An Overview of On Farm Water Management Practices

A Case Study of Salar Bagh Canal in Asadabad District, Kunar, Province

Shakirullah

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The Netherlands

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6708 PB, Wageningen
Postbus 411
Tel: 0317- 486230

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DEDICATION

This thesis is dedicated to those Afghans who are still searching to find out place to spend peaceful life

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ABBREVATION

ADB:	Asian Development Bank
APCM:	Agriculture Production Chain Management
CIA:	Central Intelligence Agency
CSO:	Central Statistics Organization
GDP:	Gross Domestic Product
DAIL:	Department of Agriculture, Irrigation and Live Stock
FAO:	Food and Agriculture Organization of United Nations
ICARDA:	International Center for Agricultural Research in the Dry Areas
LWM:	Land and Water Management
OFWM:	On Farm Water Management
O&M:	Operation and Maintenance
SPSS:	Statistical Packages of Social Sciences
USAID:	United States Agency for International Development

TERMINOLOGY

Conveyance Efficiency: The measurement of water losses in irrigation distribution from the point of diversion to the field.

Ground Water: The Water below the pheratic level is called ground water

Deep Percolation: The amount of water which goes vertically through the root zone to the deeper soil layer below the root zone.

Irrigation Efficiency: It is the ration between the amounts of water used usefully to the amount of water supplied by irrigation and rainfall to the field.

Irrigation: The artificial methods of applying water in systematic way to land or fields for the optimal growth of plants. Any human intervention in the natural hydrological flow for the purpose of providing water to the soil or the plan for crop production has to be included in the definition of irrigation (Singh, 1997 Cited by Thakkar, 1999).

Infiltration: The process through which the surface water enters into the soil is called infiltration.

Infiltration rate: The speed at which water goes into the soil is called infiltration rate. It is often measured by the depth (mm or inch) of water layer that can enter the soil in unit time (hour).

Runoff: That amount of water which flow on the soil surface without entering the soil.

Surface irrigation: The most common and well know type of irrigation in which water is applied and distributed in the field along the gravity.

Water logging: The condition of land in which the water table rises near or to the surface resulting in a reduction of crop yields.

ABSTRACT

The main theme of this study is to investigate the on-farm water management practices of the farmers and give recommendations for the improvement of these practices to reduce water losses at farm-level. The study was carried out in the Tisha and Nawabad villages in the capital of Kunar province. The people of this area were farmers and were engaged in farming.

This research studied the current on-farm water management practices of farmers at farm level. The on-farm management practices studied included land preparation and leveling, irrigation scheduling and determination of irrigation time. The physical structure of the watercourses were also studied and observed. The water distribution among the water users was also studied.

A survey was conducted in Tisha and Nawabad villages with the help of pre-structured questionnaire. Thirty farmers were selected randomly with the consultation of the directorate of agriculture, irrigation and livestock, Kunar, Asadabad. The data collected was tabulated and analyzed with the help of SPSS.

The result of the study revealed that the farmers of the study area were not practicing good on-farm water management practices. Their fields were not leveled properly. There were high and low spots in the fields. The rodent's problem was also there and the farmers were not able to manage this problem. The physical condition of the watercourses was poor. The water courses were not lined and there were poor water control structures. There were a lot of water losses due to the poor condition of water courses.

The water distribution was done by a traditional water management system known as Mirab. The Mirab system was not effective in proper water distribution and O&M of irrigation infrastructure. The water was inequitably distributed among the users.

There was no linkage between the farmers and the DAIL department of irrigation. The farmers did not know about the improve water management practices due to the lack of extension services.

It can be concluded that the current on-farm water management practices of the farmers were very poor. The poor practices have contributed significantly in the water losses at the watercourse and farm level. Therefore, there is a need to improve the on farm water management practices of the farmers at the farm level in order to address the current water shortage and meet the increasing demand for irrigation water. The DAIL department of irrigation could play important role in this regards.

CHAPTER ONE

1. INTRODUCTION:

This chapter indicates the background of the study. The chapter also describes the problem statement. It contains the formulated research questions that guided the study. It describes limitations of the study and also provides general overview of the irrigation system of Afghanistan.

1.1 Background Information:

Afghanistan is a mountainous and landlocked country located in the south – central Asia. The total area is about 652,230 Km^2 with 5,529 Km land boundaries. Arable land cover 12% of the total area, 3% is forest, 46% is permanent pasture and 39% is Mountains and others. Afghanistan is bordered on the southeast by Pakistan, Iran on the west, Turkmenistan, Uzbekistan and Tajikistan on the north and china on the far northeast. (CIA, 2010)

Figure 1: General Map of Afghanistan

Source: ADB, 2002

According to the Central Statistics Organization (CSO) the total estimated population of Afghanistan in 2008/09 is 25 million which includes nomadic and the settled ones. About 79% of the total population is living in the rural area while the rest (21%) is settled in urban and semi urban areas. The annual growth of the population is estimated to be 2.03% with 6.3 fertility rate. The male and female percentage is respectively 51% and 49%. Due to high fertility rate the

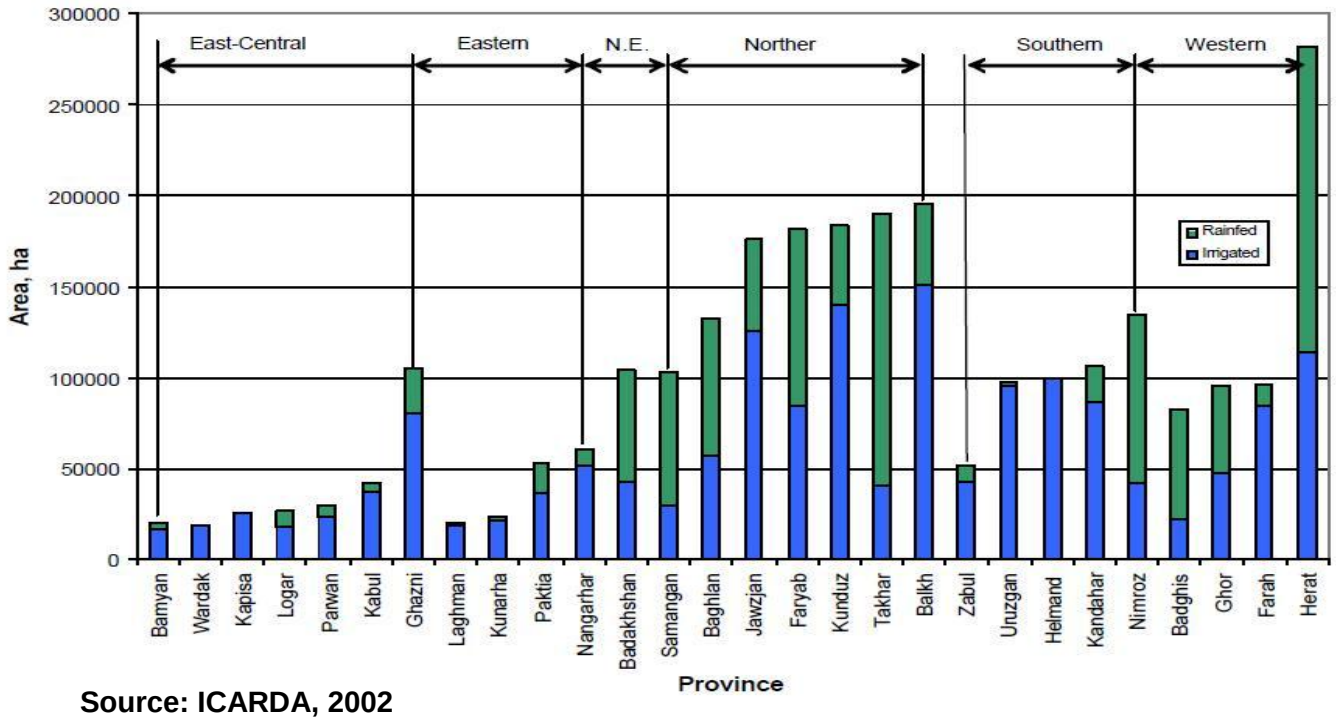
population is highly dominated by young generation and the majority is below 15 year of ages. The average lifespan is between 40 and 46 years of age.

The climate of Afghanistan is arid to semi arid with hot summer and cold winters, due to the presence of mountains the climate varies according to the location. The air temperature varies from -20 C^0 in winter to 45 C^0 in summer. The average rainfall is about 300 mm. The amount of rainfall varies as low 75 mm in Farah Province to very high in South Salang. Most of the rainfall (50%) occurs in winter seasons particularly from February to April in the form of snow in the central mountainous regions. About 30% of the rainfall occurs in the spring season from April to June and a very little amount of rainfall occurs from June to October. (Favre, 2004 and FAO, 2004)

Agriculture is the backbone of Afghanistan's economy. About 80% of the total population relies on agriculture which provides food, income and employment. The agriculture sector contributes more than half of the GDP and employs more than 70% of total labor force. (Jurenas, 2001 and Rout, 2008)

The irrigated land of Afghanistan is mainly located at the river basins of north, east and southwest. The southern, eastern and western parts of the country have less irrigated land as compare to north, east and southwest. The northern region of Afghanistan is considered as the agriculture region because of the presence of major rivers and relatively high average rainfall compare to other regions. The total cultivable land is 3.9 million ha of which 1.3 million ha is rain fed while the remaining 2.6 million ha is irrigated. The production of the irrigated area accounts for about 85% of all agricultural productions. (ICARDA, 2002)

Figure 2 : Area of irrigated and rain fed cereal crop in Afghanistan



Source: ICARDA, 2002

Due to unavailability of agriculture inputs like seeds, fertilizers, pesticides and low water use efficiency the crops yields are low and the current drought further cause reduction in the yields.

It was mentioned that the average yield per hectare in 1978 was 1.1 tons as compared to 2002 which is 0.8 tons per ha. In 1978 cereal crops covered about 3.4 million ha land out of the total 3.9 million ha of both irrigated as well as rain fed land and the production was 4.15 million tons in which the contribution of wheat was accounted 2.65 million tons. The rain fed cultivation has been suffering a lot due to the continuous drought conditions in the past few years which prevent the normal cultivation and the area has been reduced to less than 0.5 million ha, as a result of this the production level declined to 0.6 tons per ha which is 10% lower than normal expected production in a year. The above mentioned problems create food security issues in rain fed areas. (Qureshi and ICARDA, 2002)

Table 1: Cultivated area, Production and Yields of Cereal Crops in Afghanistan in 1978

Crops	Area		Production Million tons	Yield Tons/ha
	Million ha	% age of Total		
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: Qureshi, 2002

The amount and duration of water for irrigation largely defends on annul snowmelt. In 2011 the amount of precipitation was lower than the normal rate, as results the availability of water for irrigated wheat crops were low. In the southern provinces due to low precipitation the amount of water in river basins were low in the sowing period of winter wheat, which has resulted in less acreage sown compared to the previous year. It has been observed that the summer 2011 wheat harvest is not looking promising. The irrigated crops are likely to be below normal, the poor harvest and high prices of wheat may cause the lean season to be earlier and more severe than normal. This will lead the need for external assistance (Hanasz, 2011)

“Domestic wheat and rice prices remain high throughout South Asia. In mid-February 2011, the average price of wheat flour in Afghanistan was 41 per cent higher than in the same period of 2010 and 70 per cent higher than pre-crisis levels. They are expected to continue rising over the Afghan autumn while households are stocking wheat for the winter”. (Hanasz, 2011)

“In anticipation of a poor harvest, wheat market prices in northern Afghanistan increased by 32 percent between March and May which further exacerbates food inaccessibility”. (Hanasz, 2011)

According to the USAID (2011) Filed assessment in Kunar Province pointed out that due unseasonal rainfall (above normal) damaged the irrigated wheat crops in heading stages. As a result of this the estimated harvest lowering by 20 to 30%. The late season rainfall benefited the rain fed wheat and the estimated harvests have not change that much. Due to several disruptions in regional wheat productions and market the wheat price continue to rise. In August 2010 the floods affected the 10% of Pakistan’s wheat production while demand for Kazakh wheat has increased because of a Russian and Pakistan wheat ban. (USAID, 2011)

One of the major challenges for the agriculture sector of Afghanistan is the high pressure on irrigation water. Three decades of war in Afghanistan not only affected people but also destroyed the irrigation infrastructure and water sources. The un-judicial use of natural resources (deforestation, over-grazing), climate change and global warming added in the depletion of water resources of Afghanistan. The above mentioned factors have caused the irrigation water scarcity in various part of the country. The climate change, drought conditions and water scarcity are posing new challenges both for irrigated and rain-fed agriculture. (ADB, 2002)

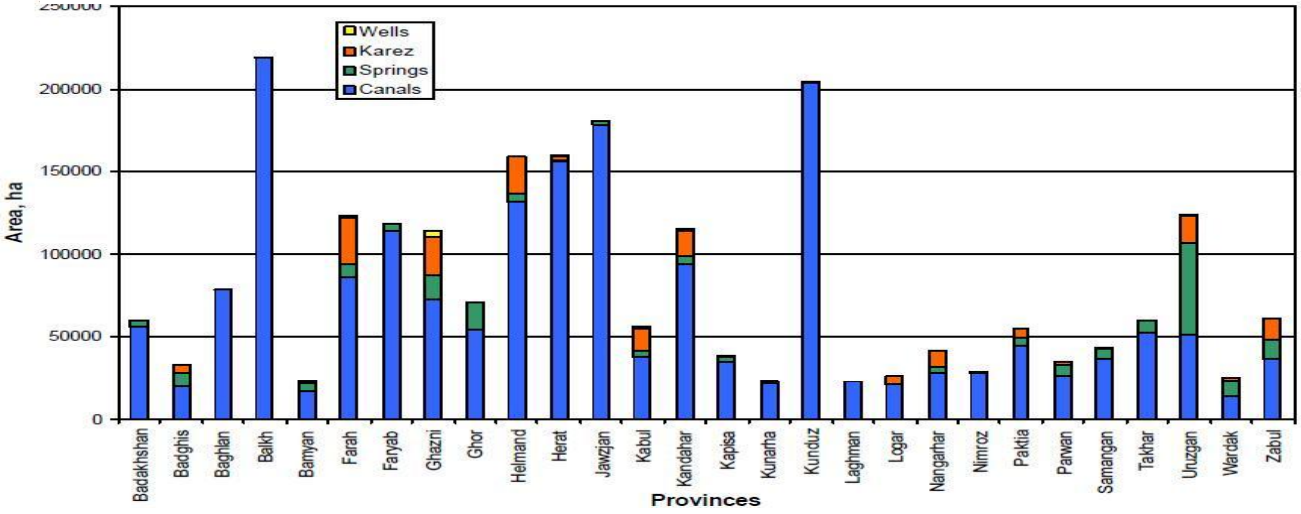
The droughts in the late 2007 and early 2008 have led Afghanistan to the worst drought conditions in the past ten years. There was a significant reduction in wheat production. The wheat production declined from 3.8 million tons to 1.5 million tons in 2008/09, experiencing 60% decrease compared to last year. The Afghan government and United Nations appealed to the world community to donate $ 400 million to cover significant wheat import and food aids for about 4.5 million affected Afghans.(Huntzinger and Delesgues, 2009).

Afghanistan basic irrigation infrastructure has mainly affected and damaged by unstable political situations and war. As a result of this only a third of the farmland that was irrigated before conflict now receives the irrigation water it needs. The efficiency of the irrigation system is quite low and the irrigation system used 30% of the total water resources. The farmers practiced non furrow flood irrigation method for corps as well as in the fields, the farmers didn't use any water saving techniques. As a result, the agriculture productivity remains low. In last few years the situation has been further exacerbated by frequent droughts. The management of irrigation system is a key to reduce poverty (World Bank, 2006 and Bhattacharyya, 2004)

1.2. An overview of irrigation types:

The history of irrigated agriculture in Afghanistan stretches back to about 4,500 years ago. Due to uneven and unreliable rainfall the agriculture sector mostly relays on irrigated agriculture and the agricultural production is not possible without irrigation except those areas where rain fed irrigation is practiced. The allocation of water and land is tightly bound to traditions and customs and maintenance activities of such traditional schemes are a part of farmers' daily life during the season. (Qureshi, 2002)

Figure 3: Irrigated Area of Afghanistan by different irrigation schemes



Source: ICARDA, 2002

A survey conducted in late 1960s shows that there are 29000 systems exist in Afghanistan. Out of this 27% get origin from the surface water sources like rivers and streams while the remaining get source form groundwater sources like spring, Karez and wells. (Rout, 2008). According to Aini (2007) the Ministry of Water and Power has classified the source of irrigation water into four main types which includes “rivers (84.6%), springs (7.9%), Karezes (7%) and Arhad (0.5%)”

The irrigation system in Afghanistan is divided into traditional and modern irrigation systems.

- Traditional Irrigation system:

- Small scale informal surface water systems:

These systems are very old and exist along the history and for the diversion of the water different temporary brush weirs are made along the river. Most of these are found in the valley areas along the stream or river and cover an area up 100 ha. The construction and maintenance of the system is done on traditional communal way and also the water rights are based on the same way.

- Large scale informal surface water systems:

These systems cover an area about 200,000 ha and mainly located in the plain areas as well as those areas which are located along the main river of the valleys. It is considered as informal systems but the maintenance and operations was well arranged and control by different ethnic groups and communities. Decades of war and other problems like water logging and salinization have been badly affect these systems and were abandoned.

- Shallow wells (Arhad) System:

Arhad (Persian wheel) is used to get water from the well. These wells mainly supply irrigation water to an individual farmer. About 8595 shallow wells are existing in Afghanistan and the land under the coverage of this type of irrigation system is 12060 ha.

