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Water scarcity and its impact on agriculture

– Case study of Layyah, Pakistan

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Abstract

The issue of water scarcity and socio-economic impact of water shortage on small scale farmers is a reality in many developing countries including Pakistan. With its high population density, mostly in the rural areas, a majority of the households engage in activities that are geared towards survival for their livelihood activities. Small farmers are poor and can't afford more advanced agriculture tools to extract water and to conserve water. The tribulations for small farmers are poverty and illiteracy.

The study was conducted in Layyah, a southern district of Pakistan to explore small farmer's perspective on water scarcity. The main objective of this research is to evaluate impact of water shortage on small land holders and their strategies to cope with it. For this purpose, a detailed data set was acquired by making field trips to small villages and arranging extensive interviews with the farmers. A standard questionnaire was prepared to maintain consistency and coherence in the analysis. The study also contains some interviews with active stake holders/authorities involved in this dilemma such as government officials and NGOs. This study is based on in-depth qualitative analysis of 13 households to trace out the socio economic impacts of water scarcity**.** To understand the agriculture practices and water availability for local farmers, the study themes are Ground water; Rain water and Canal water cultivation. In the last section, a number of conclusions and recommendations are presented based on the analysis of collected data.

Key words: Water Scarcity, Small Scale Farmer, Livelihood, Layyah, Pakistan, Ground Water, Rain Water, Canal Water

Abbreviations and Glossary

Abiana	**Water tax**
Ahl e sadaat	**A social term for an Ethnic Community**
Baildar	**Revenue official who keeps record of the crops and warabandi schedules, etc**
Barani	**The land which is totally based on rain for crop cultivation**
Descon	**An integrated engineering and manufacturing company working in Pakistan and Middle East**
District	**Districts are the third order of administrative distributions below provinces and divisions**
NGO	**Non Governmental Organization**
Tehsil	**Administrative distribution of the district which consists of further towns and a number of villages**
Union Council	**Smallest unit of administration**
UNCCD	**United Nations Convention to Combat Desertification**
WAPDA	**Water and Power Development Authority**
Warabandi	**A rotational method for distribution of irrigation water, with fixed time allocation based on the size of landholdings of Individual water users within a watercourse command area.**

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Chapter 1: Introduction

Agriculture is accountable for the largest extraction of water and thus considered the chief 'culprit' under conditions of local absolute scarceness (COAG, 2007:7). Water is vital for all socio-economic development and for maintaining healthy ecosystems. As population increases the utilization of groundwater and surface water for the domestic, industrial sectors and agriculture exaggerate, leading to tensions, conflicts between users, and extreme pressure on the environment (UN-WATER, 2006:2).

Food policy must not lose sight of surging water scarcity. Water is a key element of agricultural production. Water scarcity can cut production and badly impact food security worldwide. The brutality of the water crisis has prompted the United Nations (UNDP, 2007), to conclude that it is water scarcity, not to be deficient in arable land that will be the most important limitation to increased food production over the next few decades. For example, Australia is one of the major food producing and land copious countries, but recent drought minimized its food and agricultural production substantially (Goesch et al., 2007 cited in Hanjra, and Qureshi, 2010:366). Irrigation has helped enhance agricultural yields and outputs in arid and semi-arid environments and stabilized food production and cost (Hanjra et al., 2009a, 2009b; Rosegrant and Cline, 2003; Sampath, 1992; Hanjra and Qureshi, 2010:365). Globally, increased agricultural production is required for dropping rural poverty and more economic growth (Hanjra and Gichuki, 2008:185). New investments in irrigation infrastructure and enhanced water management can reduce the impact of water scarcity (Falkenmark and Molden, 2008 cited in Hanjra and Qureshi, 2010:365).

The majority of developing countries have a shortage of renewable fresh water resources. Kamal (2009:28), estimates that Pakistan has a population of 165 million, out of which at least 41 million (25 percent) are under the poverty line; 98 million rely on agriculture; 50 million do not have access to safe drinking water; and 74 million have sanitation problem. Kugelman (2009:5), admits that Pakistan's water situation is enormously precarious. Water availability has declined from about 5,000 cubic meters (m3) per capita in the 1950s to less than 1,500 m3 per capita at present, thus a drop of more than 70%. However, Kamal (2009:28), quotes a United Nations Development Programme source which mentions Pakistan's current water availability as 1,090 m3 per capita per year. According to 2008 data from the Food and Agriculture Organization, Pakistan's entire water availability per capita status is the lowest in a list of 26 Asian countries and the United States. Pakistan is estimated to become water scarce (the description of a country with annual water availability below 1,000 m3 per capita) by 2035. Meanwhile some experts project this may happen as soon as 2020, if not before.

Khan (2009:82), shows that Pakistan went from being relatively water abundant in 1981 to water-stressed by about 2000, and will be expected water scarce by 2035. Certainly, in one important sense, the tale of Pakistani agriculture is a tale of decreasing farm-gate water

availability throughout its history (Bandaragoda 1996). Figure 1 below shows the fast declining water availability in Pakistan.

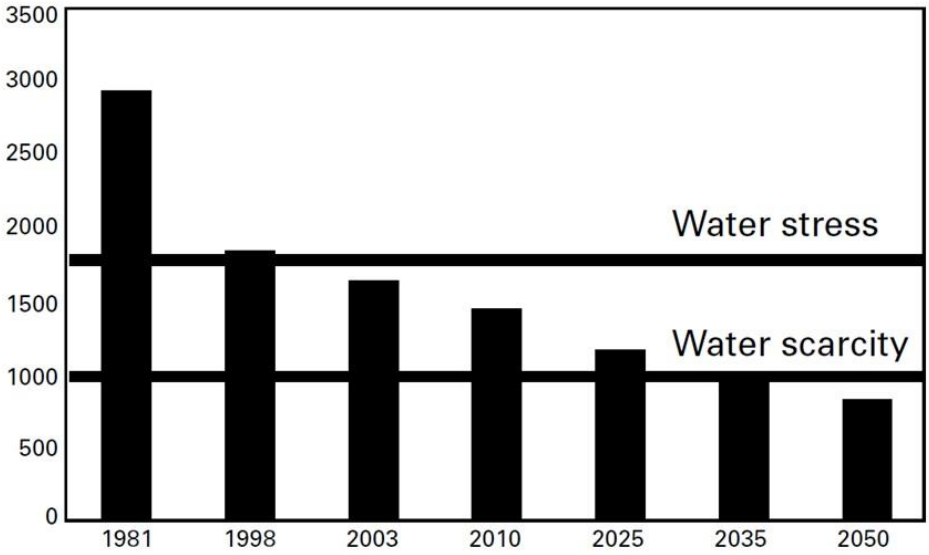


Figure 1: Declining Per Capita Water Availability in Pakistan (meters3/capita/year) (Source: World Bank 2005).

According to Bhatti et al. (2009:1), the quantity of water supply is not matched with the time pattern of crop needs. The imbalance in water supply and demand varies greatly both regionally and seasonally. In Pakistan, the demand for fresh water resources is extremely important due to the agrarian nature of its economy. Agriculture is the strength of Pakistan's economy. The share of agriculture sector in the Gross Domestic Product (GDP) of Pakistan is about 24% and about 60% of the population relies on agriculture and allied industries for their bread and butter (Bhatti et al., 2009:1). All together water is the most important input in agriculture; the agricultural productivity and its sustainability depend on the timely and sufficient availability of water.

In Pakistan, the space between water demand and supply has increased manifolds, due to more agriculture activities and reduced river flow. The gap normally widens in the summer growing season as compared to winter growing season and it widens also towards the tail end of distributaries and watercourses (Bhatti et al., 2009:2). One of the most persistent problems of the irrigation systems in Pakistan's Punjab happens at farm level. Farmers cannot be sure there will be water in the watercourse as their turn comes (Kijne, 2001:113). During 1960s, groundwater development in Pakistan has been exponential, particularly in Punjab. This is more about the introduction of private tube wells of which, the latest estimates, there are about 500,000 in all of Pakistan. A national survey held in 1991 showed that at that time about 46,000 million cubic meter of groundwater was used in the Indus Basin for irrigation, 85% of which got from private tube wells (NESPAK/SGI, 1991 cited in Kijne, 2001:113). If right, the amount taken from groundwater would go beyond more than 50% the annual usable

groundwater recharge, previously given as 29,000 million cubic meter (Kijne, 2001:ibid). Evidently the current situation of excessive water pumping is non-sustainable.
The Pakistani problems with water should be viewed in relation to water scarcity and the problem of agriculture and water globally. A major study, the Comprehensive Assessment of Water Management in Agriculture, make public that one in three people today face water shortages (CA, 2007). Approximately 1.2 billion inhabitants, or almost one-fifth of the world's population, exist in areas of physical scarcity, while 500 million people are approaching this state. Another 1.6 billion people, or almost one quarter of the world's population, face economic water shortage (where countries lack the essential infrastructure to take water from rivers and aquifers UN-WATER, 2007:4).

In history, large-scale water development projects have played a major role in poverty alleviation by providing food security, security from flooding and drought, and expanded prospects for employment. In different cases, irrigated agriculture has played a main role in the development of rural economies, poverty reduction and maintaining economic growth. However, at the same time, poor societies have tended to suffer the greatest health burden from insufficient water supplies and, as a result of poor health, have been incapable to escape from the cycle of poverty and disease. Therefore, growing scarcity and struggle for water stand as major threats to future advances in poverty alleviation, particularly in rural areas. In semi-arid areas, rising numbers of the rural poor are coming to see entitlement and access to water for food production, domestic and livestock purposes as more critical than access to basic health care and education (UN-WATER, 2007:6).

The water scarcity scenario according to FAO (Food and Agriculture Organization) in 2007 argues that most countries in the Near East and North Africa experience acute water scarcity. Others such as Pakistan, Mexico, South Africa, and huge parts of China and India also experience chronic water problems. Irrigated agriculture requires larger demand for water in these countries. To mitigate the water problems, these countries have to focus on the efficient use of all water sources (surface water, groundwater and rainfall) and on water allocation plans that maximize the economic and social returns to limited water resources and at the same time increase the water productivity of all sectors. During this endeavor, there needs to be a particular focus on issues relating to equity in access to water and on the social impacts of water allocation policies (UN-WATER, 2007:6).

"Agriculture water use varies between the countries. The countries that import food and have a developed and diverse economy the use of agriculture water is about 40 percent; meanwhile it rises to over 95 percent in several of the countries where agriculture is the major economic activity. In the previous century, the global population has tripled. It is expected to increase from the existing 6.5 billion to 8.9 billion by 2050. Globally the use of water has been increasing at more than twice the rate of population in the last century. In 2025, 1.8 billion inhabitants will be living in countries or regions with supreme water insufficiency, while two-thirds of the world population could be in situation of water stress" (UN-WATER, 2007:10).

1.1 Problem Statement

This study has been conducted in Layyah district, southern part of Punjab, Pakistan where the importance of water for agriculture use is very high. The major source of income for rural household is agriculture because the district does not have any minerals or other natural resources.

According to Punjab Development statistics (2012:284), the total population of Pakistan is 174.4 million persons in which the population of Punjab province is 96 million. The demand of irrigation water is increasing tremendously due to increase in population pressure. As the population pressure is increasing the demand of agriculture product will be more, so there is a need to manage and efficient utilization of irrigation water.

The setback in this area is the uneven distribution and low water use efficiency. About 59% of irrigation water supplied is misplaced from diversion headwork before reaching the fields (Abbas, 2004). The main reasons for less efficiency are the poor infrastructure and lack of funds. Irrigation sector of Pakistan is in front of certain troubles like financial burdens, technical incompatibility. The problem is the collection of *abiana* (the local term for water fee collected by government from farmers) which usually some powerful farmers don't pay. Water theft and imbalance use of water is also quite common in the province (Abbas, 2004).

1.2 Aim of the research

The main objective of this thesis is to study peasant's livelihood course in the context of water shortage in three selected villages in Layyah a district of Pakistan. Water scarcity is a big problem for farmers, especially smallholder farmers who lack the adequate resources to adapt themselves to the current reality of water scarcity. The small farmers are vulnerable and that therefore they need someone to voice their problems and struggles and for that I have selected three villages with different farming practices, my aim is to examine how these different farming approaches are connected to the farmers' socio economic activities more precisely and also describe and analyze the help they are receiving from the authorities.

This will be achieved by investigating the following aspects:

- To study how water shortage affects the livelihood of the smallholder farmers.
- To analyze and evaluate the small land holder's strategies to cope with water shortage.

1.3 Research Questions

The following questions will be investigated to convey the above mentioned objectives:

- What are the problems of local farmers related to irrigation water availability?
- What socio-economic impacts does the water shortage have on local farmers?

- How do the authorities act to help the farmers with water shortage?

