Qualitative Analysis of Non-capital Barriers to Farmers' Acceptance of Efficient Irrigation Saving Technologies in District Loralai, Balochistan

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CERTIFICATE

This is to certify that this thesis entitled: "*Qualitative Analysis of Non-capital Barriers to Farmers' Acceptance of Efficient Irrigation-saving Technologies in District Loralai, Balochistan*" submitted by Mr. Mohibullah is accepted in its present form by the Department of Development Studies, Pakistan Institute of Development Economics (PIDE), Islamabad as satisfying the requirements for partial fulfillment of the degree in Master of Philosophy in Development Studies.

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Dedication

To my family, friends and all well-wishers.

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Abstract

In South Asia, the spectacular increase in food production is attributed to ground irrigation. Ground water usage has gone unprecedented in scale as well as intensity leading to the depletion of the resource. In Pakistan, the sustainability of the irrigation and agriculture is under serious threat due to the decrease in water table as a consequence of excessive extraction of ground water leading to the extinction of Karez system of irrigation. In this study, an attempt was made to figure out how the farmers cope with decreasing water table and their strategies by converting to less water requiring agriculture like orchard farming. This technique was extracted from literature and was investigated in the field by finding its factors of adoption and non-adoption amongst farmers. Qualitative research method was used to conduct field work in Loralai District, collecting data from farmers of different villages. The data was then analysed using thematic analysis, which led to findings of this research like unsustainable economic gains on water intensive vegetable crops [cauliflower], high weather vulnerabilities of tree crops [almond], inconsistent water resource in the region and some indigenous water saving strategies like water tank irrigation technique and crop shifting. Based on the findings, it was concluded that, quick economic gains on vegetable crops, lack of government incentives on drought resistant crops like almond and following the trend of popular growing crops are the factors that hindered the process of adoption of efficient irrigation technology.

CHAPTER I

Introduction

1.1.Background

In the recent times Irrigations systems face huge pressure to produce maximum agricultural production with less supply of water. This target could be achieved now with the advent of more advanced and efficient irrigation innovations, which could increase production and reduce environmental issues like excessive extraction, pollutants and energy use (Faures et.al, 2007).

In South Asia the spectacular increase in food production could be attributed to ground water irrigation. The timeliness and reliability of ground water has created it as an integral unit of the green revolution of the region since 1970's. However, it is also the most mined resource of the world (Mukherjee et al., 2015). In the recent decades, ground water usage has grown unprecedented in scale as well as intensity in many regions, leading to the depletion of ground water aquifers (Giordano, 2009; Wada et al., 2010; Kulkarni et al., 2015). A report on the Himalayan glacier melt by National Research Council (2012) argued that the over use of the ground water in the Indo Gangetic Basin is a bigger issue than the climate change impacts and air pollution. While in Pakistan, the sustainability of irrigation and agriculture is under serious threat due to the decrease in the water tables in the non-canal areas (Steenbergen and Oliemans, 2002).

The province of Baluchistan is termed as the most arid part of the country. It is entirely dependent on the ground water except from some areas. Baluchistan constitutes 44 per cent of Pakistan's total land with population of 12.34 million people with growing rate of 3.37 per anum as per the Pakistan Bureau of Statistics (2017). The main production of the region includes Onion, Barley, Wheat, and fruits like Cherry, Apricot, Apple etc, and also vegetables.

Historically most of the region of Baluchistan relied on *Karez* System of Irrigation. However, with the advent of modern pumping technologies combined with repeated droughts, institutional support for pumping system and population growth changed the shape of water and land in Baluchistan. These changes were intensified by the interest free loans and subsidies by international donors and Government with the realization that new pumping technologies would bring profit and more land under cultivation (Altaf et al., 1999, Mustafa and Qazi, 2008, Rehman 1981, Steenbergen and Olieman, 2002).

This resulted in an uncontrolled shift from the traditional *karez* system to tubular wells and drastically altered the social, environmental and economic landscape of Baluchistan (Steenbergen and Olieman, 2002). The tube well irrigation increased by almost 400 per cent which included new areas and also about 70 per cent of land which was previously cultivated by *karez* irrigation system (Garces, 1993, Hussein et al., 1996). Consequently, water table fell drastically in various regions of Province affecting both the *karez* and shallow wells (Chaudry, 2010, Khan, 2008, Qureshi et al., 2010). This led to 30-150, meters decline in aquifer over the past few decades in Baluchistan (Ahmad, 2007).

Keeping all the above discussion in mind, the question arises is that what should be done now? Indeed, it is almost impossible to reverse the previous irrigation transition because of different socio political reasons. Tubular wells often bring new areas under irrigation and also benefit relatively poor people of the region. In addition, the issue of excessive ground water extraction has many social and political implications in the province.

1.2. Statement of the Problem and Justification

Various studies have been conducted so far in Baluchistan directed towards different appalling issues of ground water management starting from water scarcity to the revival of traditional karez system of irrigation (Mustafa and Qazi, 2007, Memon et al. 2017). In addition, on the willingness of farmers to adopt tube wells (Khair et al., 2015), the role of subsidies (Khair et al. 2012). Despite, some research on the importance of water saving technologies (Altaf et al. 1999, Ahmad 2016, Memon 2017). The most relevant research in this regard in this area (i.e. Loralai) is done by (Memon et al. 2017) which investigated quantitatively the "Farmers` acceptance of efficient irrigation technologies", however, the study focused only on the capital oriented specifications/scenarios in relation to technology adoption/acceptance and focused on technologies that require mechanical alteration (such as drip irrigation) that require farmer capacity to comprehend. In fact, there is a plethora of technologies such as planting of water resistant plants, preferring long term sustainable income on short term high profits returns (as in case of growing vegetables), all of which require farmers to realize water as scares commodity and a concern about future of their agriculture activities in case of further drop down in water table. Many of such technologies are not as capital-intensive as the drip irrigation systems investigated by Memon (2017).

