Policy Implications for Improved On-Farm Water Management

Before any substantial progress can be made in the improvement of the distribution and utilization of water and other inputs for increased crop production, a major policy shift is required to provide the incentives necessary to change the farmers' attitudes and behaviors. Studies are needed that will clearly identify farmer constraints and their consequences. Little is yet known about the social, legal, economical and institutional problems that box the farmer in and operate as disincentives to his progress towards using scarce water resources more efficiently.

The farmers should be considered as the most important building block of any cropping and irrigation system and special attention should be given to their constraints and needs. Before making any policies for the farmers, we need to examine their irrigation and cropping behaviors, his knowledge and use of service institutions, his sources and channels of information, his decision-making procedures, and his perceptions of various farm constraints and how they might be removed. We will suggest several policy alternatives, which may prove useful in helping the farmer improve his existing low levels of crop production. This will also provide important guidance to policy makers and planners to formulate policies of national interest aiming at improving on-farm water management strategies.

- A countrywide emphasis may be justified to make farmers aware of the magnitude of losses and the benefits of reducing these losses. A mass media campaign complemented by some other sources of information would help farmers become more aware of the magnitude of on-farm water losses.
- Increased supplies of irrigation water do not provide the answer for improving farmers' field application efficiencies. Improvements in the application of water efficiency requires: level fields for efficient control of water in the field, reliability of irrigation supplies, and radical changes to the farmers present irrigation practices.
- Farmers have no means of adequately controlling water on their fields except by dividing their fields into several small basins. Any program to improve on-farm water management practices must do more than providing increased water supplies for irrigation or land leveling technologies. The program must be comprehensive and include intensified extension services, which help farmers to know when, how and how much to irrigate particular crops. This will require a totally new approach for training extension workers. During the survey farmers showed their eagerness and willingness to adopt new technologies to increase their water use efficiencies and crop production. However, they were particularly concerned that no such information is available to them from extension workers. More than 80 percent of the respondents believed that their knowledge about on-farm water management strategies is much more comprehensive than the extension workers.
- Adaptive research should be initiated to determine the suitable irrigation schedules for different crops grown in Afghanistan. These studies should focus on the revision of irrigation schedules for different crops under different agro-climatic conditions with the objective of minimizing the use of irrigation water without compromising

on crop yields. The results of these research studies should be translated into simple guidelines for farmers and extension workers.

- Credit and capital availability to buy farm inputs are major problems of the farmers. The major source of credit is usually family and friends. For the improvement of on-farm water management, availability of farm inputs and credit facilities for the small farmers should be provided.
- Farmers do not know exact crop water requirements or what stages of crop growth require more critical demands of water. Their decisions are based on visual crop and soil stress indicators and the amount of water applied for each individual irrigations is based on the estimates derived from trial and error practices. Farmers' knowledge about water management practices at the farm level is impressive under the given physical, legal, social and economical constraints. The problem lies not so much with the farmer as with the lack of institutional services and incentives. The major problems are organizational and structural. For example, neither extension workers nor irrigation engineers have been trained in the water management problems and their solutions the farm level. We recommend that institutional studies be conducted by the agricultural extension services, agricultural universities, irrigation department and agricultural research stations.
- Extension workers are not trained in problem conceptualization, diagnoses or solution. As a first step, extension workers should learn about measurement of water and estimation of losses, identification of moisture stress and soil fertility, estimation of the need for land leveling, and communication skills. Once the field workers have been trained in these problem identification skills, they will need to learn about problem solving skills. These should include: estimating crop water requirements, water conservation techniques, irrigation schedules for different crops, organizing farmers for maintenance of canals and watercourses, improved irrigation and cultural practices and crop planning.

