Seasonal Climate Forecast and Farmer's Adaptation Behavior: Case study of tehsil Athara Hazari, District Jhang, Punjab

By

Ghulam Jilani

Department of Environmental Economics
Pakistan Institute of Development Economics
Islamabad

2016

Seasonal Climate Forecast and Farmer's Adaptation Behavior: Case study of tehsil Athara Hazari, District Jhang, Punjab

A Research Dissertation submitted to the Pakistan Institute of Development Economics (PIDE), Islamabad, in partial fulfillment of the requirements for the award of the degree of Masters of Philosophy in Environmental Economics.

Submitted By

Ghulam Jilani

02/M. Phil-ENV/PIDE/2013

Supervisor:

Dr. Rehana Siddiqui

Dedicated to My Brother

Ghulam Rabani

ACKNOWLEDGEMENT

Alhamdulillah, all praises are belonging to Allah S.W.T nothing is possible without his help and blessing. The wisdom he bestowed upon me, the strength, peace of my mind and good health in order to finish this research.

I would like to express my gratitude towards my beloved family for their continuous encouragement and support which helped me in completion of this thesis. Let me express my sincere gratitude to the Pakistan Institute of Development Economics for letting me to fulfill my dream of being a student here. I would also like to thank the Environmental Economics Department for giving me the opportunity to write this draft.

I acknowledge, with gratitude, my debt of thanks to the HOD Professor **Dr. Rehana Siddiqui** for advice, guidance, encouragement and supervision. Special thanks to course coordinator Dr. Anwar Hussain and all my teachers who make me proud for being their student at PIDE Dr. Asad Zaman, Dr. Muhammad Iqbal, Dr. Usman Mustafa, Dr. Khaild Mehmood, Dr. Junaid Memon and Dr. Aneel Salman.

Acknowledgment can never be completed without saying thanks to classmates and friends. Moral support gained from list of friends Mr. Irfan Siddique, Mr. Anjum Amin, Mr. Saleem Ali Shah, Amjad Khan, Atif Naeem, Hassam Shaid, Navid-ur-Rehman, Umer Hayat, Sajjad Haidir, Suhaib Dogar, Hassan Awan, Faisal Riaz, Ilyas & Khawar, Mussavir Shah.

Ghulam Jilani

Table of Contents

List of Tables

List of Figures

List of Appendix

ABBREVIATIONS AND ACRONYMS

WTP	Willingness To Pay
CVM	Contingent Valuation Method
HS	Household Size
FCD	Farmer Cropping Decision
SCF	Seasonal Climate Forecast
EW	Agricultural Extension Worker
GDP	Gross Domestic Product
UC	Union Council
MWTP	Maximum Willingness To Pay

ABSTRACT

Sustainability of agriculture sector is indispensable. From a beggar to duke, everyone shall need something to stuff their bellies. It has to continue in this manner till the doom's day. Productivity of agriculture is at risk because of climate variability. Therefore there is a need to cope with these changing scenarios of climate.

Solution lies in reduction of factors that cause climate variability and in adjusting the usual farming practices with the climate phenomena. This study proposes adjustment strategies to cope up with the climate variability through adaptation. Adaptation can be implemented through acquiring information of seasonal variability. Seasonal Climate Forecast (SCF) before the sowing season is indispensable for the modern day farming. The suggested channel for dissemination of information regarding SCF is an agriculture extension worker.

Accuracy of this probabilistic information can never be ignored. On the basis of technological advancements in metrological sciences, authenticity and accuracy of information is improving day by day in this sector. Another very important factor to truly benefit from adaptation is the correct interpretation of SCF. An extension worker can be very effective in this regard. He can correctly evaluate farmer's adaptability behavior regarding this phenomenon.

Thesil Athara Hazari, District Jhang, Punjab has been selected for this specific study. A total of 267 respondents have been selected for their behavioral analysis. Other tools of study include descriptive statistics, cross tabulations, bar charts, logit and linear models. Results show that farmers want to incorporate this probabilistic forecasted information in their decisions regarding farming practices. Farmers' seriousness regarding SCF has been examined through their willingness to pay against the dissemination of this information to them at village level.

On an average Rs. 95 per household is willing to pay (WTP) for the services of extension worker. About 79 percent of the respondents are WTP for services of extension worker and 88 percent of the respondents are ready to change their farm cropping decisions. According to results farmers are expecting increase in their crop productivity on an average of 6.8 maund per acre. Hence it can be concluded that farmers are willing to pay, willing to change their cropping decisions, willing to adopt new techniques. Only thing is required i.e. policy makers should consider it in their policies.

CHAPTER 1

Introduction

1.1. Agriculture an Overview

Agriculture provides food to consumers, shelter to residents, raw material or fiber to industry, tradeable surplus, livelihood and employment opportunities and so on. Agriculture is a major social, cultural and economic activity across the globe. It delivers a wide range of ecosystem services. At present 1.2- 1.5 billion hectares of land is under crop cultivation whereas 3.5 billion hectares are being used for grazing globally [Howden, *et al.* (2007)]. Therefore agriculture sector is a major land user. Increase in population means more food requirement which ultimately can be produced through a progressive and productive agriculture sector.