Over the years, farmers indeed responded to escalating water scarcity in form of shifting to low-water demanding crops such as almonds, olives and others, to cope with the exacerbated water table conditions in region. However, there is very little research on the characteristics of those farmers and there is literally no clue on what make these farmers different from the rest which is still trapped into cultivation of high water demanding crops such as vegetables. Such an understanding is very important from policy perspective as the factors determining farmers who are more inclined to water saving technologies may be subject to policy interventions so that this environmentally and socially important trend can be further strengthened. This research has tried to fill this gap by trying to qualitatively find the reasons behind the Crop shifting and non-shifting patterns of farmers of district Loralai, Baluchistan, as this approach suits best region like Balochistan where people do not have sufficient resources and knowledge to invest in capital oriented modern water saving technologies like Drip and Sprinkler technologies.

1.3.Objectives of the Research

The objectives of the research are to:

- To investigate the non-capital barriers to adoption of water saving technologies namely, Crop Shifting, Irrigation Scheduling, moisture monitoring
- To suggest policy recommendations for coming water laws/regimes in the water scarce province of Balochistan.

1.4.Research Structure and Outline

This study is comprised of five chapters. Chapter 1 has introduction, research problem and objective. Chapter 2 deals with the review of the existing literature. Chapter 3 is all about the methods, methodologies, and data analysis. Chapter 4 composed of results and discussion from the collected data. Chapter 5 contain conclusion, and recommendation.

CHAPTER II

Literature Review

This chapter represents a familiarity with the body of knowledge and creates credibility of research with prior researches. The variables in this study are extracted from the literature reviewed and also from the work done in the field.

2.1. Irrigation Livelihood Nexus

Irrigation provides better livelihood through proper water usage. Water control in irrigation can increase production and income by providing higher yields and also quality by removing water deficiency. It secures crop production even in variable and inadequate rainfall regions (Smith, 2004). In addiction it provides very cheap and secure fodder for livestock. About 17 per cent of total cultivated land of the world provides 40 per cent of global cereals (FAO, 1996). Between 1996 and 1990 only irrigation provided 92 per cent of world grain production (International water management institute (IWMI), 2005). Huang et al. (2005) argues that income share from irrigation is much more for a poorer household than the richer ones. It accounts almost 60 per cent share of income from irrigation cropping for poor and about 10 per cent for rich household. According to the report of FAO (2011), cited in Walter and Groninger (2014), half of the gross domestic product (GDP) of Afghanistan is provided by agriculture (irrigation). Although less than 6 per cent of land is cultivated and only 15 per cent is arable. furthermore, Torell and Ward (2010) found that about 80 to 95 per cent of population of Afghanistan live in rural areas and are indirectly or directly connected to agriculture (Walters and Groninger, 2014).

According to the International Water Management Institute (IWMI) study, about 50 per cent of the growing water demand by 2025 could be met with the increased effective irrigation system (seckler et.al, 1998). The solution to the growing demand for ground water and the excessive depletion of ground water tables is two folded. First is the supply side management including water resource management through different irrigation projects and also through water shed management. Second, is the demand side management of water through efficient use of water resource, which include drip irrigation and sprinkler system. In addition, it includes demand management strategies like water pricing, turn over water system and water users association (Kumar, 2012).

Drip irrigation is much more efficient at water saving as (in comparison of) compared to flood method of irrigation (FMI) (Narayanmoorthy: 1997). The irrigation efficiency of drip irrigation on-farms is about 90% as compared to 70% of sprinkler and 45% of surface irrigation method including FMI (Sivanappan; 1994, INCID, 1994).

However, Benouniche et.al (2014) argues that the real results of modern technologies are much more different in the field. The main objective of these technologies as envisioned by the state/inventor is water saving but, in the farmers view the modern technologies are more of a tool for saving water cost and intensifying their crops production (Knox et al., 2012, Luquet et al., 2005). They adopt them for intensifying the agriculture. In addition, the adaptation of modern technologies for them is sign of social status. The farmers more often over-irrigate their fields using modern technologies. Thus, the saved water by new technologies is lost in over-irrigation. Therefore, the use of modern irrigation technologies do not lead automatically to water saving.

2.2. Determinants of Technology Adoption

The most significant determinants of adoption of micro-irrigation technologies are the ground-water access, availability of cash, cropping pattern, level of education, poverty status and the social status of farmer (Namara, Nagar, & Upadhyay, 2007). The high cast households are expected to have a higher probability of adopting micro-irrigation technologies. Similarly Kumar (2012) points out some of the important determinants of drip irrigation adoption like, experience of farmer in irrigation, ratio of spaced crops production, farm size and the proportion of income earned from non-farm activities.

The cost of water also determines the level of acceptance of the farmers to adopt the water saving technologies. If the cost of water increases, the possibility for adopting water saving technologies increases. In addition, the amount of land under irrigation also affects the likelihood for adoption of irrigation technology (Negri and brooks, Caswel and Zilberman (1985)). The more irrigated acreage tend to decrease the adoption of advanced irrigation technologies i.e., Drip, Sprinkler etc. furthermore, climate also plays a vital role in technological choice (if there is more rainfall then there is adoption for technology because technology presents more controlled irrigation in rainfall). In hot and windy season technology (Sprinkler) is not good because water evaporates. So water is lost. Moreover, the users of ground water would more likely to adopt modern irrigation technologies than surface water users. In addition, the water-price i.e. tax could induce adoption of modern irrigation technologies and could lead to substantial saving (Caswel and Zilberman (1985).