- Springs:

Springs are formed by the flow of rising groundwater table to the surface. There are about 5558 springs in the country and it’s irrigating 18800 ha of land. The flow rates of the springs depend on the level of groundwater. When the groundwater level goes downs it affect and reduce the springs outflow. Irrigation through spring is mostly practiced in the eastern and in the western part of the country.

- Karez (qanat) systems:

These are underground tunnels which deliver water along the gravity with a mild slope from the source to the settled areas. The average discharge of Karez range between 10 l/s to 200 l/s but in some areas the discharge can reach up to 500 l/s. The water of Karez is used for both drinking as well as for irrigation purposes. There are 6741 Karezes in the country which irrigates about 163,000 ha of land. Large numbers of Karezes are located in the south and southeast part of the country while a less numbers also exist in the east of the country. The water of Karez flow throughout the year and there is lack of mechanism to stop and store water when there is no need for irrigation purpose or during the winter season and as a result in each Karez 25% of water is wasted annually.

- Modern Irrigation Systems

- Formal surface water systems without storage:

The irrigation department is responsible for the operation and maintenance of these systems. These systems follow the rules of large scale traditional surface water. The regulation of water flow depends upon on the negotiation between government and village communities.

- Formal surface water systems with storage:

These systems are subsidized by the government and the farmers were not allowed to grow crop on their own desired. Establishing large scale irrigation system came into being in the late 1970s and five large scales irrigation were built. These systems were under the operation of both government owned and private land ownerships.

- Formal ground water systems:

The practice of irrigation through formal ground water from deep as well as shallow wells is not that much common. The farmers in the tails of the large traditional irrigation systems where the water scarcity is more frequent, some individual farmers irrigate their field from shallow wells. There were about 100 deep wells in Khost province which were used to deliver water to the surface irrigation schemes. The evidence from 1970s shows that some private and government owned sprinkler irrigation systems were used to irrigate about 100,000 ha of land. (Qureshi, 2002)

1.3. Research problem:

Like in all countries, In Afghanistan water is a precious resource for farmers. Majority of land is irrigated by canal through surface irrigation. The current drought condition and the depletion of natural water resources and decades of war have caused water scarcity throughout the country and have put more pressure on water demand. In addition, there are a lot of conveyance losses of irrigation water at canal and farmer field level. The on farm water management practices at farm level are very poor. In order to meet the high water demand an improvement of the current on farm water management is needed.

1.4. Research Objective:

To contribute in the reduction of on farm water losses by recommending proper on farm water management practices

1.5. Main research questions:

1. What are the current on farm water management practices in Kunar Province?

- What are the current irrigation application methods in the area?

2. What are the most effective irrigation application methods?

- What water management practices are currently applied at the farm level?

1.6. Limitations of the study:

Decades of war and conflicts have badly destroyed and damaged Afghanistan from all aspect including the irrigation infrastructure and it is difficult to find out the actual data because the all data which were present in the past were lost during the war. Less technology, Security problem, inexistence of correct data, low level of education, inadequate extension services, are

the main obstacles for the research. The real and actual data was hard to obtain in all sectors especially in Agriculture. Therefore, the current situation makes the study to relay on limited sources.

The provided information of this report is through agriculture department information and direct survey of the farmers. The information of this study can be used for further study but the full description of the current situation need full investigation and practical works.

1.7. Report Structure:

This report is structured into six main chapters. Chapter one deals with the background information and also gives insight to the problem statement. It also includes the research questions that steered the study. Chapter two provide the information about the literature review used. Chapter three describes the research methodology, information about the study area, research strategy and the tools used for analysis. Chapter Four presents the finding of the research. In chapter five the result of the survey is discussed and an effort was made to relate the literature with result. Chapter six present the conclusion and recommendations.

CHAPTER TWO

2. LITERATURE REVIEW:

This chapter describes the review of different literature related to the objectives of the research. In this chapter the concept of on farm water management practices, irrigation types and its efficiencies and socio economic problems has been discussed. This chapter also describes the indicators related to on farm as well as off farm water management.

2.1. On Farm Water Management:

Water Management can be defined as “The planned development, distribution and use of water resources in accordance with predetermined objectives while respecting both the quantity and quality of the water resources. It is the specific control of all human interventions concerning surface and subterranean water. Every planning activity relating to water can be considered as water management in the broadest sense of the term” (ICID, 2000 cited by Wolf and Stein, 2003)

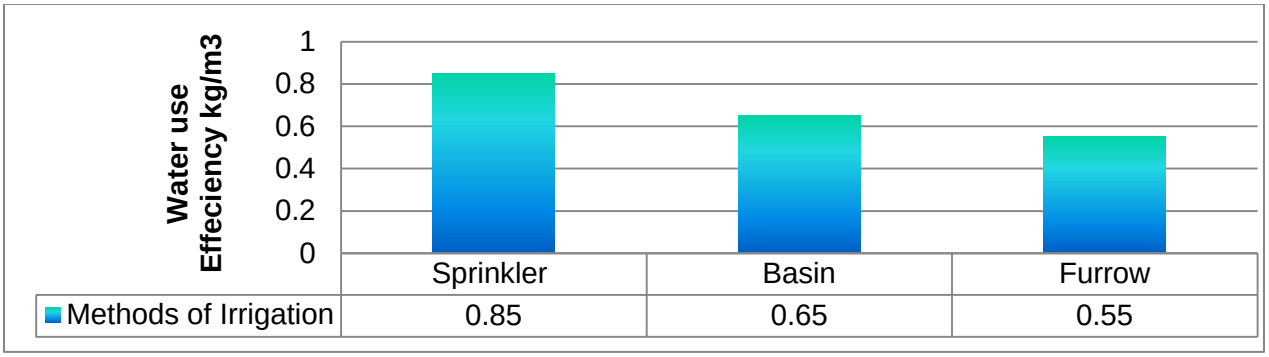
The On Farm Water management can be defined as “the manipulation of water within the borders of an individual farm, a farming plot or field. For example, in canal irrigation systems, OFWM starts at the farm gate and ends at the disposal point of the drainage water to a public watercourse, open drain or sink”. (Wolf and Stein, 2003)

Afghanistan economy mostly relay on agriculture particularly on irrigated agriculture while The farmers use and practices the traditional farming techniques with oxen providing the draught power. The knowledge of farmers about the new irrigation technologies and cultural practices are insufficient, as a result, the efficiency of irrigation system is quite low and counted between 25 – 30% and the main reason of the low efficiency are “(i) high conveyance losses in traditional schemes with earth canals, (ii) high operation losses in modern schemes with lined conveyance canals (iii) high on-farm distribution losses (over-irrigation, poorly leveled land) in both traditional and modern schemes”. The productivity levels are also low even by regional standards. About 20 percent of both traditional and modern irrigation systems need improvements of on farm water management in order to overcome and addressed the issue of low crop yields or water logging and Stalinization. To a large extent the production potential of land under low and variable rainfall can be improved by promoting technology transfer. (Qureshi, 2002)

In the university of Faisalabad at Post graduate research station between 1998 – 2002 a study on sunflower was conducted to find out the irrigation efficiency, nitrate – nitrogen leaching and yield of sunflower. It was pointed out that in sprinkler irrigation the irrigation efficiencies were much higher as compared to furrow and basin irrigation. During the study it was found that about 5.64% and 1.71% higher yield was obtained in sprinkler irrigation as compared to basin and furrow irrigation respectively. The nitrate and nitrogen leaching was low in sprinkler irrigation which was 50 mm of depth as compared to basin and furrow irrigation which was 70 mm of depth. It was also observed that sprinkler irrigation helped in water saving during the early crop season when the infiltration rate is high and the need of water is less in the root zone. In sprinkler irrigation 30.8% and 28.3% water use efficiency was achieved as compared to basin and furrow irrigation and also high water application efficiency was achieved in sprinkler irrigation as compared to basin and furrow irrigation respectively. Therefore it is concluded that

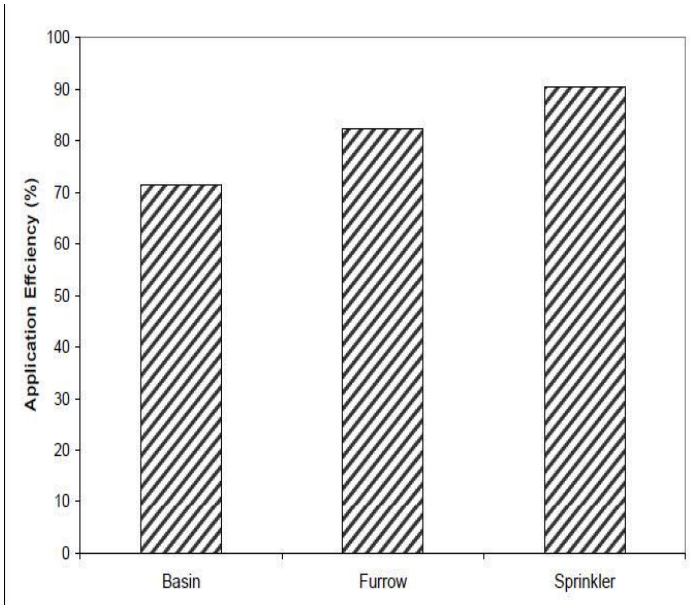
sprinkler irrigation is most feasible in rain fed area. It has been observed that clear differences in terms of water use efficiency were found in the three different irrigation methods. (Rana, 2006)

Figure 4: Water Use Efficiency for Different Irrigation Methods



Source: Rana, 2006

Figure 6: Water application for different irrigation methods



Source: Rana, 2006

Figure 5: Grain Yields of different irrigation methods

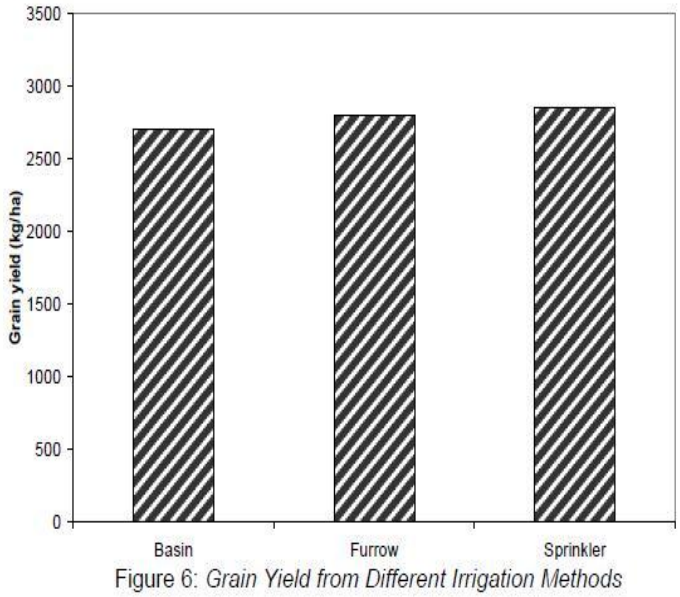


Figure 6: *Grain Yield from Different Irrigation Methods*

Source: Rana, 2006

"In irrigated agriculture, good OFWM practices require well-leveled fields, appropriately designed on-farm distribution systems, and a good knowledge of when to irrigate and how much water to apply. Irrigated agriculture also requires a reliable source of water, readily available when needed, and in quantities that can be distributed effectively and efficiently over the farmer's field." (Wolf and Stein, 2003)

In intensively cultivated areas the common method of irrigation is basin and check basin irrigation. The usage of basin and check basin irrigation in traditional leveled or unleveled fields create water logging problems in low lying areas while it creates water deficit at higher spots. It has been observed that about 10 -25% of irrigation water is lost during application at the farm

level due to inadequate management and uneven fields. Performing surface irrigation system in un leveled fields results in over irrigation and as a result of this water losses occur due to deep percolations and it also reduce application efficiency up to 25%. (Jat et al, 2006).

In India a study from 2002 to 2003 was conducted in the two villages of Punjab province to determined the irrigation practices followed by famers in wheat – rice cropping pattern with the aim to recognize the obstacles in terms of skills and knowledge of famers in the existing agriculture practices such as land preparation, water application, flow regulations, irrigation scheduling and water management practices. During the study it was found that the land was not precisely leveled to ensure uniform water distribution, irrigation scheduling were based on farmers own parameters and judgment, the farmers were not aware of water losses in the conveyance system as well as in the water channels. The seepage losses in the unlined canal were 10 – 28% while the losses in the lined water channels were 5 – 8%. These parameters result in water loss, low efficiency and non uniform distribution of water in the field. (Kaur, Sing and Gulati, 2009)

According to Rana (2006) water shortage can be overcome by improving the water application efficiencies at the field level. This will contribute in the reduction of water logging and salinity problem, so therefore it is necessary to develop techniques to use the available irrigation water in more efficient way during field application. The application efficiency can be increased by adopting pressurized irrigation system like sprinkler irrigation, however this system is expensive and the farmers can't afford also it is difficult to operate by common farmers. It has been observed that well designed and well managed surface irrigation systems have comparable application efficiencies to those of pressurized system. Therefore, it is necessary and important to improve and develop the surface irrigation system and their management in order to increase and get desire application efficiency without affecting crop yield.

"Traditional management practices of the irrigation supply and conveyance systems often contribute to high water losses. On many farms, the low irrigation efficiency is further accentuated by farmers' traditional irrigation methods and practices, inadequate land leveling, lack of a crop-specific water application, insufficient drainage, and poor maintenance of irrigation and drainage infrastructure. Farmers are often unaware of the possibilities of applying water in a more productive way. The potential of horticultural crops with their high land, water and labor productivity is often not adequately recognized, especially by less educated and poorer farmers. Farmers generally lack technical and economic information on improved on farm water management (OFWM) methods and techniques and on the related aspects of more productive cropping patterns and crop management. Therefore, proper training and capacity building at all levels of OFWM would be useful." (Wolf and Stein, 2003)

According to ICARDA (2002) in irrigated agriculture the most common grown crops in Afghanistan are wheat, barley, maize, munbean, cotton and melon. In 2002 it has been found that with normal application of water availability to the fields the crop yields were reduced on average to between 75 and 85% and it is widely varied amongst farms for instance the wheat yields were ranged from less than one to 5 tons per hectare. There are some constraints to productivity and the farmers ranked the lack of credits as the most severe problems followed by lack of water, nutrients deficiency, lack of seeds, pest & disease and weeds.

The availability of water for irrigation and crop productivity is decreasing day by day and on the other hand demand of food is increasing causing serious concerns for food security, which provide platform for the adaption of modern scientific technologies for the efficient use of water management. The efficiency of water at the field level has been poor due to water loss in conveyance. Farmers used traditional methods to level their fields such as animal-drawn or tractor-drawn, it has been observed that even the best leveled fields using traditional leveling practices are not precisely leveled and cause water losses. (Jat et al, 2006)

A Pakistani journal indicated that the irrigation water losses in the unlined water channels range between 30 – 35%. The main causes of the water losses in the unlined water channels are inadequate delivery capacity, improper shape or cross section, weeds, debris, sediment, rodent holes and poor alignment while in the lined water channels the main causes of irrigation water losses are due to cracks in the concrete side walls, damaged brick lining and poor maintenance. (Ahmad, 2007)

Afghanistan has limited water resources; it is the most precious resource so it must be managed in such a way that it could be use in efficient and sustainable manner to increase agriculture output. In current situation the use of available water resources is not effective and urgent attention must be paid to develop a long term strategy to manage water resources and to reduce vulnerability to drought. The strategy should focus on increasing the water capital and making better use of water. It should include "(i) water harvesting and watershed management, including more water storage structures both small and large, (ii) effective control of groundwater use, (iii) better information systems on water availability, (iv) eliminating unsustainable land use practices (v) improved intake structures and corresponding on-farm water management, (vi) the management transfer of state owned schemes, plus, (vii) extending the irrigated command area". (Afghanistan, 2002)

2.2. Traditional Irrigation Methods and Efficiency:

In most developing countries, agriculture is the dominant user of water, accounting for more than 85 percent of all water use. Agricultural water use raises significant issues for water resource management including water scarcity, competing demands from other sectors, irrigation service delivery and system management, water use efficiencies, and so forth. The primary objective in coming years will be to balance water supply and demand among users to ensure adequate water for agriculture and sustainable irrigation system management while satisfying other needs. (World Bank, 2006)

According to Rout (2008) there are local and regional variations exist in the distribution of water throughout Afghanistan. He pointed out that "in general water is distributed according to its availability and established rights and entitlements, but the adopted method is a function of these factors as well as system design, infrastructure and system operation". He further stated that water distribution include "proportional, rotational, needs-based and a combination of all three methods".

The rotational water allocation system is based on water entitlements and normally it is determined as allocation in hours per return interval (measured in days). It is practiced on secondary and tertiary canals. The return interval varies system to system, in case of low flow in the main canal the interval can be short four or five days but during water shortage may be more than 20 days. (Rout, 2008)

Due to less performance of the surface irrigation system the irrigated land has reduced day by day as compare to the 1980. According to the estimation of irrigation department that currently 1.4 million hectares of the total irrigated land get irrigation water, which account half that of 1980. As a result of this the overall national foods declined 30%. (Qureshi, 2002).

According to Qureshi (2002) the overall percentage of crops grown under irrigation is 85. He also mentioned that irrigation through canal is the most well known method in Afghanistan and it irrigates about 75% of the total irrigated land. As compare to other source of irrigation the contribution of canal irrigated land is greater. In order to get water from the river to the irrigation canal various structures are made along the river at different locations and then from these canal water is delivered to the field through small irrigation channels.

According to Thomas and Ahmad (2009) “along the source the effectiveness of surface irrigation is related to three major factors which are: the hydraulic performance and structural quality of the conveyance system, location of the farm site and water allocation management through local institutional arrangements”.