1.4 Research outline

This research consists of seven chapters. The sixth chapter presents the empirical data based on small farmers in Layyah. This chapter also has three case studies based on different water use; ground water cultivation, rain water cultivation and canal water cultivation. Meanwhile the second chapter develops main theoretical issues, focusing on agriculture and water scarcity globally. I will also discuss terms such as water scarcity, small landholder, land tenure and livelihood. The third chapter presents the water scarcity in Pakistan more specifically describing tube well water, water course cleaning and water course lining. Whereas the fourth chapter presents methodology, the fifth chapter describes the water management in the District and explains the governmental and NGOs participation to overcome the water scarcity. The thesis ends with a conclusion.

Chapter 2: Analytical Perspectives and Concepts

This chapter is divided into three sections. The first section presents the theoretical approaches to water scarcity. The second section will discuss what water scarcity is (the term). The third section presents key concepts like small land holder, land tenure and livelihood. The selection of a more precise definition of these terms is to give the reader an idea of who is small land holder, how the land tenure system works in Punjab and how the livelihood concept is connected with water scarcity.

Theoretical approaches to water scarcity

Solutions to the challenge of water availability can be explored at three levels. It can be tackled by increasing the upstream storage capacity; by improving the efficiency of the transportation and distribution infrastructure; and by better allocating water to end users (Couton, 2009:120). To introduce other irrigation technologies, such as drip irrigation and precision leveling would also help to produce more crops per unit of water (Kijne, 2001:116).

Couton (2009:121), describes drip irrigation consists of running water through pipes to supply small amounts of water continuously at the base of plants (surface drip) or directly at the roots (sub-surface drip) through emitters attached to lateral lines. It generates massive increases in the efficiency of water use, especially for those cultivating crops in semi-arid regions (the increase in yield as compared to conventional irrigation methods is from 20 to 100 percent, while savings in water range from 40 to 70 percent). In August 2007, the government of Pakistan launched a $1.3 billion subsidized drip irrigation program. It sought help from the Japanese government to double the efficiency in irrigation water use from the present 45 percent to 90 percent, with the help of drip irrigation. Pakistan's federal minister for food and agriculture set a target of 300,000 acres of land to be brought under drip and sprinkler irrigation in the first year, with federal and provincial governments to provide an 80 percent subsidy on drip irrigation equipment (Couton, 2009:122).

Kijne (2001:116), suggests that the cropping pattern is also important for instance with less rice and sugarcane, as these crops is especially water demanding. Bhatti and Suttinon, et al (2009:3), argue for water demand management which stresses making better use of existing supplies, instead of developing new ones. In evaluating the impact of the Pakistani government's various water policy reforms, Khan (2009:98), concludes "the government habit of creating more institutions to cover the inefficiency of parent institutions has damaged the farming sector". An important concern in water resources assessment is variability. Water availability should meet water demand not only in average years, but also in dry years (Bhatti, 2009; Suttinon et al., 2009:3). Since the devastating flood in 2010 there is no serious effort to increase the system's ability to cope with the fluctuations in annual and seasonal flows in the Indus River System. Pakistan's current water storage capacity is around 12% of annual availability. No major dam has been constructed since the completion of Tarbela Dam in 1974. Construction of new dams and reservoirs has been hindered by inter-provincial disputes. As Pakistan board of investment (Pakboi, 2006:13), observed more waters is

expected in the rivers because of greater melting of glaciers in the period of next 25 – 30 years.

In 2006, the Government of Punjab launched a new program to maintain a computerized database for irrigation releases to improve irrigation management, reduce rent seeking, increase transparency and demonstrate which users are getting what quantity of water. It is expected that these initiatives will improve data management and availability of surface supplies. There is also a need to study water distribution and consumption patterns and the impacts of this on agriculture productivity (Ahmad et al., 2008:5). The Pakistani Federal Board of Revenue estimated that an agricultural income tax, even one with generous exemptions for small and subsistence farmers, would have generated about Rs. 60-70 billion (approximately U.S. $750-875 million) in additional revenue, versus the Rs. 1 billion—U.S. $12.5 million—generated from the current tax collection system (Khan, 2009:99). However, the power of large landowners in the parliament was so strong that the IMF's proposals came to naught. The IMF now denies that it is encouraging the Pakistani government to implement an agricultural income tax as part of its current assistance program (IMF, 2008).

There is no legislation about ground water use at a national scale. Afzal (1996:979), asserts about 2.2 million ha of irrigated land is outside Indus Canal Commanded Area (CCA), spread in somewhat small parcels with water coming from open wells, life pumps, karezes, tube wells, springs, and small diversions. Generally, water supply in these systems is uncertain and varies with season and location. The water pumping by tube wells are used by both head-enders and tail -enders but the level of reliance on groundwater is higher in the latter case. Presently, there is neither any mechanism for allocating groundwater rights nor for regulating its use. An owner of land can install a tube-well and begin pumping groundwater. In some areas there has been overexploitation due to anarchic and uncoordinated private tube-well development (Afzal, 1996:980).

"Water scarcity"

The term water scarcity is defined by Rijsberman in the following manner "When an individual does not have access to safe and affordable water to satisfy her or his needs for drinking, washing or their livelihoods we call that person water insecure". Hence when when a large number of people in an area are water insecure for a considerable period of time, in that case we can name that area water scarce (Rijsberman, 2006:6).

Gleick (2002), cited in Rijsberman (2006:7), provides a useful analysis of this issue, using the most commonly used measure the Falkenmark indicator or "water stress index" (Falkenmark et al., 1989). The Falkenmark indicator projected 1700 m^3 of renewable water resources per capita per year as the threshold, rooted in estimates of water necessities in the agriculture, household, industrial, energy sectors, and the needs of the environment. The countries whose renewable water supplies cannot maintain this figure are supposed to experience water stress. Accordingly when supply falls lower than 1000 (m^3) a country experiences water scarcity, and less than 500 m^3, absolute scarcity.

The United Nations Convention to Combat Desertification UNCCD (2009:1) explains in its report from 2009 that water scarcity is the long-term imbalance between available water resources and demands. Increasing rate of water scarcity, whether natural or human-induced, serve to activate and intensify the effects of desertification through direct long-term impacts on land. Excessive cultivation, overgrazing and deforestation put further immense strain on water resources by reducing productive topsoil and vegetation cover, and cause greater dependence on irrigated cropping. UNCCD (2009:1) identifies in its thematic report about Desertification and Water as the existing irrigated cropping systems require the maximum share of water in most countries and demand is expected to go up 14 percent in the next 30 years. For that reason adaptation to this increase in demand is very important, requiring variability and flexibility. UN-WATER (2007:4), mentions disproportion between availability and demand, the dreadful conditions of groundwater and surface water quality and interregional and international conflicts, all bring water issues to the front.

2.1 Key concepts

Small land holder

The farming system of Pakistan is mainly based on small landholders. The Government of Pakistan Board of Investment pakboi (2006:2) defines a small land holder as having 12.5 acres of land and claims that a major part of arable land of Pakistan is cultivated by small farmers, among 86 per cent of the total number of farms consist of less than 12.5 acres. The small farms are incessantly shrinking because of land division due to inheritance and population growth. The land division is impacting agricultural productivity, as small farmers are usually resource poor and have less economic capital to install modern technologies like drip irrigation, electric motor pumping, laser leveler for the land.

Land-tenure

At the present three variants of private or individual tenure are available in Pakistan (Naqvi et al., 1989 cited in Arif 2004:13). The simplest variant is peasant proprietorship; in this category individually owned little parcels of land are cultivated by family members. In the second variant, the landlord-tenant system, cultivation on land is held by sharecropping tenants. The last variant of the capitalist tenure takes two basic forms. One form is the fixed-rent tenancy, whereas in the second form the landowner cultivates the land with the help of wage-laborers (Khan, 1981; Hussain, 1988; Naqvi et al. 1989 Cited in Arif 2004:13).

Terpstra (1998:9) explains there are two major types of tenancy contracts; sharecropping and leasing. Sharecropping contracts are generally on a 50-50 basis, whereby the yield and costs of agricultural inputs are divided equally between the land owner and the sharecropper/farmer. The sharecropper is accountable for all of the manual labor, along with daily soil and water management activities. The landowner if not absentee, usually decides together about watercourse activities and of water rights, together with selling and purchasing

canal and tube well water. Joint decision making requires that the landowner acts as the main actor, although he is not the actual water user.

Furthermore Terpstra (1998:9) claims that in leasing contracts the water and usufruct rights transfer to the leaseholder for the duration of the contract, normally for a period of one year. Once paying the rent, the renter takes full accountability for soil and water management tasks. He pays 100% of all inputs and reaps the rewards of the full yield. The landowner does not have control over soil and water management practices during this period. The lessee can even sharecrop the land; he is the contemporal owner of water rights and is also considered as such in communal decision-making.

Terpstra (1998:14), defines tenancy relationships as agreements among two parties, the landowner and the cultivator, concerning usufruct (i.e. the right to use and get profit from a piece of land which belongs to another, provided that the property itself remains undiminished and undamaged in every way). A lessee is a person who pays a definite amount of rent for a granted time period to the land owner before he starts cultivating the land. A sharecropper is one who cultivates a landowner's land for a share of the profits, agreed upon in advance. In Punjab, sharecropping is generally done for 50% of the yield, even though contracts for 25% or less also exist.

Livelihood

The word 'livelihoods' commonly means the way some one earns (Cambridge dictionary) or means of living (Oxford dictionary). The livelihood concept, although, contains more than that. A livelihood "comprises the assets (natural, human, financial, and social capital), the activities and the access to these (mediated by institutions and social relations) that together determine the living gained by the individual or household" (Ellis, 2000:10). A livelihood is called sustainable when it can cope with and recover from stresses and shocks, sustain its capability and assets, and give sustainable livelihood opportunities for the next generation (Chambers & Convey 1992:1). Whereas, not all households are the same in their capacity to cope with stresses and repeated shocks, Maxwell and Smith (1992) argue that poor people balance contending needs for asset preservation, income creation and present and future food supplies in complex ways.

Chapter 3: Research Background

In Pakistan, the prevailing temperature and rainfall patterns administer two cropping seasons. The major food wheat is grown in the drier winter season while rice and sugarcane are cultivated during the monsoonal summer season. To perform the agricultural activities water is therefore a critical resource. In order to utilize the river water resources, the Indus Basin Irrigation System (IBIS) has emerged as the largest contiguous irrigation system in the world (Ahmad, Turral, and Nazeer, 2008:7). Summers are usually long and hot in Pakistan, lasting from April through September with maximum daytime temperatures ranging from 21.8 C to 49.8 C. The winter season extends from December to February with maximum temperatures ranging between 25.8C and 27.8C and occasionally falling below zero at night. As the total crop water prerequisite is more than double the annual rainfall, it is obvious that irrigation is vital to maintaining the current level of agricultural productivity (Ahmad, Turral, and Nazeer, 2008:6).

3.1 Indus Basin Irrigation System (IBIS)

The IBIS with its five major tributaries – Sutlej, Beas, Ravi, Chenab and Jhelum is the main source of water in the country. The IBIS is the biggest contiguous irrigation system in the world and is the mainstay of the irrigated agriculture in Pakistan. The IBIS comprised of 3 super dams, 19 river barrages, 12 inter-river link canals, 45 huge canal commands, and above 900,00 tube wells. The average annual flow of Indus River System is around 172 Billion Cubic Meters (BCM) of which presently 119.5 Billion Cubic Meters (BCM) is being diverted for irrigation and the remaining balance outflows into the sea. However 80% of the cropped area, approximately 18.09 million hectare of land, is irrigated and 90% of the agricultural output comes from irrigated land. Irrigated agriculture in Pakistan is not well-organized and overall system efficiency is about 45 %. Annually, the outflow to the sea is about 43 Billion Cubic Meters (BCM). While, about 13 BCM is obligatory for environmental flow for the coastal areas (Bhatti, 2009; Suttinon, et al., 2009:2).

3.2 From canal water to ground water

Kijne (2001:113), describes one of the most persistent problems of the irrigation systems in Pakistan's Punjab occurs at farm level. This is illustrated in Figure 2 where the number of missed turns (irrigation water turn of a farmer to irrigate his land but the water does not show up and the farmer misses his turn) is plotted for a watercourse in the head reach of a distributary during the kharif season (summer crop season officialy from mid april to mid october) of 1994. Every week farmers dependent on water from this watercourse missed between 15 and 95 turns due to no availabity of water in the canal, and thus could not irrigate or had to revert to tubewell water. The farmers are shifting to groundwater irrigation which has its own drawbacks. Afzal (1996), presents the enormous expansion of private-sector tube-well irrigation in Pakistan has had severe environmental consequences; 11 per cent of the 22 million hectares of arable land has been declared as 'disaster area' due to severe water logging

and salinity (water table only 0 – 5 feet below the surface), while another 20 per cent is under stress (water tables 5 – 10 feet below the surface).

