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Evaluating Farmers' Perceptions on Causes of Water Scarcity and Coping Strategies: a Case Study Example from Tehsil Karazat District Pishin

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Abstract

This paper probes into the major causes of water scarcity and farmers coping strategies in tehsil Karazat of district Pishin, Balochistan. Both primary and secondary data were used for the study. A well-structured questionnaire was constructed to collect primary data from sample respondents. Systematic random sampling technique was used for the selection of sample respondents. This study employed both descriptive analysis and econometric model to quantify the key variables. The econometric model used in this study includes multiple regression model to predict the effects of various factors causing water scarcity. The dependent variable fallow Land other than Current fallow FLOTCF is taken as a proxy for showing the effect of water scarcity. The model results showed that among other variables, family size and lack of government control on tubewells installation significantly affect the dependent variable. While the other variables such as subsidized electricity, awareness about water as a scarce resource, inappropriate cropping pattern, over irrigation of crops and orchards, extensive pumping of groundwater, mass installation of tubewells, the availability of proper water management practices, and lack of water storage reservoirs were though non-significant but influencing the dependent variable as per prior expectations. To meet water scarcity, the farmers' coping strategies were also analyzed. The results show that among other strategies, changes from flooding to control/basin irrigation was ranked first by the farmers, followed by changes in the irrigation interval, increase in number of tubewells, water courses lining, and installation of delivery pipes at the farm.

Key words: Farmers, perceptions, water, scarcity, coping strategy

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INTRODUCTION

The issue of water scarcity

Scarcity means shortage of something or lack of something and water scarcity is such a phenomenon where water is not enough to meet the demands of users of a certain region. Water is an imperative input for agriculture production, if the supply of this input is insufficient, the yield per acre would be less and the farmers would confront with possible economic loss. Mehta (2003) and Gleick (1993) explored that water scarcity is multifaceted nature and may result from a range of phenomena. These may be produced by natural causes, may be induced by human activities, or may result from the interaction of both (Pereira et al., 2009). While Gleick (1993), further described that water scarcity is elucidated in four dimensions. First, unlike other environmental resources such as forests and coal, water is a renewable resource; secondly, water scarcity has temporal and cyclical dimensions; thirdly, there is tremendous inequality in access to and control over water resources. For e.g., in water scarce western India, irrigation pumps work 24 hours a day, while the poor women find their drinking wells run dry. In the arid parts of the world, a person consume 10 liters per day, while an average American, by contrast consumes 700 liters a day. The fourth dimension is anthropogenic dimension of scarcity. It's well known fact that the degradation of Aral Sea and Caspian Sea are largely due to human intervention. Furthermore, the silted up dams, broken hand pumps and defunct water pipelines schemes are indicative of bad management practices (Mehta, 2003).

Causes of water scarcity

Pereira et al., (2009) underlined that aridity is a natural permanent imbalance in the water availability consisting in low average annual precipitation, with high spatial and temporal variability, resulting in overall low moisture and low carrying capacity of the ecosystem. Pereira et al., (2009) further added that drought is other natural cause of water scarcity and is a natural but temporary imbalance of water availability, consisting of a persistent lower-than average rainfall, of uncertain frequency, duration and severity, of unpredictable or difficult to predict occurrence, resulting in lessened water resources availability, and reduced carrying capacity of the ecosystem. They further added that desertification is a man- induced permanent imbalance in the water availability, which, combined with damaged soil, inappropriate land use and mining of groundwater, can result in increased flash flooding, loss of riparian ecosystems and a deterioration of the carrying capacity of the land system. Moreover, the dwindling groundwater supplies due to over- extraction are also man-induced. Subsidized electricity for agriculture inputs have been part of poverty alleviation programme in many developing countries (Khair et al., 2014; Badiani and Jessoe, 2011; Shah, 2009). Subsidised electricity to agriculture tubewells was introduced in Pakistan to encourage farmers to use groundwater for increasing agriculture production but it has adversely affected the groundwater and has caused its overdraft (Ahmed, 2005; Meinzen-Dick, 1998; Khair, 2013).