More than three decades of war has badly damaged the irrigation infrastructure and less attention were paid to repair the irrigation system during the period of war which force the people to managed and maintain the irrigation system traditionally. (Kakar)

During the war the local community tried their best to maintain and managed the community based irrigation system. Due to continuous war and civil conflicts the social system was destroyed completely which put negative impacts on the community based water management, although the people were able to managed and maintained the system and mostly it was considered as alone mechanism of canal and on – farm water management (Lee, 2006 and 2007)

The operation and maintenance of irrigation system is based on the contribution of each water user or farmers who use water from the canal. The cleaning of the canal (de silting) is mainly done in the beginning or at the end of the irrigation season under the supervision of Mirabs. In order to use the water resources in efficient way in the traditional irrigation systems the farming communities have developed some technical and institutional mechanisms but due to neglect in the periods of conflict it was affected badly, and it was out of reach of farmers community to repair and maintain both institutional and technical damage. (Azimi, 2002 and Riviere, 2005)

The operation and maintenance of the main canal is “organized by the wakil or Mirab bashi; according to their water entitlements, landowners and sharecroppers contribute Hashar or cash in kind”. (Rout, 2008)

The well known and familiar irrigation method in Afghanistan in both traditional and modern irrigation schemes is basin and border irrigation in cereals crops while the farmers used furrow irrigation for vegetables and grapes. The insufficient knowledge of famers about crop water requirements result over irrigation. It has been observed that at the initial stage of growing season the main cause of wastage of irrigation water in traditional system is the entrance of unregulated flood water in the conveyance canal but during the second half the growing season the main reason is the gradually decrease in river flow. (Qureshi, 2002)

According to Roe and McEwen & Whitty (2006) the characteristics of traditional or community based irrigation management are "(i) Community-embedded Mirabs, or water-masters, appointed, paid and supported wholly by landowners, (ii) water rights and allocation regimes in the systems which are solely decided by communities, based on land ownership and contributions for canal maintenance(iii) water infrastructure (intakes, canal) maintenance practices are developed by communities, which are based on contributions (in kind or financial) from land owners and land users of the canal area, (iv) the role of the state in such systems are minimal or absent and (v) most of the land-water conflicts in these systems are settled internally".

According to FAO (2002- 2003) cited by Shobair and Alim. Due to draught condition the rate of water flow reduced to 66% in canals. As a result of this the cultivation was limited and it reduced 58% of the irrigated land and three main reasons were identified as a source for reduction in irrigation schemes, which are "i. Severity of the droughts and reduction of water in the main sources, ii. Effect of war and improper operation and maintenance of canals (siltation in the canals, damaged regulating systems in the canals etc…) – including improper irrigation water management which causes low water use efficiency, iii. Lack of sound irrigation structures (mainly 90% of irrigation systems in the country are the traditional schemes; and additionally water conservation appropriate technologies are not yet introduced widely)".

According to World Bank (1998) cited by Thakkar (1999) large numbers of surface irrigation infrastructure has been in bad condition and need urgent attention to repair. It has been observed that the problems are mainly related to neglected efforts of the people towards maintenance of the systems, in appropriate design and low quality of construction materials. Due to siltation, erosion, and collapsing of the walls of the canal the capability of canal to deliver water on time has been reduced from its actual delivery. Inappropriate maintenance of the irrigation facilities has cause several damaged to the management schemes, decline irrigation efficiency, cause over irrigation in the upstream, fragile facilities and services to all farmers and specially the inequitable distribution to the downstream users.

2.3. Socioeconomics Problems:

The emerging water conflicts between different water sectors and inequities in the distribution of available water resources are important problems currently faced by Indian water sector. The allocation of water between different water sector such as agriculture, industry, domestic supplies, hydropower generating plant and as well as those areas which are located within river basins are often uncontrolled and inequitable. Inadequate water allocations rules and uncertainty of water right of each sector has enforced high economic and environmental problems. As the large number of river of India are interstate rivers and the demand of water is increasing in all sector, as a result interstate dispute on water sharing arises()

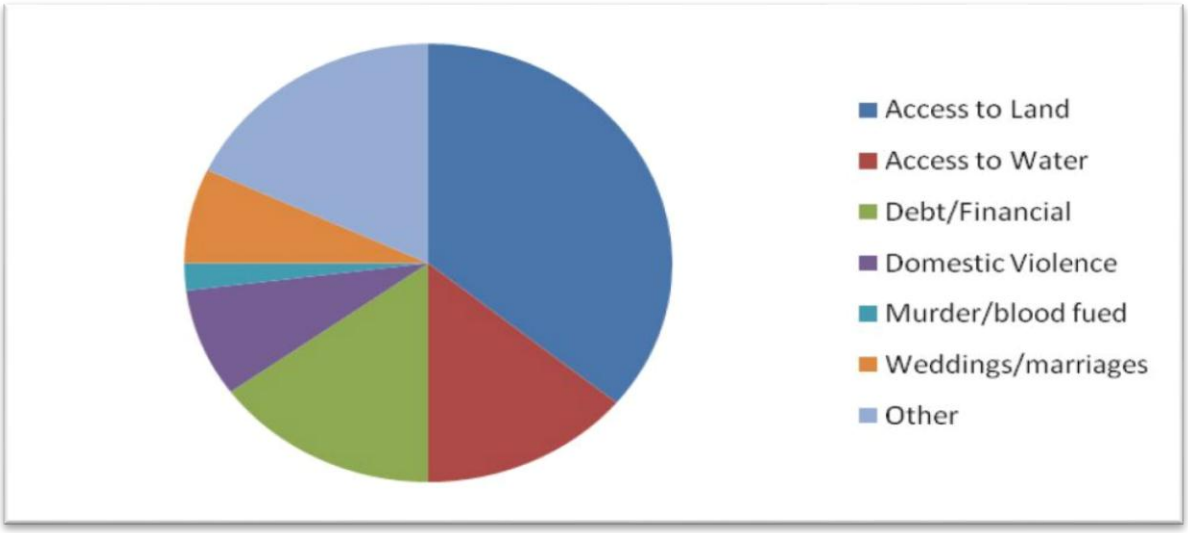
In afghan water laws of 1981it was clearly mentioned that the allocation of water to each farmer is based on the cultivation area, Crop type, Irrigation system, water rights documents, local practice and the availability of water in the main source. These rules and regulations only exist on paper but in practical life farmers don't follow these rules and regulations and the distribution of water occur amongst the farmer through informal agreements. (Qureshi, 2002)

Afghanistan is located in the arid zone, the water resources issue in such zones is vital and attention should be paid for its efficient use. Water has been considered a trigger of internal or

external tension and also it has been considered a source of conflicts between neighbouring countries as well as amongst the communities. It has been observed that several years of war and droughts have increased the inequalities and conflicts between villages, districts and provinces. In order to overcome and addressed these issues national development strategies need to rely on a fair and efficient water management between domestics' users as well as amongst neighbouring countries. (Riviere, 2005)

The several years of war and revolution have taken away the attention of people from water in Afghanistan. It has been observed that land and water is the main cause of all local conflicts and it accounts nearly half of the all conflicts particularly in those area whether family or communal in nature. The local water related conflicts is highly linked with seasonality and most often it is also related to water shortage particularly during the dry months. The conflicts arise when the farmers and user in upstream limit the amount of water for downstream users. Due to water conflicts one of the farmer in Andarab district loss his son and brother. Sometimes the unequal distributions of water also bring grievances against the local government. The conflicts over water are quite severe in those rural areas where other economic activities are partial and agriculture is the sole mean for their livelihoods. The conflicts have also put enormous pressure on water supply system, especially because of the destruction of irrigation infrastructure and power supplies. The warlords play a vital role in the rising of water and land conflicts at the local level. (Barakat, 2011)

Figure 7: Different Causes of conflicts



Source: Barakat, 2011

CHAPTER THREE

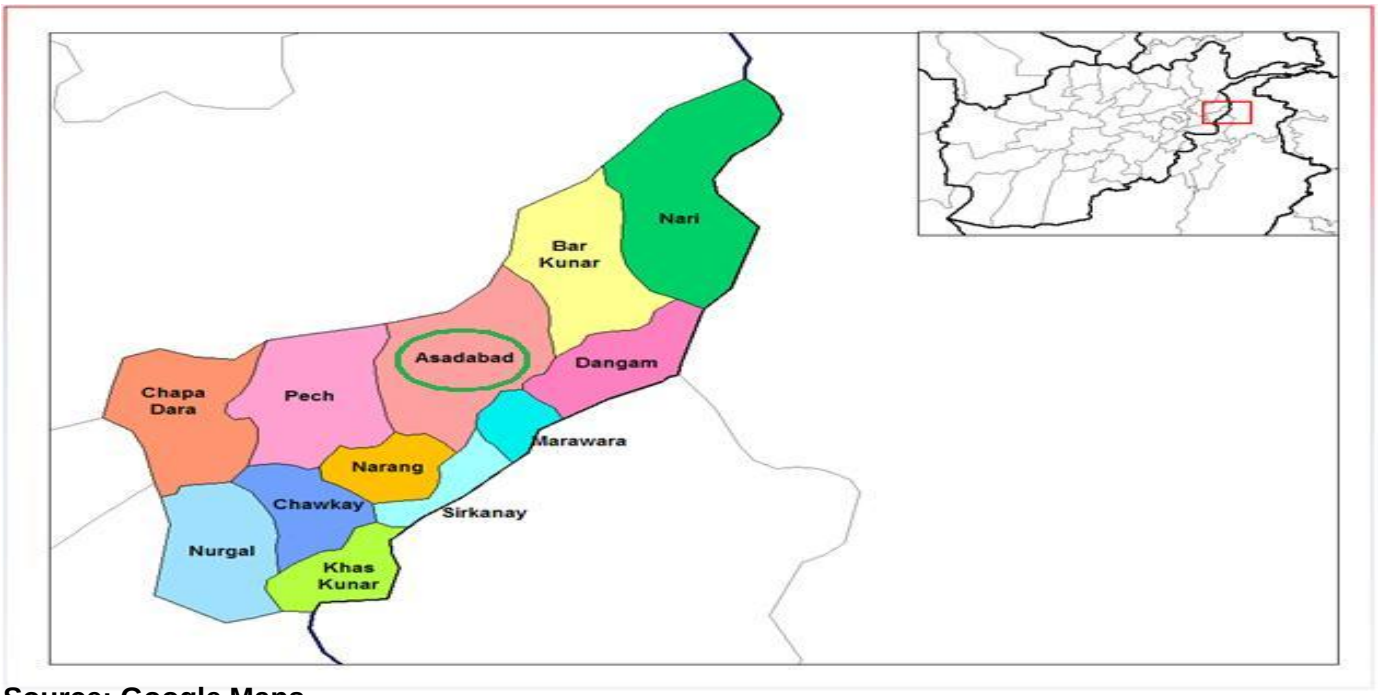
3. METHODOLOGY:

This chapter describes the approach of data collection and the tools used for data analysis. It also indicates the significant information about the study area and source used for secondary data. This chapter includes the conceptual frame work of the study.

Study area:

Kunar is located at the eastern part of Afghanistan. The province has international border with Pakistan at the east, Nangarhar province at the south, Nuristan province at the north and Laghman province at the west. (Kunar Provincial Profile)

Figure 8: Map of Kunar Province



Source: Google Maps

The total area of the province is about 4,339 km^2. About 86% of the total land is mountainous or Semi mountainous and 12 % of the land is flat. (Kunar Provincial Profile)

Table 2: Topography of Kunar Province

Topography Type					
Flat	Semi Flat	Mountainous	Semi Mountainous	Not reported	Total
12.3 %	0.9 %	78.7 %	7.7 %	0.4 %	100

Source: CSO/UNFPA Socio Economic and Demographic Profile

The total cultivable land is about 24,000 ha, in which18000 ha is under irrigated agriculture while the remaining 6000 ha is rain fed. It has been reported that 9000 ha of the total land is waste land which is inappropriate for agriculture. The irrigation infrastructure is badly damaged by war and maintenance of the system was neglected during the war. The main source of irrigation is canals, springs and Karezes. About 97% of irrigation takes place through canals

while the remaining is done through springs and Karezes. About 72 large and medium canals take water from Kunar River and only 21 is registered with irrigation directorate and know as large canals. Irrigation through springs mostly takes place in the valley and there are 120 – 150 springs exist in the different parts of the province. Irrigation through Karezes is only exists in Marawara and Shegal districts. (Kunar Provincial Profile)

The province has divided into 15 districts. The total population of Kunar is 413,008. The total number of households is 64,588 with each household has the average of 8 members. The provincial capital is Asadabad which has population of about 29,177 inhabitants. The total irrigated land of Asadabad is 2,505 ha and the total rain fed area is 2,282 ha. Agriculture is the main source of income and about three quarter of the households relay on agriculture .The main crops grow in the area are wheat, maize and rice. Around 88% of the total households have access to the irrigated land while the remaining 31% have access to the rain fed land. An average 24% of the households have access to use safe drinking water, 62% of the households have directly get drinking water within community, 32% of the households suffered to traveled about an hour to get safe drinking water and 6% have to travel more than 6 hours in order to get drinking water. (Kunar Provincial Profile)

Different ethnic groups are living in Kunar Province; Pashtons make the majority of them while the others ethnic groups are Ashkun, Gawar-Bati, Gujari, Pashayi and Waigali. The major language is Pashto and is spoken by about 90% of the population. The other languages are Dari, Uzbeki, Pashaie and Nooristani. (Kunar Provincial Profile)

The main source of the Kunar River is the glaciers present in the region of Teraj Mir which is about 7,750 m above sea level and get the name of Yarkhun River, but entering to the Chitral Valley of Pakistan it becomes Chitral River. Due to permanent snow and glaciers on the high mountains the flow of the Kunar River increases in summer season. The Chitral river gets the name Kunar river when it enters into Afghanistan in Nari district of Kunar province. The Pech river which is one of the two main tributaries of Kunar river take the sources from the high mountains of Hindu Kush and join the Kunar river in the center of the province (Marawara and Asadabad) while the other tributaries is the Bashgal which is also known as Landaisin take the source from large number of streams in Bargi Matal and Kamdesh districts of Nuristan province. This tributary joins the Kunar River in Nari districts near to the border of Pakistan. The Kunar river form a delta in the Nangarhar province near Tangi and irrigates the agricultural land of Kama district on the left and Jalalabad districts on the right bank. The Kunar River joins the Kabul River in Nangarhar province in the east of Jalalabad town. (Favre, 2004)

According to the Extension Department the total length of the Salar Bagh canal is 24 Km which originates from the Pech River one of the tributaries of the Kunar River which later joins the Kabul River, the Salar Bagh canal irrigates about 1200 ha of land in Asadabad and Narang districts. In Tisha and Nawabad villages the canal irrigates about 300 ha land. The water enters at the intake of the canal at the rate of 5 m^3 per second. The water distribution is based on turn system in which each village receives water in terms of hours including night time. The water allocation is based on registered land with government. Each village has its own Mirab who is responsible to manage water.

Figure 9: Map of Salar Bagh Canal

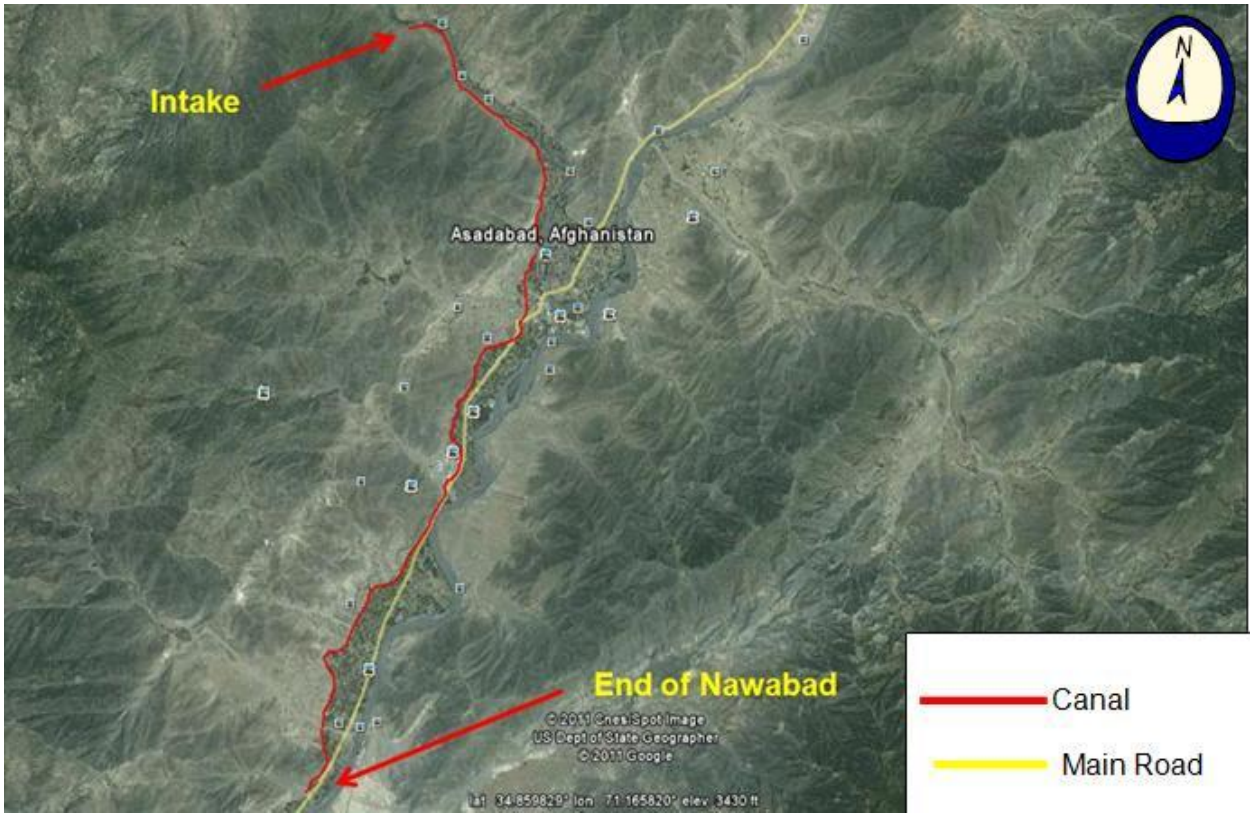


Figure 10: Map of the study area (Tisha and Nawabad)