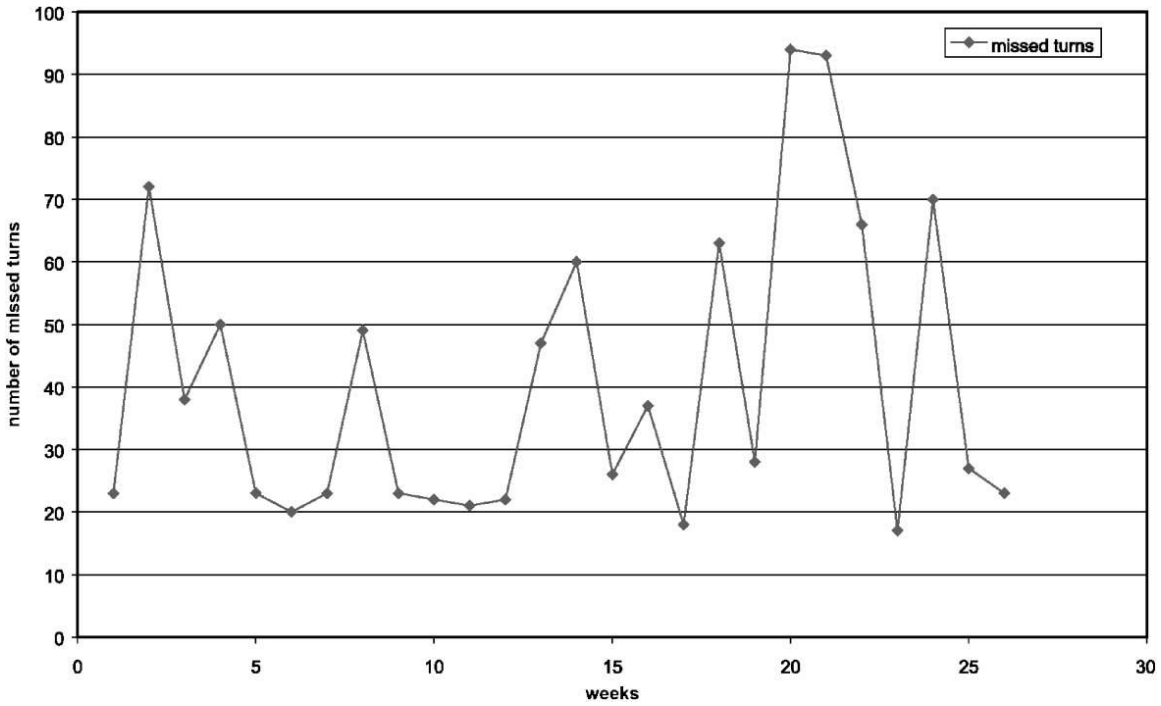


Figure 2: Missed turns in Watercourse (Kijne, 2001:112).

The farmer's turn to irrigate his land is distributed in warabandi system. Water distribution to farmers is usually based on a seven day fixed rotational turn called ''warabandi''. This means that every one farmer is allowed to take an entire flow of the outlet once in seven days and for a period proportional to the size of his land holding. The amount of water during a turn is generally insufficient to irrigate the entire farm. Farmers usually practice either deficit irrigation to irrigate their entire land or choose to leave a fraction of their land holding un-irrigated (Kijne, 2001).

3.3 Corruption

Rinaudo (2002:408), contends that outlet of water acts as a channel to different areas from one stream. Illegal enlargement of the outlet from the main stream can give the farmer more water than his actual discharge of water. As a minimum of 25 percent of farmers report bribing irrigation officials for irrigation water, among the usual payment averaging about 2.5 percent of income/hectare (Rijsberman, 2008:73 cited in Khan, 2009:96). Groups of farmers located in the upper reaches of the distribution canals may partly break their outlet or enlarge it in order to raise the discharge delivered to their fields illustrated in Figure 3 below (Rinaudo, 2002:408).

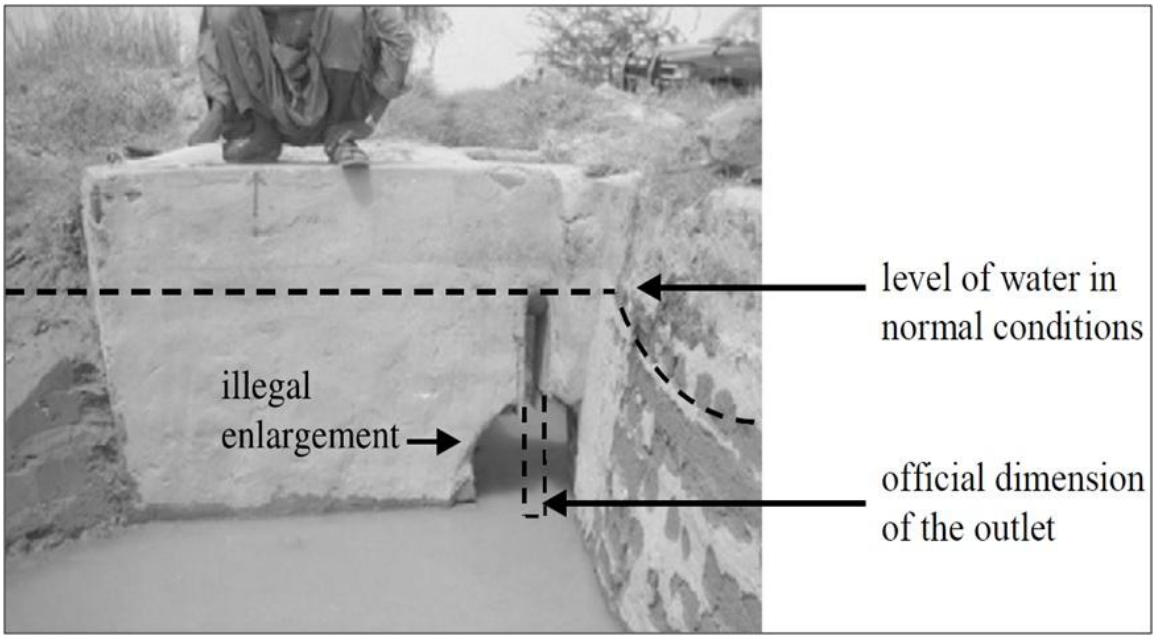


Figure 3: Illegally customized outlet observed during a low-water period (Rinaudo, 2002:408).

The problems when it comes to water distribution in Pakistan becomes clear when Rinaudo (2002:412), demonstrates that large landlords can exploit their good connections with local politicians or high-ranking administration officers to apply pressure on the staff of the irrigation agency so that their outlet can be enlarged without presenting bribes. Furthermore, Pakistani irrigation officers are sometimes criticized for not going into the field to identify what is happening in their jurisdictions. Khan (2009:96), describes that one development practitioner with considerable firsthand experience working with irrigation officials in Punjab and Sindh explain these authorities as "the real villains in this piece. They are horribly corrupted, inefficient, and bloody lazy."

Pakistan does not make proficient use of the resources it does have. As shown below in Figure 4, Pakistan's wheat production (a vital staple in Pakistan) is very low in both absolute and relative terms. It is understandable that wheat production in the Pakistani Punjab would be lower than those in the United States (because of lower capital intensity in the production process, less access to inputs, and so on). But, the fact that the Pakistani Punjab's wheat yields are approximately half those of Indian Punjab (in both absolute terms and per unit of water used) shows the inefficiency of the Pakistani Punjab's agriculture (Khan, 2009:83).

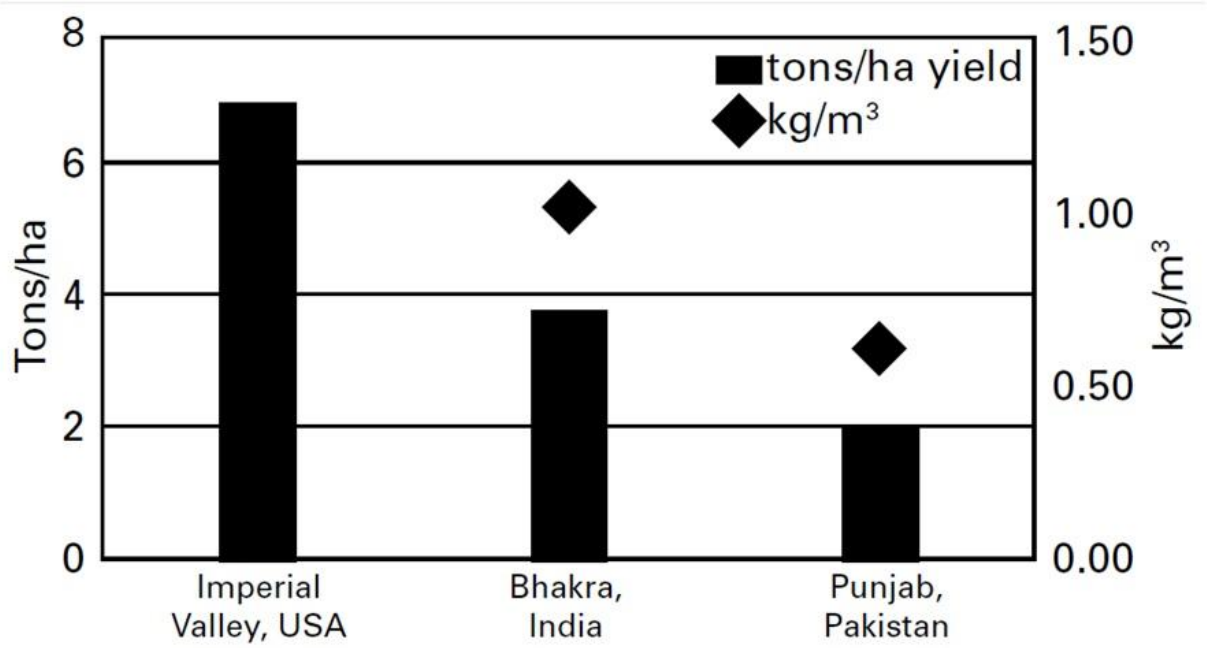


Figure 4: Assessment of Yields and Water Productivity of Wheat in USA, Pakistan, and India

*Source: International Water Management Institute (2003) cited in Khan (2009:84)

Sugarcane is one of Pakistan's major crops, grown on 1.03 million hectares in 2006-07 (FBS 2008a, Table 1.5) and producing about five million tons of sugar, making Pakistan the world's 10th-largest sugar-producing nation (Ilovo, 2008:46). Sugarcane is tremendously water-intensive crop. The following figures on water consumption for major crops in Pakistan express how it compares with the rest of Pakistani agriculture (WWF, 2002, adapted from the below Table 3 (Khan, 2009:90).

Table 3: Production of main crops

Rice		Cotton		Wheat		Sugarcane	
hectares	water m3 (millions)	hectares	water m3 (millions)	hectares	water m3 (millions)	hectares	Water m3 (millions)
2,419,000	70,508	2,955,000	51,427	7,554,000	51,418	1,059,000	48,882

*Source: (WWF 2002, adapted from the below Table, (Khan, 2009:90).

Khan (2009:90), explains the given data and shows that sugarcane uses more water than wheat. The estimated water consumption is 6.8 times per hectare more than wheat, 2.7 times more than cotton, and 1.6 more than rice. Sugarcane yield is particularly sensitive to water salinity, the production becomes half under heavy salinity conditions; approximately half the sugarcane grown in Pakistan is in saline areas. This results in Pakistan's average yield of 47.5 tons/hectare being "possibly the lowest among all the major sugarcane growing countries in

the world." By assessment, the world average is 62.5 tons/hectare and various countries average well over double Pakistan's yield.