2.3. Cropping Pattern and Adoption Behaviour

There are two main obstacles in in agricultural production which are labour and water shortage. They affect the cropping pattern as well as adoption of efficient irrigation technologies (Kumar, 2012). Farmers respond to these constraints by diverting to less water and less labour intensive crops. Water intensive crops such as sugarcane, cotton, vegetables are replaced by less water taking plants like coconut (in loralai it could be Almond) and then it is followed by adoption of efficient water technology i.e. drip irrigation as it reduces reliance on both excessive water and labour.

2.4. Theories Explaining Adoption of Efficient Irrigation Technologies

Rogers's theory of Diffusion of Innovation is the best example to begin with. According to Rogers (2003), adoption is a decision of "full use of an innovation as the best course of action available" and rejection is a decision "not to adopt an innovation" (p. 177). Rogers defines diffusion as "the process in which an innovation is communicated over time thorough certain channels among the members of a social system" (p. 5). As stated in the definition, innovation, time, communication networks, and social structure are the four main constituents of the diffusion of innovations (Sahin, 2006).

According to Steanbergen et.al (2014) "resource depletion either lead to cooperation or conflict" in specific area. But in Kuchlagh Balochistan neither cooperation nor conflict happened. Whereas the Ground water level fell very drastically due to extensive extraction starting from 1980s onwards due to increased amount of dug-wells. However, the users of ground water responded unexpectedly by changing their livelihood from agriculture to other economic activities fortunately presented by rapid urbanization in the area. The rapid decline or even the drying of aquifer of the region is attributed to many factors including population growth due to refugee influx, good economic returns on orchard garden, subsidized electricity by the government, no local water management mechanism and lack of local leadership who would take the initiative of restricting ground water extraction.

2.5. Synthesis of the Literature Review

Based on the literature studied it can be inferred that in wake of climatic changes and irregular precipitation, usable water is under stressed from over consumption (Giordano, 2009). Agriculture is the sector whose consumption of water is alarming and has stirred researchers and policy makers to tackle the challenge. It has been observed that traditional irrigation system Karez, before the advent of electricity run tube wells, was an effective and efficient mechanism for using water economically and prudently. It had no negative impact on the water table. However, with the advent of tube wells irrigation share in water consumption hiked tremendously, causing water table plummet (Steenbergen and Olieman, 1997).

Previous studies suggest that farmers shift when from labour intensive and water intensive crops to the one which require less labour and water (Kumar,2012), i.e., crop shifting is one of the strategies which farmers employ to maximize their profits.

CHAPTER III

Research Methodology

Ontological and epistemological assumptions provide basic foundation for research methodology. If a researcher is aware of these assumptions, he will understand his position and phenomena under study in a better way. Research methods can be said as the techniques used by the researcher to collect data (Bryman, 2012). Similarly, Blaikie (2000) defines research methods as the techniques or procedures employed to collect data. Whereas methodology refer to the process employed by researcher to solve research problems step by step (Kothari, 2004).

Qualitative method was used in this study as qualitative research emphasis more on situational and structural context as compared to quantitative method (Strauss 1994:2). In addition, qualitative research design stresses subjective understanding of the phenomena under study (Neuman 2013, chap.4).

3.1. Universe

Universe of this study included all farmers of District Loralai Balochistan.

3.2. Unit of Analysis (Target Population)

Unit of analysis in this research was farmers from those villages where there is a declining water table as there are many areas/villages of District Loralai which are on the verge of drought while other villages are comparatively much better in water conditions.

3.3. Sampling Technique

Purposive sampling was used to collect data from farm respondents. This technique suited this research because researcher aimed in-depth understanding of farmers' viewpoint about the mesmerizing and exacerbated water availability conditions.

3.4. Sample Size

Many researchers argue that sample size selection prior to research is inherently against the philosophy of qualitative approach. Rather, the principle of saturation should be followed. There are some rules to select sample size which are based on conceptual model, numerical guidelines and statistical formulas. Sample size can range from one to more than hundred, depending upon the nature of research question and quality of interview (Sim et al 2018). Researcher followed the principle of saturation in the process of data collection from villages of the universe (District Loralai).

3.5. Tools for Data Collection

An interview guide was used, which covered the important areas of the related to the objectives of this study to assist interview process. Qualitative interview is best suited when it is less structured and it allows researcher to be flexible, contextual and creative (Babbie 2013:340).

3.6. Techniques for Data Collection

In-depth interviews were conducted to gain deep understanding of farmers' understanding of the sever water conditions. Because, an in-depth interview started with rapport building and it gives time for a researcher to establish relationship with the subject. Furthermore, it is considered more appropriate to explore feelings, intentions, motivations and attitudes or behavior (Hayink and Tymstra 294).

3.7. Data Analysis

Quantitative analysis is an unstructured research technique in which data identification is employed (Sarantakos 2012). Herein researcher finds pattern of data and search for repetitive behavior and events. It is a technique in which there is data is organized and interpreted. In this research endeavor, thematic analysis was used.

3.8. Thematic Analysis

It is one of the most frequently employed research technique in the qualitative data regime (Bryman, 2016). It was used to generate themes from the data. Themes were generated in the field from the conversations of the respondents and then those themes are elaborated in the light of their views (Andrew and Henry 2015). Interviews were conducted in Pashto and were transcribed using clean transcription to avoid repetition and unhelpful phrases. This transcription was then translated into English. These interviews are studied and analyzed to find themes. It is pertinent to mentioned that original Pushto transcriptions are available upon request.

CHAPTER IV

Results and Discussion

This chapter is dedicated to the findings and results obtained in this study. Using thematic analysis, themes are identified in the findings of this study. These themes are presented under different headings with relevant quotations. In the final section of this chapter is a detailed discussion in light of the research findings.