RECOMMENDATIONS FOR SOILS

The recommendations are directed towards irrigated agriculture. From a food security standpoint, the overall goal should be to increase productivity of the staple food crop (wheat) so that more land can be devoted to crops that provide greater economic returns to farmers and contribute to nutritional security of the population, e.g. grain legumes and vegetables. Productivity issues need to be addressed for a range of crops, including feed crops such as maize for chickens and forage legumes for dairy animals. Specific recommendations are:

1. On farm water use efficiency should be improved so that the available water can be used to irrigate more land. This means moving away from flood irrigation. The best strategy would be to use permanent raised beds and furrow irrigation. Water use on irrigated wheat can be reduced 30-40% by using raised beds (ref). Important additional benefits are reduced seeding rates, improved recovery of fertilizer N, reduced disease pressure and a convenient arrangement for cultivation of weeds and banding of fertilizer. Soil organic matter levels would also increase over time as permanent beds are a reduced tillage practice. The raised bed technology is widely used throughout the developed world but is only now being introduced into the region, e.g. in Pakistan and India. It is proving to be successful on lighter textured soils similar to those in Afghanistan.

The raised bed technology requires tractors and equipment to form beds and for planting operations etc. A low-cost bed former and drill, which also doubles as a cultivator, has been developed at Punjab Agricultural University in India and is being produced locally.

2. The poor response of crops to nutrient inputs suggests that nutrient management practices need to be improved. In the short-term, the reasons for poor nutrient response need to be identified and addressed in ways that can be immediately implemented. The constraints may or may not be directly related to nutrient management. The development of sustainable, strategies/capacities are also recommended for the long term. Specific activities (not prioritized) for nutrient management are:

Short Term

- Develop recommendations for scheduling and rates of water and nutrient inputs that will ensure N retention in the root zone.
- Carry out more extensive survey of soil fertility status in order to develop province or watershed level nutrient recommendations. Applies especially to P and micronutrients.
- Provide access to zinc and boron fertilizers.
- Evaluate fertilizer quality.
- Determine if there are constraints to N fixation in legume crops through a survey of nodulation and nodule viability. Recommend use of N if appropriate.
- Characterize performance of wheat varieties to low P and micronutrient environments (Zn and B) using current knowledge and, if necessary, field testing. Develop recommendations for use of varieties and link to seed supply programs.
- Develop information transfer tools and strategies for extending nutrient management recommendations and knowledge to farmers.

Medium to Long Term

- Use field fertilization trials to determine if P and Mo are constraints to biological N fixation.
- Develop rhizobium innoculum supply for legume crops, if needed.
- Use field fertilization trials to determine the extent to which P and micronutrient deficiencies constrain crop yields and to refine nutrient recommendations.
- Improve N use efficiency by use of raised beds and furrow irrigation.
- Implement plant breeding programs that explicitly include P and micronutrient efficiency traits.
- Establish within country testing capacity for soil nutrient status.

3. Use crop models to determine potential yields of wheat based on temperature and solar radiation regimes (i.e. water and nutrients not limiting). Estimate achievable yield goals for different agro-climatic zones. Develop GIS to display results.

4. Develop an interdisciplinary research program to identify, quantify and address constraints to crop productivity. Note: Most programs organize by disciplines and each promotes their own area. Few programs attempt to identify the major constraint(s) to crop productivity and then proceed sequentially as constraints are solved.

THE WATER LAW ISSUED IN 1981

Chapter One

General Provisions

Article One

This law has been enacted based on the values enshrined in the Basic Principles of the Democratic Republic of Afghanistan with a view of effectively using water to meet the needs of the people and the national economy, converse the sources and reasonably utilizing the water resources and preserving the rights of the users.

Article Two

Water belongs to the people and is preserved by the Government.

Article Three

Water sources comprise the following:

a. Rivers, streams, canals, marshes, drainage outlets, reservoirs and other overground sources.
b. Springs, tube wells, regular wells and other underground sources.
c. Glaciers.

Article Four

Water resources can be used by enterprises, government agencies, joint public and private ventures, cooperatives, social organizations and by the nationals of the People's Democratic Republic of Afghanistan.

Article Five

Water can be used, in the light of this law and according to national and historical traditions, to meet the needs for drinking, living and other requirements of the people in agriculture, industry, public services, energy transport, etc.

In using water, priority is given to water for drinking and other living requirements.