At the farm level, the poor management of water, especially in the agriculture sector causes water losses. Average losses in irrigation projects suggest that only 45 per cent of water divided or extracted for irrigation actually reaches the crops (Abu-Zeid and Hamdy, 2008). But losses vary widely. Low irrigation efficiencies can be primarily attributed to water mismanagement in addition to technical problems of conveyance, distribution and on-farm application as well as the poor maintenance of irrigation structures, often caused by inadequate resources for operation and maintenance (Abu-Zeid and Hamdy, 2008).

The effect of climate change cannot be ignored while discussing the causes of water scarcity. "Climate change refers to changes in the earth's weather, including changes in temperature, wind pattern and rainfall, especially the increase in temperature of the earth's atmosphere that is caused by the increase of particular gases, especially carbon dioxide" (Oxford dictionary, 2008). Water and agriculture sectors are likely to be the most sensitive to climate change. Fresh water availability is expected to be highly vulnerable to the anticipated climate change. While the frequency and severity of floods would eventually increase in river deltas. The arid and semi-arid regions could experience severe water stress (Farooqi et al., 2005). Abellanosa et al., (1987) reported that water scarcity can be physical or absolute and economic water scarcity. Whereas physical water scarcity is the result of meager natural water resources to supply to an area's water demand and economic water scarcity is the result of poor management of the sufficient water resources in a particular area. Further, the physical water scarcity has been increasingly happening in the recent decades owing to withdrawal of water for economic reasons and as a consequence of climate change (POST, 2011).

Moreover, water quality would also suffer from the projected impacts of climate change. Poor water quality effectively diminishes the availability of drinkable water, and increases the costs associated with rendering water suitable for use. Changes in water quantity and water quality are indistinguishably connected (Farooqi et al., 2005). The excessive exploitation of groundwater resources from shallow and deep aquifers has caused the water table to fall (Khair et al., 2013, IUCN, 2000).

Water use is not just governed by population growth, however, in 20th century the world population almost tripled and water use enhanced six- fold (Cosgrove and Rijsberman, 2000). Many water scarcity projections assume a rapidly increasing water use per capita, usually related to rising incomes (Alcamo et al., 1997). It is safe to assume that domestic and industrial demands will rise phenomenally in developing countries, but it is much less evident how often demand for water will develop and how much water would be needed per person in the coming decades to satisfy our daily needs (Cosgrove and Rijsberman, 2000). Worldwide, water shortage currently affects one in three people, and is projected to pursue with the same proportion in the future as well (POST, 2011).

The excessive use of groundwater in many developing countries is causing the excessive drawdown of watertables and resulting in overdraft and in the new millennium in many arid regions, it sends major warnings of its effect on environment, health and food security (Barker et al., 2000). The consequences of groundwater mismanagement seem to be disastrous in several countries of the globe (Seckler et al., 1999; SAM, 2009). The countries and regions confronting serious water scarcity for various uses exist in many parts of the world. They include China, Pakistan, Mexico, India, Central Asia, Australia, Middle East and North America (SAM, 2009; POST, 2011).

Pakistan is an agricultural country and the irrigation in Pakistan is massively dependent on groundwater. Groundwater is overwhelmingly pumped by electricity and the energy crisis has further aggravated the water scarcity in Pakistan in general and in district Pishin in particular (Ashraf et al., 2013). Shah (2009) reported that groundwater is a very important source of irrigation for farmers and being pumped extensively in order to meet the current demands for food production. Moreover, if our demands and needs exceed the renewable supply, we will be forced to over-pumping the groundwater to meet demands. Rehman (2010) reported that nature's endowment of water blessings upon Pakistan has always been envied by the world at large. The per capita water availability in the country has decreased from 5,630 cubic meter in 1950 to 1,200 cubic meter in 2006 and this will further decrease to 838 cubic meter by 2020. Balochistan in general and district Pishin in particular is confronted with unprecedented water scarcity, due to climate change and poor water management resulting in over exploitation of water at a rate faster than its replenishment (Halcrow and Cameos, 2008). Particularly in the upland Balochistan, the water scarcity problem is even more alarming as watertables are falling at the rate of more than two to five meters per annum, threatening the viability of agricultural communities (Khair et al., 2013b). Moreover, the problem of depleting watertables in many of aquifers, tubewells drying is a common phenomenon due to; unchecked installation of tubewells in massive numbers and indiscriminate pumping of water fuelled by subsidized electricity for the last two decades (Khair et al., 2013b); and the inefficient irrigation methods followed by irrigators (Ahmed, 2007).