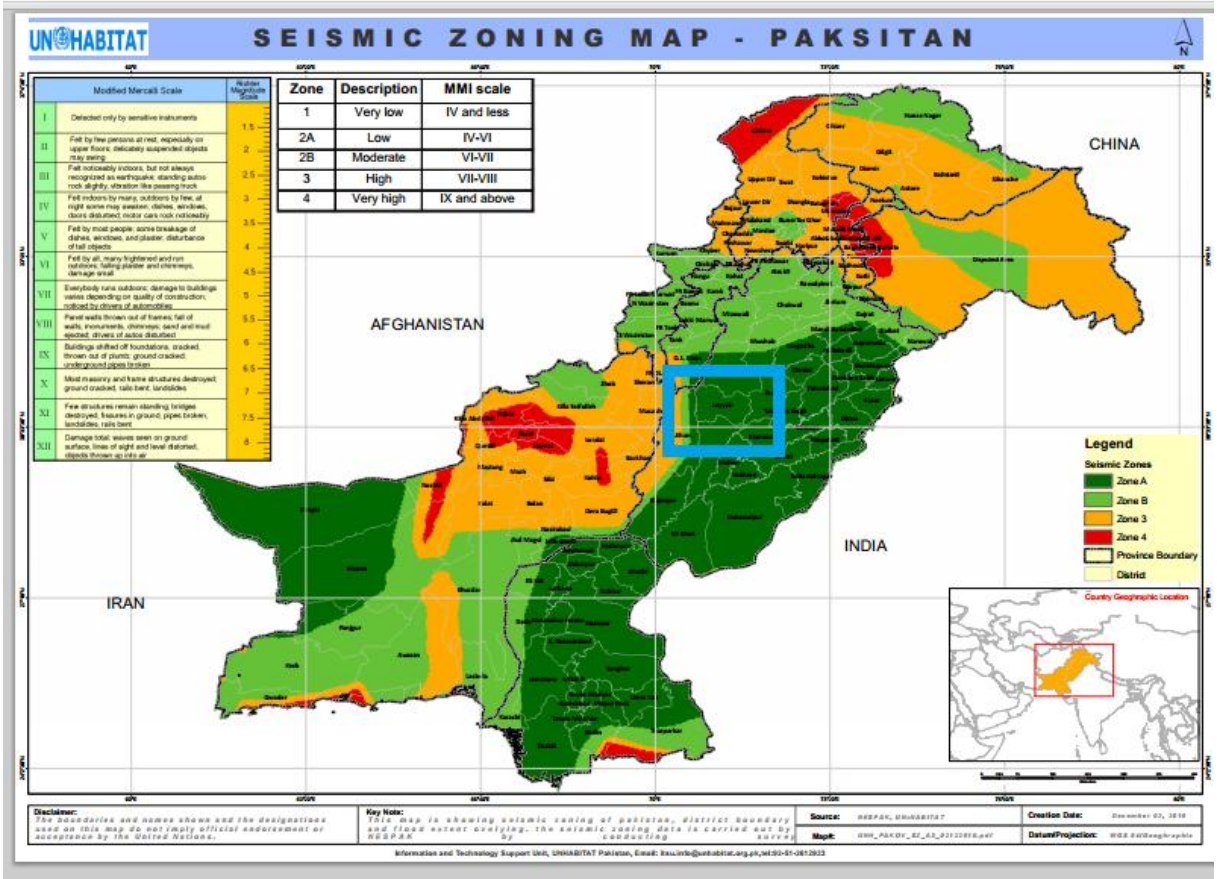
In addition, many large landowners in Sindh and Punjab provinces hold sugar mills and grow sugarcane on their land, and the sugar mills apparently have the second-highest market capitalization on the Karachi Stock Exchange. Apparently, in the 1990s Prime Minister Nawaz Sharif privileged subsidized loans for building sugar mills because his family firm, Ittefaq foundries, was the main equipment supplier for sugar mills (Khan, 2009:90).

Therefore Pakistan, a water-scarce country, is one of the world's largest and highest-cost producers of sugar as it is politically expedient, even if economically foolish, to do so. Many of the most powerful Pakistani politicians benefit tremendously from this extremely misguided strategy (Khan, 2009:90). Couton (2009:120) asserts the assessment of a former head of Water and Power Development Authority (WAPDA) echoes this view. The WAPDA head noted in 2001 that "the return on the cash crop is not commensurate with the input of water that is required to produce sugar. We could import sugar from Cuba at less than half our production costs".

Chapter 4: Research Methodology

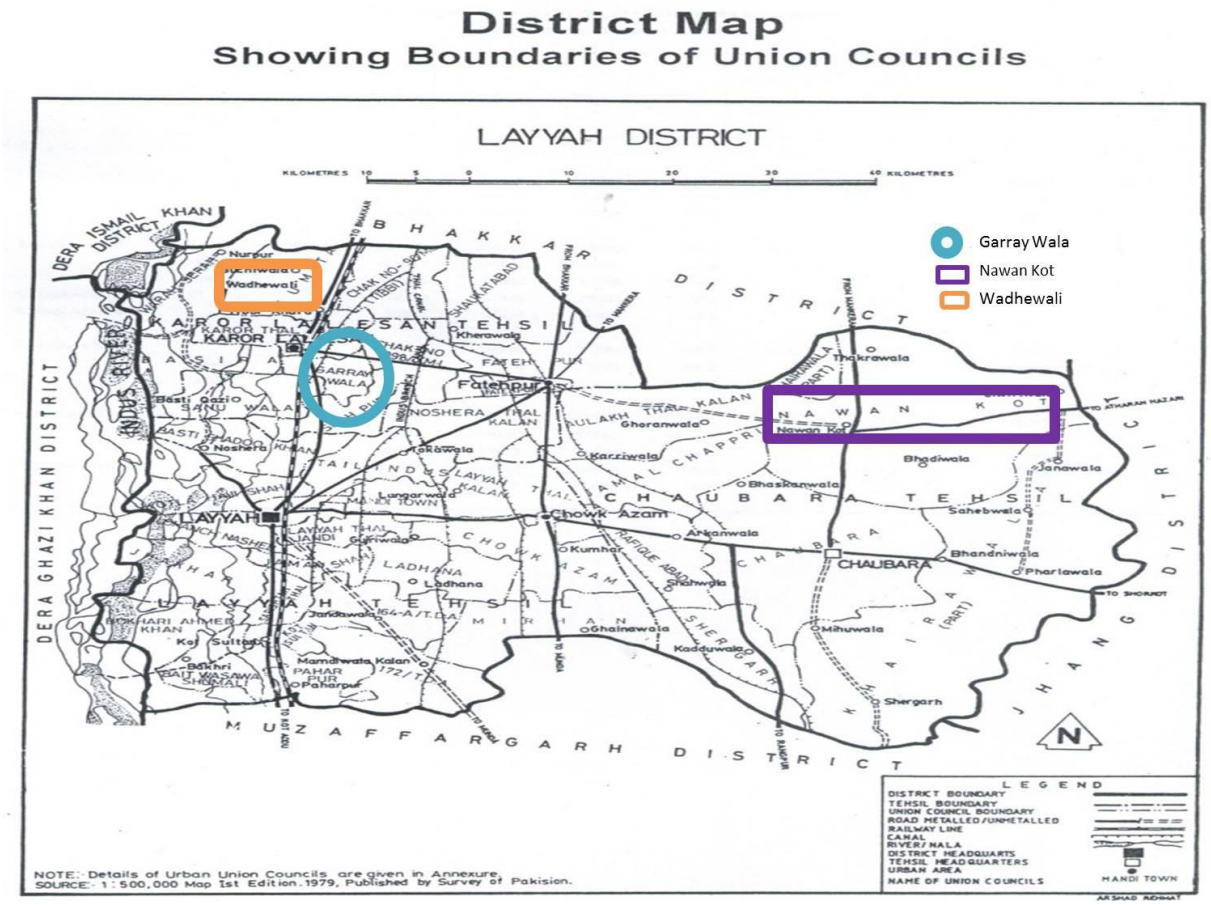
4.1 Study area

District Layyah is part of the Punjab, Pakistan and located in the southern part of the province. The city has a hot climate and the maximum temperature in the summer rises up to 53 degree Celsius. According to District Pre-Investment Study, Layyah, (2012) the temperature in winter is low due to closeness to Koh-Suleman range of mountains. It has an area of 6,291 square kilometers while the circled area shows its location in the below map.



Source: UN-Habitat (2010)

Layyah District consists of three administrative subdivisions of tehsils: a) Layyah b) Chaubara and c) Karor Lal Esan. Out of the three sub divisions a) Layyah b) Chaubara and c) Karor Lal Esan, the Tehsil Chaubara is barren and comprised of forests and sand dunes. While the other two Tehsils Layyah and Karor Lal Esan are relatively better developed agriculturally but have also big tracks of sand dunes and uncultivated land. The city of Layyah has a big river called River Indus which goes by from North to South on Western part of the district. I have conducted my field work in three villages; Wadhewali, Nawan Kot and Garray Wala in Layyah district. In the below map of Layyah district the circles show the studied area.



Population

Punjab Development Statistics (2011) presents the population of Layyah district stood at 1.5 million persons, 787 thousand males and 727 thousand females. Density of population in the district is 241 persons per square kilometer. Distribution of urban and rural population in different Tehsils is given in Table.

Table 1: Total Population of the District

Town	Population (Thousands Nos.)		
	Urban	Rural	Total
Layyah	143	661	804
Chaubara	-	218	218
Karor Lal Esan	52	440	492
Total	195	1319	1514

*Source: Punjab Development Statistics, 2011

Source of income

According to the pre-investment study, Layyah, (2012) District Layyah is one of the least industrially developed districts of Punjab. Except for one sugar mill founded in 1955, the only conventional industries operating are eight flour mills, eight cotton ginning and pressing

factories. The major population of the district lives in the rural areas and their source of income come from agriculture. The local farmers generally grow sugarcane, wheat, cotton, gram and guar seed are the major crops grown in this area. The measure of these crops during the period 2008-09 to 2010-11 is given the below table.

Table 2: Production of main crops from 2008-9 to 2010-11

Crop	Production (Th. M. Tons)		
	2008-09	2009-10	2010-11
Sugarcane	648.55	623.48	468.05
Wheat	503.86	515.36	554.18
Cotton	130.96	126.97	112.02
Gram	87.1	67.9	53.2
Guar Seed	18	15	14

*Source: Directorate of Agriculture, Crop Reporting Service, Punjab

4.2 Data collection

Primary data

The field data was collected during four weeks from November 20 to 20 December, 2012. Introductory visit to some agriculture farms was also made in the first week of the data collection period. The visits were assisted by a district government official working in the area as a water management officer. It was really helpful for me as a researcher as there was some government projects and farms owned by private farmers which I could not approach directly without the help of the official. Five key informant interviews with personnel of government organizations and NGOs were also carried out.

Farmers Interviews

A total of twelve interviews with farmers were conducted. Out of twelve interviews ten were conducted with small farmers while two interviews were held with big farmers. The interviews were carried out with the male household representative. Because of culture limitations I was not able to perform interview with female members of the households. Although I consider the absence of women in the study as a drawback, one has to remember that in Layyah it is the males that run the agricultural farms. The female mostly don't own any land and sometimes the women own land but the agricultural activities are held by the male of that family. A detailed semi-structured questionnaire was prepared in English but the communication between me and my informants was held in the local language called Saraiki.

This research is based on a purposive sampling. In purposive sampling, we select the study area and the sample with specific purpose in mind. The research is based upon small farmers of three selected villages. These three villages were selected because each village has different water use practices. The selection was done with the consultation of a water

management officer providing assistance in the area. The selection of farmers is based upon their land ownership. The supremacy of purposive sampling lies in selecting information rich cases for in-depth analysis. Thus, it is a suitable technique to select the farmers engaged in agriculture who face water shortage.

The government and NGOs

Five interviews were conducted with personnel of three government organizations; one Government based community organization and one NGO (Non-Governmental Organization) actively concerned about providing funds to agriculture. The central reason behind these interviews was to get information about the type of assistance they have provided/are providing to the farmers in the study villages. These interviews were conducted with personnel of Soil and Water fertility labs, Canal Water Irrigation Department, Water Management Department, Punjab Rural Support Programme (PRSP) and Doaba Foundation Layyah.

Secondary Data

The Elsevier published books and journals regarding agriculture and water management have been used. So has also the Woodrow Wilson international center for scholar's reports about Pakistan's water crisis have been utilized. Other literature includes reports from International Non-Governmental Organizations and the United Nation reports on coping with water scarcity. Online information from the provincial government about Layyah district and figures from bureau of statistics Pakistan have been helpful when it comes to figures such as total population of Layyah and the source of income of the inhabitants. Additional literature was also collected from different web sources.

Chapter 5: Water management in the Layyah district

Water management in the Layyah district is governed by many institutions. The researcher managed to take notes from some of the most important institutions. The main department is Water Management Department which also is in charge of water courses lining as well as tube well installations. Canal Irrigation Department is also vital for the whole responsibility of canal water distribution in the area and which farmer will get how much water according to his land is decided by Canal Irrigation Department. Governmental soil and water fertility labs examine the quality of land and guide the farmers regarding their farming. There is always role of some organizations which are community based organization to help the local people. Punjab Rural Support Program (PRSP) is one of them. Doaba Foundation is one of active foundations which help rural people regarding their agriculture problems. The foundation also helps small farmers for their social economic issues.

5.1 Governmental soil and water fertility labs

The official website of Government of the Punjab says soil and water testing laboratories were established at the district level in March, 1981 to facilitate the needs of the farmers. Seven other laboratories were introduced in February, 1988 in newly created districts. Soil and Water samples are collected from farmers' lands on their request and analyzed for physical and chemical characteristics in laboratory at nominal fee. The recommendations are made on the basis of analysis report to improve the soil fertility and to get high yield by applying recommended doses of fertilizers for the land. Gill and Mushtaq (1998:28), say the staff at each soil testing laboratory consists of one Assistant Agriculture chemist (soil fertility), six agricultural officers and four laboratory assistants. Moreover, sixteen soil and water testing laboratories are commissioned at district level for the advisory services. To know more about the laboratory services an interview is made with the official of the laboratory. Bilal Khan is one of the agriculture officers who work at soil and water quality labs district Layyah. Bilal Khan is appointed as an agriculture officer since 2010 in the laboratory.