Article Six

Use of water shall be free of charge

Article Seven

Water installations such as irrigation systems, tube wells, regular wells, water pipes, water pumps and other facilities can be owned by the government, cooperatives or private enterprises and allowed to be purchased or sold.

Article Eight

Owners of irrigation systems can levy charges on water users in order to meet the maintenance cost of their installations whose amount is to be determined according to local customs agreed upon between the owners and the users to be confirmed by the Local Government Organs.

Repairs and clearing of the installations, if carried out by the users, can be taken proportionately into account when commuting the charges.

Article Nine

The rights of the users shall be protected by law. In case the right of a user is usurped or curbed, he shall be compensated for it according to law.

Chapter Two

Article Ten

Computation of water reserves, preparing annual plans to develop and expand irrigation on a national level, devising plans for distribution of water among users, designing a water balance and drawing maps for the complex use and water conservation, control and distribution and a reasonable use of water shall be carried out by the Ministry of Water and Electricity of the Republic of Afghanistan.

Article Eleven

The Ministry of Water and Electricity shall create and equip with technical equipment, if necessary, the irrigation systems and offices of construction and installations of irrigation to build, improve and repair irrigation systems and installations in the provinces according to law.

Based on Article 7 of Decree of No. 8 of the Revolutionary Council Concerning Land, the costs of improvements and repairs of irrigation systems shall be paid for according to loan contract with the Agricultural Development Bank upon application by individual farmers or cooperatives under favourable terms.

Article Twelve

Matters related to public irrigation systems shall be organized by the Ministry of Water and Electricity.

And those pertaining to irrigation installations and system whose maintenance costs are paid for by individual farmers, cooperatives and farmers' unions shall be organized through farmers' committees chosen by farmers themselves headed by the local chief water supervises or his assistant.

Article Thirteen

Craftsmen, merchants, industrial plants, public services institutions and other agencies shall utilize water according to permits from the related organ of the Ministry of Water and Electric in which the objectives and conditions of use shall be specified.

Use of water without such specifications shall be prohibited.

Article Fourteen

In order to distribute water on a just and equitable basis. The chief water supervision or his assistants or the representatives of water users shall submit through approved forms, their application for the water they shall need and report back about the amount so used.

Article Fifteen

Designing and building constructions and installations beside sources of water such as the river banks, water reservoirs and public canals and likewise sinking deep and other types of wells using water-pumps shall be permissible only by the Ministry of Water and Electricity.

Article Sixteen

In the case of a drought or inclement weather affecting water resources or under extra-ordinary circumstances resulting in water scarcity, the Ministry of Water and Electricity can, in agreement with the Local Government Organs restrict the use of water providing that this shall not reduce the amount of drinking water.

Chapter Three

Use of Water in Agriculture

Article Seventeen

According to Article 6 of Decree No. 8 of the Revolutionary Council Concerning Land the Ministries of Water and Electricity and Agriculture and Land Reform shall fix the annual capacity of water on a national level and accordingly determine the water rights of each "jerib", i.e. half an acre.

Article Eighteen

Water needed for irrigation is distributed according to official documents, confirmed by water rights, taking into account the local practice.

Article Nineteen

Water shall flow into public irrigation systems under the supervision of the Office to Organize Irrigation Systems based on agreement between the Water and Electricity and Agriculture and Land Reform Ministries.

Article Twenty

Water running into irrigation systems whose maintenance costs are paid for by the farmers, cooperatives and unions of farmers is distributed by farmers' committees headed by the chief water supervisor or one of his assistants in turns fixed by the general assembly of water users.

Article Twenty-one

The chief supervisor shall settle all disputes in connection with water rights and water distribution on behalf of water users. The chief water supervisors shall cooperate with organs if the Ministry of Water and Electricity and Agriculture and Land Reform with respect to technical matter and report about their performance to the assemblies of water users.

Article Twenty-two

The chief water supervisors' remuneration shall be paid for by water users.

In case of chief water supervisor and his assistant discharge their duties diligently and honestly and actively cooperate with the Ministry of Water and Electricity in connection with irrigation, they shall be rewarded by the latter ……………………….