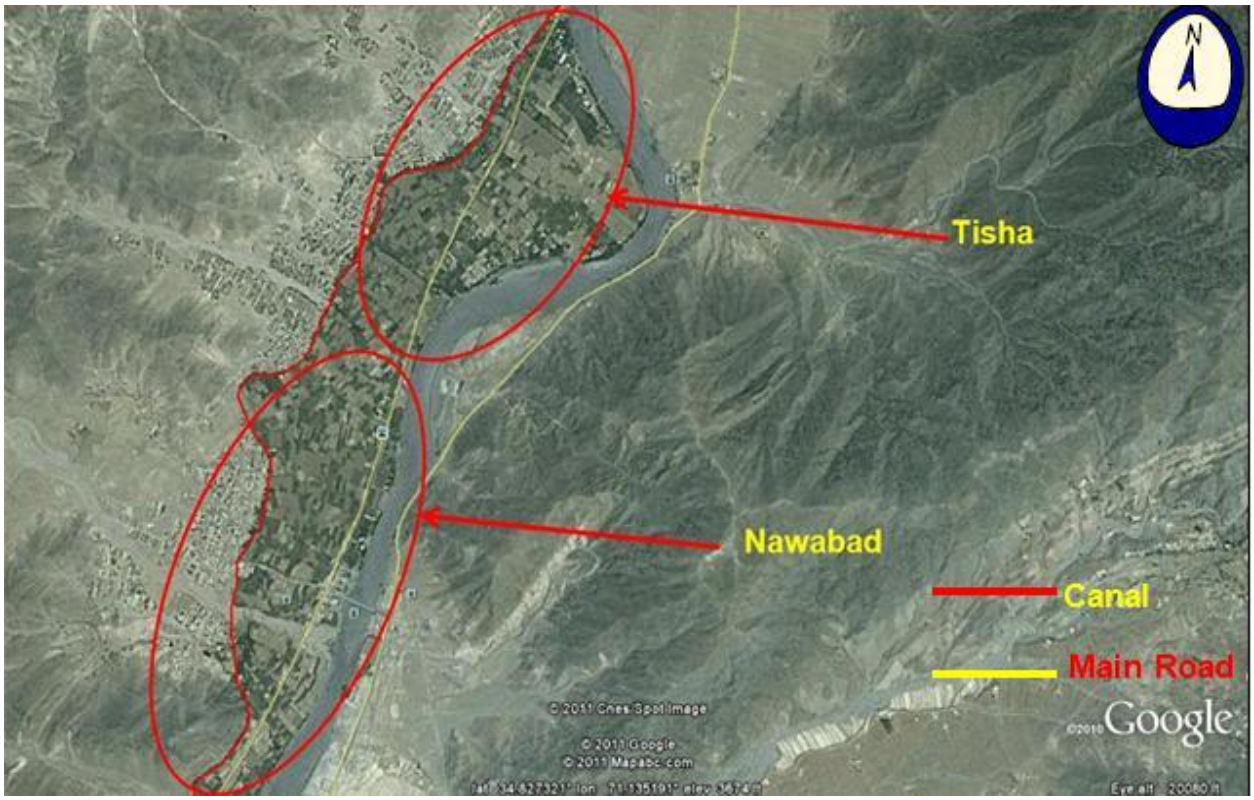


Table 3: Climate Data of Asadabad

Latitude: 35.000° **Longitude:** 71.200° **Elevation:** 1 466m

Month	Prc.	Prc.	Prc. cv	Wet days	Tmp. mean	Tmp. max.	Tmp. min.	Grnd Frost	Rel. hum.	Sun shine	Wind (2m)	ETo	ETo
	mm/m	mm/d	%	days	°C	°C	°C	days	%	%	m/s	mm/m	mm/d
Jan	73	2.4	80.9	4.4	4.9	10.8	-0.9	19.4	55.3	50.7	1.0	36	1.2
Feb	111	4.0	41.1	6.6	6.3	12.0	0.6	15.6	56.4	50.2	1.0	40	1.4
Mar	165	5.3	39.8	11.6	11.0	16.8	5.3	8.8	55.4	46.9	1.0	67	2.2
Apr	129	4.3	50.7	11.8	16.3	22.6	10.1	2.4	52.5	53.5	1.0	97	3.2
May	69	2.2	81.5	9.1	21.7	28.6	14.8	0.7	42.5	63.6	1.3	149	4.8
Jun	27	0.9	111.5	5.7	27.8	35.1	20.6	0.2	34.2	70.1	1.6	194	6.5
Jul	74	2.4	87.7	7.8	28.7	34.6	22.9	0.1	45.4	65.6	1.6	190	6.1
Aug	76	2.5	104.8	8.6	27.9	33.6	22.3	0.1	50.8	64.9	1.5	169	5.5
Sep	43	1.4	101.4	5.8	24.8	31.6	18.1	0.3	46.3	68.9	1.3	137	4.6
Oct	33	1.1	86.5	4.6	19.1	26.6	11.7	2.0	43.4	69.5	1.0	95	3.1
Nov	34	1.1	119.5	3.2	12.5	19.8	5.3	8.2	44.2	69.0	0.9	57	1.9
Dec	64	2.0	110.8	4.8	7.0	13.2	0.8	16.3	52.4	52.0	0.9	38	1.2
Total	898											1 268	

Source: FAO, 2011

3.2. Conceptual Frame Work

The First priority of the research was to focus on, On Farm Water Management practices, but due to the outcome of the literature review and field survey it was found that not only on farm water management practices are important but the off-farm water management practices have also equal importance. Studying only one out of the two will not provide good results therefore, a decision was made to address both off and on-farm water management practices.

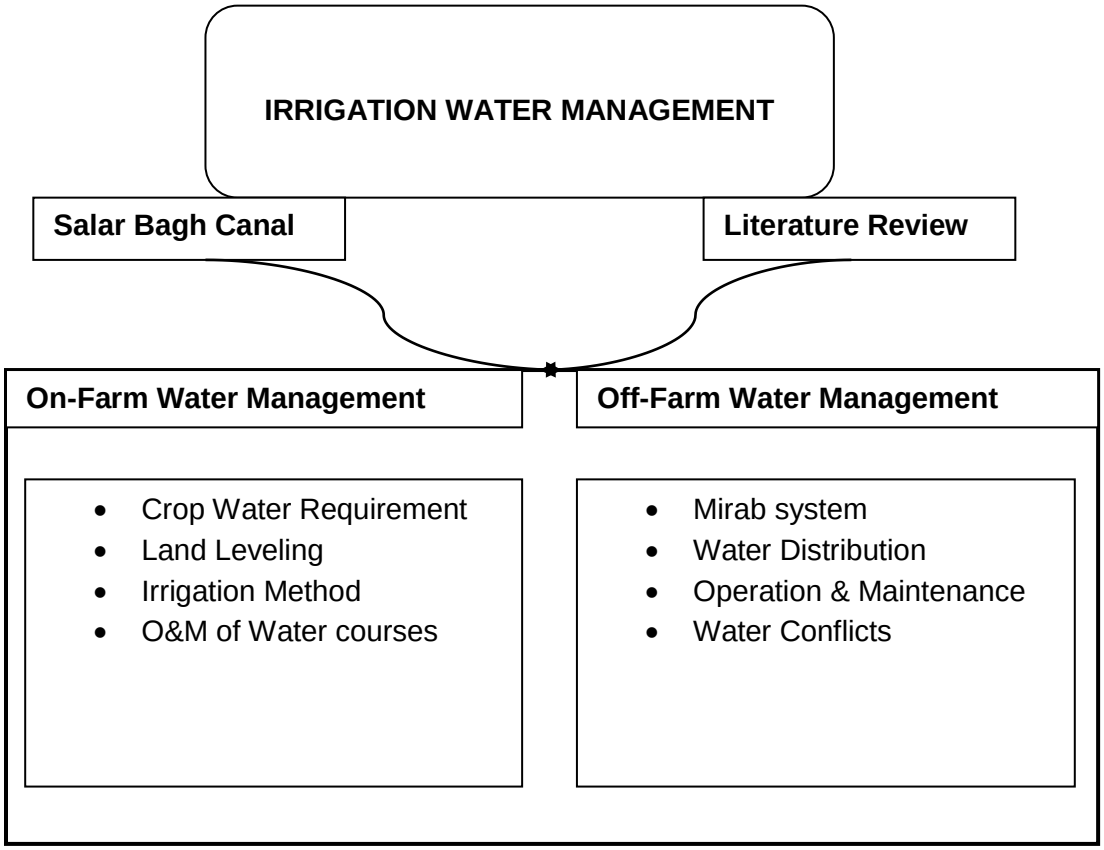
This study investigates the on-farm water management and off-farm water management practices of the farmers. The following four indicators are selected for the on-farm water management practices:

1. Irrigation Scheduling
2. Land Leveling
3. Irrigation Method
4. Physical conditions of watercourses

For the off-farm water management practices the following four indicators are selected:

1. Mirab system
2. Water Distribution
3. Operation & Maintenance
4. Water Conflicts

The selection of indicators both for on-farm and off-farm water management practices was based on the importance of those indicators



Strategy:

The research has qualitative and quantitative approach and was based on survey, observation and literature review.

Survey:

The research conducted in the Asadabad district of Kunar province. Two villages were selected after the consultation with extension department. In each village 15 farmers were selected randomly.

The survey conducted according to pre designed questionnaire and determined the irrigation practices followed by farmers in cropping system, water application, land preparation practices and irrigation scheduling.

Focused Group discussion:

A group discussion was made with the extension department and irrigation sub department in order to get information about the climatic data, soil conditions and off-water management activities of the study area. The discussion also includes getting information about the current Mirab system, operation and maintenance, water conflicts, water distribution, cropping pattern, and extension services.

Additional data collection:

The FAO website tools like climate information tool, CROPWAT tool were also used to get information about climate and crop water requirement characteristics under different climatic situations.

Literature review:

The relevant data about on farm water management practices was collected through desk study which includes reviewing books, reports, and journals. The following terms were used during desk study.

- Integrated water management
- On Farm Water management
- Water conservation
- Water resource management
- Socioeconomic problems and limitations

Data Analysis

After data collection the collected data were analyzed using Statistical Packages for Social Sciences (SPSS) and an Excel sheet. The results presented in charts and tables. The SPSS tools like descriptive statistics, cross tabulations were used for analysis and comparison.

CHAPTER FOUR

4. RESULTS

This chapter indicates the result obtained from the survey, observation and group discussion. This chapter describes the current situation of the on farm and off farm water management practices.

4.1. Group Discussion:

A group discussion was made with the extension department and irrigation department in order to get information about the climatic data, soil conditions and off-water management activities of the study area. The discussion also includes getting information about the current Mirab system, operation and maintenance, water conflicts, water distribution, cropping pattern, and extension services.

According to the extension department the soil of the study area varies from sandy loam to clay loam. Due to unavailability of the meteorological station in the area it was not possible for the extension department to give the accurate information about the climatic data.

The extension department was asked about the physical condition of the canal. According to the irrigation department the physical condition of the canal is not good. Although, USAID has built the intake of the canal along with some retaining wall but it is not sufficient enough. The canal is long and passes through the skirts of high mountains. In summer season, floods occur due to heavy rain falls which damage various parts of the canal. The floods water has high pressure and brings stones and sediments which block the canal.

They mentioned that the canal is not built in technical way, there are no proper technical division boxes and control structures. The people use traditional available materials like mud, stones and bushes to control water. They also mentioned the turnouts are made in such a way that the farmer can't control the amount of water and as result the water goes with high pressure and volume, which damaged the fields channel and thus it is difficult for the farmers to control water in the fields and over irrigation occurs which affects the downstream users.

The irrigation sub department was asked about the conflicts over water and its resolution. The informants replied that the water conflicts are frequent in the Salar Bagh canal. The act of water theft is a common practice among the water users which causes conflicts among them. The Mirab tries his best to mitigate and resolves the water conflicts but if he fails do so then the community elders are approached. The community elders play active role in the conflict resolutions.

The water allocation is based according to registered land with government. The water distribution in the area is based on turn system. The Tisha village receives water after 16 days. At each turn Tisha village receive water for 48 hours including night time. After Tisha village the turn of Nawabad village reaches where only 24 hours of water is allocated to this village.

The irrigation sub department was asked about the water management on the Salar Bagh canal. The informants of irrigation sub department replied that the water management and O&M of infrastructure is carried out by community based, traditional management system known as Mirab system. The Mirab (water master) is responsible to manage water distribution in the area. He is also responsible to gather the people (Hashar) for the maintenance of the canal. The Mirab is also responsible to take active part in the resolving water conflicts and dispute amongst certain farmers of the village and also to resolve water conflicts with other villages Mirabs.

There are no rules and regulations on cropping pattern, the farmers cultivated the crops according to their own desire. The farmers (especially upstream) are growing high water consuming crops like rice and vegetables which have adversely affected the downstream water users.

The extension department and irrigation sub departments were asked about the extension services to the farmers especially in on farm water management. The informants of the extension department replied that they have not provided any kind of extension services in on farm water management to the farmers. The extension department only provides extension services when ever asked by the NGOs (DAI). We have provided trainings in preparation of seed beds (vegetables) to the farmers with the request of DAI. The informants of the irrigation sub-department stated that our department has newly established and so far we do not have provided any kind of extension services in on farm -water management.

4.2. Field Observations:

From the field observation it was found out that majority of the farmers used Basin and Border irrigation for cereal crops while some of the farmers also used furrow irrigation for vegetables and in case of vegetables it was also observed that some of the farmers also used check basin irrigation for vegetables. It has been observed during the survey that the farmers in the upstream areas cultivated rice, vegetables and maize while in the middle stream areas there were limited field with rice and vegetables cultivations, large number of farmers cultivated maize.

From the field observation it was find out that the farmers were not aware of irrigation scheduling and they used the water till the entire field gets irrigation water and after this they close the turnouts of the fields and let the water to flow down along the gravity to other famers' field. The fields' channels were not proper in conditions there were a lot of weeds in the fields' channels it was difficult to distinguish between the field channels and rest of the fields and the embankment of the fields channel were weak, and the water easily overtop from one field to others. The control structures were made of traditional material like mud, bushes, sand bags and stones. There were no divisions' box along the main fields channel as well as along the canal and the volume of the irrigation water for individual farmer were not known, he get much water as he can. There were a certain amount of water losses through field channels, control structures as well as in the fields.

Photo 1: Condition of water course

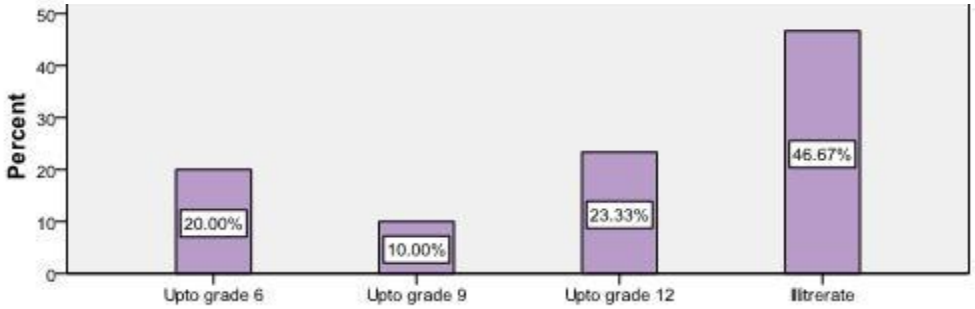
The fields of the farmers were not leveled and there were low and high spots in the fields and also it was observed that there were some stones present in the fields. The conditions of the land leveling of the vegetables fields were good as compared to other corps. There were weeds present in the farmer's field. The farmers of the study area used oxen and tractors for land leveling. It was observed that the farmers used broadcasting methods for the cultivation of cereal crops while the row methods of sowing were observed in the vegetables fields. The main crops grow in the study area are Maize, rice and vegetables

Photo 2: Condition of land leveling

From the observation made during the field study it was find out that the intake o f the canal was in good shape and it was recently built by the USAID and also retaining wall along the river was built but it was not enough still there are some parts along the canals which need urgent attention for repair and protect against flood water, there were culverts built in various parts of the canal to avoid the canal from flood damage and siltation, but due to low capacity of holding the flood water passing through the walls of the culvert and damage the earthen parts of the canal and bring lots of stones and sediment to the canal. The leakage problem was also observed in different parts of the canal. The turn outs and the off take were built from traditional materials and some places the turn outs were concrete and there was no proper control structure and the farmers used the local materials like stones and mud to control water.

4.3. Educational Background of the Famers: According to the survey most of the farmers are illiterate and have never been to school, 24% of the farmers have completed their secondary education, 10% have been graduated from middle school and 20% of the farmers have completed primary education.