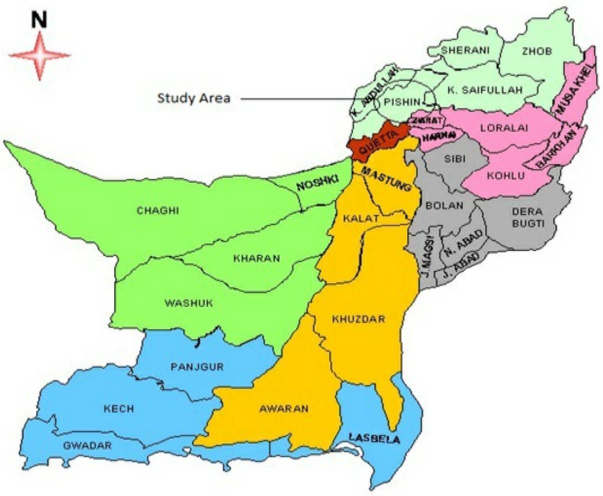
The present research study focuses on the problem of water shortage and its causes. Moreover, it also reviews the issues related to groundwater depletion and tubewells irrigation. Additionally, it tries to learn about the existing strategies of farmers to tackle water scarcity problem. Moreover, water shortage for orchards and other crops and the economic losses in the form of uprooting of trees due to depletion of groundwater. The above mentioned facts compelled the researcher to investigate the farmers' perceptions about the causes of water scarcity and how does they cope with the problem in terms of economic losses and what management strategies do they apply to tackle the situation. Another important aspect of the water scarcity is its nexus with energy crisis- on one side farmers are facing economic losses in the form of reduction in agricultural production due to energy shortage and on the other side, it can be considered as a blessing in disguise owing to farmers' inability to operate tubewells for longer duration at their will. A farmer who could pump water for 18 hours a day few years back has now reduced to just 6-8 hours due to reduced electricity supply. Thus keeping in view the grave nature of the problem, the study is designed with the following objectives:

- To figure out the causes of water shortage in tehsil Karazat district Pishin Balochistan.
- To find out the existing strategies of farmers to cope with water shortage in tehsil Karazat District Pishin Balochistan.

MATERIALS AND METHODS

Description of the study area

District Pishin is located in the north west of Balochistan province of Pakistan. Geographically, district Pishin lies between 30*04 to 31*17 North latitude and 66*13 to 67*50 East longitudes (Ashraf et al., 2013). District Pishin's total area is 787,400 ha. It consists of four tehsils (Pishin, Huramzai, Barshor and Karazat) and one sub tehsil Saranan. In 1998, the total number of rural localities was 386 with a total population of 344,228 (183,894 male and 160,334 female) and of them some 22,955 (6.3 percent) were urban and 344,228 (93.7 percent) were rural (Government of Pakistan, 1998). Union council Dilsora is selected as a study area.



The area can be classified as arid in terms of rainfall, receiving an average rainfall of 200 mm to 250 mm annually, which emphasizes the need for irrigation water in this area for high value crops. Overwhelming proportion of the population lives in rural areas and is engaged in agricultural sector for their bread and butter. Climatically, district Pishin in general is appropriate for fruits cultivation and tehsil Karazat in particularly appropriate for growing fruits (Survey, 2014). Almost 86 percent of the cropped area is irrigated mainly by groundwater. Tube wells and dug wells provide almost 96.7 percent of water and the rest by karezes and springs (Government of Balochistan, 2012). About 68 percent of the cultivated area is under fruit production. Major fruits include apple, apricot and plum and the important crops are wheat and barley. Farmers have made phenomenal investment in planting fruit orchards with tube well irrigation, resulting in significant growth in the production of high value fruits since 1970s (Khair et al., 2014, Khair et al., 2009). Besides growing fruits and crops, rearing of livestock is also an important source of income and employment in the area.