Article Twenty-three

The meeting of the users to collectively settle all the disputes from water distribution shall be held by the chief water supervisor or his assistant at least once a month.

Article Twenty-four

The general assembly of water users using water from irrigation systems shall settle matters related to water distribution in general assemblies held by the chief water supervisor or his assistant at least twice a year.

The general assembly shall be participated by a representative of the Local Government Organ to settle the following matters.

1. Elect the chief water supervisor, his assistants and member of the committees of farmers for a definite period.
2. Fix the remuneration of the chief water supervisor.
3. Review and confirm the proposals of the chief water supervisor about water to be distributed among the users for irrigation.
4. Shall determine the volume of all collective works with respect to clearing, repairing and improving the irrigation systems and fix the deadlines for each piece of work.
5. Certify contracts with various organizations regarding construction improvement and repair of irrigation systems and water installations.
6. Certify applications for credits from the Agricultural Development Bank in connection with improvement and repair of irrigation system.
7. Consider explanations furnished by the chief water supervisor or his assistant about water distribution, the statement of accounts for the credit obtained from the Agricultural Development Bank and the results of the collective work on irrigation systems.
8. Review other matters which could be resolved collectively.

Article Twenty-five

The government encourages the development and expansion of irrigation.

To encourage farmers who build irrigation installations and water, their dry-cropping lands on their own shall pay land taxes for 15 years payable for dry-cropping areas, computable from the first year during which the dry-cropping land is brought under irrigation. In the case of converting the dry-cropping lands to irrigated ones, the surplus from the ceiling fixed for lands ownership shall not be sequestered from cooperatives and farmers.

Article Twenty-six

Water for drinking and other domestic purposes can be obtained from sources whose quality conform to the specifications determined by the Ministry of Public Health.

Article Twenty-seven

Organizations and offices making available to the people water for drinking and domestic purposes through concentrated water-supply systems shall regularly supervise the sanitary status of the sources of water in case of quality of water deteriorates, the matter shall be immediately reported to the Ministry of Water and Electricity.

Article Twenty-eight

Those who use water for industrial purposes shall be obliged to observe the plans and norms about water consumption approved by the authorities concerned.

Article Twenty-nine

Water used to generate energy can be utilized in agriculture, industry, public services and transportation to meet the multipurpose public demand for water.

Article Thirty

Streams, canals and other sources of water fit for fenying can be used according to regulations concerning exploitation of water for transport.

Article Thirty-one

The transport of timber by water is permissible according to rules after obtaining permit from the Water and Electricity Ministry.

Article Thirty-two

Water needed for fire engines could be obtained from all sources as much as required.

Chapter Five

Article Thirty-three

In order to prevent from pollution of water sources, the Ministry of Water and Electricity in cooperation with those of Public Health and Agriculture and Land Reform shall adopt the necessary measures which are to be observed by all concerned.

Article Thirty-four

It is strictly prohibited to pollute water sources with industrial waste waters and those from public service utilities.

Article Thirty-five

Those using water for industrial or domestic purposes are obliged to observe the rules of the organs of the Ministries of Water and Electricity and Public Health regarding the purification of waste waters. They shall be permitted to mix such purified water with that used by the public after this process.

Article Thirty-six

In order to conserve the level of water sources above and under the ground to be used by the people through water supply system, the Local Government Organs in cooperation with the Ministries of Water and Electricity and Public Health determine sanitary areas and the matter is brought to the attention of the public.

Article Thirty-seven

Control on the implementation of measures adopted by the authorities concerned about water is exercised by the Ministry Water and Electricity and the water quality by the Ministry of Public Health.

Article Thirty-eight

The Emergency Preparedness Department of the Council of Ministers and the Committee to Combat Disasters are to prevent from the grave consequences of flooding, land slides, floods and other unpredictable phenomena by adopting the necessary measures.

Under such circumstances, the above organs can restrict the water rights of water users before overcoming of the effects of these disasters.

Chapter Six

Article Thirty-nine

Dispute between farmers and others stemming from water distribution and use in agriculture are settled by the chief water supervisor in the presence of both parties. In case the parties do not agree to the decision make by the chief water supervisor of his assistant, the matter is referred to the Farmers' Committee.