4.1. Water Management Issues

Water is the scarcest resource in the arid geography of Balochistan. Unfortunately, it is the most unmanaged and carelessly used resource and the theoretical deliberations that a certain degree of scarcity is necessary to trigger sustainable resources management seems not holding here (Ostrom 1990). There are many reasons behind this attitude toward water resource. The most scaring fact is that people do not acknowledge it is a scarce resource in the first place let alone the sense of saving it. In addition, it is used very excessively by growing high water demanding crops e.g., Cauliflower. It is because these plants are yield higher returns compared to less water requiring plants like Almonds. Similarly, high water requiring plants are also preferred because of their resilience in the form of multiple time production to weather vulnerabilities like hail storming, unexpected cold and strong wind flowing. In the succeeding sub-sections each of these issues/themes is discussed based on what emerged out of qualitative field data.

4.1.1. Transition in Irrigation Infrastructure

It is important to shed some light on the traditional irrigation system of Balochistan. Traditionally irrigation in Balochistan was to be done through Karez system, a system of water tapping through underground channels and interconnected wells connected to a mother well dug into the water table (Mustafa and Qazi 2008). It was regarded as the most sustainable, environmental friendly and had no impact on the water table. This system was sufficient for the irrigation needs of the time. As one respondent pointed to this effect:

> "20-25 years back, Karez water was used for irrigation. That water was very much effective as compared to today's water".
>
> Haji Juma aka, aged 65 years

With the advent of electricity, people started installing tube wells to expand their agriculture (Steenbergen and Olieman, 1997) this started heavy extraction of water in the region. To make the matter worse, water intensive vegetable crops were cultivated and with this tube wells were installed in massive amount and substantial water extraction took place. With this water table started declined and is still declining and the water in Karez depleted. These findings are vividly explained by one respondent in these words,

> "Before that, there was karez system of irrigation. Everybody had their own time and date of their part of the karez water depending upon the size of their land holding. So when karez water start becoming insufficient and also with the availability of electricity to the region, people started extending their agriculture to a higher level, and started installing tube wells. Tube wells were considered as one's personal karez. We sold a small part of our land and installed two tube wells at that time".
>
> Abdul Samad, aged 35 years

> "With time the ''karez system'' of our area was depleting and we anticipated that the drought is coming. So, people started 'dug well' to retain the water supply and also to extend agriculture/farming to the barren lands".

Haji Ali, aged 51 years

To retain the water table and to restore Karezez of the region somewhat however, the Government of Balochistan has taken some positive steps in this regard. Government of Balochistan is engaged in karez reconstruction and rehabilitation. Karez rehabilitation is supplemented by the installation of hand-pumps, drinking water supply schemes and sanitation scheme. The Government of Balochistan has spent Rs 40 million extending and improving 100 karez in Balochistan. Most of these, 23 in all, were rehabilitated at a cost of Rs. 8.28 million. The government has also recently built a number of water storage bunds and dams which are linked to the karez (Appell and Baluch 2004*)*. The Delay Action Dam of Uryagai is recently constructed (2018) near the mother well of Uryagai Karez, which will help restore the water in the karez after rain falls in the region. In addition, a proposal is being sent by Sub-Division Irrigation section Loralai, to the secretary for the approval of reconstruction and rehabilitation of Gurmai Karez.

> ‘’We are trying our best to restore the dead karezez of the region because karez system is nature and environmental friendly. Also it is beneficial for the people of the region’’.

Waseem khan SDO Irrigation

Furthermore, eleven small to medium to large dams have been constructed in the region over the past 4-5 years of time. They include; Bawar Storage Dam (2018), Azad tah Dam (2016), Uryagai Check Dam (2018), Sheen Ghar Delay Action Dam (2018), Murtat Delay Dam (2017), Landai Khwla Dam (2017), Baz Barad Spra Dam (2018), Pathan Kot Dam (2020), Zara Nalai Dam (2017), Barad Thairag Dam (2018) and Karkana Dam (2016). These dams will help to restore water table as well as karezez to some extent of the region in coming future.

4.1.2. Sure but Unsustainable Economic Gains

Vegetable like Cauliflower and tomatoes are the crops which are grown extensively in the Loralai region. These crops require massive amount of water which is unimaginable in a region that lacks adequate rain (less than 225 mm) and lies outside Indus Irrigation System, if seen from sustainability point of view. In practice however, despite severe scarcity of water in the region, these crops are grown/preferred over various other water saving crops. As per literature Knox et al (2012 the main reason behind this is the quick economic returns, for instance on vegetable crops in this study, while altogether ignoring the scarcity water. An interviewee states:

> "Vegetables give good profit compared to tree crops [Almonds]. One of the other main causes for the good profit on vegetable crops is that we grow on different intervals, if one plot does not get good price the other [probably] would, if the other also does not the third will and it goes on. Whereas, tree cropping has only one-time market pricing otherwise you have to stock it."

Haji Ali, aged 51years

By producing multiple productions on vegetables, the likelihood of getting good prices increases. This advantage over the crops like almond compel farmers cultivate high water demanding crops like Cauliflower. As one the other farmer's told:

> "One of the main reasons why people [many like me] do not prefer tree cropping over vegetable crops is that the vegetables earn three to four times more than trees.

Because, tree plants produce only once in a year, people want to get more profit in less time, as there are good varieties of vegetables. Tomato has now very advanced seed, which can produce many times in one season, and same is the case with cauliflower."

Bara Khan, aged 39 years

Similarly, another farmer relates high water demanding crops with good profit/incomes:

"Our fruit products are very cheap [are not sold at good market price], why would I grow tree crops [Almond trees]? Comparatively vegetable crops have very good market prices. This is the main reason why people [increasingly tend to] grow vegetable crops in our region."