Data collection

Primary and secondary data were used for undertaking this research study. In order to avoid the errors and deficiencies in the primary data collection, questionnaire was pre-tested before moving into the fields. The secondary data on crops, area and tubewells were obtained from the various issues of the Agricultural Statistics of Balochistan. For conducting the survey, some local enumerators were hired for assistance in the data collection and they were given some basic trainings to make sure that they understood the purpose and method of conducting the survey. Moreover, some group discussions were also held with the farming community to make them aware about the purpose and importance of this research study.

Sample Selection

In order to achieve the objectives of the study, a thorough and comprehensive field survey was conducted in the month of August, 2014. The sampling unit was individual farm household. A household is a group of people living together in a housing unit as a family and sharing the same kitchen (Ashraf et al., 2013). Total 188 farmers as a population were listed from five village of union council Dilsora. Systematic random sampling technique was used for sample selection-it is a method of choosing a random sample from a larger population. The process of systematic sampling typically involves first selecting a fixed starting point in the larger population and then obtaining subsequent observations by using a constant interval between samples taken. Finally, some 63 farmers from five villages were selected as a sample which included farms of all categories i.e., large, medium and small farm sizes. Union council Dilsora consists of five villages namely, Murghazakarazai, Killi Haji Ghafar, Mandan, Seori and Sharan. In table 1, the frequencies and percentages of the respondents chosen from each village are shown.

Table 1: Distribution of sample respondents' village wise

S.No	Village	Frequency	Percentage
1	Murghazakarazai	18	28
2	Killi Haji Ghafar	11	17
3	Mandan	12	19
4	Seori	10	16
5	Sharan	13	20
6	Total	63	100

Source: Survey 2014

Empirical model used

Agriculture remains central to the highland Baluchistan's economy. Water scarcity has been severely affecting the cropped area, thus the main problem is the shortage of irrigation water. The statistical data shows a decrease in cropped area and consequently an increase in the Fallow Land other than Current Fallow FLOTCF over the last few years. Therefore FLOTCF is taken as a proxy for indicating water scarcity. FLOTCF is affected by several factors and are empirically modelled and presented in the following section:

To see the effects of various factors causing water scarcity, multiple regression model was developed. Owing to the continuous nature of the dependent variable, the ordinary least squire (OLS) method of multiple regression analysis was used to determine the influence of different factors causing water scarcity by affecting the FLOTCF. The dependent variable fallow Land other than Current fallow FLOTCF is taken as a proxy for showing the effect of water scarcity following Khair (2013a) who reported that the reasons for the land remaining idle are: no irrigation water available from other sources; non-ownership of a tubewell; owner's tubewell dried up; distantly located farm; not enough available water; poor power supply; land unsettled; *kareze*/spring dry; and shortage of capital.

It is assumed that the smaller the FLOTCF, the higher is likely the effect of water scarcity and vice versa. The independent variables include both continuous and categorical variables measured on five category Likert scale. The description of variables is presented as Appendix A). The most affecting independent variables were, education level of farmer (EDN), family size (FAMILY#), extensive pumping of water (EXTPUMPWAT), irrigated crops and fruits (IRRICROP), Subsidized electricity (SUBSELEC), massive installation of tubewells (MASSINSTTW), lack of effective control of government on tubewells (LACKEFFCCONTGOVTW), lack of proper water management practices (PROPMANG), awareness about water (AWARABTWAT), inappropriate cropping pattern (INAPPCRPAT) and less water storage reservoirs (LWSR).