Figure 11: Education level of farmers

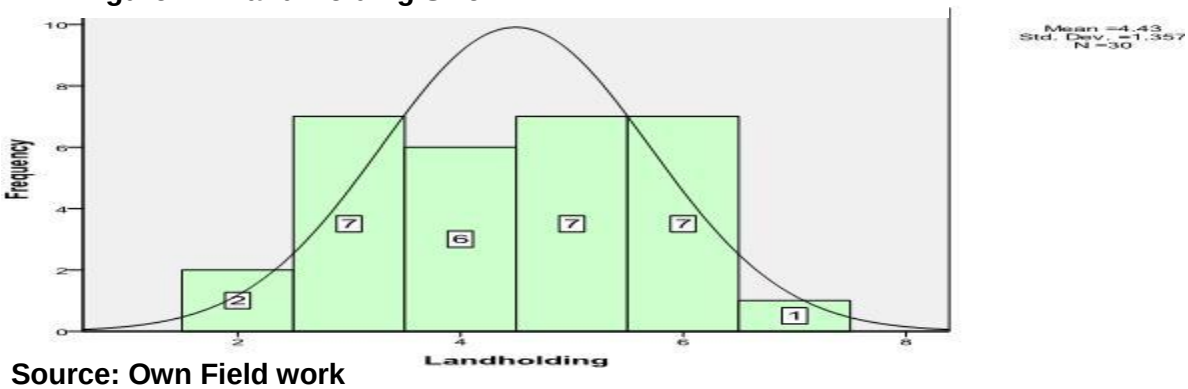


Source: Own Field work.

4.4. Land Holding Size:

The average farm size in Tisha and Nawabab villages of Asadabad district is 4.43 Jeribs. It indicates that the most of the farmers are small scale farmers and the farm size range between 2 – 5 Jeribs (One Jeribs = 0.2 ha)

Figure 12: Land Holding Size

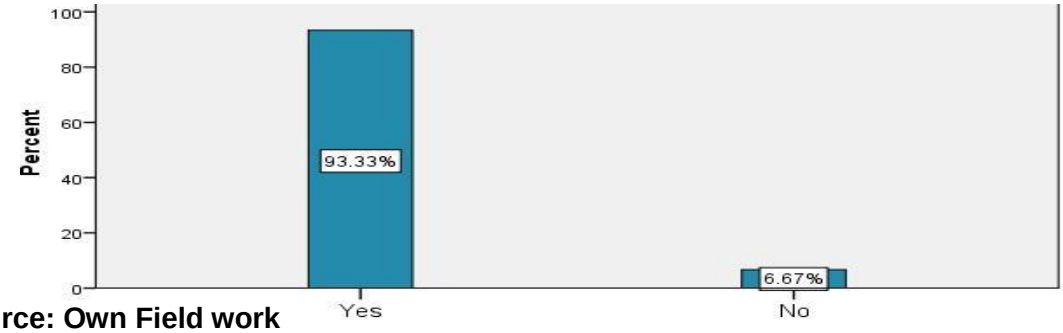


Source: Own Field work

4.5. Water Shortage:

The figure below indicates that the majority of the farmers face water shortage while few of them were not facing water shortage.

Figure 13: Water Scarcity

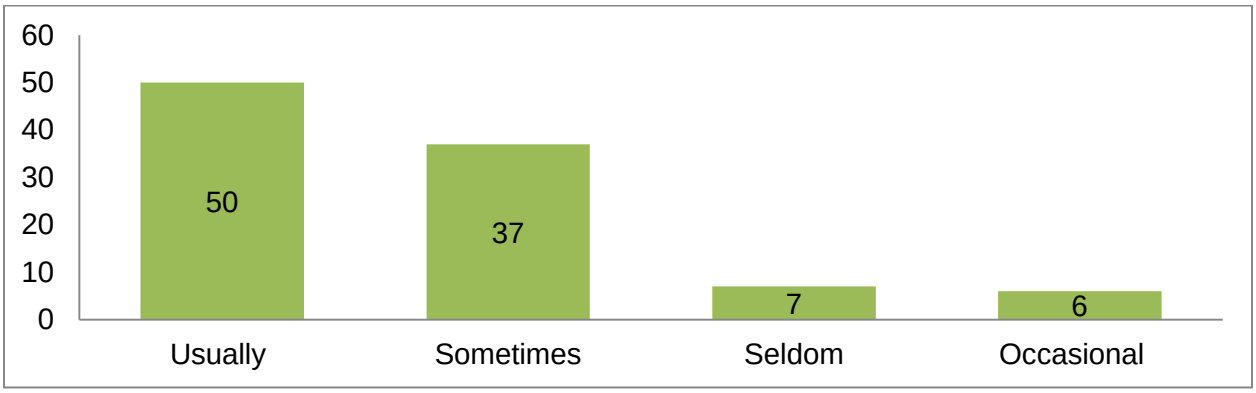


Source: Own Field work

4.6. Frequency of Water Shortage:

The figure below shows the frequency of the water shortage faced by the farmers. The chart below indicates that majority of the farmer (50%) faced water shortage usually. Some of them are facing water shortage not very often. Very few farmers were not facing the water scarcity. The classifications were made on the basis of time of facing water shortage during the year. Those farmers who were facing water shortage more than three times were placed in the usually, those who faced water shortage between 1 and 2 times were placed in the class of sometimes, those who faced water shortage less than one times during the year were placed in the seldom class while in the occasional class those farmers were placed who face water shortage only occasionally either in case of canal or intake or other parts washout.

Figure 14: Frequency of water shortage

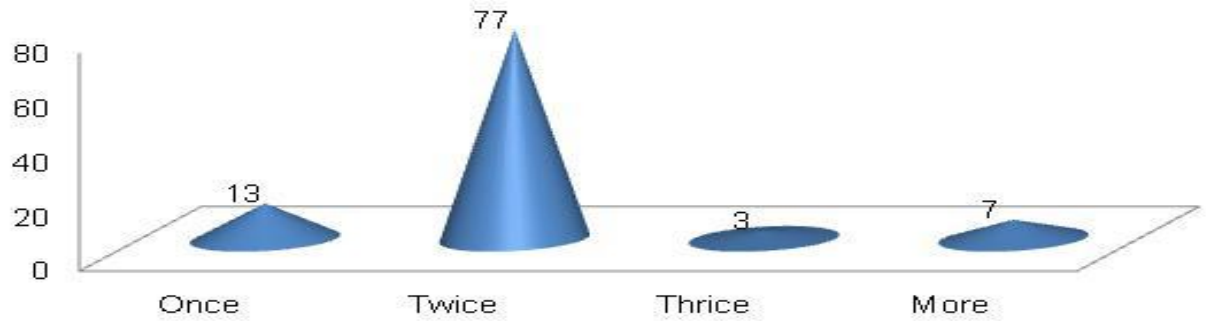


Source: Own Field work

4.7. Access to Water in a Month:

According to the survey most of the famers get water twice a month. Few of them have access to water once a month. Very less number of farmers gets water more than three times a month. The water allocation in the study area is base on turn. The water rights were recorded on land registration base. The study areas have access to water twice a month and they have a total water right of two shab o roz (Day and night irrigation) to irrigate the entire area.

Figure 15: Access to water in a month

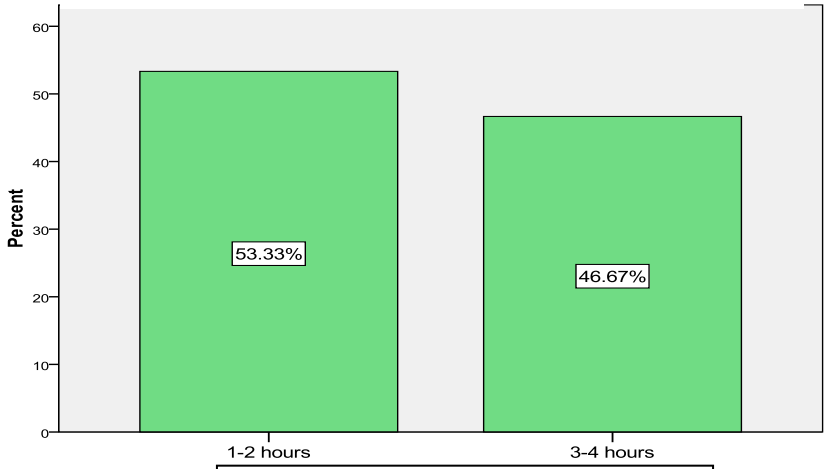


Source: Own Field work

4.8. Hours used per turn:

The figure below shows that more than half of farmers (53.33%) take one to hours to irrigate their fields, 46.67% take three to four hours to irrigate the field, this also defends on the land the volume of water exist in the canal. If the discharge in the canal is high and land is small it will take less time to irrigate but if the discharge is small and the land is large it will take much time to irrigate. This also defends on the conditions of soil, land leveling, crop type, condition of field channels and types of irrigation. The farmers of the study areas were not aware of irrigation scheduling and the determination of irrigation time was based on local indictors and knowledge. They usually used and look to the condition of soil, plant wiliness and gap between two irrigation.

Figure 16: Hours per turn

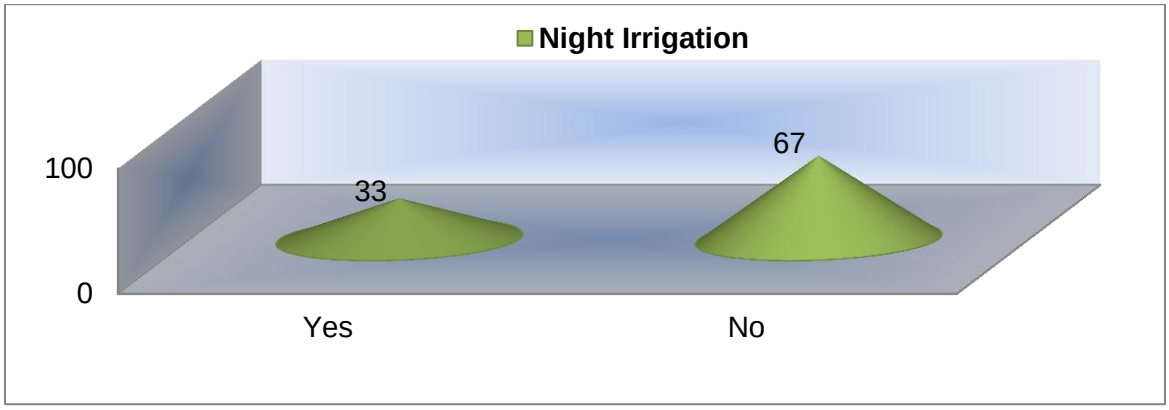


Source: Own Field work

4.9. Night irrigation:

According to the survey 33% of the farmers practice night irrigation in the area whiles the remaining 67%of the farmers didn't use to irrigate fields during the night time. The farmers at the study area irrigate their field in the month of July and August. The allocation of water is different in different part of the country. The water allocation is based in some area in night day irrigation but now days due to security situation the farmers are not following that rules and water at night is wasted. The water right in the study areas were based on day and night irrigation they have fixed turn of getting water on 16th of the every month. The farmers of the study area practiced the night irrigation during the mid August and September.

Figure 17: Practicing night irrigation

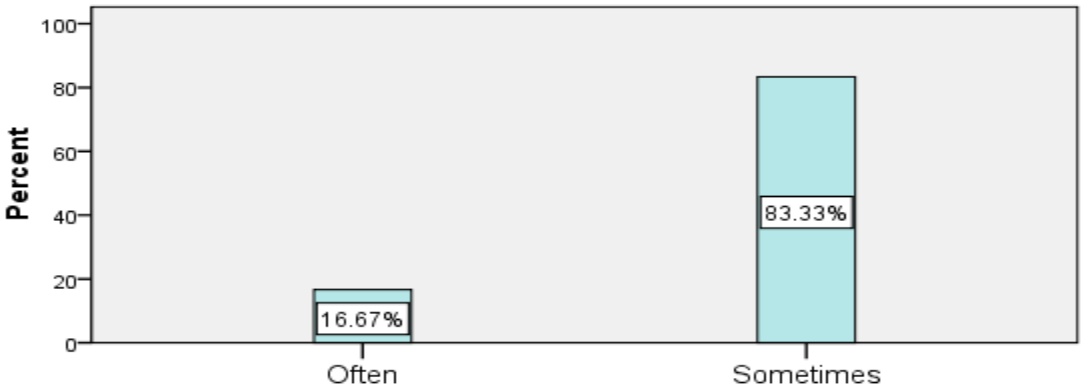


Source: Own Field work

4.10. Dispute over Water:

It is indicated from the survey that the 17% of the people have often dispute over water in the area, 83% of the people sometimes have dispute over water. According to the survey when there are conflicts over water between the water users Mirab is responsible to resolve the dispute along with community elders.

Figure 18: Dispute over water

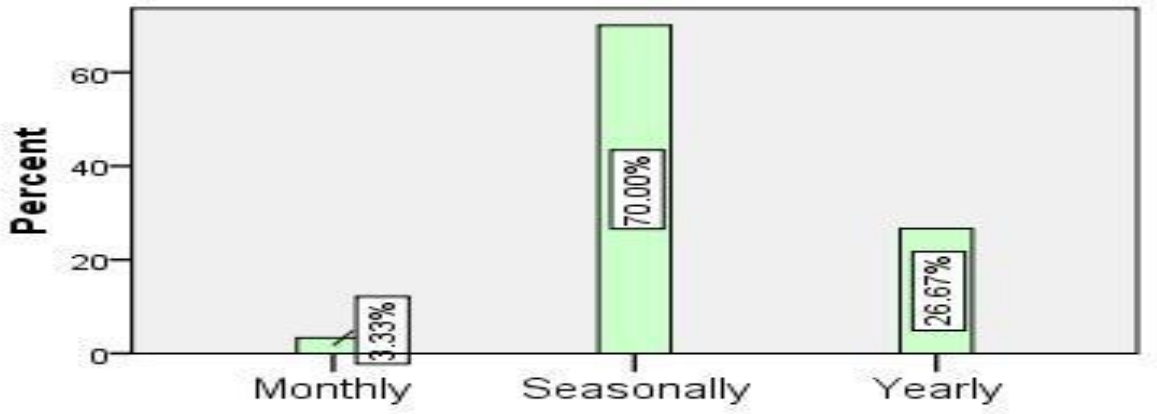


Source: Own Field work

4.11. Frequency of watercourse cleaning:

The figure below shows that 3% of the farmers used to clean the water channels monthly, 70% of the farmers watercourse cleaning is closely related to seasonality and 27% of the farmers cleans the water channels once a year. Although majority of the farmers mentioned that they cleaned the water course and field channels seasonally at the beginning of the season but in late season there is no proper maintenance of the fields' channels and it disappeared with the passage of time and dissolved in the fields. As a result of this farmers faced difficulties while irrigating their fields.

Figure 19: Frequency of water course cleaning

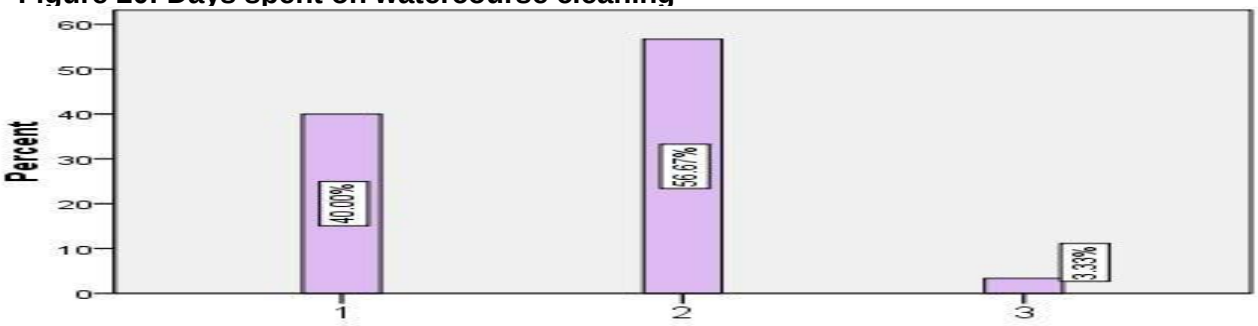


Source: Own Field work

4.12. Days spent on water course cleaning:

Due to relatively small land size it was observed that 40% of the farmers spending one day on cleaning of watercourse, 57% clean their watercourse in 2 days while the remaining 3% mentioned that they spent 3 days on cleaning their water courses.

Figure 20: Days spent on watercourse cleaning

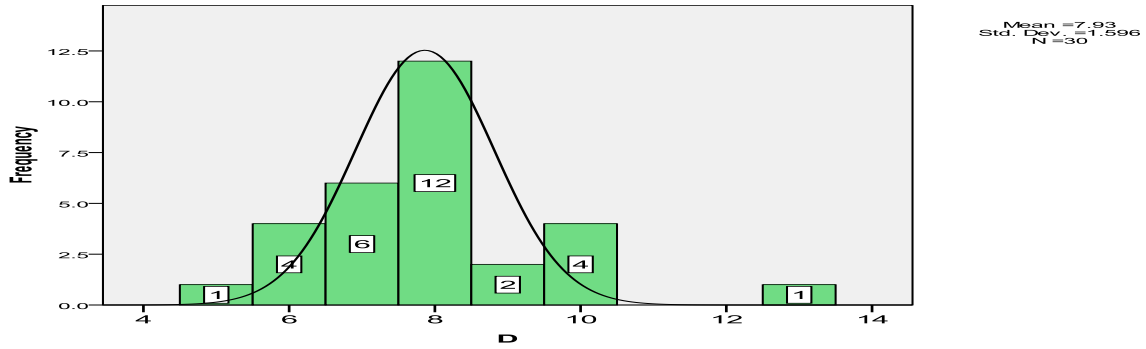


Source: Own Field work

4.13. Days spent on canal cleaning:

The figure below shows that the farmers spent an average 8 days on canal cleaning. The days spending on canal vary and it range between 5 – 13. The canal cleaning usually takes place in the beginning of cropping season. The Salar Bagh canal is mainly in the skirts of mountains during raining season often there is great risk of washing away, and water from the mountains take a lot of sediments which not only blocked the canals at various part which affect the discharge of the canal but also washed away the canal at different places, which take lots of time to repair at again. In this case Mirab is responsible to gather people in order to clean and repair the damage parts of the canal. Every farmer has to clean the part of canal pass through has land and the areas which are commons or those areas without irrigate land is cleaned collectively and Mirab is responsible to inform farmers.