Fazal Muhammad, aged 48years:

However, not all farmers lack concern over depleting water source and there are many who condemn increasing trends towards vegetables. A respondent states this quest for quick economic gains as greed of farmers while saying:

"It is the greed that has led us to these miserable conditions, the greed to earn more and more money."

Haji Juma Aka, aged 65years:

Moreover, the unchanging demand for vegetables growing in the region is described by respondent as:

"The main reason for the inflexible demand for vegetable cropping despite severe water shortage is that, these crops have very good market prices and demand."

Saeed Khan, aged 29 years:

However, there is a more rational argument contradicting the aforementioned claims, as one respondent argues that the income on vegetable crops is only gross, by including the heavy expenditures/input costs in the accounts outlay the real profits become meagre:

> "Vegetable crops are good in giving quick profits. For the time being this seems good, but for the longer run it is nothing but wastage of time and energy due to the heavy costs of vegetable crops [associated with fertilizers and pesticides]. On the longer run, tree crops like Almond are economically more productive".

Sikender khan, aged 36years:

4.1.3. Weather Vulnerability

Weather vulnerability is a consideration only for tree crops like Almond and pomegranate, because it affects the production of tree plants the most. Whereas for vegetables crops like Cauliflower and Coriander [Dhania], weather change is very mildly affective on its production, because vegetable crops have a very less time duration between plantation and produce. In addition, vegetables also have the advantage of multiple production quality in a season, which makes them better in terms of continuous incomes flow throughout the year – which is clearly not the case with its competing crops like Almonds. Tree plants [Almond] lack this advantage, and are easily affected by unexpected changes in weather particularly during May and August. According to a respondent:

> "If there happens a sudden weather change in season time (like cold) then the farmer is surely bankrupted for that year if not long, he would have to wait for a year to be able to get something of it [production]. See even these days, it is May, and it's still pretty much cold here, since almond's flowering starts in March, definitely this year

produce will much less [as cold negatively affects almond's flowering and thereby yield]".

Bara khan, aged 39 years:

4.1.4. Government Subsidies

It is found in this study that there is no economic incentive on planting less water intensive crops in the region. Based on the study of Dinar and Yaron (1992), as well as findings of this study, it could be said with certainty that a single government incentive of support price ceiling [fixed lower/minimum crop yield price] on Almonds would change the overall attitude of farmers towards less water intensive agriculture like Almonds. If the farmer is satisfied with the consistency of crop market prices, they will grow in maximum amount. Most of the farmers expressed their willingness to shift towards Almond growing if the government of Pakistan sets a minimum fixed rate on their Almond crop production. A respondent says:

> "In my view, the only possible practical way is to shift towards trees and in turn save water. In this region, the government must give a high price ceiling to Almond products and similarly disincentives the production of vegetable crops. A high price of Almond previous year caused its demand to become very high this year; the plants in the nursery got ended very soon."

Haji Juma Aka, aged 65 years:

Furthermore, another interviewee expresses same thoughts that the government of Pakistan must provide farmers of this region at least the subsidy of fixed prices of Almonds:

> "At least the government must give a fix crop yield price on Almond products so that the farmer would be satisfied that whatever happens, there is a fix price."

Fazal Muhammad, aged 48 years:

Natural disasters are inevitable but in case of their occurrence, farmers will be compensated to some degree, which will in turn encourage them to grow these crops.

Presently the government gives a heavy subsidy on the operational monthly bills of electricity thus incentivizing the farmers to use water as much possible which in turn lead to massive decline of ground water table (Steenbergen et al., 2015). Electricity supply company charges each tube well Rs.4000 per month irrespective of the use. From the findings, it can be inferred that in order to discourage the use of excess water and make the consumer realize the worth of this scare natural resource, government must annul the subsidies on water. And instead give subsidy on low water demanding crops i.e. Almonds.

4.1.5. Unawareness about Water Depletion

It is beyond understanding to know that Loralai farmers do not pay any heed to water scarcity despite the fact that water is the fast depleting resource in the area, this points to the fact that either they have no knowledge of water resources in wake of climatic changes or they, as per classical economist, are in the race for accumulation of maximum profit. These two are distinctively two different phenomena. Knowing about something does not necessarily mean caring for it or having a sense and responsibility of saving it. However research findings suggest that most of the respondents in this study have knowledge of water depletion and based on this very few of them have practically manifested water conservation or saving schemes. In the words of one respondent,

> "People pay very little attention to the scarcity of water resources and keep on exploiting it irrespective of its availability. They are in the run to exploit maximum water to grow their crops and earn maximum profit. They are careless in using water

regarding water extinction. They are very careless in using this depleting resource. They do not care about the alarming consequences of it".

Abdul Samad, aged 35years:

4.2 Indigenous Water Saving Strategies

With all those management, behavioural and natural issues associated with water resource management in the region [Loralai], there, however, have emerged many pragmatic indigenous water saving strategies over the time. These techniques are product of extensive experience and common sense understanding of day to day water usage that people are left with in the absence of effective agricultural extension program. Interestingly, none of the adopted strategy requires any capital [money] investment/requirement. They are as following:

4.2.1 Irrigating Crops at Night Time

Watering at night time saves a large amount of water as compared to irrigating at day time when evapotranspiration rate is significantly high. This is because nights are generally cooler than days, so there is no water lost in vaporization and the soil moisture is retained for a longer time. As one respondent, says:

> "Irrigating at night time is very useful as compared to day time; it saves much water as there is no evaporation"

Bara Khan, aged 39 years:

Similarly, another respondent agrees with the effectiveness of this technique is though, a simple one, but useful in saving water:

> "We use simple technique of applying water at night time instead of day; this saves much water as compared to day time because water is not wasted due to sun light"