The empirical model for quantifying the effect of various factors causing water scarcity, the regression model is as follows:

$$(FLOTCF)k = \beta o+\beta 1(EDN)k+\beta 2(FAMILY\#)k+\beta 3(EXTPUMPWAT)k+\beta 4(IRIRRICROP)k+\beta 5(SUBSELEC)k+\beta 6(MASSINSTTW)k+\beta 7(LACKEFFCCONTGOVTW)k+\beta 8(PROPMANG)k+\beta 9((AWARABTWAT)k+\beta 10(INAPPCRPAT)k+\beta 11(LSWR)+\varepsilon k$$

Where,

FLOTCF =Fallow Land Other Than Current Fallow, the dependent variable (acres), a proxy for reflecting the effect of water scarcity

βi = Vectors of parameters to be estimated;

εk = Error term;

EDN = Education level of the farmer (years)

FAIMILY# = Family size (number);

Categorical Independent Variables (Measured on five category Likert scale)

EXTPUMPGWAT = for extensive pumping of groundwater (EXTPUMPGWAT = is a categorical variable which is rated for its level of acceptability from '1' (Strongly disagree) to '5' (strongly agree) ;

IRRICROP = for irrigated crops and fruits (IRRICROP = a categorical variable which is rated for its level of acceptability from '1' (Strongly disagree) to '5' (strongly agree) ;
SUBSELEC = for Subsidized electricity (SUBSELEC = a categorical variable measured as level of acceptability from '1' (Strongly disagree) to '5' (strongly agree) ;
MASSINSTTW = for mass installation of water (MASSINSTTW = a categorical variable which is rated for its level of acceptability from '1' (Strongly disagree) to '5' (strongly agree) ;
LACKEFFCCONTGOVTW= for lack of effective control of government on new tubewell installation (LACKEFFCCONTGOVTW = a categorical variable, measured as level of acceptability from '1' (Strongly disagree) to '5' (strongly agree) ;
PROPWMANG = for proper water management practices (PROPMANG = a categorical variable which is rated for its level of acceptability from '1' (Strongly disagree) to '5' (strongly agree) ;
AWARABTWAT = for awareness about water (AWARABTWAT = a categorical variable which is rated for its level of acceptability from '1' (Strongly disagree) to '5' (strongly agree) ;
INAPPCRPAT = for inappropriate cropping pattern (INAPPCRPAT) = a categorical variable which is rated for its level of acceptability from '1' (Strongly disagree) to '5' (strongly agree);
LWSR = for lack of water storage reservoirs (LWSR) = a categorical variable which is rated for its level of acceptability from '1' (Strongly disagree) to '5' (strongly agree).

RESULTS

This chapter presents the results derived from the data analysis. The first section is devoted to the causes of water scarcity and its numerical analysis, the second section presents the farmers coping strategies to combat water scarcity and its analysis. The descriptive statistics of the factors causing water scarcity are presented as table 2.

Table 2: Descriptive statistics of factors causing water scarcity

Variables	Maximum	Minimum	Mean	STD
Education (years)	0.00	16.00	8.61	4.52
Family# (size)	4.00	45.00	16.88	7.88
Extensive pumping	1.00	5.00	4.84	0.72
Irrigated crops and orchards	1.00	5.00	4.88	0.54
Subsidized electricity	1.00	5.00	4.23	1.27
Mass installation of tubewells	1.00	5.00	4.87	0.55
Lack of effective control by government	3.00	5.00	4.87	0.38
Proper water management practices	1.00	5.00	4.88	0.54
Awareness about water	1.00	5.00	4.03	0.99
Inappropriate cropping pattern/high water demanding crops	1.00	5.00	3.87	1.18
Lack of rainfall and snowfall	5.00	5.00	5.00	0.00
Lack of water storage reservoirs	1.00	5.00	4.80	0.69

Source: survey 2014

The results of empirical analysis derived from the multiple regression model are presented as table 3.

Table 3: Regression estimates for the factors causing water scarcity

Variables	Coefficient	t statistics
Constant	***42.84	2.742
Education (years)	-0.110	-0.582
Family# (number)	**0.229	2.117
Extensive pumping of groundwater	1.516	0.809
Irrigated crops and orchards	-3.871	-1.193
Subsidized electricity	0.512	0.733
Mass Installation of tubewells	3.111	1.018
Lack of effective control on new tubewell installation by government	**-7.011	-2.694
Proper water management practices	-2.255	-0.720
Awareness about water	-0.593	-0.490
Inappropriate cropping pattern/high water demanding crops	0.634	0.594
Lack of water storage reservoirs	0.667	0.444

N = 67, R^2 = 0.27
*, **, *** means significance at 10, 5 and 1% respectively.