Article Forty

Disputes arising from the use of water among cooperatives, state farms, industrial plants, public service organizations, craftsmen, merchants, etc. shall be settled by the Local Government Organs.

1. Disputes among water users in one particular "woloswali" shall be settled by the Local Government Organ of the same.

Disputes among water users in various “woloswalis” shall be settled by the provincial organs of the Ministry of Water and Electricity in agreement with the Provincial Local Government Organs.

Article Forty-one

A person who misuses the water rights of another shall pay compensation to the person so damaged.

Article Forty-two

A person who purposely destroys or damages water installations built based on the provisions of this law shall be liable to punishment according to law.

Chapter Seven

Article Forty-three

Computing the utilization of water sources, the development and expansion of water-supply system, use of water for agricultural and non-agricultural purposes, water conservation, maintenance on water installation and water-supply and irrigation systems shall be organized through special regulations not contrary to the provisions of this law.

Article Forty-Four

This law shall come into effect after publication in the Official Gazette and thereafter paragraph 2 of Article 5 and Article 24 of the 8^{th} Decree of the Revolutionary Council on land and the provisions of other laws running counter to this one shall be considered null and void.

REGULATIONS CONCERNING THE USE OF WATER IN AGRICULTURE

Chapter One

General Provision

Article One

These regulators were enacted according to Article 43 of the Water Law with a view to using water in agriculture.

Article Two

Water needed for agriculture shall be made available to users based on the plan for use of water and likewise the valid documents on land ownership and water rights in accordance with local practice.

Article Three

Use of water according to a plan shall ensure equitable distribution thereof to users and effective utilization of irrigable lands.

Article Four

The following terms connote the following meanings in these regulations

1. "Use of Water" means water utilization by a person deserving water for the purposes of agriculture.
2. "Irrigation system" means the complex of irrigation installations to meet the needs of farmers, cooperatives, state farms and users in connection with irrigation.
3. "Irrigation Regime" means the aggregate irrigation specifications and technology consisting of irrigation frequency specifying the irrigation times, period amounts and norms.
4. Irrigation Norm" means the necessary amount of water needed for one "jerib" i.e., half an acre under irrigation for raising certain crops in one irrigation.

Chapter Two

Article Five

A person can use water for irrigation whose water rights pertaining to a specific area under irrigation are recorded in his documents concerned, based on local practice.

Article Six

The amount of water needed for irrigation shall be determined according to the area under cultivation, the kind of crop, the irrigation regime, the water rights documents, the local practice and the amount of water in its source.

Article Seven

Water shall be used in irrigation system based on plans for use and distribution of water from the same system approved by the Ministries of Water and Electricity and Agriculture and Land Reform.

Article Eight

Irrigation norm for the crops shall be prepared and approved by the Ministries of Water and Electricity and Agriculture and Land Reform.

In the case of absence of such approved norms, those commensurate with local practices shall be used.

Article Nine

During drought years, the organs of the Ministry of Water and Electricity in cooperation wilt the Ministry of Agriculture and Land Reform and in participation of the chief water superviser and his assistants shall adopted the necessary measures on time about the redistribution of waters taking into account the priority of certain crops.

Article Ten

In case the irrigation system begins to exploit a new source of water, new documents are prepared to record the water rights of farmers with lands under irrigation by the system from the same source.

The changes so brought about are also registered in the Land Tax Register

Article Eleven

Should the dry cropping lands be converted into irrigated ones as a result of building irrigation systems paid for by cooperatives and farmers, this shall not affect the areas owned by cooperatives and farmers.

Based on the conditions provided in Paragraph 1 of this Article, the cooperatives and farmers will enjoy land tax concessions under Article 25 of the Water Law.

Article Twelve

Dry cropping of fallow lands can use the existing irrigation system when there is available in the system some surplus water certified by the organs of the Ministries of Water and Electricity and Agriculture and Land Reform.