In an interview that I had with Bilal Khan, he said that the main purpose of this lab is to check out the water and soil whether they are good for cropping or not. The price for the soil and water sampling is very less while the farmer pays some of it meanwhile the rest is subsidized by the government. The officials provide information and technical assistance if the water and soil is not healthy enough to support good farming. The interviewee demonstrated the number of samples which we analyze per month is not much. The farmers do not seem to be interested in knowing about their water and land health. There can be a lot of reasons behind that but what he thinks is lack of education and information in the community. The official also claimed that sometimes farmers have to wait more to get the results of their soil and water samples. Some representatives of their department are lazy. The reason behind that is the fixed salary of the officials which is not connected to the amounts of tests that they are required to do.

The official described that the department does not get enough funding to improve their service and reach out to the whole district and each farmer. He claimed that their role is just to conduct testing and give the farmers results. The official explained for example how to conserve water and which practices the farmers should adopt is basically the responsibility of the water management department. So the official blamed the water management department for the lack of water tests. The official describes the water of Tehsill Karor and Thehsil Layyah is fit for irrigation while the available water in Chobara Tehsil is not good for irrigation.

5.2 Canal water irrigation department

Figure 5: Interviewing the canal water irrigation official

Source: Author

Haq (1998:1) asserts that the Canal Network Department started around the middle of 19th century when the British occupied the subcontinent. The British rulers initiated a massive canal construction program. The canals were first improved and then weirs and barrages were constructed across the rivers. This system was developed into the world's largest canal network to offer irrigation facilities to 33 million acres of land of the Indus basin. According to Haq (1998:15), reorganization of the Punjab Irrigation Department was made in 1984. As the work force was not enough, 25 percent increase in the revenue and engineering subordinate staff as well as 25 percent enhance in the sub-divisions was recommended. Gill and Mushtaq (1998:14), point out that the Irrigation Department is well equipped to carry out the engineering side of its work. But the management of water at farm level is not so efficient. Unfortunately the canal network largely ceases at the canal outlet points and little is done to

ensure the best use of water. That could be the efficient distribution systems, by leveling the land to ensure uniform water supply, or by advising the amount and timing of water applications for various crops. The result is that crop production gets less water and much water is wasted. To get more detailed information on canal water irrigation from the department I interviewed Malik Ilyas, an official at the department who is a Sub Divisional Officer (SDO) for Canal Irrigation Department in Layyah with 19 years working experience with the Department.

Malik Ilyas claimed that the main goal of their department is to distribute water for each farmer for his agricultural practices. The water in the river is converted into barrages. From barrages it comes to the main canal then it is distributed to minor canals, small branches and distributaries. The minor canals and distributaries are for farmers to irrigate their land. The water availability depends on each farmer`s land holding. Malik Ilyas described that they get water fees *(abiana)* from each farmer which costs less if you compare it with other water availability sources. The official also accepted that there are some weaknesses in the system. The government policies are more encouraging for industry rather than agriculture. He mentioned one of the bank policies to lend money for agricultural purposes. The official said that the interest rate for lending bank loan for industrial use is 2% while higher than 18% for agriculture use. According to Malik Ilyas, the farmers cannot take bigger steps to improve their social-economic situation due to the high interest rate policies.

The informant said that politicians are not making reforms to collect agriculture tax because that will not benefit the big agriculture landlords. The reason for this is that there are a lot of big politicians who own thousands of acres of land. Proposing reforms that will tax them is therefore not seen as something positive. The positive development is instead the World Bank legislation that presently is forcing the government to implement agriculture tax reforms. Malik Ilyas admitted that they are not able to distribute water to the whole area and blamed it on management and availability problems. He recommended the government to create more reservoirs i.e. Kala Bagh dam, to save water so that the country's energy and agriculture crises can be resolved.

Malik Ilyas asserted that farmers complain about water availability because there is a real water scarcity in the water reservoirs. His department does not have enough water to provide them for the whole month. According to Malik Ilyas, there will soon be a project about maintenance of main water canals that will increase the efficiency of the canal network and more water will be available for farmers. The funding of the project (which is expected to cost 17 billion Pakistani Rupees) has been secured through donation by Japan. The project's partners are National Engineering Services Pakistan (Pvt.) Limited (NESPAK), National Development Consultants Pvt. Ltd. Pakistan (NDC) and Descon Company. He also said that the maintenance of the main water courses will add much water in the system. And that the World Bank is also encouraging drip irrigation and donating much more to the project. Malik Ilyas believed the Drip Irrigation Project will help to eliminate pressure on Pakistan agriculture water need.

5.3 Water Management Department

Figure 6: Interviewing the On Farm Water Management official

Source: Author

The On Farm Water Management (OFWM) section in the agriculture department is the most recent structural change in the Punjab Agriculture Department (PAD) (Gill and Mushtaq, 1998:36).The official website of the department states that first On Farm Water Management (OFWM) Project was launched in October 1976. The five year pilot project was funded by the assistance of United States Assistance for International Development (USAID). According to Gill and Mushtaq (1998:37), the organizational set up of the On Farm Water Management department is part of the Provincial Agriculture Department. The administrative head is the Secretary Agriculture, Government of the Punjab, Pakistan. The Director General of Agriculture (Water Management) is responsible for its implementation in the province while he is assisted by the Additional Director General and five Directors (field). The official website of the On Farm Water Management describes their organizational structure at district level. The offices of District Officers (OFWM) have been established in all 36 districts of the province to supervise water management activities. Tehsil is the lowest tier of the administrative system where office of Deputy District Officer (OFWM) has been created for physical execution of works through field staff. I collected detailed information from Mr. Muhammad Shakeel who is designated as the Deputy District Officer, of the Water management Department in Layyah. Mr. Shakeel working experience within the department is one year.

Mr. Shakeel showed that the main goal of the department is to conserve water. The official claimed that they are doing their best in the area to save water. And that the department is working for the improvement of water courses to avoid water seepage loss and continues the flow of water fluently which helps the farmers to get water. Meanwhile the department also has some schemes for laser land leveling and high efficiency irrigation systems (Drip and sprinkler).

The informant described the department was working on a drip irrigation project held by The Asian Bank. Currently the World Bank has started a new project and the department is working on that. A project that will bring 1, 20,000 acre land under drip and sprinkler irrigation out of which 1,00,000 acre will be under drip irrigation and 20,000 acre under sprinkler irrigation. According to Mr. Shakeel, the time period for the project is seven years. The FAO is also having a project for converting earthen water courses to cemented brick water courses. The informant says these projects will help in eliminating water loss.

To illustrate the problem, the official commented:

> The government is paying 60% subsidy out of the total cost for drip irrigation at the fields but farmers still think we are trying to take money from them. The small farmers don't want to pay the farmer share which is 40%. The local farmers way of income is agriculture but large land holders have more sources meanwhile they have different sources of income and they can invest easily. The local farmers' attitude is not positive that is why we do not approach them because we know they will not adopt.

Mr. Shakeel argued that politics disturbs the consistency of the work. Whenever a new government holds power they quit the last projects and introduce new ones to gain fame. The official wished that the water department should work independently without political pressure. Mr. Shakeel added that capacity building is also important for saving water and more information should be forwarded to the farmers. Tube well water pumping should be more regulated and set a standard for farmers in how to use the tube well water.

5.4 Punjab Rural Support Program (PRSP)

Many rural development projects have been introduced by the past and the present governments in the public sector. A number of them have participatory project approach. Punjab Rural Support Program (PRSP) is one of them. Anwar, Zafar and Hussain (2006:60), point out that in 1997 the Government of the Punjab decided to fund the establishment of an organization to address the issue of prevailing poverty and rising unemployment in the province. As a result, the Punjab Rural Support Program (PRSP) came into existence in June 1998 as a non-political, non-government, private organization. The objective of the PRSP is reduction of poverty and improvement in the quality of life of the rural poor. This organization is currently working in twenty six districts of the Punjab and Layyah is one of them.

Mrs. Aqeela Alvi is a district Manager of Layyah for the Punjab Rural Support Program (PRSP), with a working experience of 12 year within the organization. Mrs. Alvi asserted that

their organization is government based community organization. The organization has a community based committees in each village in the district of Layyah. The attention is rural people and the organization is having many projects for the betterment of rural livelihood. Mrs. Alvi described that their community based committees advise them what they need and as the organization get funding and the project related to their need the organization give them that service. The social immobilizer at least spends six months with the local community and involves them in the project before we start our work. The organization provides agriculture facilities to the farmers such as tube well. Micro financing is also applied in effort to help small farmers. The organization has donated water courses, draining system, culverts and bridges to small farmers. The PRSP is connected with other stake holders such as the Water management department, the Agriculture extension department etc. The organization communicates with other related stake holders before starting a project. When I asked Mrs. Alvi she also said that because the Layyah district is abundant of small farmers the organization should work more for them.

5.5 Doaba Foundation Layyah

Doaba is a Non–Governmental Organization which works for the under privilege communities. The official website of the foundation says Doaba made its first move on self-help basis as community based organization from a village "Shah Din" near Rang Pur district Muzaffargarh, Punjab. That happened during the flood disaster in 1987. With more than thirteen years of successful self-help initiatives on Disaster Risk Reduction, Doaba felt the need of sharing its experiences with other organizations and to expand its practical knowledge in disaster affected villages of other districts. Doaba was registered as public welfare trust in the year 2000 and is now working with communities of six districts in South Punjab. Layyah is one of those districts.

Mazhar Iqbal is a district coordinator for Doaba Foundation Layyah. He has a working experience of eight years with the foundation. According to Mr. Mazhar Iqbal, Doaba foundation is an NGO which aims to increase the livelihood standard of poor people. It's a project based organization. In 2010 there was devastating flood in the district of Layyah and the foundation was conducting many projects during that time due to national and international donors. The foundation also has some projects for better livelihood strategies for the small farmers donated by the Oxfam international organization. Mr. Iqbal demonstrated:

> As an NGO we act as a facilitator between research institutions, educational universities, farming communities and Government institutions. It is the Government prime responsibility to support and facilitate the society, but we are still trying our best and adding to the welfare of the community.

Realizing the small farmer's needs the foundation introduced low cost systems like one hand tractor to plow and donkey pumps to irrigate. However, the foundation does not have financial sources to practice these systems on a wider scale. Now it's the government's responsibility to implement the low cost systems on a bigger scale. These donkey pumps use 20% diesel and 80% biogas which are very cheap and easy to use. The interviewee described it like this:

> We think farmers are very poor in this district and have very small lands. In our organization we define a small farmer which has 1-5 acres land while government considers a small famer the one who has 12.5 acres land. So we always focus on a farmer who has one acre land and the Government should make policies that could benefit the one acre land farmer.

According to the informant, the foundation has two projects which aim to support small farmers. One project is about "value-added for wheat" which is explained by Coltrain (2000:5), adding value is the process of transforming a product from its original state to a more valuable state, for instance processing wheat into flour. Mr. Iqbal showed the other project is to "motivate farmers to grow medicinal plants". He divided the farmer communities of Layyah in two categories; drought affected and flood affected community. When I asked Mr. Iqbal where is the solution of small farmer's problems he asserted the Government should give fully cemented water courses for farmers who are having troubles with drought land because their land is sandy and it also requires subsidies to install drip irrigation in those areas. The flood affected area has no canal irrigation and the farmers must use tube well which is the cause of too much water pumping. Mr. Iqbal stated the agriculture inputs are costly for the farmers to use tube well due to energy cost and that the government should give subsidy to those farmers of who can't buy tube well for their land.

Chapter 6: Small farmers in Layyah

After having presented the institutions responsible for agriculture water management, it is now time to move on to describe water scarcity from the viewpoint of the small farmers in district Layyah. As I have mentioned earlier, the farmers in district Layyah have three ways to irrigate the crops based on the availability and the utilization of water. And that's the main reason why I have decided to make use of three different case studies illustrating this when describing Layyah agriculture. The first case study describes the farmers who use ground water for their agricultural activities. The second case study is about the tehsil Chaubara consist of sand dunes comes under the rain water cultivation. The Tehsil of Karor Lal Esan are comparatively better developed agriculturally. The presence of the river Indus makes water available for canal irrigation and the third case study is therefore about canal water irrigation.

6.1 Case Study 1: Ground water cultivation

The canal water is cheaper and preferable by farmers but in case of no availability of canal water. The farmers firstly transfer to tube well water as replacement. According to Terpstra (1998:57), the preferred opportunity to cope with the canal water is using tube well water. Also, for farmers who have their personal tube- wells still canal water is cheaper as fuel is needed to run the tube well. When the *warabandi* (water distribution system among farmers) turn is not sufficient to irrigate the whole plot, it is frequently mixed with tube well water. Whilst the quality of the tube well water is bad, it is also mixed with canal water to diminish its hazardous effects. Some people, who do not have their individual tube well, exchange canal water rather than arranging tube well water.