Haji Ali, aged 51 years:

4.2.2. Making Closer Row Spacing for Irrigation Purpose

This is one of the customized local irrigation strategies. It is a self-constructed version of Furrow system of irrigation. Generally Furrow system is a technique of free-flow or Gravity Surface irrigation in which there are two parallel furrows in a wide distance from each other, and the water flows between the furrows towards fields. In the region, farmers have narrowed row spacing to a minimum level in order to save water as well as serve the purpose of irrigation properly this arguments is supported by literature in the work of De pascal et.al (2011) . In the words of an interviewee:

> "With plenty of water, people used flood irrigation. Now, very close row spacing is used to irrigate lands. The distance between two furrows now is only two to three feet instead of six to seven feet"

Abdul Samad, aged 35years:

Likewise, another farmer expresses his view as:

> "Irrigation techniques of tree plants have also changed a lot with the shortage of water. Earlier we irrigated by making furrows of five feet width, now we make three feet width furrows"

Ashraf khan, aged 37 years:

4.2.3 Ploughing Land with Heavy Wooden Bar

In this type of ploughing, the purpose is to save water for a longer period of time. This technique is affective in tree crops like Almonds due to its quality of resilience to water stress conditions. In the words of one respondent:

> "One of the indigenous ways of saving water is to irrigate tree land and then plough the land having a long heavy wooden peace attached to it. This will level the surface of that land and the weight attached to it makes the surface harder which helps retain water inside underground. This technique is very helpful in saving water in arid/drought conditions. This could save water for about six to seven months"
>
> Haji Ali, aged 51 years:

Furthermore, another interviewee responds that this technique saves water up to four months:

> "A water saving strategy people use is that, when there are rains, people irrigate their lands with tube well water immediately and afterwards they plough the land with a heavy wooden bar attached to plough. This makes the surface of land harder and the extensive water given is then stored underground and the moisture so preserved can be used for almost four months. The moisture remains there for long time"
>
> Abdul Samad, aged 35 years:

4.2.4 Water tank Irrigation Technique

This technique is the most rare one of all partly because it requires some resources like tractor and water tank, and partly because it is something different from the prevailing ways of water saving. A respondent explains as:

"In these days I use water tank system to irrigate our tree plants. I have bought a water tank and have tractor already, so, we fill it and take it to trees and irrigate every tree individually by pipe attached to it. By one water tank, we irrigate 200-500 trees. In one day we can irrigate 500 trees by it"

Ashraf khan, aged 37 years:

4.2.5. Crop Shifting

With depleting water resource, some farmers have adopted to change the ways of doing agriculture in the region of Loralai. They have acknowledged the severity of water availability, which could even exacerbate further in the coming time. Therefore, shifting from high water intensive cropping like Cauliflower to low water requiring plants like Almonds is the best strategy to cope with these starving conditions. According to, an interviewee:

"With time and water situations, cropping patterns are gradually changing. People are shifting from vegetable to tree cropping, which requires less water e.g. almonds. Almond can survive up to 3 months without water"

Abdul Samad, aged 35 years:

These findings support the literature studied for this research. In this case, it is pertinent to mention those farmers around the world shift to less labour intensive and less water intensive crops (Kumar.2012; Miyan, 2014).

Moreover, another farmer also expresses same views:

"In recent times people have shifted to tree cropping due to water shortage"

Ashraf khan, aged 37 years:

4.3. Discussion

Water is a scare source and is fast depleting resource. Fresh water namely ground water is under serious threat from unregulated for commercial, irrigation and industrial uses. Depleting fresh water resources is a global phenomenon but its seriousness is felt more in arid and semi-arid regions; and is a source of concern for policy makers, practitioners, scholars and academicians. In Pakistan situation is not altogether different. Pakistan home to 207 million[1] populations is a water scarce country having 935cubic meters per capita, while global average is 1800 cubic meters. Its agriculture economy is sustained by the Indus water system. Arid and semi-arid areas outside Indus valley like in this study, Loralai was irrigated through traditional system of Karez. Owing to limited aquifer and precipitation, less water requiring crops were in practice. However, with the electrification and mechanisation, tube wells are surged in the areas and multiplied vastly over the last thirty years (Steenbergen and Oliemans, 1997). With tube wells availability, water intensive crops start cultivated in multitudes. This study has found that tube wells have seriously affected the ground water situation in line with the work of Hussain et al. (2008) and Khair et al. (2015) and has made it plummeted further and has made policy makers to ponder over this crisis.

After briefly depicting the situation, it is important to shed some light on the traditional irrigation system of Balochistan. Traditionally irrigation in Balochistan was to be done through Karez system (Steenbergen and Oliemans, 1997), a system of water tapping through underground channels and interconnected wells connected to a mother well dug into the water table (Steenbergen et al., 2015, Steenbergen and Oliemans, 1997, Mustafa and Qazi 2008). It was regarded as the most sustainable, environmental friendly and had no impact on the water table. This system was sufficient for the irrigation needs of the time.

[1] As per census 2017

This study has found that multiple crops are in practice in the research locale Loralai, but two types of crops are in abundance: orchard farming (almond) and vegetables (cauliflower and tomato). Almond farming requires less water and is the most suitable to the local biophysical conditions in contrast to the water stressed vegetables like cauliflowers and tomato. Traditionally almond orchards were in fashion watered by Karez but with tube well initiation vegetable crops spread quickly and affected water table.

It is important to mention the water use patterns of these two crops. Almond orchards have a life span of average 15 years, require less water on sustainable basis throughout the year while vegetable having a life span of three to four months require huge amount of water during this small period. Since vegetables have minimum period of growth and fruition, they are cultivate multiple times in a year-two to three crops are in practice on a single farm in a single year.