Recent and projected changes in climate pose a major threat to the agriculture sector. Rural farmers and poor people are mostly living in vulnerable areas. They are always at the mercy of disasters and catastrophes which is brought to them by none-other than the climate variability [Skoufias, *et al.* (2011); Thurlow, *et al.* (2009); Oram (1989)].

1.2. Climate Variability and Agriculture

In developing countries, climate variability is expected to have serious impacts on environment, economic growth and social wellbeing. Agriculture sector is worst hit by the climate variability in developing countries as it depends on natural resources and thus faces directly the adverse impacts. [Gbetibouo (2009)]. Over time, the role of seasonal climate variability in agriculture has increased across the globe. Above or below average rainfall, fluctuations in temperature and other factors[1] effect crops which thus decrease the profits of farmer, affect food security and ultimately hamper overall growth of economy. [Jones (2000)].

If variability is correctly predicted before the start of a season and right information is available to the farmer before the sowing of the crops, the unwanted impact of climate variability might eventually be averted/reduced by decision modification. For reduction of adverse impacts, availability of climate variability forecast information is a prerequisite. [Tarhule and Lamb (2003)].

1.3. Seasonal Climate and Weather Forecast

Weather forecasting is a very old art but its scientific study began in nineteenth century. In recent times, forecasting techniques have improved a lot in terms of accuracy. Experts not only predict precipitation and temperature but also predict the concentration level of greenhouse gases like CO_2, CH_4, O_3, SO_2 and the aerosols [Chahine, *et al.* (2006); Barnston, *et al.* (1994); Latif, *et al.* (1998)]. Seasonal and climatic predictability with accuracy is indispensable in order to reap benefits [Doblas-Reyes *et al.* (2013)].

Seasonal Climate Forecast provides information in advance regarding the climate variability which helps in preparing a range of possible adaptation and management strategies for cropping system[2]. This reduces the negative impacts of climate variability. [Hansen (2002); Carberry (2000)]. Climate predictability and its role on farm productivity, recommends that application of climate forecast in agriculture is essential. It reduces the associated probabilistic risk and is highly valuable to the society. [Sah (1987); Blacket (1996)]. Forecasters should consider Seasonal Climate Forecast as a fundamental input for the cultivation as farmers have to depend

[1] Wind speed, wind direction, soil moisture etc.
[2] Highly vulnerable due to climate.

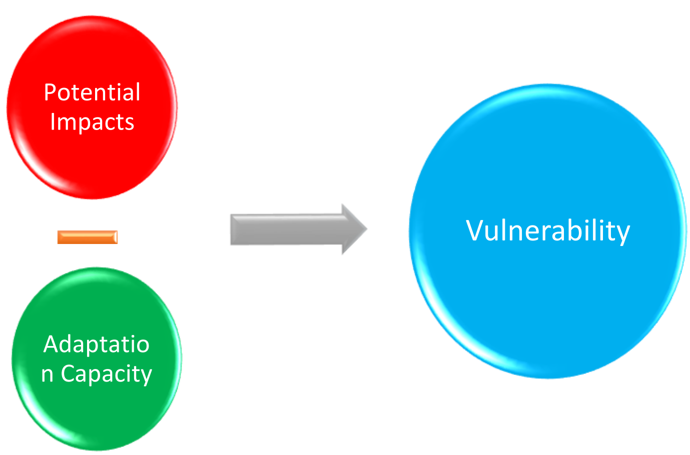
on this information to plan their adaptation strategy for daily schedules[3]. [Stern and Easterling, (1999)].

1.4. Role of Adaptation in Agriculture

Adaptation to climate change is not just a onetime measure, it is a set of long term activities. Examples of adaptation measures include use of extreme weather tolerant verities of seeds, watershed management, building of physical structures for the diversion of floods etc. [Nizami and Robledo (2010)].

The IPCC (2001) defines adaptive capacity as the ability of a system to adjust to climate change. The goal of an adaptation measure should be to increase the capacity of a system to survive external shocks or changes. The IPCC (2007) also defines adaptation as the adjustment in natural or human systems in response to actual or expected climatic inducements or their effects. The IFPRI (2007) defines adaptation as the process of improving society's ability to cope up with the changes in climatic conditions across time.

Graph: 1.1. Vulnerability is Equal to Potential Impacts Adjusted for Adaptation Capacity



Source: Nizami, A., Robledo. C. (2010)

[3] Drying hay is only feasible in dry weather. Extended periods of dryness can ruin cotton, wheat and corn crops. Different crops require different conditions to grow etc.

Climate vulnerability can largely be reduced through adaption strategies. [Easterling, *et al.* (1993); Reilly and Schimmelpfennig (1999); Smit and Skinner (2002)]. Potential benefits of climate change forecast, depend largely to the extent of adaptation response to climate change. [Gbetibouo (2009)]. Only a "far-sighted farmer" can get benefit from the complete and accurate knowledge of future climatic conditions. [Belliveau, *et al.* (2006)].

Another important issue related to adaptation in agriculture, pointed out by Bryant, *et al.* (2000), is: how perceptions of climate change are translated into decision in the agriculture sector. Maddison (2006) argues that farmers learn about the best adaptation options through:

- Learning by doing
- Learning by copying and
- Learning from instruction.