Figure 21: Days spent on canal cleaning

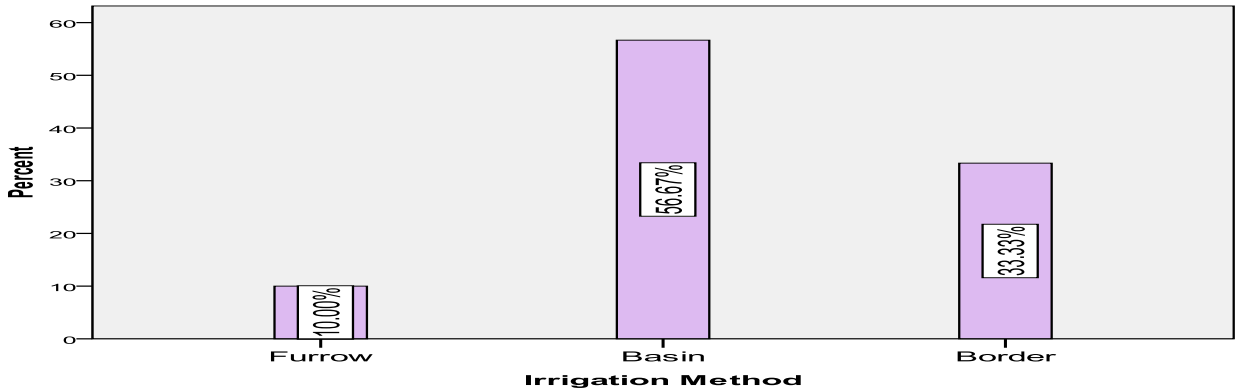


Source: Own Field work

4.14. Methods of irrigation:

The figure below shows that majority of the farmers use basin irrigation, some of them use border while a less number of farmers used furrow irrigation. The furrow irrigation is used for vegetables while Basin and Border irrigation is used for both maize and rice

Figure 22: Method of irrigation

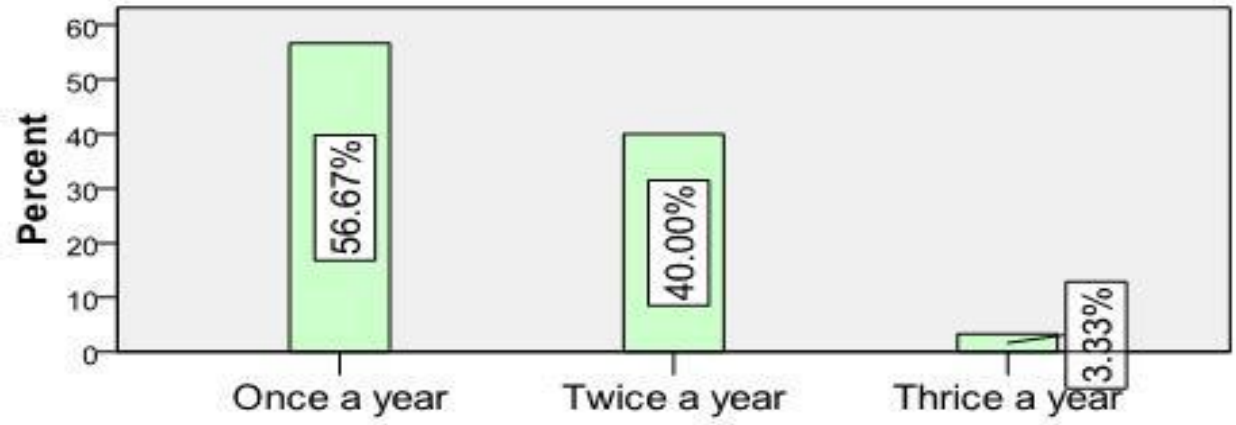


Source: Own Field work

4.15. Frequency of canal cleaning:

It is indicated from the survey that more than half the farmers take parts in canal cleaning once a year, some of the farmers take part in the canal cleaning twice a year while very few mentioned that they take parts in canal cleaning three times a year.

Figure 23: Frequency of canal cleaning

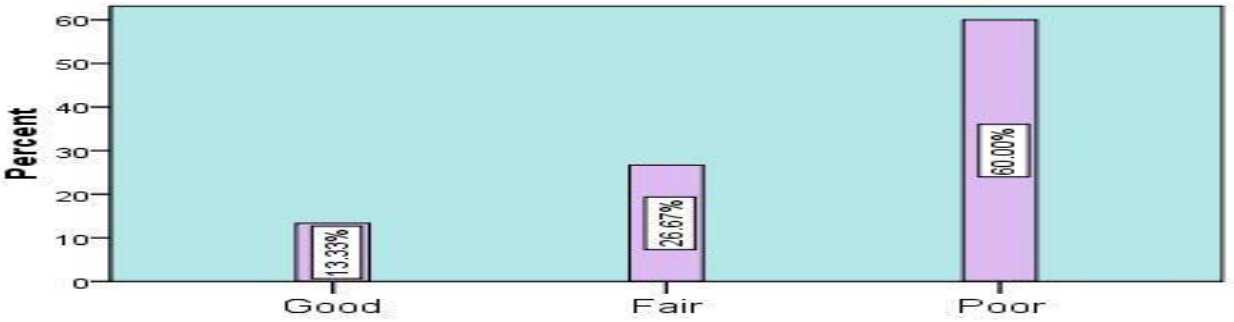


Source: Own Field work

4.16. Condition of land leveling:

According to survey majority (60%) of the mentioned that there fields are uneven and face many problems during irrigation, 27% of the farmers rated their land leveling is fair while 13% of the farmers said that the level of their field in good condition. The classifications were determined according to the low and high spots as well as clods present in the field. The fields which have more low and high spots and also have more clods were put under the Poor class, the fields which have moderate low and high spots and moderate clods were put under the Fair class while the fields which have less low and high spots and less clods were put under the Good class. According to the survey the farmers used tractors and oxen to level their field.

Figure 24: Condition of Land Leveling



Source: Own Field Work

4.17. Most important water issues:

The figure below shows that most of the respondents (87%) replied water theft as the most important water issue for them, secondly (47%) of them give priority to silting issue and leaky out fields (canal) and no proper control structures are prioritized as 3rd and 4th issue of water.

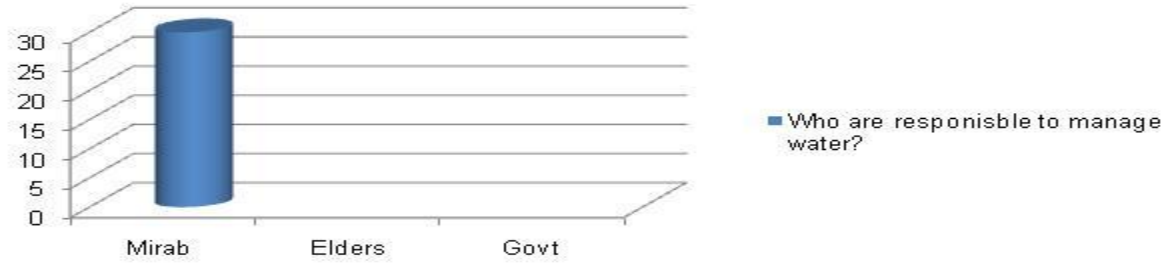
Figure 25: Important water issues

Source: Own Field Work

4.18. Who are responsible to mange water?

According to the survey all the respondents mentioned that Mirab is responsible to manage water in the area. The main responsibilities of Mirab (water master) are water distribution, take active part in the resolving of water conflicts along with community elder and gather people (Hashar) for the maintenance of the canal.

Figure 26: Water management

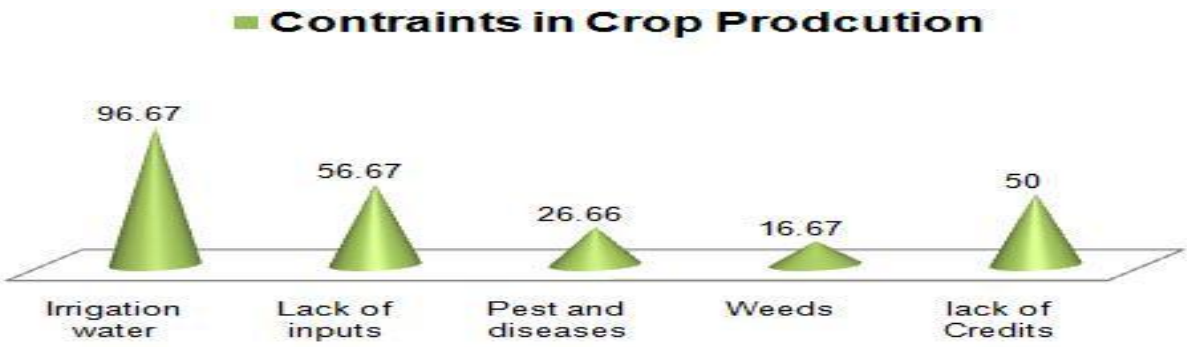


Source: Own Field Work

4.19. Constraints in crop production:

According to the survey most of the respondents ranked that irrigation water is the most important constraints in crop production in the area, they mentioned that lack of inputs such improved seeds, fertilizer, pesticides are the 2nd most important obstacles in crop production, they ranked the credits as the 3rd most important constraints, they ranked pest & Diseases and weeds 4th and 5th constraints in crop productions respectively.

Figure 27: Constraints in Crop Productions

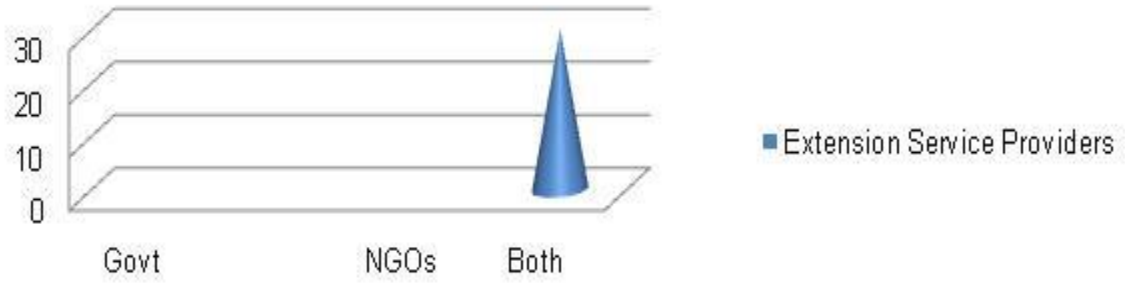


Source: Own Field Work

4.20. Extension Service providers:

According the survey the farmers mentioned that both government and NGOs is providing extension services in the area.

Figure 28: Extension Service Providers

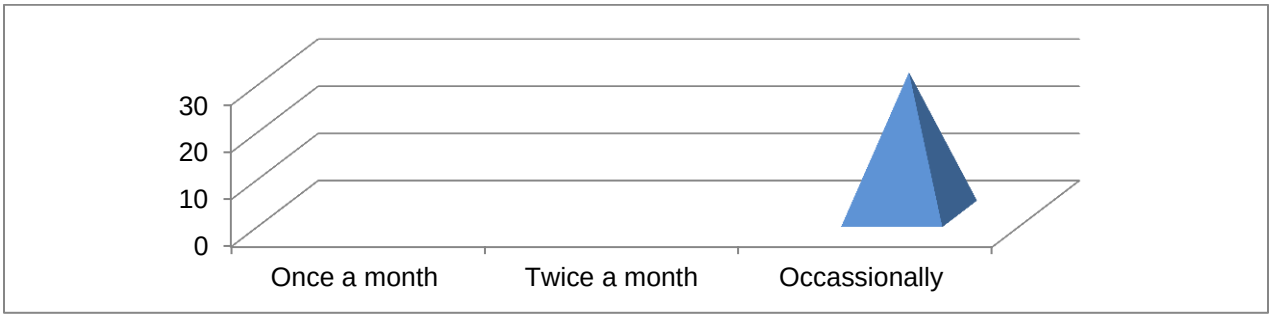


Source: Own Field Work

4.21. Frequency of Ext. officer visit farmers

According to the survey the farmers mentioned that the extension department only visit occasionally and provide extension services whenever they were asked by NGOs. They also mentioned that they only provided training in preparation of seed beds for vegetables. They mentioned that so far we didn't receive any kind of training in on farm water management practices.

Figure 29: Frequency of Ext. Officer visits farmers

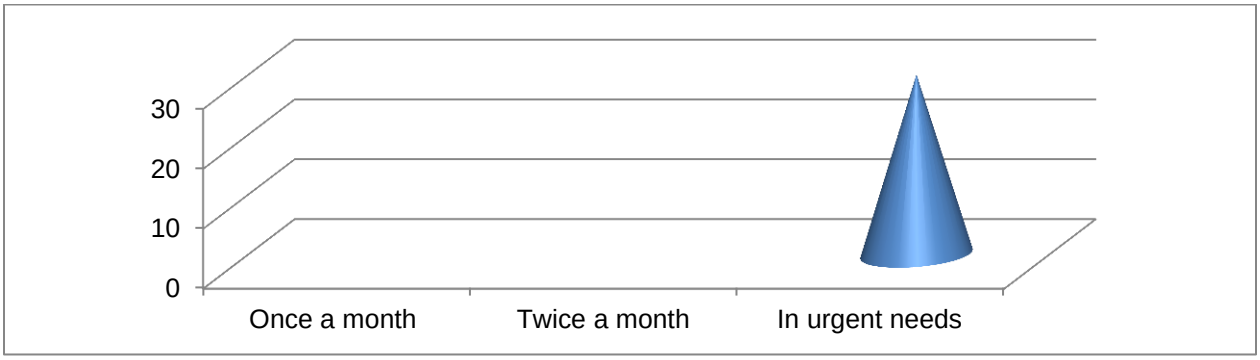


Source: Own Field Work

4.22. Frequency of farmer visit Extension Department

According to the survey the farmers visit the extension department in the district whenever they need help. The result of the survey is shown in the figure below..

Figure 30: Frequency of farmers visits Ext. Dept.



Source: Own Field Work

CHAPTER FIVE

5. DISSCUSSION

This chapter describes the way of relating literature review with result. The chapter further discussed the problems of on farm and off farm water management practices in the area.

5.1. Water shortage:

The water shortage problem is spreading in different part of the country. The water shortage is caused by change in the climatic conditions and depletion of natural resources. However, according to some scholars the existing water scarcity condition in Afghanistan is not mere the problem of water source depletion but it is also governance and management problem. The poor water management at different levels including at farm-level has also great contribution in the current water scarcity. The inequitable water distribution among users and the poor maintenance of irrigation infrastructure are two main management problems caused water scarcity. The irrigation water is managed by traditional water management system which is very less effective. The irrigation water management was also carried by traditional Mirab system. According to the survey result 94% of the respondents were facing the water shortage problem.

5.2. Off-farm water management

The irrigation water of the Salar canal is managed by the community based system known as Mirab system. A person is appointed for water distribution and O&M of irrigation infrastructure locally called as Mirab. The Mirab system is consisted of Mirab, community elders and water users. The responsibilities of the Mirab in the Mirab system are to distribute water according to the pre-determined water allocation by opening the gates, he has to let the farmers know their respective turns, play active role in solving water conflicts and maintain irrigation infrastructure. The role of the community elders is the conflict resolution and Mirab selection. The water users contribute labor whenever needed for maintenance of irrigation infrastructure.

In past the government was playing active role in the Mirab system. The local government (DAIL) was monitoring the Mirab system regularly and providing guidance for the Mirab. The government was also providing financially support for the O&M of irrigation infrastructure. Currently the government is not involved in the Mirab system and it is totally based on community rules and regulation.

The operation and maintenance in the current Mirab system is very poor. From the fields observation it was discovered that the physical condition of the canal is not good and has a lot of water losses. The farmers use local materials (mud, stones and bushes) for making turnouts and other structures. One of the main reasons of the poor maintenance is the poor resource generation in Mirab system. The farmers only contribute in the form of labor for the annual cleaning of the canal. They do not have any kind of fund for maintenance of canal.

Irrigation water is scarce and the water users try to divert the water to their fields illegally. The farmers who have the turn usually watch the canal off-takes for illegal water use. The water users open the turn-out diverting water to their fields illegally. The water user having legal turn closes the turnout back. The closing and opening of turnout sometimes continue several times.

The illegal water use sometimes causes serious conflict among the water users. Community elders try to solve these conflicts in un-biased way and usually the conflict resolution process is done in a transparent way.

The allocation of water in the study area is based on registered land. The farmers mentioned that in the past the farmers registered less land in order to avoid taxes, so now the farmers get water according to registered land not according to the land they have right now. The water distribution is based on turn system. At each turn Asadabad receives 144 hours including night time, Tisha receives 48 hours in their turn including night time, Nawabad receives 24 hours in their turn including night time, and Peer Mohammad Khan receives 36 hours while Narang village receives 108 hours in their turn.

5.3. Land Leveling:

Land leveling play important role in the proper irrigation of field and the protection of water losses. Land leveling, smoothing and shaping the field surface is very important for surface irrigation. It is done to ensure for ensuring the uniformity to water depths and discharge over field and also at the root zone. According to FAO (2002) land leveling has various advantages; it always improves the efficiency of water, labor and energy resource utilization. A leveled field is easily irrigated than the field with undulations.