Dependent variable: fallow land other than current fallow FLCW: All land which is taken up for cultivation but is temporarily out of cultivation for a period of not less than one year and not more than five years.
Source: survey 2014

The values of coefficient can be presented in the following mathematical equation:

FLOTC = 42.84-0.110 (EDN) + 0.229 (FAMILY#) + 1.516 (EXTPUMPGWAT) 3.871(IRRICROP) + 0.512 (SUBSE) + 3.111 (MASSINSTTW) - 7.011 (LAKEFCOTGTW) - 2.255 (PROPWMANG) - 0.593 (AWARABTWAT) + 0.634 (INADEQKNWNATPOTW) + 0.667 (LACKWATRES) + Ɛk

Where, among the other responsive variables, Education (EDN) had a negative and non-significant effect on the dependent variable (FLOTCF). This implies that with the increase in education by one year the FLOTCF will decrease by 0.11 acres. The reason for this may be that the more educated farmers are more likely to use irrigation water more wisely and efficiently and hence restricts the FLOTCF (Table 3).
Among the explanatory variables, family size (FAMILY#) has the coefficient 0.22 and significant at 5%. It can be interpreted in the way that with increase in the family size by one member, the FLOTCF will increase by 0.22 acre *ceteris paribus*. This can be justified on the ground that the more the family labors availability, the more area may be reclaimed and brought under cultivation and well managed.
The coefficient of CONTGOVTW is -7.01 and significant at 5%, and has negative effect on the FLOTCF. It implies that the more the government control on installation of tubewells, the less will be FLOTCF and vice versa. This also shows that in the study area, the government has meagre control on the installation of tubewells owing to which farmers are installing new tubewells indiscriminately. Similarly, the independent variable, awareness about water (AWARABTWAT) defined whether it affects FLOTCF or not. It was found negative and non-significant. It is implying that the lack of awareness about water as a scarce resource causes its miss use and more FLOTCF *ceteris paribus.*
The variable subsidized electricity (SUBSELEC) had a non-significant but positive relationship with dependent variable FLOTCF. This implies that the availability of subsidized electricity to tubewells causes an increase in FLOTCF by enabling large number of tubewells to extract groundwater and hence causing negative externality in the form less water available to nearby tubewells and hence less water available to irrigate lands. The relationship is justifiable on the grounds that subsidy on electricity makes it possible for the farmers to run tubewlls for longer duration and use water wastefully. Had there been no or less subsidy, would have been difficult for the farmers to run electric tubewells due to high tariff rates.
Similarly, the independent variable, inappropriate cropping pattern (INAPPCRPAT) has a positive and non-significant relationship with FLOTCF. It is implying that the farmers cropping pattern dominated by fruits need abundant water and with the rising scarcity it is hard to keep alive and irrigate all the area hence FLOTCF increases with increase in fruit area and making it difficult to cultivate crops other than fruits. The other variables can be interpreted in the same way with the help of description of variables given as appendix A.

Farmer's water scarcity coping strategies

To overcome the problem of water scarcity, farmers take various measures. The term coping strategy is used to comprehend the actions taken by farmers to tackle the impacts of water scarcity or drought on their fruit orchards or crops (Ashraf et al., 2013). During survey 2014, farmer's perception on several water coping strategies and their effectiveness were recorded (Table 4). According to the results among other strategies, changes from flooding to control/basin irrigation was ranked first by the farmers, followed by changes in the irrigation interval, increase in number of tubewells, watercourses lining, installation of delivery pipes etc. (Table 4).