Despite all the challenges it is recommended in a number of studies that adaptation is the need of time. For adoption of any agricultural strategy, climate information is a prerequisite. This information is disseminated in many countries through number of channels like radio, television, newspaper, agricultural extension worker etc. For adaptation "top-down" and "bottom-up" approaches are used. The top-down approach evaluates climate change scenarios and estimates impacts through scenario analysis based on which possible adaptation practices are identified. The bottom-up approach takes a vulnerability perspective wherever an adaptation strategy is required. It is more of a process that involves policy makers, extension workers, producers and other stake holders while also considering socioeconomic characteristics of the targeted area. [Bryant, *et al.* (2000); Wall and Smit (2005); Belliveau, *et al*. (2006)].

1.5. Local Agricultural Practices and Way Forward

There are many programs that have been implemented so far in order to increase farmer's and land's productivity.

While developing a policy, priority is assigned to irrigated areas[4] foregoing the potential benefits of dry-land farms due to their low productivity. Without reforms these costs will continue to rise because of climate change. [Frederick and Schwarz (2000)]. The study will capture the potential benefits of seasonal climate forecasts in agricultural sector[5].

Pakistan is blessed with four seasons[6]. For these four seasons Department of Metrology forecasts the seasons in advance. Agriculture, especially in case of Pakistan, is facing number of issues such as extreme weather events like floods and droughts etc. due to climate variability. Climate change effects Pakistani rural community and farmers. This leads to reduction in yield. Failing to take timely steps by the stakeholders, the effects of climate change will be felt very strongly and will be devastating in Pakistan. [Malik, *et al.* (2006)].

Combating climate variability requires either mitigation or adaptation or a combination of both. Adaptation is a more feasible strategy for developing countries like Pakistan and a key priority for Pakistan [Task Force on Climate Change (2010)]. Pakistan needs take immediate adaptation measures specifically focused at its agriculture sector. It will help stabilizing its agricultural growth rate at around 5 percent. It is notable that the rate of population growth in the year 2009 was 2.4 percent. [IUCN (2009)].

---

[4] Areas which have an irrigation network.
[5] Both dry and irrigated farm lands.
[6] Autumn, spring, winters and summers.

Understanding when, where and how to use this tool is a complex and multidimensional problem. To do this effectively, a participatory cross-disciplinary research approach is required. It will bridge the gap and bring the disciplines[7] to work together for reaping the benefits from climate knowledge. [Holger and Stone (2005)].

To check farmers ability to incorporate this probabilistic information of Seasonal Climate Forecast (SCF) into their decisions for minimizing risks, particularly the production risks generated by climate variability. Information of SCF will be provided through agricultural extension worker. Farmers Willingness to Pay will also be checked for the said information through the services of extension worker. However, only credible information of forecasts, and their wise use in farm management decisions can lead to improve overall agricultural productivity through efficient resource use besides providing allied benefit of environmental sustainability.

1.6. Objectives of the Study

The main objectives of the study are as follows

- To explore the impact of Seasonal Climate Forecast (SCF) on farmers' cropping decision in irrigated areas and dry land areas.
- To analyze the Willingness to Pay of the farmer's for the service of agriculture extension worker (who will provide information about SCF).
- Finally the study suggests the pathways to adjust to the climate variability with an emphasis on the role of extension workers.

[7] Climate science, agricultural systems science, rural sociology and many other disciplines and people like scientists, policymakers and direct beneficiaries they all are equal partners

1.7. Hypothesis of the Study

H_o: Seasonal Climate forecast does not affect the Farmer's Cropping Decision.

H_o: Farmers are not Willing to Pay for the provision of services of Seasonal Climate Forecast.

H_o: Irrigated land respondents are not Willing to Pay more for SCF information than the dry land respondents.

1.8. Organization of the Study

After the introduction, this study is organized as follows: chapter 2 elaborates the literature review. Chapter 3 explores the data and describes the methodology. Chapter 4 presents descriptive analysis based on data collected. Chapter 5 presents estimation results of models. Finally chapter 6 presents conclusions and policy implications of the study.

CHAPTER 2

Literature Review

In this chapter we have discussed the findings of previous research studies conducted, in various parts of the world including Pakistan, on the impact of Seasonal Climate Forecast and weather forecast on farmer's productivity.

Ngilangil (2013) showed farmer's adaptation toward climate variability, their knowledge and awareness about it. This study is undertaken in four provinces of Philippine. Randomly selected respondents (Farmers) were 799 in numbers. Data collection method was personal interviews and focus group discussion. Simple descriptive statistics like mean and ranking, correlation and variance were used for the analysis of collected data. Results show that most of the respondents were aware about the concept of climate variability. They were of the opinion that extreme weather events are a big threat for the crop production in the region. They were asked about seventeen adaption strategies out of which fifteen were frequently adapted. This shows their highly adaptive capacity. Results also show that adaptive measures were laborious, highly technical and expensive. Hence, these were constraint to the adaptive strategies.