Figure 7: Ground water cultivation

As canal water is cheaper the farmer does not need fuel cost to run the tube well. Tube wells in Pakistan Punjab are typically fitted with 16-20 horsepower (hp) diesel engines with delivery pipes of 5-inch diameter (Shah et al., 2000:8). Figure 7 above shows the delivery pipe of tube well water pumping for ground water cultivation. Four interviews are held to understand the farmers' views about ground water use and its impacts.

Farmer A

Farmer A belongs to village called Wadhewali Thesil Karor in the district of Layyah. His land size is twelve acres. He uses the land for agriculture and livestock which provide him with major source of income. He grows cotton, pearl millet and rice on his farm. The main water resource is tube well irrigation. According to the respondent, the lands are fertile and productive due to the near site of the river but farmer A does not have real access to the river water. There is not any water storage reservoir or canal to bring it to the agriculture field therefore he is highly dependent on tube well water.

The tube well is run on diesel and therefore farmer A needs fuel to run his machine. Through the years the diesel prices has increased but the crops prices has not increased. So the farmer has not made any economic improvements due to the high prices of fuel and low prices of crops. Farmer A needs more water in the summer season due to the high temperature of that area. The temperature is usually 40-50 degree Celsius in the summer. When interviewing the farmer he said that there was a devastating flood in this village in 2010. The flood has impacted the farmer in both negative and positive aspects. The positive aspect was that it has become easier to pump water due to the high level of water while the negative aspect has it ruined his agriculture land and livelihood. The respondent saves water by cleaning the water passages which helps him to minimize the cost of irrigation.

Figure 8: Watercourse without cleaning. Source**:** Author

According to Terpstra (1998:64), watercourse cleaning is essential to raise the velocity of water in the channel, enabling additional water to reach the fields within the same period of time. Weeds are removed, and the central watercourse is desilted. Each farmer is responsible to clean that part of watercourse which he uses. The length of the watercourse is divided between farmers according to the amount of acres they cultivate. The day when the watercourse should be cleaned is also decided and communicated to farmers one day in advance using a mosque loudspeaker. The real watercourse cleaners are owner- cultivators, lessees and sharecroppers, or their representative, like a family member. They can even manage wage laborers to do their portion of the cleaning on that day. Some farmers don't clean the watercourse Figure 8 is example of that. In this way the water velocity decreases and chances for weed growth and insect habitat are high which are not beneficial for the crop. The lack of infrastructure of water such as watercourse lining with cemented bricks for that area is also a dilemma for farmer A. The Government does not provide any services for the farmer. The farmer does not get any new information from the government institutions and he cultivates his land by his own experience and teachings from his elders.

Farmer B

Farmer B lives in village Wadhewali Tehsil Karor District, Layyah. Growing of crops (cotton, rice and mung beans) is the main source of income for his family. He owns ten acres of land.

The major source of irrigation in his village is tube well irrigation. Water scarcity does not affect him directly but indirectly as he has to use more diesel fuel to pump underground water. The water level is low during the summer season which makes the production more costly. The farmer does not have any access to canal water or any other source like reservoir which can make the farming cost less. Farmer B does not have enough resources to purchase agriculture machinery. Meanwhile it's difficult for him to follow the ideology of saving water because he can't afford more advanced technologies like drip irrigation or sprinkler irrigation to save water on his farm.

Farmer C

Farmer C lives in the village Wadhewali Tehsil Karor District, Layyah. His land holding is fifty acres out of which he tenants forty acres from other farmer. He is a school teacher; his source of income comes from Agriculture and his teaching job. He cultivates crops such as cotton, rice and pearl millet in summer season while wheat in winter season.

Farmer C uses mainly tube well water. The respondent mentioned that flood of 2010 have both beneficial and harmful aspects. The beneficial aspect is the water level is up after the flood which lowers the cost of water pumping. During the summer season farmer C needs more water to irrigate his land and at the same time he needs more diesel fuel and therefore the production cost increases.

Farmer C is using watercourses lining with cemented bricks to save water rather than earthen water passages. The watercourse with proper lining can save water. According to Terpstra (1998:66), watercourse lining is an acquisition strategy, which prevents water losses during

seepage and leakage. Additionally it saves the time necessary for watercourse cleaning. Figure 9 shows the watercourse lining which can be easily evaluated for less cleaning. Dawn (2011) writes about watercourse lining and takes the opinion of the Deputy Director Drainage and Reclamation Institute of Pakistan (Drip), Abdul Saleem Arain, who says one kilometer of lined watercourse, brings water to the tail-end in 12-14 minutes while in a katcha (earthen) watercourse it takes three hours. According to him, "So the difference and percentage of water saved through two different watercourses is quite evident,"

Figure 9: Watercourse lining with cemented bricks

Source: Author

Farmer C gets help from a provincial organization called Punjab Rural Support Program (PRSP) to for this watercourse since farmer C can't bear the cost of construction by himself. This is a common problem for farmers in this village because farmers can't afford the expenses of water courses with cemented bricks. As farmer C said the attitude in this village is not to pay for new technology aiming at more productive farming but the attitude is to get everything free from the government or private organizations. Meanwhile the organizational process for any subsidy is to pay some percentage of the cost by the farmer itself and the rest the organization will pay. He thinks that a very important tool for water conservation is precision land leveling by laser leveler operating system. The operating system cost a lot of money which farmer C can't buy. The only way is to borrow through the government institutions and it's more complicated because you should have contacts with local politicians. He has not used the approach of land leveling for his land.

Farmer D

Farmer D belongs to the village of Wadhewali Tehsil Karor District, Layyah. He is cultivating thirty five acres of land out of which he tenanted twenty five acres from other farmer. His major source of income is agriculture and livestock. He is cultivating the crops cotton and mung beans while he also grows vegetables for household use.

Farmer D was greatly affected by water scarcity before the major floods of 2010. The respondent said it is easier to pump water now and that's the only positive aspects of the flood incident. The floods totally damaged his crops and livelihood. Farmer D is highly dependent on farming and don't have other sources of income. To save water he cleans the water passages because on his land the water courses are earthen. Terpstra (1998) argues that old watercourses with poor maintenance cause water loss. Water loss happens due to side leakage from the watercourses. The zigzag alignment of banks creates many weak points which can cause water loss. The chances of weeds, grass and vegetation growing are more in the watercourses. Figure 10 shows the irregular watercourse with a lot of vegetation on its banks. As grass and vegetation attracts animals and rodents which can cause damage to crop and watercourse.

Figure 10: Earthen watercourse without lining

Source: Author

Farmer D suggested that more collaboration between farmers and officials would increase the saving of water but unfortunately communication is missing between these groups. Farmer D said that most farmers in the village are small farmers and only rent the land. For that reason there is less interest in taking care of the land because they are unsure if they will be able to keep the land. Usually the rent contracts are between 1-2 years.

Analysis of Case study 1

The village of Wadhewali Thesil Karor in the district of Layyah is one of those villages which are very close to the Indus River but does not have any real access to the river. As a result, the majority rely on tube-well to cultivate their crops. However, this way of getting water is also affected by the energy problems the farmers face. The village, like other villages and districts in Pakistan, does not have a reliable supply of electricity. Since water from the tube-well can only be obtained by pumping water using diesel, petrol or electricity the lack of reliable, efficient and affordable energy limits the ability of the farmers to pump water for irrigation purposes. The lack of power, and hence water for irrigation, undermines the ability of the farmers to provide for themselves and their families. Their livelihoods are critically affected. Since they could not pump the water manually and could not obtain power to pump the water they have to rely on nature for water (rainfall) in order to grow their crops. Waiting for rain is not an ideal for farmers who want to plant crops the year round. Unable to plant the year round means that the income of the farmers are drastically reduced which also affects their purchasing power and hence their standard of living. In addition, to access of energy and water problems, the old earthen watercourses (small canals) which are very old ways of supplying water to field causes most of the water to be lost in the form of evaporation. The loss of water also affects the operations of the farmers as they are forced to pump more frequently. Thus, because the farmers do not have modern technologies that enable water pumped, stored and used over a longer period their operations are handicapped. In other words, water is crucial to farmers and the lack of it coupled with other problems affects them both economically and socially. To ameliorate the situation, farmer B argued that there should be the construction of water infrastructure such as dam or reservoir for the local inhabitants so that they can have access to water and use it all year round. Farmer B argued that the government should provide watercourses made of cement which can last for a very long time without replacement to each farmer which can help not only the farmer but the state itself to save water. However, it remains to be seen if the government can support the farmers with the infrastructure needed. Particularly as Khan (2009) has pointed out, corruption and governance challenges facing Pakistan make it difficult for the farmers' sentiments to be heard and addressed. Even when the Central Government releases funds for the construction of the water infrastructures it is likely that it will not be delivered but instead diverted to other areas

by officials. This mismanagement is a big challenge for farmers and particularly for their livelihood strategies.

6.2 Case study 2: Rain water cultivation

Khan (2011:82) asserts that the districts of Mianwali, Bhakkar, Jhang, Khushab, including Layyah, and Muzaffargarh make the Thal desert. The climate of Thal is arid, it is a hot and dry desert where scarcity of water prevails and the average annual rainfall is 185 mm to 300 mm. The area is rain fed consists of sand dunes and resource deficit, land is of marginal quality and poverty is inherent. Agriculture and livestock rearing are the main sources of livelihoods in the area. The main crop of Thal desert is gram meanwhile farming is extensive as scope for capital input is limited. Windstorms are a usual component which causes severe soil erosion. Due to harsh environmental factors, the biodiversity is low in the Thal desert. Because of the resource deficient community the only way to irrigate land is rain water. Figure 11 shows the rain water cultivation.

Figure 11: Rain water cultivation

Source: Author

Farmer E

Farmer E lives in the village Nawan Kot Tehsil Chobara District, Layyah. His major source of income is agriculture and livestock of some goats. His land size is ten acres and grows gram on his field.

Farmer E has no tools for irrigation and is only dependent on rain water. Land is also not much fertile as the area contains sand. Scarcity affects his farming because he relies only on the availability of rain water. During the dry season his family faces extreme poverty. From 2005 the production has been very low because of less rain. For that reason he produces gram crop because it requires less water than other crops. He cannot afford tube well water and the nature of land is also sandy and therefore it requires more power to extract water, which makes the input higher than the output. That's why he has not installed the tube well on his land. Meanwhile farmer E said rain water is an unreliable source of irrigation because you can't control the amount of water. Sometimes the water is too much in the field which is bad for crops while sometimes is too less.

The sowing time for the gram crop is during the months of November and December which is more important for the farmer and farmer E prays for rain water during that time. Farmer E has no contacts with any government or private agriculture institutions for the assistance. The farmer said he needs more developed infrastructure for water use which is lacking in area.

Farmer F

Farmer F lives in the village of Nawan Kot Tehsil Chobara in the district of Layyah. His major source of income comes from construction labor work and agriculture. He owns fifty acres of land which is blank during the whole summer season while in winter he grows the gram crop on his field.

The farmer claimed water scarcity is common in his village because the land is sandy. Farmer F works as a construction labor worker to support his family because the farming doesn't provide him with enough profit to sustain his family. Farmer F stated the summer season is too hot to irrigate the land and mostly no water is available for the crop that's why he only cultivates his land during the winter. The crop he cultivates is gram because it needs very less water than other crops to grow. Farmer F said he is doing construction labor work on a petrol pump to support my family meanwhile he owns fifty acres of land. Due to water shortage his farming is affected and is facing major economic problems. Farmer F demanded help from the government and thinks the government should be more concerned with poverty reduction in his village.

Farmer G

Farmer G lives in the village of Nawan Kot Tehsil Chobara in the district of Layyah. Farmer G land size is ten acres and he cultivates gram crop on his field. To support his livelihood expenses he additionally has a small business buying and selling of wood.

Water is scarce in the studied area and affects his livelihood. Farmer G grows gram crop during winter season while his field is shallow during summer season. The reason behind that is the same as the last farmer said. Some watercourses and one small dam are provided for the farmers in his area from the NGO named Oxfam international. The farmer said this small dam is really helpful during rainy season to store water and is helping the farmers to have a better production which minimize poverty for some farmers.

The informant described due to water scarcity they have not been able to continue their farming and many farmers have sold their animals and migrated to urban cities for work. Farmer G has another source of income in wood business because farming was not providing with much capital for his family. Besides this, the respondent admitted that people are not educated enough in this area because there are few facilities for good education and the natives lack economic activities in the village.

Farmer H

Farmer H lives in village Nawan Kot Tehsil Chobara District, Layyah. His land holdings are thirty acres out of which he tenants twenty acres from other farmer. His major source of income comes from the crops of pearl millet and gram. The farmer also has few goats and cows at his farm.