According to the survey result the farmers level their field once a year. However, the farmers avoid leveling due to expensive rent of tractors. Moreover, the technical capability of operator is not so good to level the fields precisely. Some farmers use oxen for leveling of fields but the only remove the high spots in the field. Laser leveling is the most advance leveling for the surface area. According to FAO (2002) the preciseness of laser leveling is 10-50 times more than the visual judgment and hydraulic control of an operator on the tractor. It does not require much skill of operator in term of preciseness. However, laser leveling is expensive and is not affordable for small land holding farmers.

According to ICARDA (2002) generally the leveling of farmer fields is poor. The unlevel fields not only create problem for individual farmers but also affect the system as a whole, farmers used to fill the entire field in order to reach the water to high spots of the field, as a result some of the field receive more water and some of the field receive little water than its need. The above mentioned problems provide the platform of even distribution of water in the field and different infiltration rates (low and high) can occur in the same field, which produce low and high salinity within the same field. It is concluded that proper leveling of the field is required to get the desired irrigation application efficiencies.

According to Jat et al (2006) the Precision land leveling along with conservation agriculture is the best way to reduce water losses and ensure uniform distribution of water in the field. The most common used irrigation systems in intensively cultivated areas are flood basin and check basin irrigation systems. In low- lying areas the water logging problem is very common while in high area the water deficit and the main reason behind this is traditionally leveled or un leveled fields. It has been observed that performing irrigation practices on those uneven fields lead to considerable amount (10 – 25%) of water loss.

5.4. Water losses:

The water courses in the study area were poorly maintained. These water courses were not lined. There were no improved control structures in the water courses. These control structures like turnouts were made of mud, bushes and stones. Farmers spend a lot of their time for making a bund or control structures for diverting the waters. The problem of rodents is also common. The rodents make holes in the watercourses as well as fields through which a lot of water is lasted through percolation. There were a lot of vegetations along the water courses which were consuming water in the courses. All these factors contributed to great losses of water from the water courses before it reach to the farmers' fields. The un-leveled fields have high and low spots. The low spots receive more water as compared to high spots in the fields. Farmers have to irrigate more to be able to make the water reach to the high spots. Some water is also lasted in the low spots of the fields. Ahmad et al 2007, in his study in Pakistan reported 30-35% losses in unlined water courses. These main causes of losses in the lined watercourses were improper shape or cross section, weeds, debris, sediments and rodent holes. The lined canal had comparatively little losses. The losses were caused by cracks in concrete walls and damage of brick lining.

The total losses in canal irrigation in Punjab and Haryana was 62% which includes main and branch canal 17%, Distributaries 8%, water courses 20% and Field seepage 17%. (Dhawan, 1993 cited by Thakkar, 1999)

5.5. Irrigation Scheduling:

Irrigation scheduling is the decision of when and how much water to apply to a field. The main purpose of irrigation scheduling is to maximize irrigation efficiencies by applying the exact amount of water needed maintain the soil moisture content to the desired level. According to Broner 2005, there are various advantages of irrigation scheduling; it enables farmers to schedule water rotation among different fields, reduce cost of water and labor through fewer irrigation by maximum use of soil moisture, reduce fertilizers loss by runoff and deep percolation, increase net returns by increasing crop yield and crop quality, reduce water logging and reduce root zone salinity problems. According to result of the survey no farmers know about irrigation scheduling. They use their own local knowledge and indicators for determining time of irrigation. The water distribution amongst the farmers was base on old traditional system.

5.6. Crop water requirements:

The farmers of Afghanistan do not have technical knowledge for the determination of crop water requirements. They use their own traditional knowledge which is inherited from their ancestors. The extension departments are not active and capable enough to provide extension services to the farmers and the farmers only rely on their own knowledge. ICARDA 2002 has also pointed to this issue in its report on need assessment of water and soil of Afghanistan.

5.7. Determination of irrigation time:

Farmers usually use their own traditional knowledge and experience for the determination of irrigation time. The farmers have their own indicators for the determination of irrigation time. They usually look to the dryness of the soil and wilting of the plants. According to the ICARDA

2002, in its report on the need assessment of water and soil of Afghanistan the farmers do not plan their irrigation and their decision for irrigation depends upon visual plant stress and the instant of water availability in canal. They also look to the time period between two irrigations. They do not have any adequate method of deciding the irrigation time. They learned from their parents the traditional ways of deciding irrigation time.

5.8. Night and Day Irrigation:

The farmers of Afghanistan used to irrigate their farms day and night. The recent in-security situation stopped the farmers from night irrigation in the most part of the country especially in the insecure parts. Farmers of Kunar province face the same problem. They used to irrigate at night but the patrol of NATO and US forces have posed threat to them. This has adversely affected the farmers. The water in the canal at night time is wasted.

5.9. Depth of Irrigation Water:

The irrigation water is applied to the field to make water available at the root zone. Both over and under irrigation is not good. Over irrigation not only waste the water and labor but it also leaches important nutrients below the root zone and make it unavailable for plants. It also reduces soil aeration and thus reduces crop yields. Mean while under irrigation causes plant stresses and reduce crop yields. Unfortunately, the farmers of the study area do not have knowledge about the importance of the depth of irrigation. They sometime over irrigate their fields and sometimes under-irrigate depending upon the availability of the water in the canal which ultimately have adverse effects on crop yields and waste water.

According to ICARDA (2002) farmers' don't have sufficient knowledge about the exact amount of water to be applied while irrigating the fields. They use their own knowledge and some common perceptions. Most of the farmers let the water from one end and wait till basin filled completely and over flow into the next field. Some common perceptions of farmers' about the amount of water used in irrigation turn are "when water reaches the far end of the field, when water covers all the high spots of the field and when a certain depth of water is applied to the field". The farmers' idea and knowledge about good irrigation is that when irrigation is completed there still certain amount of water present in the basin. The farmers don't pay attention to the infiltration rate, soil moisture, condition of soil and slope of the field, in such cases the applied amount of water is more than double of what the actual required amount of water for a particular crop. It has been observed that the farmers having access to ground water want to apply more as compared to those who are completely depends on canal water.

5.10. Methods of irrigation and its efficiency:

There are three main types of irrigation methods, i.e. surface, sprinkler and drip irrigation. There are various factors which determine the choice and suitability of irrigation methods. These factors include natural conditions, type of crop, labor, costs and benefit ratio.

In Afghanistan the most frequently used method of irrigation is the surface method. The natural conditions (slope) and cheap labor, low technology contributes in the selection of surface irrigation methods. The surface irrigation method is further divided into basin, border and furrow irrigation. According to the result of the survey 57% of farmers used the basin irrigation, 33% border and 10 % used furrow irrigation methods.

According to FAO “most water can be applied per irrigation application when using basin irrigation, less with border irrigation and least with furrow irrigation. In practice, in small-scale irrigation projects, usually 40-70 mm of water is applied in basin irrigation, 30-60 mm in border irrigation and 20-50 mm in furrow irrigation”.

A comparison of sprinkler and surface irrigation was made and it was found that sprinkler irrigation has the capability of saving 30% more water as compared to surface irrigation. He also mentioned that the crop yields per unit of water used were also high. In sprinkler irrigation the production of crop per unit of water used was 4.13 kg/m3 as compared to 2.88 kg/m3 of surface irrigation. In sprinkler irrigation the electrical conductivity of soil and sodium adsorption ratio (SAR) were remained same while in surface irrigation it was increased 30 to 45 cm depth at post harvesting. The nitrogen contents were more in sprinkler irrigation as compared to surface irrigation. (Haq, 1990 cited by Rana, 2006)

Table 4: Application Efficiencies of Different Irrigation Systems

System Type	Application Efficiency Range* (%)
Surface Irrigation	
Basin	60 - 95
Border	60 - 90
Furrow	50 - 90
Surge	60 - 90
Sprinkler Irrigation	
Handmove	65 - 80
Traveling Gun	60 - 70
Center Pivot & Linear	70 - 95
Solid Set	70 - 85
Microirrigation	
Point source emitters	75 - 95
Line source emitter	70 - 95

Source: Rogers, 1997

CHAPTER SIX

6. CONCLUSIONS AND RECOMMENDATIONS

In this chapter an effort was made to conclude the overall finding of the research. The chapter also indicates some possible recommendations to over the problems

6.1 Conclusions:

Asadabad is the central district of Kunar province. Agriculture is the main stay of the people. The average farm size in Asadabad districts is 4.43 Jerib which indicates the majority of the farmers are small scale farmers.

It can be concluded that the current on-farm water management practices of the farmers in the Tisha and Nawabad villages of Asadabad district of Kunar province are very poor. The farmers were not good at leveling because of poor skills of operators and rocky land surfaces. They also avoided proper leveling due to high cost of machinery. The determination of irrigation time was based on their own local indicators which was not précised and accurate. The depth of irrigation was not according to the requirements of the crops. The farmers have learned from their ancestors the on-farm water management practices and this process continued from centuries.

The physical structure of the watercourses was not maintained properly. These watercourse were un-lined with were poor control structures. There were un-wanted vegetations along the watercourses which consumed a lot of water. The poor physical structure had significant contribution in the water losses.

The canal is not built in technical. There are no proper control structures and the farmers use local available materials to control water. The intake of the canal along with some retaining wall was built by USAID but the canal needs further retaining wall to control and prevent the canal from the damage of flood.

The allocation of water is based on registered land with the government. The water distribution is based on turn system in which each village receives water in terms of hours including night time.

The water management and O&M of infrastructure is carried out by community based, traditional management system known as Mirab system. The Mirab (water master) is responsible to manage water distribution in the area. He is also responsible to gather the people (Hashar) for the maintenance of the canal. The Mirab is also responsible to take active part in the resolving water conflicts and dispute amongst certain farmers of the village and also to resolve water conflicts with other villages Mirabs.

The main methods of irrigation used in Asadabad district are Border, Basin and Furrow irrigation. The water allocation is based on day night turn and the people get the water on the 16^{th} of each month in cropping season. Mirab is the only way to organize and responsible to manage the water in the districts. The cleaning of canal takes place at the beginning of the irrigation season.

The most important water issues in the areas are water theft, unequal distribution, no proper control structures and leaky out fields.

Among the improved on-farm water management practices, the laser leveling, lining of canals and installation of better control structure, irrigation scheduling, crop water requirements are the most important practice needs to be introduced in the area. The water distribution system also needs promotion to a well organized management system having legal status, better in equity and better resource generation. Due to high cost of modern machinery it is better for the farmers to share rent or purchases of such machinery; this will not only reduce the cost but will help the farmers to adopt new technology and improved water management practices.

The existing government extension services especially those related to water management in the study area were not satisfactory. There was no link and coordination between farmers and DAIL department of irrigation. More attention is needed to the provision of extension services for the farmers.

6.2 Recommendations:

Land leveling is one of the important issues which must be considered. The current land leveling done by farmers is not satisfactory. Farmers should be provided with credits to enable them buy the modern laser land leveling instruments. There are various NGOs and Banks engaged in credits services. The department of agriculture and other active NGOs should link farmers with these credit institutions.

The current traditional water management system is not effective in equitable water distribution and proper O&M of irrigation infrastructure. The DAIL irrigation department should organize the farmers in associations which are better in equity and O&M of irrigation infrastructure.

The current physical condition of the water courses is not good. These water courses are not lined and have poor control structures. Therefore, there are a lot of water losses in the watercourses before the water reaches the farmers' fields. MAIL and MRRD could coordinate to put resources together to help the farmers to line their water courses or even canals. There must be contribution from the community as well. The farmers should contribute 50% by raising a common fund for canal or watercourse lining.

Efforts should be made to develop strong link and coordination between the department DAIL and farmers' community. There should be regular meetings, seminars and workshops on various topics and issues. In this way, the DAIL and farmer community could be brought closer to each other.

The agronomic practices of the farmers are very poor especially those practices pertaining to water management. The DAIL especially its irrigation department should provide farmers regular trainings on various topics of on-farm water management. These trainings might be on irrigation scheduling, crop water requirements, proper time of irrigation and depth of irrigation required.

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ANNEXES

Annex 1: On Farm Water Management Practices Questionnaire

An Overview of On Farm Water Management Practices Questionnaire

General Information:

Interview date _____ Interviewers _____ Signature _____

Name of interviewee _____ Village_____ District _____

Province _____ Contact Number _____

Education level:

a) Up to grade 6 b) Up to grade 9 c) Up to grade 12 d) University e) Illiterate

Land Tenure ship:

a) Owned b) Rented c) share cum tenant

Land holding (Jeribs):

Total land _____ Land owned_____ Land rented_____

1. What are the sources of irrigation?

a) Canal b) Karez c) Spring d) Others

2. What irrigation method do you use?

a) Furrow irrigation b) Border irrigation c) Basin irrigation d) Others

3. How often do you have access to the water in a month?

a) Once b) Twice c) Thrice d) More than thrice

4. Do you face water shortage?

a) Yes b) No

5. If yes how often

a) Usually b) Sometimes c) Seldom d) Occasionally

6. How many hours do you use in your turn watering the field?

a) 1 – 2 hours b) 3 – 4 hours c) 5 – 6 hours d) More

7. Do you irrigate at night?

a) Yes b) No

8. If no what is the reason?

_____

_____

9. If yes which months?

_____

10. Who are responsible to manage water in the area?

a) Mirab b) Elders c) Govt

11. What are the most important water issues?

_____

_____

_____

12. What is the role of Mirab in water management?

_____

_____

13. Are you satisfied with Mirab system?

a) Yes b) No

14. If no how it can be improved?

_____

_____

15. How often do you have dispute over water with other farmers?

a) Often b) Sometimes c) Never d) Others

16. How are the disputes resolved?

_____

_____

17. What kind of tools you are using for land leveling?

a) Hand tools _____

b) Operated machinery_____

18. How would you rate your land leveling?

a) Good b) Fair c) Poor

19. What kind of problems do you face during irrigation?

_____

_____

_____

20. Do you clean your water course?

a) Yes b) No

21. If yes how often?

a) Weekly b) Monthly c) Seasonally d) Yearly e) Other

22. How many days you spent on cleaning water course during one cropping seasons?

_____

23. Do you take part in canal cleaning?

a) Yes b) No

24. If yes how often?

a) Once a year b) Twice a year c) Thrice a year d) More than thrice

25. How many days you spent on cleaning canal during one cropping seasons?

_____

26. What are the most important constraints in crop production?

_____

_____

a) Weeds b) Pest and diseases c) irrigation water d) Others

27. Who is providing the extension services in the district?

a) Ext. dept b) NGOs c) Others

28. What kind of advice they provide?

_____

_____

29. How often the extension agents visit you?

a) Once a month b) Twice a month c) Never d) Occasionally

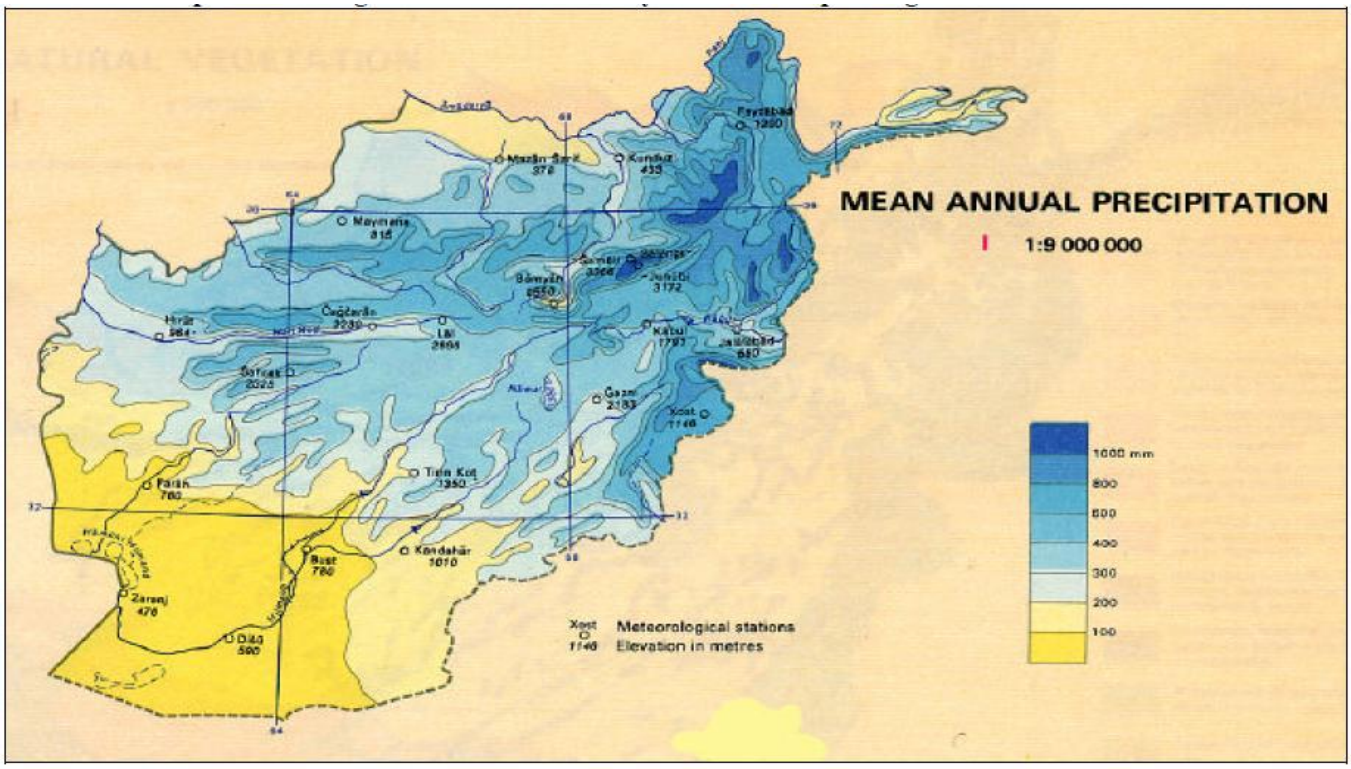
30. How often you visit the extension dept?