Komba and Muchapondwa (2012) study is about small farmers of Tanzania. Authors tried to evaluate the farmer's behavior towards climate change, adaptation to climate change and constraints on the adaptation. For the evaluation of above objectives, data was randomly collected from 534 households. Heckman sample selection model was used for the correction of selection bias. Binary probit model was used to investigate the influencing factors on farmer's decision to adapt to the techniques of coping with the climate change. For selection of specific adaptation method, Multinomial probit model was applied. These results show that farmers had observed changes in climate. Mean and variance changes in temperature and precipitation were estimated. The farmers responded to adaptation by growing early maturing crops, changing sowing and cropping dates and by planting drought resistant crops. It was also observed that government can play a significant role in promoting adaptation techniques and methods.

Acquah and Onumah (2011) tried to check the adaptation capacity of the farmers, their perception and adaptation strategies for climate change in Dunkawa, Ghana which is located towards the Western side of the country. A sample size of 98 was determined and random sampling technique was used. Data was collected through personal interviews. For analysis descriptive statistics and probit regressions were estimated. Results showed that majority of the farmers thought and perceived that precipitation had gone down and temperature scale had gone up. For these observed changes the farmers changed sowing, harvesting dates and used different crop varieties to combat climate variability. Lack of information, knowledge, uncertain property rights were the major bottlenecks in adaptation. Results of willingness to pay (WTP) showed in educational level, age and ownership of the land increased WTP.

Shankar (2011) studied farmer's perspective towards seasonal climate forecast (SCF) adaptation. Their suggestions and constrains for SCF adoption were also examined in this study. The study area was South Indian state of Andhra Pradesh. Total interviewed respondents were 180. Simple descriptive statistics analyses like percentages, frequencies were used to draw results. Farmers pointed out that the major problems were absence of location or area specific forecast, accuracy and reliability of the information, and poor methods of disseminating SCF information. Farmers were of the view that area specific, accurate and reliable information should be properly disseminated through extension services and the extension workers should be well equipped with material and method to provide suggestions to farmers. This study also highlights constrains and issues of the farmers for the adoption of SCF. Farmer's suggestions were also analyzed to overcome prevailing situation related to climate variability.

Ahmad *et al.* (2010) aim to check the performance of wheat production in the presence of climate variability. To minimize the impact of climate variability different strategic management decisions were made. In an experiment three different locations were taken in Pakistan. Locations included Islamabad, Chakwal and Talagang termed as location 1, 2 and 3 respectively. Experiment was conducted to note the impacts of change in the sowing time of wheat. Early sowing is referred to as "Planting Window One" and late sowing as "Planting Window Two". To observe the impacts of changes in precipitation and temperature, over the different level of phonological stages of wheat, it was observed that experiment affected the yield of wheat. At location 1, early sowing resulted in good yield i.e. 4605 kg per hectare. A negative trend was observed in the planting window two. Similarly at location 2, planting window one resulted in the highest yield of wheat and a negative trend observed in planting window two. At location 3 Talagang, which is also considered as a low precipitation and high temperature area of Pothwar region, lowest yield was observed in planting window one. Whereas highest yield in planting window two i.e. 2270 kg per hectare. Simultaneously whole-process model explains the observed climate variation in the dynamics of above ground biomass productivity with coefficient of determination R^2 equals to 0.95.

The study by **Ding *et al.* (2009)** proposed "Alternative Tillage-Systems" as a possible adaptation strategy that reduced the associated climatic risks to agricultural practices and yield. The panel data used in the study enabled to test the effects of time varying factors including short term and medium term weather extremes, prices and policy variables. How farmers adjust their agricultural practices to reduce risks from drought and other hazards is considered vital for developing effective and efficient drought mitigation programs for reducing the impacts of other natural disasters. Results described that self-protection is a better strategy to enhance resilience to handle drought. Though it is cost effective in the long run; relief money can serve to compensate the short term income losses. The negative effects of crops insurance on self-protection would catch the attention of policy makers when designing the disaster assistance programs.

Gbetibouo (2009) for this primary-data based study applied a bottom up approach. Farmer's insight related to the problem-set was studied: the perception of farmers about climatic variability and their adaptive response was examined. Targeted study area was Limpop River Basin of South Africa. Data was collected from 794 households in years 2004-2005. Climatic information was collected from the local metrological stations. Multinomial logit and heckman probit models were used to get the results. Statistics of climatic variables showed an increase in temperature and variability of precipitations over the years. It was also observed that previous three years were dry in the study area. Results showed that climatic data and farmer's perception about climatic variability were in line. Only 50 percent of the farmers adjusted their cropping patterns according to the climatic data. Results also described that farming experience, household size, access to extension worker, loans, water and off-farm practices were the main factors affecting the farmer's adaptive capacity.

Jyotirmayee and Mahamaya (2008) examines vulnerability of the farmers towards climatic variables and extreme weather events such as cyclone and flood etc. Marketing and distribution, low food production by farmers and low farmers income were the three key factors termed as obstructions to substantial agricultural production and food security. The results of the estimated production function revealed that prices of livestock, prices of inputs and prices of fertilizers were also affecting farmer's productivity. Whereas farmers' response towards precipitation revealed that investment in irrigation projects could increase farmer's income significantly.

Howden (2007) argue that agricultural productivity is at risk in different forms, regions and locations due to climate variability. Inter-annual variability is the main source of disruption not only for agriculture but also for ecosystem services. EI Nin o southern oscillation and La Nin o southern oscillation index are responsible for variability in climate, cycles of flood and droughts. It resulted in 15 to 35 percent of variation in agricultural products like oilseeds, wheat and coarse grains. Moreover increase in climate variability will have a devastating impact on agriculture. Due to these reasons adaptation to climate change was considered indispensable. In the coming decades.