Farmer H´s main available source of water is rain water. He demonstrated that water is very scarce in their village. The farmer said canal water irrigation cost less and is effective for cropping. He wishes to have canal water but the government hasn't provided that service for his village and therefore he depends on rain water. Nobody can predict about rain only God knows. The farmer said if God will be happy from us we will have rain and good production if God will be unhappy we will not produce anything. All depends on us if we will do good deeds God will give us more rain otherwise God will make us suffer.

Farmer H claimed that the development of the village is blocked due to corruption of politicians. In one incident the provincial agriculture minister approved one road for this village. The minster then made that road only for his land to increase its value. Farmer H said the basics of life are missing in the village; there is no school and electricity. Education is important for us to improve our lives and the local politician has failed to provide schools in our area. Our children have to walk 2.5 kilometers to access the school in the neighboring village.

The agriculture is not a profitable profession now the production cost is so high sometimes he loses money. The people in the village are dependent on agriculture because there is no other form of economic activities in this area and that's why people are poor. The interviewee showed that farmers are not getting any bigger profit from agriculture which can make any change in their lives. Due to that many progressive farmers from his village are moving to urban cities to earn more money. Meanwhile the small farmers are becoming labor workers. Farmer H claimed that approximately 80% of the farmers in the village are defaulters of banks and are not able to pay the loan back.

Analysis of Case study 2

Unlike the village of Wadhewali Thesil Karor above which is close to the River Indus and that has a limitation to water because of infrastructure difficulties, the village of Nawan Kot Tehsil Chobara also in Layyah district is both water scarce and resource deficit. The lack of water and other resources including finance weakens the ability of the farmers to cultivate on

farms. This has forced some of them to leave the farming profession and instead take up other professions. There is a real need to seriously consider the situation of small farmers as this study shows as many farmers are getting desperate. Farmer G suggested that there should be a water canal in the village and big reservoirs to support the local farmers. As indicated by farmer G, one small water reservoir built by Oxfam international organization really helped some farmers, although not all farmers in the village. As water management officer Mr. Shakeel mentioned:

We do not approach small farmers as we know they will not adopt the new techniques. Sometimes the small farmers refused to adopt new approaches due to the fact that they have meagre economic resources and sometimes it is due to the less adoptability approach. He asserted the agriculture officers give attention to big farmers based on their good economic situation.

In both cases I think it is the agriculture institutions responsibility to let the small farmers participate in the system. In the current situation, small farmers are ignored which creates a lot of difficulties for them which eventually lead to economic opportunities being lost. Small farmers are not able to provide for themselves and their families which further deepen their frustration. To further aggravate this, the banking industry does not support farming activities of small farmers. The interest rate is too high for small farmers and discourages them from borrowing money to expand their activities. This also impedes their economic progression and social mobility. As farmer H articulated above, 80% of the local farmers are bank defaulters and are not able to pay back the loans they have taken from the banks. This has the negative effect of not only denying the banks the money to continue to loan money to the farmers, but also it denies other farmers the opportunity of securing loans to expand their operations which could also help them to improve their livelihoods. The banking system should set different rules for a small farmer and big farmers and give more opportunities to small farmers.

6.3 Case study 3: Canal Water Irrigation

Terpstra (1998:57) explains canal water which is cheaper and healthier for the land. Farmers have preference irrigation with canal water above irrigation with tube well water. When fields are irrigated with canal water regularly, the soil becomes more fertile, and less irrigation is needed, as the water stays in the soil longer. Using saline tube well water can stop and diminish the growth of plants, and not always does tube well water suit soil types. Even good quality tube well water lacks the good qualities of canal water. Figure 12 below shows the canal water source of irrigation in Layyah district.

Figure 12: Canal water irrigation Source

Source: Author

Farmer I

Farmer I lives in a village called Garray Wala Tehsil Karor in Layyah district. His major source of income comes from agriculture and additionally he works as a construction labor worker. The farmer owns four acres land size meanwhile he cultivates the crop wheat during the winter season and cotton and pearl millet during summer.

Farmer I prefers canal water because it's cheaper and more efficient than tube well water. The tube well water cost him more expensive because he has to pay for diesel fuel to pump water. The negative aspect of canal water is that he has to depend on the availability of water. The canal water is distributed between the farmers by canal water irrigation authority under the system of Warabandi. The water is provided to each farmer according to his land size. Farmer I get 15 minutes/ acre. The informant explained the drawback of canal water is the given time to my land which is not enough to irrigate the total area. Out of 4 acres of total land I can just irrigate 4 canals of land which are 10 % of total land during the given time. The remaining land I again have to irrigate by tube well water which is very costly due to the fuel cost.

The farmer claimed that the land only supports my basic needs like food and vegetables but the household incomes come from the labor work in construction. Farmer I therefore have to work as a labor worker in a construction company to support his family. The interviewee can't afford agriculture instruments such as tractor, laser land leveler to develop his land. Farmer I acknowledge that education is an important factor for good farming which he lacks. He said he has no communication with the agriculture offices.

Farmer J

Farmer J lives in Garray Wala Tehsil Karor village in Layyah district. His source of income is agriculture and he also rents out a tractor. He owns five acres of land and cultivates sunflower during winter and cotton during the summer seasons.

Due to water scarcity he changed his farming crop is sunflower rather than wheat because sunflower requires less water and gives him more profit. Farmer J said that farmers are not changing the farming trend which is a big setback for the area. Farmer J saves water as he cleans the earthen water passage to avoid water loss. Farmer said that the mismanagement of water is common in the village and asserts that corruption is common in the canal water irrigation department. The farmers can get more water by bribing; the farmers give bribe to irrigation sub divisional officer (SDO) who is the responsible for the water distribution in the area.

Middle men exploit small farmers as they have transportation resources and decide the prices of the crop. Small farmers don't have any other choice then to follow because they don't have any transportation facilities to sell their own crop to industries or bigger markets. Farmer J added that small farmers are totally trapped in the middle man game. The farmer suggested that the government should take initiatives against middle men who are completely controlling the market chain and entirely robbing the small farmer.

Farmer K

Farmer K also lives in village Garray Wala Tehsil Karor village in Layyah district. He is cultivating 25 acres of land out of which he is owner of only 5 acres and the other 20 acres he tenanted from other farmer. He grows cotton and wheat crops meanwhile he has a small live stock of cows and buffaloes.

Farmer K asserted that land is becoming smaller and smaller each day due to inheritance. The sources are less and agriculture is not supporting the farmers to buy additional land. Many small farmers are selling their land and changing their profession. Meanwhile big landlords have more sources and are able to buy the land from small farmers and by doing so they get bigger and more powerful.

Regarding the famer's water needs the canal water is not sufficient to irrigate his land therefore he uses tube well water as well but it's more costly due to the use of diesel power. Due to water scarcity farmer K have to spend extra money to get availability of water by pumping. Meanwhile he saves water by cleaning the water channels. The cropping inputs like seeds, pesticides, urea fertilizer, and land preparation, land plowing, irrigation and crop harvesting cost a lot of money. Farmer K doesn't get any subsidy or financial help for any of this from the Government. Agriculture officials don't take much interest in small farmers and therefore don't help them to develop their farming. At the same time there are no farmers unions in the District, Layyah but some farmers unions exist in other districts of Punjab. Farmer K suggested that there should be farmer unions in the district to enhance communication and knowledge about farmer's rights.

Farmer L

Farmer L lives in Garray Wala Tehsil Karor village in Layyah district. He is cultivating 200 acres of land and is counted as a big farmer; major source of income comes from agriculture. He cultivates sugarcane, cotton, wheat and sunflower.

Farmer L mainly uses drip irrigation and only gets about 20% from canal water. Farmer L's main goal is to use all natural sources sustainably including water. Farmer L calculates the water use under two different farming practices and concluded that one acre of land takes 8000 cusec of water under canal water irrigation while it by drip irrigation takes 4000 cusec of water so in this way he claims that he saves half of the amount by drip irrigation. Farmer L got subsided from government for the drip irrigation farming, and he added that the World Bank is funding to agriculture institutions to encourage drip irrigation in Pakistan. The farmer claimed that other farmers are not interested in agriculture more professionally and that's why they don't develop their farming. According to the farmer, the government is subsidizing laser leveling operating systems for land, cemented water courses, drip irrigation practice etc. Farmer L uses sprinkler irrigation, drip irrigation and laser leveling to save water.

Farmer L told me that the agriculture sections like soil and water quality labs, agriculture water management department, canal water irrigation department, adaptive research institute, agriculture universities and agriculture extension department and most importantly the agriculture community is not much connected with each other. All stake holders work independently and don't share their knowledge with each other while their goal is the same. There should be more collaboration between all agriculture sections.

The farmer claims that the government should regulate the agriculture market in a way that the prices don't differentiate so much. According to him the trading corporation of Pakistan should play a bigger role in the market. When the government doesn't regulate the market then the middle men have more power to fix the prices of the market sometimes can have an unfair outcome for small farmers. If the Government subsidizes farmers in Pakistan then the farmers have a better chance to compete in the international market. The farmer demonstrated that India can be a good case study for Pakistani policy makers when it comes to agriculture because both countries have almost same agricultural background but Pakistani farmers are not progressing well because of less subsidies and mismanagement.

Farmer M

Farmer M lives in village Garray Wala Tehsil Karor District, Layyah. Professionally he is a school teacher. The sources of income are agriculture and teaching job. He owns 40 acres of land meanwhile he cultivates the crops cotton, mung beans, pearl millet and the guar.

Farmer M uses tube well water, rain water and canal water for his farming. Farmer M prefers rain water, but due to less rains during the summer season he has to use other forms of water sources like canal water, tube well water and electric motors. He claimed that the electric motor used for water irrigation and tube well water pumping are more costly than rain water and canal water.

The interviewee has cemented water courses and is subsidized by the Government. Farmer M gets financial help and the guidance from the institutions which assist for farming. Farmer M added that Pakistan faced a historical flood in 2010 which damaged their crops and the economy of the country. The flood water was wasted in the sea and damaged livelihood of farmers in 2010 but rather than that it could be saved and used for agriculture farming or other purposes. The government is not able to manage water and not only in 2010 every year a lot of water is adding in sea without proper use. The government has not built any dams or big reservoirs from last 40 years.

Analysis of Case study 3

The village Garray Wala Tehsil Karor District, Layyah has all the three water resources but the available sources and opportunities are not the same for farmers. Farmer L and farmer M have government subsidies and all the collaboration from the agriculture institutions something that all the other small farmers lack, while the market rate for the crops is the same. The state does not provide the equal resources for farmers in the village and in the district as a whole. Another important factor regarding water consumption is the selection of crops and cropping patters. I would say the small farmers should be more careful and selective when it comes to the crop selection as they are already scarce in resources and they should cultivate those crops that require less water as an example, farmer J and L grows sunflower rather than wheat as wheat requires more water to grow.

Chapter 7: Concluding Remarks

Three research questions have structured this research into livelihood trajectories in the context of water scarcity in three villages of district Layyah, Pakistan. These questions aimed to study what these trajectories have been and how and why they varied between households and villages, exploring how the case household's livelihoods affected and what were their implications for the welfare of households. It also aimed to assess the effect of assistance provided by state or non state actors on household livelihood security. Evidences from secondary and primary data demonstrate that water scarcity in Pakistan has negative impact on the lives of small farmers and crops production. I believe that if Pakistan wants to get rid of water stress and support the farmers to increase their livelihood standard, a lot must be done for poor peasant farmers and distribute natural resources more equally among the households, which is not in practice so as to bridge the gap between the rich and the poor in the society.

Water is a critical resource necessary for improving the living conditions of the small farmers and for maintaining economic growth and development. Meanwhile the political structure is not too supportive to maintain the current water situation. In evaluating the impact of the Pakistani government's various water policy reforms, Khan (2009:98), concludes "the government habit of creating more institutions to cover the inefficiency of parent institutions has damaged the farming sector". Water insecurity is influenced by politics on different social levels as Rinaudo (2002:412), demonstrates that large landlords can exploit their good connections with local politicians or high-ranking administration officers to apply pressure on the staff of the irrigation agency so that their outlet can be enlarged without presenting bribes. I should say poor governance and political injustice regarding water management is making enormous share to create poor small farmers more miserable.

As Khan (2009:83) said Pakistani irrigation officers are sometimes criticized for not going into the field to identify what is happening in their jurisdictions. Corruption is a social hierarchy which is naturalized in Pakistan bureaucracy now. Pakistan does not make proficient use of the resources it does have. Weak administrative measures are an important factor in creating water scarcity. Water scarcity and insecurity is an effect of weak social and political structures and practices. This does not mean that I claim that there is not any absolute shortage of water but the organization and management of water in general and irrigation in particular turns the control of water into a political tool that seems to establish and strengthen inequalities. The technological solutions as Cauton (2009) recommends some of them on the next page are also important to overcome water scarcity but I would say politics has a bigger role having farmers water scarce in Pakistan and Layyah in particular. The dominance of powerful people is quite common in Pakistan agriculture system. The poor farmers are completely ignored and even there is no interest of state actors to improve their life. The official representative stated that he is not interested in modernizing small farmer's agriculture shows the lack of interest to help them to improve their livelihood.