In addition to their advantage of short life span, vegetable crops have the additional benefit of giving quick incomes than almonds; this is why they are grown in massive quantity. They can be grown three to four times in a single year, which gives them the edge of getting good market prices at least in one season. So, they are relatively reliable in terms of investment and expectations. However, the net income/profit on vegetable crops is very low, because there are so much expenditure on inputs like pesticides and fertilizers, share of tenants, seed prices, transport and others charges [commissions etc.]. With the subtraction of all these costs, the net incomes on vegetables are very low. Vegetables however ensure income flow throughout the year and are thereby considered as a better option. On the other hand, tree plants like Almonds, are good in net profit, as these crops demand minimum input and other costs on them. At the end of the day, a tree crop farmer is very well off than a vegetable growing farmer.

Another aspect of these two crops almonds and vegetables when compared was found to be the impact of climatic changes. Latter have an edge over former. Vegetables have a small life span and farmers can cultivate three to four crops in a single year. Their profits are less prone to climatic changes. for instance in wake of natural disaster like hailstorm, orchard gets completed disrupted and causes huge loss while in case of vegetable, if a crop get destroyed, the preceding or following crop compensate for the losses. Vegetables though give low returns but their returns are certain vis-a-via orchard farming.

After comparing the water consumption behaviour of almond orchards and vegetable crops, and looking into the severity of water crisis, it was found that farmers in the region [Loralai] have responded to deal with this severe water conditions in their own simple technical ways. Some of them adopted the technology of shifting their agriculture to low water requiring crops like Almond in line with study of Kumar (2012) of transition from water intensive crops to low water demanding crops in India. While others have changed the irrigation practices by applying water to their lands at night time.

Similarly, wide and open furrows for irrigation purpose are replaced by small and narrow furrows exactly coincides the finding of De pascal et.al (2011) regarding changing furrow size for irrigation. In addition, this study has found an interesting feature of irrigation by water tank to save water and agriculture. In this technique every tree is irrigated individually by tanker with thin pipe attached to it.

It is worth mentioning to note that farmers who are younger and educated have concerns for decreasing water table and are prone to accepting water conservation schemes and technologies [crop shifting and irrigation through water tanks] reinforcing the findings of Junaid et al (2017) and Khair et al (2015).

Study did not find any regulation and limitation for water extraction from the aquifers. Consumers are left unchecked in this competition for water resource which may end in conflict in future as predicted precisely by Steenbergen et al., (2015) regarding the cooperation-conflict competition for a demanding resource. Study has found that flat rate of electricity for irrigation tube wells is another factor responsible for encouraging massive pumping of water and plummeting of water level as discussed by Steenbergen and Oliemans, (1997).

These findings and discussion find a broad base support in literature. For instance in line with the work of De pascal et.al (2011), this study found adoption to water scarcity or the threat of its scarcity by replacing wide and open furrows for irrigating purpose by small and narrow furrows. Similarly finding coincides with the work of Kumar (2012) that farmers shifted to less water consuming crops. Furthermore, reinforcing the study by Steenbergen and Oliemans (1997) that fixed rates of electricity usage promoted tube well intensification in the region, this study find similar finding.

CHAPTER V

Conclusion and Recommendations

This chapter is comprised of two sections. First section is composed of conclusion and second section deals with policy recommendations.

5.1. Conclusion

Water table in Loralai district has declined exponentially over the last two decades. The reasons behind this abrupt decline can be attributed to number of factors both natural and anthropogenic. The most important anthropogenic factors include excessive number of tube wells and persistent crops and irrigation patterns which require huge amount of water i.e. vegetable crops like Cauliflower and tomato in case of the study area. The plausible strategy in these conditions is to save water as well as agriculture practices in the region. One of the most easy and pragmatic ways to do so is to shift on less water intensive crops i.e. tree plants like Almond and Olive as has been recommended.

Responsively, though some farmers have shifted to water saving plants like Almonds, acknowledging its water resistance quality, good income and less input costs/expenditures, thus reinforcing the study of Kumar (2012) that farmers prefer less water intensive cropping patterns. However, most of the farmers are still somehow reluctant in shifting towards it. The main reasons explored in the study consists; inconsistent water resource[water resources as tube wells in this study depend solely on the precipitation level, there are times when rainfall is scare, water table goes plummet and tube well is failed and vice versa], quick economic gross profits on vegetable crops, comparatively high vulnerability of tree crops to weather changes, and lack of awareness on the part of farmers to acknowledge its [trees plants] advantage, lack of Government [Pakistan] incentives on tree plants [Almonds] and the fear of getting failed by doing something different [like planting Almonds and Olives], when there is a constant popular trend of growing Cauliflower and Tomato in the region. Citing literature studied for this research it is important to note that these factors hindered the way to shifting to a well efficient irrigation technology i.e. crop shifting, in the arid region of Loralai District.

5.2. Policy Recommendations

This study implies that the water scarcity is not just a developmental issue rather it is linked to many other factors for instance, government policies being a dominant factor. Therefore, it is necessary to tackle the matter with multi-dimensional approach. Looking at just the one side of the coin may lead us nowhere, but understating the issue comprehensively through the perception of the people involved in it, the real stakeholders, may bring us to a fruitful conclusion and give us a set of result oriented solutions. Following are few of the recommendations which can help the researchers working on the same studies to understand this enigma-as why is there still reluctance on the part of farmers to shift to water stress agriculture.