Ahmad *et al.* (2007) maintain that agricultural extension worker's services and electronic media can play a vital role in adoption of new technologies in agricultural sector. Agriculture extension workers can however link farmers, researchers and agriculture department. Field surveys were carried out during 2004 in the districts of Peshawar and Charsada. Four villages from the two districts i.e. Sufaid Dehri and Mathra from District Peshawar and Khanmai and Dargai from district Charsada were selected. A sample of 80 farmers i.e. 20 farmers from each village were selected. Simple descriptive statistics were used for analysis. Regrettably, the services of agricultural extension worker were not efficient. A majority of 85 percent of the farmers were not getting the service of extension workers. Only 8.75 percent of the farmers were getting technical advice, 3.75 percent were getting demonstration and only 10 percent were getting input on equipment. Majority of the farmers, 82.5 percent, did not visit agricultural extension worker's office. Only 12.5 percent, most of them were influential big farmers, said that extension worker visited their fields. Only 5 percent farmers were visited once in a year, 8.75 percent at monthly and 3.75 percent reported weekly visits. It was hoped that Radio and TV could play an important role in the adoption of technology. Out of the total respondents, who listened to radio or watched TV, 73.75 percent got new information about different agricultural problems and their solution from different programs. Another 50 percent of the respondents were interested in weather forecast and 37.5 percent wanted to know the daily prices of agriculture commodities.

Fraisse *et al.* (2006) examined ways to minimize the impacts of climate variation in southeastern part of United States of America. Efforts were made to incorporate the information of seasonal climate forecast (SCF) in agriculture sector. Southeast Climate Consortium made by six universities of state Alabama, Georgia and Florida. Agriculturists, climate scientists, agronomists, engineers, extension workers and anthropologists were gathered to make such a forum to cope up with the climatic variation situation. The forum of Southeast Climate Consortium has a mission to provide scientific knowledge and adaptation strategies to farmers in order to minimize risk associated with climate variability. Decision makers, with joint efforts, had to provide uninterrupted relevant information (SCF) on time. For the provision of this appropriate information a website[8] had been designed. Information is available to all concerned including farmers, extension workers and managers of natural resources. Information is used in decision making as a part of cope up strategy. Information regarding droughts, winter freeze, temperature and precipitation is available in shape of probabilities for Southeastern USA. Positive response was observed during focus groups discussions, interviews, meetings and workshops. A number of possible adaptation strategies in farm management decisions was proposed as potential for adaptation was noted.

---

[8] http://www.agclimate.org

According to **Maddison (2006)** important factor in the study was the difference in farmers' responses. This was because of differences in entrepreneurial capacity, family circumstances and personal managerial capacities. Study also highlights that farmers are influenced by the perception of their peers. Values, custom and traditions in any community also have an impact on adoption. As per papers reviewed on adoption of new technologies in agriculture sector, it was observed that some of main factors like tenure-ship status, size of farm, educational level, services of extension worker, availability of credit, market access, topographical structures, climatic conditions and water availability effect the readiness for adoption.

Patt *et al.* (2005) showed that, the marginal farmers who used forecast over the years and based their decisions on the information improved their productivity significantly. This was tried out in Zimbabwe. Four different locations (villages) were selected in September 2000. A group of 50 farmers was made in each village; participatory group discussions and workshops were held on climate forecast to assist each group of the farmers. These focus group discussions were used to aware the farmers regarding climate variability, to develop an understanding of forecast and to help them in applying this into their decision making process. Data was collected from 578 farmers over the period of two years. Ordinary least-square (OLS) method was used to regress cross sectional data. For the use of climate forecast information dummy variable was constructed. Results showed that more proper, carefully designed workshops and communication strategies enhance farmers' willingness to change their crop management decision according to the information.

Holger and Stone (2005) in their study used APSIM-Wheat model. It was emphasized that when a new scientific advancement in climatic forecasting is used, it is more likely to generate a positive and immediate impact. Information provision and socio-economic factors play a vital role in adoption of any new technique equally in developing and developed countries. It highlighted that to understand spatial and temporal scale variability, probabilistic approach should be considered for dissemination of the outcome. Study elaborated that an understanding of climatic variation can lead to a better decision making process in agricultural sector.

Ziervogel, *et al.* (2004) explored the impacts by disseminating the information of seasonal climate forecast (SCF) to the marginal farmers. Agent-based social simulation model had been used. Study area was Lesotho country of southern Africa. Usage of seasonal climate forecast depends on agent's characteristics, and farmer's response to the forecast information. This also showed their ability to incorporate the said information following the neighboring farmers. Adoption of SCF has the potential to help the farmers to save them from starvation which eventually increase their living standard and vice versa. Climate data was used from 1960 to 2000 to check the fluctuations in climatic variables. From Lesotho 700 agents surveyed from typical villages showed that if the forecast accuracy is 60 to 70 percent or above had a positive impact. Type of forecast determines the level of trust.