Table 4: Ranking of farmers' water scarcity coping strategies

Water scarcity coping strategies	No	Yes	Ranking
Change from flood irrigation method to controlled irrigation method	0(0%)	63(100%)	I
Reduced use of fertilizers	19(30%)	44(70%)	VI
Changes in cropping pattern	56(89%)	7(11%)	X
The installation of delivery pipes	17(27%)	46(73%)	V
Changes in irrigation intervals	1(2%)	62(98%)	II
Changes in lining of water courses	12(19%)	51(81%)	IV
Changes in the irrigation timing	37(59%)	25(41%)	IX
Reduction in crop area	28(44%)	34(56%)	VII
Increase in number of tubewells	7(11%)	56(89%)	III
Use of pesticides	47(75%)	16(25%)	XI
Uprooted some of the trees	33(52%)	30(48%)	VIII
Pruning of trees	40(63%)	23(43%)	X

Source: survey 2014 *numbers in parenthesis are percentages

The results showed that about 45 percent farmers reported that due to abnormally long dry spell they have started cultivating crops more resilient to dry conditions, such as Gaja and Black Amberi apple varieties have replaced high water demanding Tor Kulu and Shin Kulu apple varieties, similarly, grapes and crops such as wheat, barley, maize, cumin and rabbi season vegetables etc. are also getting popularity among farmers to combat stress. Similarly, other coping strategies such as reduced use of fertilizer is ranked as on sixth number, reduction in crop area is another strategy which is ranked on 7th number and uprooted some of the trees is ranked as 8th on number as shown in table 4.

CONCLUSION AND RECOMMENDATIONS

The results of model showed that among other variables, the education level of household and the categorical variable 'lack of effective control by government' significantly influenced the dependent variable FLOTCF. While the factors such as, subsidized electricity, awareness about water as a scarce resource, inappropriate cropping pattern, over irrigation of crops and orchards, extensive pumping of groundwater, mass installation of tubewells, the availability of proper water management practices, and lack of water storage reservoirs were though non-significant but influencing the dependent variable.

The second objective of this research was to find out the existing water scarcity coping strategies adopted by the farming community to combat water shortage. There are numerous coping strategies adopted by the farmers in the study area such as crop diversification, adjustment in crop inputs use, leveling and narrowing of watercourses, increase the use of pipes at the farm, digging more tubewells, increase in irrigation intervals, installation of drip irrigation system etc. Some of the strategies have been very successful in combating water scarcity such as use of pipes, leveling and narrowing of water courses, change from flood irrigation to controlled irrigation etc. but the strategy that is of grave concern and detrimental to the efforts of groundwater resources and its management in the area is the illegal of illegal tubewells in large number. Farmers reported that because the supply of electricity is short of their demand that is why they are compelled to do so in collusion with WAPDA people. The following recommendations are made for the improvement:

- In order to recharge the groundwater, check dams and other big dams may be constructed, in this way water shortage can be reduced to some extent as there is a great potential for the construction of dams.
- In the study area, farmers are using the same old farming methods and techniques. The water watercourses or drains used to carry water from tubewells to the fields are mostly unpaved and water pools (*Talaab*) are *kacha* (muddy) owing to which seepage losses are great. It is high time that government to help farmers and augment on farm water management initiatives such as, construction of lined/concrete water courses or provide pipes and help farmers construct *pakka* water ponds, so that water can be saved and water scarcity can be reduced. Moreover, it is also very important to control or reduce the crops over irrigation. The effects of over irrigation on crop production are can be quantified using crop water production

functions which relate crop yield to amounts of water supplied (English and Raja, 1996).

- High demanding water crops are cultivated in the study area causing water shortage (Ahmad, 2007; Khair, 2013a; IUCN, 2000). For example apple is grown on large scale which needs much water due to which massive pumping is in practice. It is the need of the hour that cropping pattern may be changed; the high water demanded crops and fruits may be replaced with less water demanding crops and fruits. Moreover, farming community is oblivious of the importance of groundwater reservoirs and that it is an exhaustible resource. It is imperative that farmers may be trained and awareness campaigns regarding water and its worth should be imparted. Moreover, to make the water coping strategies adopted by farmers more affective, scientific and technical training programs for farmers may be organized. Moreover, to check the installation of illegal tubewells, electricity supply to the legal tubewells may be made more disciplined and reliable and the electricity supply duration may be decided in accordance with the groundwater resources position of every area.
- In a number of countries, experience shows that institutional weakness and malfunctions are a major cause of ineffective and unsustainable water services. This requires urgent attention to building institutional capacity at all levels (Abu-Zeid and Hamdy, 2008).

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