a) Once a month b) Twice a month c) Never d) Urgent needs

Annex 2: Plan of Approach

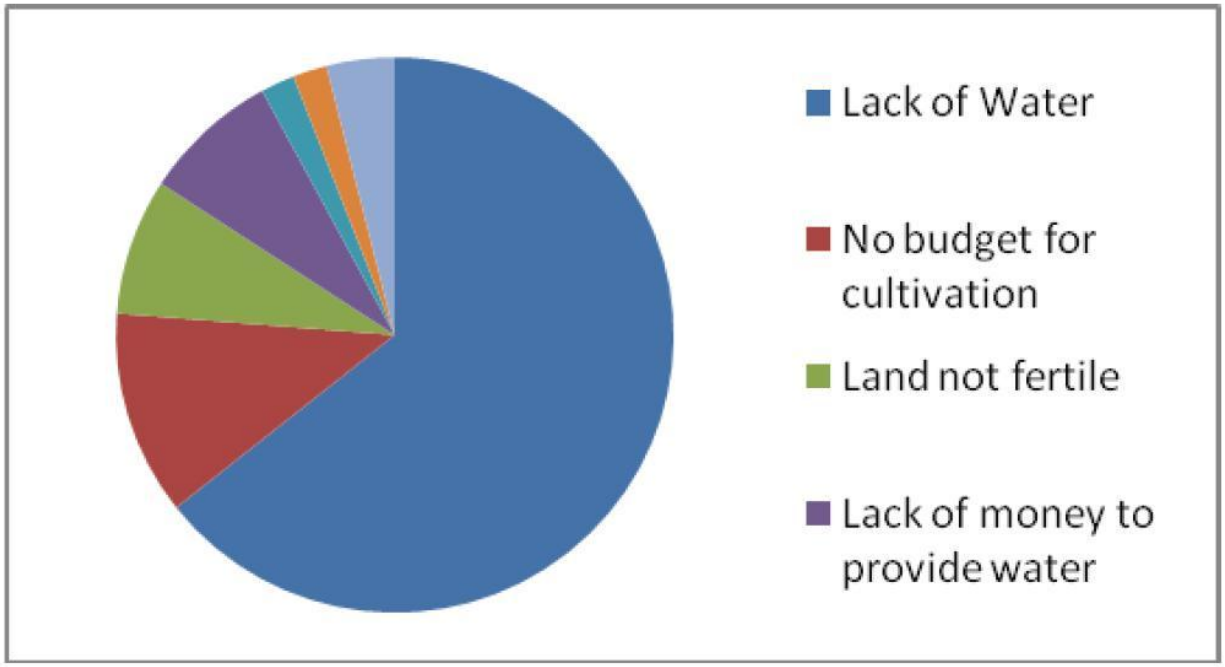
S.N	Activities	Months															
		June, 11				July, 11				August,11				September, 11			
1	Preparation of research proposal																
2	Literature review																
3	Field work/ Data collection																
4	Data analysis																
5	Report writing																
6	Submission of draft report																
7	Working on report																
8	Submission of final report																
9	Thesis defense																

Annex 3: Annual Precipitation in Afghanistan



Source: Favre, 2004

Annex 4: Main Reason Farmers Leave Land



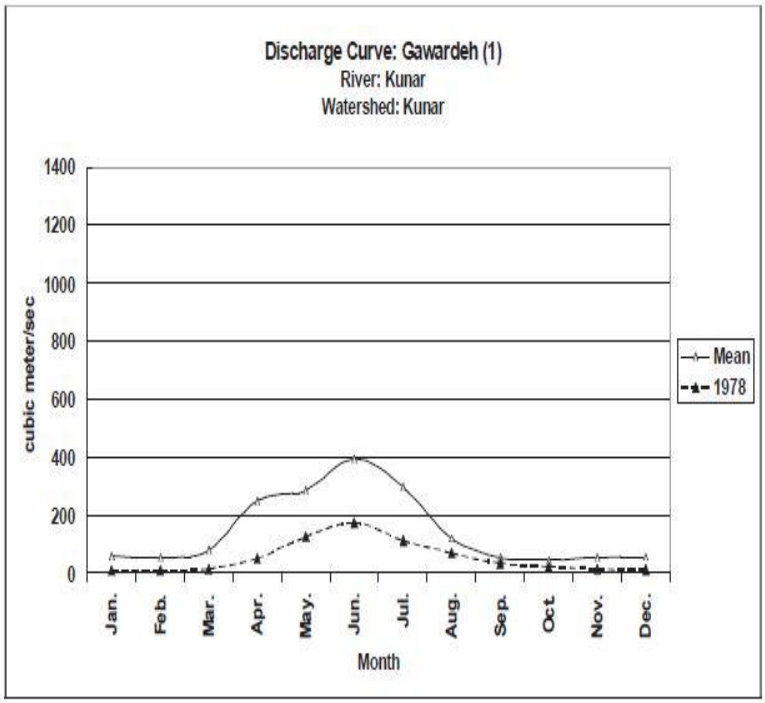
Source: Barakat, 2011

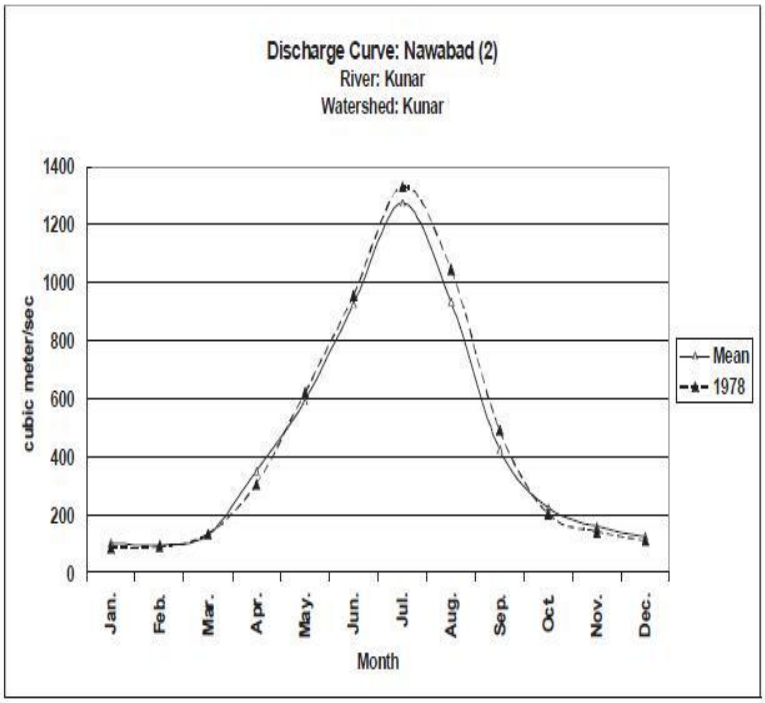
Annex 5: Land Classification of Kunar river

LANDCOVER	Area (ha)	Area (sq. km.)	% Watershed
Degenerate Forest/High Shrubs	16183	161.8	1.39
Irrigated: Intensively Cultivated (1 Crop/Year)	11863	118.6	1.02
Irrigated: Intensively Cultivated (2 Crops/year)	5897	59.0	0.51
Irrigated: Intermittently Cultivated	19708	197.1	1.69
Marshland Permanently inundated	4829	48.3	0.41
Natural Forest (closed cover)	443677	4436.8	38.04
Natural Forest (open cover)	48246	482.5	4.14
Permanent Snow	209615	2096.1	17.97
Rainfed Crops (sloping areas)	5902	59.0	0.51
Rangeland (grassland/forbs/low shrubs)	277520	2775.2	23.79
Rock Outcrop / Bare Soil	122800	1228.0	10.53
Water Bodies	122	1.2	0.01
	1166362	**11663.6**	**100.00**

Source: Favre, 2004

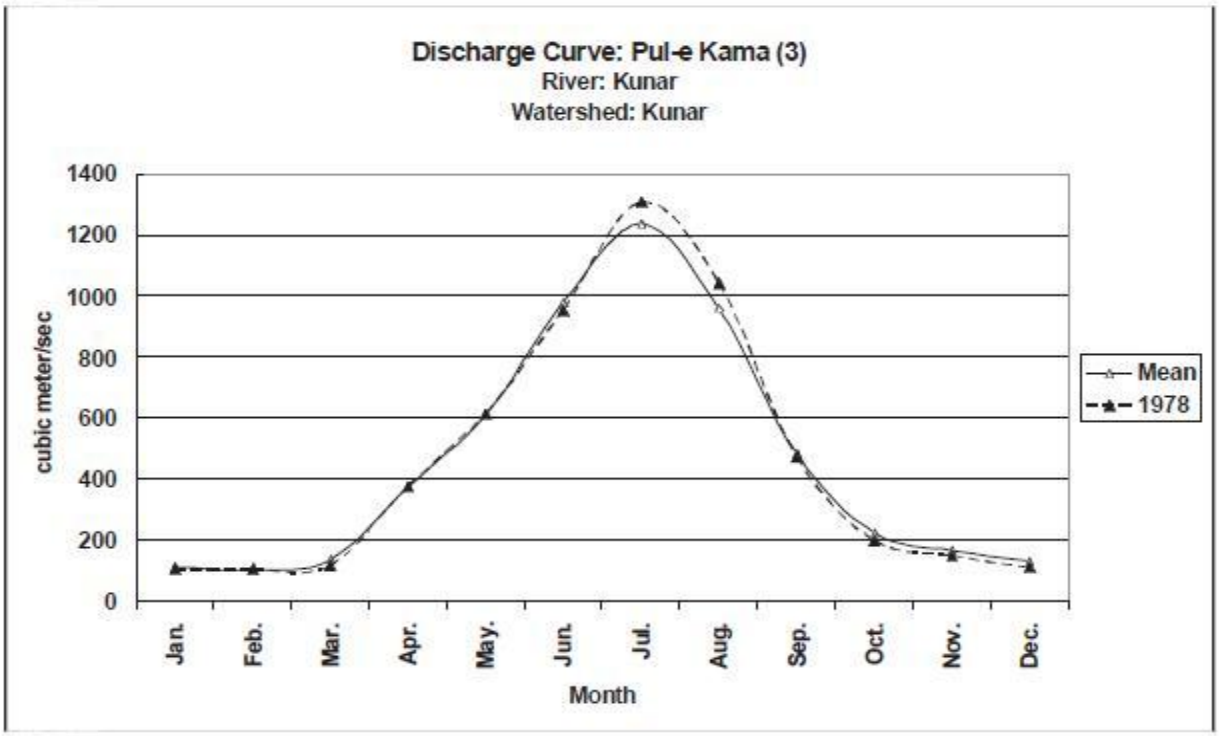
Annex 6: Discharge of Kunar River at in Nawabad and Gawardeh





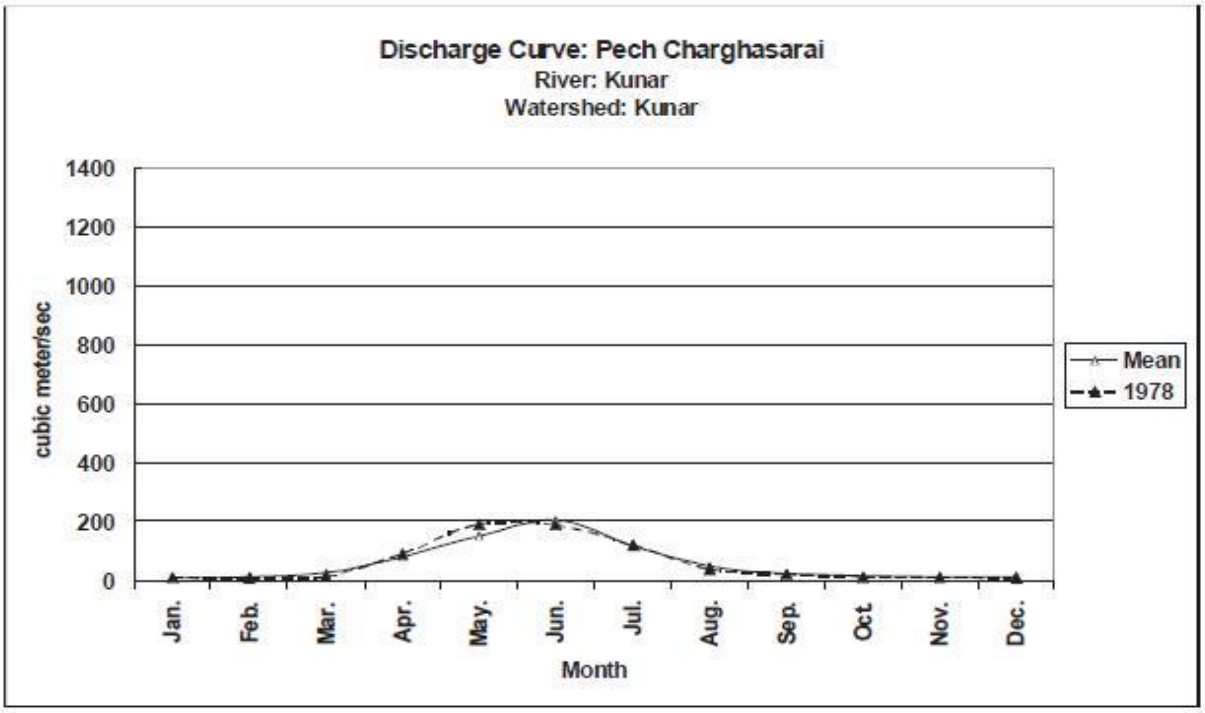
Source: Favre, 2004

Annex 7: Discharge of Kunar River in Kama District



Source: Favre, 2004

Annex 8: Discharge of Kunar River in Asadabad District



Source: Favre, 2004

Annex 9: Condition of the canal and control Structures

Annex 10: Frequency table of Education level

Education Level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Upton grade 6	6	20.0	20.0	20.0
	Upton grade 9	3	10.0	10.0	30.0
	Upton grade 12	7	23.3	23.3	53.3
	Illiterate	14	46.7	46.7	100.0
	Total	30	100.0	100.0	

Annex 11: Land holding size

Landholding

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	2	6.7	6.7	6.7
	3	7	23.3	23.3	30.0

	4	6	20.0	20.0	50.0
	5	7	23.3	23.3	73.3
	6	7	23.3	23.3	96.7
	7	1	3.3	3.3	100.0
	Total	30	100.0	100.0	

Annex 12: Frequency of water shortage

Frequency of water shortage

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Usually	15	50.0	50.0	50.0
	Sometimes	11	36.7	36.7	86.7
	Seldom	2	6.7	6.7	93.3
	Occasionally	2	6.7	6.7	100.0
	Total	30	100.0	100.0	

Annex 13: Access to water in a month

Access to water in a Month

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Once	4	13.3	13.3	13.3
	Twice	23	76.7	76.7	90.0
	Thrice	1	3.3	3.3	93.3
	More	2	6.7	6.7	100.0
	Total	30	100.0	100.0	

Annex 14: Hours used per turn

Hours Used Per Turn

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-2 hours	16	53.3	53.3	53.3
	3-4 hours	14	46.7	46.7	100.0
	Total	30	100.0	100.0	

Annex 15: Night Irrigation

Night Irrigation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	10	33.3	33.3	33.3
	No	20	66.7	66.7	100.0
	Total	30	100.0	100.0	

Annex 16: Dispute over water

Dispute over Water

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Often	5	16.7	16.7	16.7
	Sometimes	25	83.3	83.3	100.0
	Total	30	100.0	100.0	

Annex 17: Frequency of water course cleaning

Frequency of Watercourse Cleaning

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Monthly	1	3.3	3.3	3.3
	Seasonally	21	70.0	70.0	73.3
	Yearly	8	26.7	26.7	100.0
	Total	30	100.0	100.0	

Annex 18: Days spent on water course cleaning

Days Spent on Watercourse Cleaning

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	12	40.0	40.0	40.0
	2	17	56.7	56.7	96.7
	3	1	3.3	3.3	100.0
	Total	30	100.0	100.0	

Annex 19: Days spent on canal cleaning

Days Spent on Canal Cleaning

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	1	3.3	3.3	3.3
	6	4	13.3	13.3	16.7
	7	6	20.0	20.0	36.7
	8	12	40.0	40.0	76.7
	9	2	6.7	6.7	83.3
	10	4	13.3	13.3	96.7
	13	1	3.3	3.3	100.0
	Total	30	100.0	100.0	

Annex 20: Frequency of canal cleaning

Frequency of Canal Cleaning

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Once	17	56.7	56.7	56.7
	Twice	12	40.0	40.0	96.7
	Thrice	1	3.3	3.3	100.0
	Total	30	100.0	100.0	

Annex 21: Irrigation method

Irrigation Method

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Furrow	3	10.0	10.0	10.0
	Border	17	56.7	56.7	66.7
	Basin	10	33.3	33.3	100.0
	Total	30	100.0	100.0	

Annex 22: Condition of land leveling

Condition of Land Leveling

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Good	4	13.3	13.3	13.3
	Fair	8	26.7	26.7	40.0
	Poor	18	60.0	60.0	100.0
	Total	30	100.0	100.0	

Annex 23: Dispute over water

Dispute over Water

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Often	5	16.7	16.7	16.7
	Sometimes	25	83.3	83.3	100.0
	Total	30	100.0	100.0	

Annex 24: Extension Service Providers

Extension services

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Both	30	100.0	100.0	100.0

Annex 25: Frequency of Extension agent visit farmers

Frequency of extension agent

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Occasionally	30	100.0	100.0	100.0

Annex 26: Frequency of farmers visits extension department

Frequency of farmers visit extension

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Urgent needs	30	100.0	100.0	100.0