Tarhule and Lamb (2003) conducted their study in West Africa using field survey data in October-December 2001. A total of 566 respondents were surveyed. Questions were asked in local languages from 13 different communities including local farmer community, governmental heads and intermediary groups managing effects of climate variation. Descriptive-statistics[9] were used for the analysis. Results showed that very few farmers in the area of Sahel use climatic information. Only a few had access to the seasonal climate forecast information and majority of the farmer were willing to use such information.

[9] Pie charts, histogram etc.

Hansen (2002) in his study highlighted some key issues for adoption approaches and challenges faced thereby. He has outlined some prerequisites to get benefits from such forecasts. In his view the forecast must address the specific needs including both perceived and real needs. Secondly, a decision must be viable and based upon the forecast. Thirdly, the information should be accurate and viable according to the regions. Fourthly, this information needs to be properly disseminated i.e. effective communication among stakeholders. Lastly, sustained growth requires favorable policies and institutional commitments. Three phases are considered useful: (i) potential assess and understanding (ii) co-learning between decision makers and researchers (iii) equipping and engaging all relevant institutions.

Everinghama *et al.* (2002) studied sugarcane industry which is exposed to climatic variation worldwide. Sugarcane industry face uncertainty risk associated with climate variability, at every step i.e. sugarcane growing, harvesting, transportation, milling and marketing. The basic aim of the study is to provide a comprehensive system. This system must use seasonal climate forecast information (SCF) to minimize associated risk by incorporating said information into their decision making process. Climate forecast system (CFS) should include varied needs of sugarcane industry. CFS can improve irrigation management system in Bundaberg Queensland, Australia. For this purpose, APSIM-sugarcane simulation model is used. This technique provides information of temperature, rainfall and proper timing schedule for irrigation. SOI phase-5 is used for the estimation of number of wet days in a cropping season. Results elaborate that 65 percent more yield was recorded in 2000 as compared with 1999 but it decreased in 2001 as compared to 2000 because of poor prediction.

Meinke (2001) designed a research project for the reduction of vulnerability to climatic variability in South Asia. This was a multidisciplinary research project for the assessment of potential benefits of seasonal climate forecast (SCF). In case of Pakistan, two locations were selected (Islamabad and Lahore). Objective of the study was to explore pattern of cropping system for making effective and efficient decisions for crop management by using climate variability and seasonal climate forecast information. Based on 30 years of daily weather data[10] for Islamabad and Lahore APSIM-Simulation model was used for estimation. Two major crops of Islamabad wheat and mung bean were selected for the analysis. Gross margin analysis assumes production cost and current prices of products. Wheat and mung bean prices were 10 and 12 Rs. per kg respectively, whereas production cost were Rs. 4,500/- and 1,200/- per hector. Under given information of cost and price of products and topography of the area, results showed a success rate in 86 percent of the years. This materialized because of mung bean and wheat crop rotation. Average of advantage was noted as Rs. 6,322/- per hector. It was also explained that in 90 percent of the years there was an enhancement in crop productivity through crop rotation. In a few instances, advantage was nearly double. In case of Lahore rice is a major winter crop and wheat is a major summer crop as it takes more than 74 percent of the cultivated land area. Results indicated that conventional system is vulnerable to climate variability.

Jones et al. (2000) estimated the potential economic benefits of seasonal climate forecast (SCF) for farm management. This study was conducted in southeast of USA. Accurate and perfect knowledge of seasonal climate forecast for the next cropping season and daily weather forecast provided an upper limit on expected productivity. As the region has large cultivated fields, potential economic benefits are very high. However, a number of challenges are to be faced for productivity gain. These issues and challenges are mostly related to complex agricultural system and poor forecasting of climate.

[10] 1961-1990

Hammer (2000) has based his paper on tactical adoption approach in Darling Downs, Queensland, Australia. Effective use of climate forecast, eventually changes decision of farmers and leads to improved output. Decisions were consistent and were tactically based on SOI[11]. According to climate historical record, tactical adoption approach increased profit by 11 percent. Tactical adoption approach and effective use of climate forecast, resulted increase in output in 80 percent of the study years. In 20 percent of years, there was no effect which can be attributed to poor management, forecast or ineffective use of forecast information. It is suggested that effective implementation requires understanding of these risks and highlights the point that although tactical response to a forecast may pay off on average over a period of years, there can be no guarantees for the ensuing season. Simulation analysis was used to compare the management options overall years of the historical climate record (1887 - 1993) for Dalby, Queensland.

Carberry, *et al.* (2000) review a range of applications for climate forecasts. A specific case study is used to demonstrate the potential for using the Southern Oscillation Index (SOI) in assisting the incorporation of opportunity cropping into dryland cotton production systems. The standard dryland cropping rotation of long fallowing from sorghum to cotton was compared to alternative fixed rotations and to a rotation influenced by an SOI forecast. These three fixed rotations (fallow-cotton, sorghum-cotton and cotton-cotton) are compared to an SOI-influenced strategy using a simulation analysis over the long-term climate record for Dalby (town in the Darling Downs region of Queensland, Australia). The simulation case study maintain that SOI improve management skills of the decision makers. Crop rotation increased profit margin, average gross margin was increased by 14 percent. This also reduced soil erosion by 23 percent.