Article Thirteen

Flour mills operated by water and non-agricultural organizations can get the water thy need from the main or subsidiary canals under the following conditions:

1. If there exists in the canal some surplus water
2. If the lands under irrigation and the residential areas are not affected
3. If the water for drinking is not polluted and its quality not changed
4. Special permits shall be necessary from the organs of the Ministry of Water and Electricity in agreement with the Ministry of Agriculture and Land Reform

Article Fourteen

In case the headwork of an irrigation system in a certain province are fed by a source whose water is needed for the same province, the water shall be distributed according to a plan drawn by the provincial organ of the Ministry of Water and Electricity.

Article Fifteen

In case the source of water is used by two or more provinces, its water is distributed through the Ministry of Water and Electricity in agreement with the Ministry of Agriculture and Land Reform based on plans prepared for water use by each province.

Article Sixteen

Disputes arising from use of water among the water users shall be settled according to Articles 39 and 40 of the Water Law.

Chapter Three

Management of Irrigation Systems

Article Seventeen

While the irrigation system is maintained by the organs of the Ministry of Water and Electricity, the management and supervision of water reservoirs together with their annexes, the main canals and their installations, the distribution dates for irrigation shall be the duty of the Irrigation Department.

Article Eighteen

Repair and improvement of the irrigation system and promotion of agriculture affairs in the areas under the same irrigation system shall be canned out and the areas to be irrigated shall be taken into account when drawing the plans for water use.

Article Nineteen

Canals and their installations located lower than the water distribution shall be included in the land ownership using the same dyke for irrigation supervised by the chief water supervisor or his assistant.

Article Twenty

The plan for use of water in areas under the irrigation system shall be prepared by the irrigation technician or assistant water distribution supervisor according to the rules approved by the Ministries of Water and Electricity and Agriculture and Land Reform taking into account the area under cultivation, the irrigation norm, the types of crops and other factors affecting the use of water, with the help of Local Government Organs and the Ministry of Water and Electricity.

Article Twenty-One

The provincial irrigation organs shall prepare and submit to the office of the provincial government one month ahead of the irrigation season for approval the general water distribution plan according to the rules approved by the Ministry of Water and Electricity and Agriculture and Land Reform, taking into account the amount of water flowing into the water sources.

Article Twenty-Two

The water distribution plan from the irrigation system shall include the areas under and the amount and norm of Irrigation and such ….. for a span of three to five years. However, minor changes are permissible in this plan.

Article Twenty-Three

The main duties of the provincial irrigation organs of the Water and Electricity Ministry are as follows:

1. Study and survey water sources and supervise the same
2. Determine the right of using water from irrigation systems
3. Draw annual plans for use of water
4. Supervise the effective utilization of water from the water sources or irrigation installations.
5. Determine the volume of work and prepare the plans for the participation of land users in collective work in connection with the irrigation system concerned.
6. Organize collective work to combat floods and other unpredictable phenomena in cooperation with the Emergency Preparedness Department of the Council of Ministers.
7. Control the management of the provincial irrigation system
8. Adopt measures to develop irrigation
9. Participate in the election of the chief water supervisor and his assistant for the irrigation system whose maintenance costs are paid for by the water users.

Article Twenty-Four

The main functions of the provincial organs of the Agriculture and Land Reform Ministry are:

1. Implement the irrigation regime and plans for watering the crops according to modern technology
2. Help in effective utilization of water needed for irrigation
3. Assist in the activities of assistant water distribution supervisors in connection with water distribution to lands belonging to state farms, cooperatives and farmers based on their water rights whose maintenance costs are paid for by the water users.

4. Submit proposals to the authorized organs about redistribution of water needed to irrigate the areas under cultivation in case of unpredictable phenomena such as drought, earthquake, etc.
5. Prepare the documents concerned for the settling of disputes arising from use of water between individual water users and state farms.
6. Cooperate in preparing the water distribution plans with the local organs of the Ministry of Water and Electricity.
7. Cooperate in the activity to prepare the irrigation and drainage systems for the irrigation season and maintaining the installations concerned.