These are as following:

1. There is a need for price ceiling by the government. Price ceiling refers to the phenomenon in which government fixes minimum price of a commodity enabling the producers to produce them. Doing this for water stressed crops, like almonds, will encourage the farmers to cultivate these crops.
2. From the data, it is founded that there is a restriction on the number of tube wells by the government but it is not implemented. Anyone can install a tube well without any regulation and this has caused the abundance of tube wells in the research local and

exacerbated the situation and caused the ground water level to plummet. It is very important to limit this practice (Steenbergen and Oliemans, 1997). There should be imposed a limit on the number of tube wells, this has occurred in Yemen, supported by literature (see Taher et al., 2012) for farms per person. This will help in conservation of water. For instance, if a farmer has 10 acres of farm, he should be entitled to possession of one tube well and this limit should increment according to the farm size.

3. Water is a scare resource; it requires changed consumption behaviour on part of the farmers and landowners. Though there are some initiatives locally, there is still a need for awareness campaigns to educate the consumers regarding the economical use of water in general and irrigation water in particular. For the said purpose, government and non-government organizations should run education and awareness campaigns and Government may also think abolishing existing subsidies on water, in lieu of support price fixed for produce like Almonds.
4. Cultivation of water intensive crops should be discouraged while that of drought resistant crops should be encouraged through legislations. Taxation regime should be employed to tax water intensive crops and relieve those who cultivate water stressed crops. For instance vegetable growers should be taxed while those of almonds and olives growers should be relieve of tax. . It is important to note that Pakistan presently has no active taxation regime however it is important to give a recommendation in this regard.
5. Irrigation tube wells are electrified either through electricity from national grid or through photovoltaic power resources. It has been observed that there is 18 hours load shedding and these tube wells are running for an average of 8 hours while those run by photovoltaic cells are in operation during the entire day. Based on this

comparison, it can be inferred that use of solar run tube wells should be discouraged, i.e., public funding for subsidizing for these systems should be stopped. This will enable the ground water level to better replenish itself.

6. It is generally said that for when people compete for a resource, it leads to either cooperation or conflict depending upon its biophysical conditions. In case of dropping water level, there is a dire need for cooperation amongst consumer and public regulators to device mechanism so as to replenish the aquafer.

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Appendix 1

Farmers Crop-farming Experiences

Interview guide

Preliminaries

1. Self-introduction (Sharing of contact information) [ ]
2. Introduction to the study (purpose and use) [ ]
3. Informed consent (for participation, audio recording) [ ]
4. Anonymity and confidentiality (explain different possibilities) [ ]
5. Offer of sharing results post completion of report [ ]
6. Rights of the interviewee (withdraw, future contact with interviewer, verify authenticity of the study etc.) [ ]
7. Ask if interviewee has any query at this stage and permission to start the interview [ ]
8. Turn-on the recording device [ ]

Date ---/---/2019

Interview Location …………………… Confidentiality setting (Yes/No) …………

Appendix 2

Respondent's Profile

Name of the respondent ……………………… Status in HH : Head …… Member ……

Years of Education………… Age………… Respondent's Occupation …………………

Years of Farming Experience ………………………….

Family Size: Adult Males …… Adult Females ………… Boys ………… Girls ………

Family Land Holding Size (Acres): Total …… Irrigated ………… Rainfed …………

Never Cultivated …………… No. of Agricultural Plots …………

Yearly household Income (last year) in PKR………………………… Yearly household income coming from crop farming (% of total income) ………………………………

Main household income contributing Crop : Name of Crop ……………………% share that it contributes in total crop farming income ……………

No of Tube Wells: Total ……… Sole Ownership ……… Shared Ownership ………

Appendix 3

Questions

Theme checklist	Probes and Prompts
Q1. Please share your experience with groundwater availability over the last 20 years and what changes you have observed?	If respondent owns/uses a tube well, make sure that he compares the water depths when first installed a tube well and water depth at the moment,
Q2. Tell me your story of how you decided to install your first tube well and made extensions thereafter.	At the end of question, you must be able to know when tube well was installed, how much it costed, what was form of ownership, How he/she managed the finances, what has been its impact on extension/reduction of area that you c and overall happiness with adoption of tube well technology after these many years of experience with it.
Q3. What are the most prominent changes that you have made in your cropping practices over the last 20 years and what are the key triggers of such changes?	Crops sown (Changes in Crops/varieties), the way these are sown (changes in methods), the timing when sown. Key reasons for such changes. The impact of these changes on their incomes?
Q4. What are the most prominent changes that you have made in your irrigation practices over the last 20 years and what	Technologies adopted, Changes of irrigation methods or anything that reflects something for irrigation and groundwater availability.

are the key triggers of such changes?	Key reasons for such changes. The impact of these changes on their incomes?
Q5. What are some of the changes in your farming practices (1) that are possible, (2) that you may like to bring but had been unable to bring so far?	Explore in-depth all capital and non-capital barriers to brining those changes
Q5. What are some of the changes in your irrigation practices (1) that are possible, (2) that you may like to bring but had been unable to bring so far?	Explore in-depth all capital and non-capital barriers to brining those changes
Q5. How you see your crop farming activity in 20 years from now (Future Perspective)?	Encourage interviewee to portray a picture of future. Continuity, profitability, ecological sustainability, crop composition, irrigation availability and use etc. need discussion in future perspective.
Q6. How you see sustainability of agricultural livelihoods (i.e., crop farming related) of your children?	Encourage interviewee to portray a picture of future for their children livelihood. You should know if he/she really wishes (and to the extent he/she is certain) his/her off-springs would continue crop farming. Every statement need reasoning.
Q7. Any emerging concerns on (1) farming practices, (2) irrigation practices that you think requires community action.	Should be able to know the issue-wise state of communal cooperation. Satisfaction with peers' behaviour etc

Q8. Any message for fellow farmers with reference to groundwater sustainability?	Let them express
Q10. Any message to policymakers with reference to groundwater sustainability	Let them express

Vote of Thanks.