[11] Southern Oscillation Index

SOI phase based strategy might increase economic losses by 5 percent but this risk is less than the productivity improvement by crop rotation. Historical climate record between 1887 and 1997. Over the 100 years. Interestingly, there are a number of years when a preceding crop resulted in increased cotton yields due to a reduced incidence of waterlogging.

Sayuti, (1999) and Downing (1992) tried to address the issues caused by climatic crisis. Studies proved that farmer's and land productivity is very low especially in developing countries. Climate change has aggravated the situation. It is projected that in future situation will be worsen. Climate change resulted in, change in temperature and precipitation etc. States (governments) have to take serious actions in order to minimize climatic risks. Farmer's cooperation with state and agriculture departments is severely needed.

In **Calheiros and Antonio (1990)** study the procedures for identifying agricultural users' needs and estimating benefits, specifically in relation to the network, were structured. It should be taken into account, in the procedures, that the farmers less likely to be able to make full use of direct radar information, which agricultural practices it highly mechanized most of the time and which had, in general, specialized engineers and technicians. Both for farmers and agro industries it is necessary to understand their operations and assist them in identifying the uses of the information and its values to them. This had been done, to a certain extent, in the case of sugar cane. Regarding the products to be generated by the network one main step will be the implementation of now-casting techniques for the whole area, f0r coverage of the network, of the kind of the SHARP procedure presently under test with the Bauru radar system. Another important aspect was the development of rainfall accumulation maps using radar which could improve considerably the water balance for the State, to meet the needs of many cultivations.

Information, expected to overcome most of the difficulties in the use of the information mainly by the farmers.

Literature incorporates a few national and international studies. Basic focus was on reducing the impact of climate variability and discuss the risk reduction techniques. One of the risk reduction techniques was ‘adaptation strategy’ to address the changing scenarios of climate. Despite hurdles in adaptation, a number of studies recommended this technique.

Mainly two techniques have been used for adaptation namely top down and bottom up approaches. As world has become a global village, its requirements have also changed. Now it needs interdisciplinary approaches more than ever. A web based dissemination of information about SCF was noticed in some studies. Which is effective only in developed states. Strategic and tactical management adoption approach on the basis of SCF information suggested by number of studies. Participatory workshops on Seasonal Climate Forecast at local levels were very effective. In these training sessions farmers learned how to incorporate SCF information in their farm practices. For adaptation, accurate dissemination of forecast information is required through a number of channels as discussed earlier. Importance of extension worker is also vital to facilitate the end user. As per studies reviewed, missing the channel for dissemination of information of SCF through agricultural extension worker, this channel is used for the study undergoing. This study adopt almost the same procedures to check the potential benefits of provision of information about Seasonal Climate Forecast through extension worker. This may enhance the agricultural productivity. As it is a hypothetical study, the importance of the information will be checked through farmer’s Willingness to Pay.

CHAPTER 3

Site Specificity, Data and Methodology

This chapter mainly focuses on the agricultural conditions of Pakistan, characteristics of the study area, data collection method, sample unit and population, role of extension worker in existing agricultural practices, problems faced by enumerator during survey and econometric approach for research.

3.1. Overview of Agriculture Condition in Pakistan

Agriculture is the backbone of Pakistan's economy. Pakistan has a total area of 79.61 million hectares. Out of which 22.3 million hectares are devoted to farming, within which, 19.12 million hectares are irrigated and 3.67 million hectares are rain fed. The agriculture sector accounts for 21.0 percent of GDP and 43.7 percent of employment, Agriculture sector recorded a growth of 2.1 percent against a growth of 2.9 percent last year 2012-2013. The decline in growth was due to drop in cotton production and other minor crops owing to extreme weather. Pakistan Economic Survey (2013-2014). Major crops of the area are wheat, rice and gram whereas the minor crops include sugarcane and cotton etc. These crops can be affected by extreme weather events like floods, drought unusual precipitation and temperature.

3.2. Characteristics and Location of the Study Area

Study area Athara Hazari is tehsil of district Jhang. Distance of the study area from Jhang city is 29 Km and from Trimmu Barrage it is 5 Km. I having both irrigated and dryland area make the targeted area quite important. This area is sensitive to climatic conditions as floods occur due to

Trimmu barrage and drought is also part of the tehsil as three union councils fall in the dryland of Tahal.

3.3. Data Collection Method

A questionnaire was designed and used as a research tool for the collection of the data for this study. See in appendix. A holistic effort was made to prepare the questionnaire so that it may cover all relevant and important aspects of the study. To check the validity and reliability of the questionnaire, 15 questionnaires were pre tested in the targeted area. After pre-testation some questions were changed or modified and new questions were added. Even though the questionnaire was in English, questions were asked in either Urdu or in Punjabi the local language of the area. During data collection and interviews every possible effort was made to explain each question and its purpose. The interviews were carried out with respondents in the study area in their fields. Objectives of the study were explained to the respondent and every possible effort was made that farmer should feel free and relaxed while expressing his views during the interview.

3.4. Sample Unit and Population

Targeted respondents were farmers of the area. Households were taken as a sample unit while head of the household was the respondent himself i.e. the farmer. In the absence of the head, any other adult member of the household could be a respondent. Reason behind selecting the head of the household as a respondent is that the head is responsible to take the farm management decisions. Thus, almost all of the respondents were males.