Article Twenty-Five

The irrigation departments shall guide the activity of the public irrigation systems, carry out matters related to water conservation, bringing water from the headworks to the areas under irrigation according to the plan for use of water, rendering to water users technical assistance in utilizing water installations.

Article Twenty-Six

Maintenance of irrigation systems paid for by farmers, cooperatives and other water users shall be the duty of the farmers' committee elected at the general assembly of water users under the guidance of the chief water supervisor or his assistant.

Article Twenty-Seven

The general assembly of irrigation users shall be held at least twice a year with the participation of Local Government Organs to settle the following matters:

1. Elect the chief water supervisor and members of the farmers' committees for a set of period
2. Fix the remuneration of the chief water supervisor and those of his assistants
3. Review and certify the proposals of the chief water supervisor or those of his assistants regarding the distribution of water among the users during irrigation season.
4. Identify all types of collective works including clearing, repairing and improving the irrigation systems, the period in which such pieces of work are carried out and the volume of work done by each water user
5. Certify the contracts with organizations repairing or constructing irrigation systems or installations.
6. Certify the application for credit from the Agriculture Development Bank for repairing or improving the irrigation system.
7. Consider the report of the chief water supervisor or that of his assistant regarding activities concerning water distribution and consumption, the credit obtained from the Agriculture Development Bank and the results of collective work.
8. Review other matters to be settled collectively.

Article Twenty-Eight

The chief water supervisor and representatives of water users shall submit to the local organ of the Ministry of Water and Electricity the application for the water needed in special forms indicating the period for which the water is required. The chief water supervisor and his assistant showing special ability in preparing this application form shall be appreciated by the Ministry of Water and Electricity.

Article Twenty-Nine

The chief water supervisor and his assistance will cooperate with the organs of the Ministries of Water and Electricity and Agriculture and Land Reform on technical matters with respect to systems maintained on the expense of water users.

Article Thirty

The irrigatuin activities of state farms shall be guided by the by their technicians.

Article Thirty-One

The assistant chief water supervisors are responsible before the water users for carrying out all technical instructions issued to them by their chiefs

The chief supervisor and his assistants shall report to the general assembly of water users.

Chapter Four

Maintenance and Improvement of Irrigation Systems

Article Thirty-Two

Farmers, cooperatives, state farms and other water users are obliged to carry out pieces of work in connection with repairing, maintaining, supervising, improvement and developing the existing irrigation system they are utilizing.

Article Thirty-Three

Repairing and improving the existing irrigation systems according to Article 7 of Decree No. 8 of the Revolutionary Council Concerning Land shall be carried out as follows:

1. Cooperatives, state farms, farmers and other water users utilizing water from the same irrigation system shall send through local agriculture offices their applications to the provincial Agriculture Department
2. The Provincial Irrigation System is obliged to study or revise the application on site and in case no surveying or designing would be necessary, allow the repair or improvement and advise on technical
3. In case it would be necessary to survey and design, the Provincial Irrigation Department of the Water and Electricity Ministry and let the applicant know about this.
4. Cooperatives, state farms, farmers and other water users can build physically the irrigation installations according to the approved designs. In case this would not be possible for them, they can enter into contracts with construction companies.

5. The costs of surveying and designing, construction, repair and improvement of irrigation systems shall be paid for from the credit obtained from the Agriculture Development Bank.

Article Thirty-Four

In case repairs in the areas under irrigation would not entail designing and other water users are not damaged, the local technical agricultural official shall make a decision in this respect.

Article Thirty-Five

Water users are obliged to repair and activate before the irrigation season all the main canals and collecting and drainage systems.

Article Thirty-Six

Users of common irrigation systems are obliged to participate in the repairing, improving, rebuilding, maintaining and clearing the irrigation systems proportionately to their water rights.

Article Thirty-Seven

Irrigation systems maintained by the government according to the decisions of authorized organs shall be repaired, improved or rebuilt on the expense of the government.

Article Thirty-Eight

It is prohibited to allow water to flow into irrigation systems not yet repaired or ready for this purpose.

Article Thirty-Nine

These regulations shall come into effect after publication in the Official Gazette.

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