Additional findings of this research are the adaptability to more water efficient technologies such as drip irrigation, infrastructure for water and crop selection. As Cauton (2009:121) claims, improved technology such as drip irrigation is an excellent way to improve the production of crops and save water. I have seen some big farmers in Layyah district that have used drip irrigation and got good results. But small farmers seem to lack a drip irrigation approach my suggestion is that the government institutions should expand subsides for small farmers to have drip irrigation on their farms. A drip irrigation approach will increase the production of crops and also improve the livelihood of small farmers. A proper tax collection can also help the Government to improve the infrastructures in the villages to minimize water loss. Khan (2009:99) calculates that approximately $750-875 U.S. million is lost every year due to inefficient taxation.

Another important finding was the lack of communication between government institutions and small farmers when it comes to manage water sustainably. The farmers that are communicating with agricultural institutions tend to be able to increase their production and save water more than the farmers who don't have guidelines from the district administration. Kinje (2001:116) asserts that the cropping pattern is really important to combat water scarcity as rice and sugarcane are more water demanding crops than wheat and sugarcane. A crop selection approach should be adopted by all the farmers', but I only observed two farmers doing that (farmer J and L). These farmers grow sunflower rather than wheat because wheat requires more water to grow.

During my field work I observed that there was no legislation concerning the extraction of water. A landowner can install a tube well and begin pumping groundwater as he likes. As mentioned by Afzal (1996:979), there is neither any mechanism for allocation of ground water rights nor for regulating its use in Pakistan. This is a serious situation as local farmers are not aware of the current water scarcity of Pakistan. Capacity building for the small farmers is hence required, which is directly connected to education. Without the right knowledge the farmers will lack good strategies to install effective farming. The poverty is also a big drawback for the agriculture of Layyah. The minimum financial capital of small farmers does not allow the purchasing of agriculture machinery that is necessary in order to have a profitable farming. There should be community awareness seminars held by the agriculture institutions and subsidies for small farmers in the district. There is a huge amount of farmers who own less than 5 acres of land. A redefinition of what counts as small farmer will give more opportunities to real small farmers to have subsidies from the government.

The Government, institutions, and groundwater users need to formulate a joint policy and together manage the water resources to ensure that every one who needs water, and particularly the farmers, could have access to it. As water is a delicate natural resource, and climate debate points to several unforeseen problems, government, farmers and the private sector should become actively involved in managing the water in Pakistan so as to avoid problems now and in the future.

Appendices:

Appendix A:

Response of the farmers							
Name of Farmer	Gender	Age	Type of farmers	Land size	Water Availability Source	Land Status	Education
A	Male	32	Small scale farmer	12 acres	Ground Water	Owner	No
B	Male	25	Small scale farmer	10 acres	Ground Water	Owner	School Only
C	Male	43	Progressive Farmer	50 Acres	Ground Water	Owner +Tennant	School Teacher
D	Male	27	Progressive Farmer	30 Acres	Ground Water	Owner +Tennant	School Only
E	Male	60	Small scale farmer	10 Acres	Rain Water	Owner	No
F	Male	25	Small scale farmer	50 acres	Rain Water	Owner	No
G	Male	29	Small scale farmer	10 acres	Rain Water	Owner	School Only
H	Male	47	Small scale farmer	30 acres	Rain Water	Owner + Tennant	No
I	Male	54	Small scale farmer	4 acres	Ground, Surface, Rain Water	Owner	No

J	Male	39	Small scale farmer	5 acres	Ground, Surface, Rain Water	Owner + Tennant	Primary
K	Male	44	Small scale farmer	25 acres	Ground, Surface, Rain Water	Owner + Tennant	No
L	Male	30	Big famer	200 acres	Drip irrigation	Owner	Masters from University
M	Male	51	Progressive Farmer	40 acres	Ground, Surface, Rain Water	Owner	School Teacher

Source: Author

Appendix B:

Questionnaires (Water management in the District)

Title: How the peasants cope with and adapt to water shortage: A case study from Layyah, Pakistan

1. Name of the respondent _____

2. Designation of respondent _____

3. Working experience of respondents _____

4. What are the main aims of your department to resolve water issues?

_____

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5. Please mention the areas in which your department working to overcome water shortage?

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_____

6. What are the challenges your department is facing to compete water issues?

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7. What measures do you follow to resolve the water problems in affected areas?

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8. Have you any collaboration with other organizations regarding water scarcity?

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_____

9. What type of working structure do you follow to work with other organizations?

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10. Suggestion for the improvement of water management strategies

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Appendix B1:

Questionnaires (Farming community)

Title: How the peasants cope with and adapt to water shortage: A case study from Layyah, Pakistan

Demographic information of the respondents

1. Name of the respondent _____

2. Village _____

3. Age (Years) _____

4. Land holding (Acre) _____

5. Education (Years of schooling) _____

6. Tenancy Status; i) Owner _____ii) Owner-cum-tenant _____iii) Tenant_____

7. Marital: status i) Single _____ ii) Married_____

8. Size of your family _____

9. Type of family i) Nuclear _____ii) Joint____

10. Major source of income _____

11. Net annual income (Rs.) _____

Objective No. 1: To discover how does water shortage affect the livelihood of the peasants.

12. What are the main available resources of water for Local farmers?

- Tube well
- Canal water
- Rain water

13. Which resource of water more convenient for your farming activities?

_____

_____

_____

_____

_____

_____

14. Are you satisfied with the availability of water throughout the year?

- Yes
- No

15. To what extent water shortage affecting your livelihood?

- Least affecting
- Affecting
- Highly affecting

16. In which crop season you face water scarcity problem?

_____

_____

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_____

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_____

17. What are the main affects of water scarcity on your livelihood?

_____

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Objective No. 2: To analyze and evaluate the small land holder's strategies to cope with water shortage.

18. What measures do you follow for efficient utilization of water?

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_____

19. Do you have any collaboration with authorities to fulfill your water need?

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20. What are the main hurdles you face to overcome the water issues?

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_____

21. What suggestions you will suggest for sustainable use of water?

_____

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_____

References

Abbas, A.M. (2004) *General Agriculture' 3rd edition*, Lahore: Emporium Publisher.

Afzal, M. (1996) 'Managing Water Resources for Environmentally Sustainable Irrigated Agriculture in Pakistan' *The Pakistan Development Review*, vol. 35, no. 4, Winter, pp. 977-988.

Ahmad, M. D.; Turral, H. and Nazeer A. (2008) 'Diagnosing irrigation performance and water productivity through satellite: remote sensing and secondary data in a large irrigation system of Pakistan', *Agricultural Water Management Journal*, vol. 96, no. 4, April, pp. 551-564.

Anwar, H. N., Zafar, M. I and Hussain, S. (2006) 'Evaluation of Punjab Rural Support Program: The Case of Lahore Region' *Pakistan Journal of Life and Social Sciences*, vol. 4, no. (1-2), pp. 58-62.

Arif, G.M. (2004) '*Bonded labour in agriculture: a rapid assessment in Punjab and North West frontier province, Pakistan'*. Special action programme to combat forced labour, working paper series no. 25. Geneva, ILO.

Bhatti, A.M., Suttinon, P. and Nasu, S. (2009) 'Agriculture Water demand management in Pakistan: A Review and Perspective' paper presented at the *Society for Social Management Systems.*

Bhutto, A.W and Bazmi, A. A. (2007) 'Sustainable agriculture and eradication of rural poverty in Pakistan' *Natural Resources Forum*, vol. 31, pp.253-262

Bureau of Statistics, (2012) *Punjab Development Statistics*, Lahore: Government of the Punjab.

Chambers, R. and Conway, G. (1992) '*Sustainable rural livelihoods: practical concepts for the 21st century'* Brighton: UK, Institute of Development Studies. IDS Discussion Paper No. 296.

COAG, (2007) '*Agriculture and Water Scarcity: a Programmatic Approach to Water Use Efficiency and Agricultural Productivity Comparing notes on institutions and* policies' International Water Management Institute ,Colombo.

Coltrain, D. (2000) 'Value added: Opportunities and strategies' Department of Agricultural Economics, Kansas State University. *Conference proceedings*: World environment day, pp. 82-88.

Coping with water scarcity: A strategic issue and priority for system-wide action, (2006) United Nations - Water.

Coping with water scarcity: Challenge of the twenty-first century, (2007) United Nations – Water.

Couton, A. (2009) 'Tackling the Water Crisis in Pakistan: What Entrepreneurial Approaches Can Add', in Kugelman, M. and Hathaway, R. M. (ed.) *running on empty, Pakistan's Water Crisis*: Woodrow Wilson International Center for Scholars, Washington, D. C.

Directorate general Agriculture, (2012) *on farm water management: water management Punjab*, accessed: 12 February 2014, from http://www.ofwm.gop.pk/about_obj_func.html

Directorate of Industries, (2012) '*District Pre-Investment Study Layyah'*, Lahore, Punjab Poonch House.

Ellis, F. (2000) *Rural Livelihoods and Diversity in Developing Countries*, London: Oxford University Press.

Gill, M. A. and Mushtaq, K. (1998) *'Case study on agriculture department of Punjab province'*, Pakistan national program, international irrigation management institute, Lahore.

Government of the Punjab, (2012) *Soil fertility: Punjab portal: all about Punjab at one place*, accessed: 4 march 2014, from http://www.punjab.gov.pk/toba_tek_singh_agriculture_soil

Hanjra, M. A. & Gichuki, F. (2008) 'Investments in agricultural water management for poverty reduction in Africa: case studies of Limpopo, Nile, and Volta River Basins', *Natural Resources Forum*, vol. 32, no. 3, pp. 185–202.

Hanjra, M. A. & Qureshi, M. E. (2010) 'Global water crisis and future food security in an era of climate change', *Food Policy*, vol. 35, May, pp. 365–377.

Haq, A. U. (1998) '*Case study of the Punjab irrigation department*', Pakistan national program, international irrigation management institute, Lahore.

Kamal, S. (2009) 'Pakistan's Water Challenges: Entitlement, Access, Efficiency, and Equity', in Kugelman, M. and Hathaway, R. M. (ed.) *running on empty, Pakistan's Water Crisis*: Woodrow Wilson International Center for Scholars, Washington, D. C.

Khan, F. (2009) 'Water, Governance, and Corruption in Pakistan', in Kugelman, M. and Hathaway, R. M. (ed.) *running on empty, Pakistan's Water Crisis*: Woodrow Wilson International Center for Scholars, Washington, D. C.

Khan, R. A. (2011) 'Creating forests resources in thal desert for combating land degradation', *Conference proceedings:* World environment day, pp. 82-88.

Kijne, J.W. (2001) 'Lessons learned from the change from supply to demand water management in irrigated agriculture: a case study from Pakistan', *Water Policy*, vol. 3, April, pp. 109–123.

Kugelman, M. (2009) 'Introduction', in Kugelman, M. and Hathaway, R. M. (ed.) *running on empty, Pakistan's Water Crisis*: Woodrow Wilson International Center for Scholars, Washington, D. C.

Maxwell, S. & Smith, M**. (**1992) 'Household food security: a conceptual review', in Maxwell, S. and Frankenberger, T. (ed.) Household food security: concepts, indicators, and measurements: A technical review. unicef and IFAD.

Pakistan board of investment Pakboi, (2006) '*Agriculture: Food, Water and Land'*, accessed: 2 March 2104, from

http://www.pakboi.gov.pk/pdf/Agriculture,%20Food,%20Water%20&%20Land%20Vision%202030.pdf

Rijsberman, F. R. (2006) 'Water scarcity: Fact or fiction?' *Agricultural water management journal,* vol. 80, August, pp. 5-22.

Rinaudo, J.D. (2002) 'Corruption and allocation of water: the case of public irrigation in Pakistan', *Water Policy,* vol. 4, pp. 405–422.

Seismic zoning map Pakistan (2010), United Nations - Habitat, accessed: 14 march 2014, from http://www.unhabitat.org.pk/Maps-updated/UNH-PAKOV_SZ_A3_02122010.pdf

Shah, T.; Hussain, I.; Saeed-ur-Rehman. (2000) *'Irrigation management in Pakistan and India: Comparing notes on institutions and policies',* International Water Management Institute working paper 4, Colombo.

Terpstra, A. (1998) '*Tenancy and Irrigation Water Management in South -Eastern Punjab, Pakistan',* International Irrigation Management Institute report No.46, Pakistan.

Water scarcity and desertification: Thematic fact sheet series no.2 (2009) United Nations convention to combat desertification.

'Water course lining: the hurdles', *Dawn.com* (19 December 2011)