Sampling technique; every 3rd farm house (Dera in local language) was visited in the study area. The total sample size of the study was calculated as 267 with 95 percent confidence level. As the study area consists of different union councils and also the population of each union council differs from each other, the study also calculates the sample sizes for each village by using following formula.

(Uc'p/523679)× 267

Where

Uc'p is the population of each union council

523679 is the total population of the study area

267 is calculated sample for the study.

Table: 3.1. Sample Chosen Details Union Council wise about the Study Area

Serial No.	Union council (UC)	Irrigated/ dryland	Population of the UC's	Sample chosen
1	Athara Hazari	Irrigated land	58223	30
2	Rashid Pur	Irrigated land	47068	24
3	Kot Murad	Irrigated land	64880	33
4	Rodu Sultan	Irrigated land	56064	28
5	Uch Gul Iman	Dry land	52547	27
6	Wasu Astana	Irrigated land	62578	32
7	Dosa	Both areas	62125	32
8	Kot Shakir	Irrigated land	60135	31
9	Mari Shah Sakhera	Both areas	60059	30
Total	-	-	523679	267

Source: AC office tehsil Athara Hazari and population welfare office district Jhang (2014)

3.5. Existing Extension Worker Role in the Study Area

Researcher visited the local agriculture office of tehsil Athara Hazari to meet the agriculture inspector who is responsible to deal with agriculture problems of the area in the absence of agriculture officer. There were 9 extension workers working in 9 union council of the area. Extension worker visits each union council every day except public holidays. They face a number of problems and do not have permanent offices at the tehsil level and no office at the union council level either. Regulatory authority does not provide them conveyance and petroleum expenses which severely affects their efficiency. These officers are working under district government which often involves them in non-agricultural activities like involving them to arrange Sunday bazars etc. They are of the opinion that these offices should work under Punjab government directly which will increase their efficiency in work. They also believe that farmers do not have time to contact them. It was observed that education of the extension workers and of agriculture officers were around F.A and Matric. It should be kept in mind that a large number of farmer are unaware of the responsibilities of extension workers. Some farmers do not even know about extension workers and the location of agriculture office.

Farmers were of the view that government or agriculture department did not care about their farming problems and related practices. In case of floods and droughts government does not support them to recover from the climatic catastrophes. Agriculture department does not properly coordinate with framers. Extension workers do not visit all the area properly. It is suggested by the farmers that agriculture department and specially the extension workers should work with local community and join hands to improve their conditions.

3.6. Problems Faced by Enumerator

Data collection is the toughest part of the research along with meeting expenses for survey especially for a student. Cooperation of the local people was not satisfactory. When I asked them about the information regarding socioeconomic variables they started considering me a tax representative rather than an economic researcher. However, efforts were made to convince them that this study is purely for educational purpose. Union councils were far away from each other which again added to my problems and made traveling from one union council to another quite challenging. Extreme weather was also a challenge for the enumerator to work in summer season. Despite all challenges the survey was a valuable learning experience.

3.7 Econometric Approach for the Study

Basically it is a primary study exploring the benefits[12] of Seasonal Climate Forecast, farmer's Willingness to Pay for the service and impacts of forecast information on the cropping decisions. The information of Seasonal Climate Forecast should be provided through the channel of extension worker. Importance of SCF evaluated through descriptive statistics in chapter 4 and through econometric techniques[13] in chapter 5.

This part of study deals with econometric methodology applied to the collected data. Farmer's Willingness to Pay will be taken into account through information provided by agricultural extension worker. It shall also be checked whether this information should be disseminated to farmers at union council or village levels. Study has a dichotomous independent variable of farmer's Willingness to Pay. It will take value "1" in case of Farmer's positive response (Farmers Cropping Decision and Willingness to Pay for Farmer's Adaptability Behavior) and "0" vice versa. As for binary dichotomous dependent variable, we will apply the qualitative or discrete models for our study which have binary or discrete values. For further analysis i.e. to check the impact of information provision and Willingness to Pay on farmers' adaptability, Logit model estimation technique will be applied. Information like weather and Seasonal Climate

[12] In terms of agricultural productivity increase
[13] (i) Logit for WTP and FCD (ii) ordinary least square technique for MWTP

Forecast depends on experimental techniques to assess the willingness to pay for safer food and information [Hayes, *et al.* (1995)]. The same procedure will be applied on dry land as well as on the irrigated land. At the end both the results will be compared.

Table: 3.2. Description of variables and Statistics

Symbol	Description	Expected signs	Maximum	Minimum	Mean	St. Deviation
Edu	Education	Positive	18	0	7.08	4.70
HS	Household size	Negative	40	2	9.14	5.55
TFL	Total farm land	Positive	600	0.5	35.59	74.70
EIO	Expected increase in output	Positive	25	0	6.8	4.26
RVEW	Required visits of extension worker	Positive	5	0	1.25	0.69
Fer_D	Fertility decrease	Negative	1	0	0.45	0.50
IEW	Influence of extension worker	Positive	1	0	0.83	0.38
Lite	Literate	Positive	1	0	0.21	0.41
EM	Exposure to Media	Positive	5	1	3.13	1.23
I	Income	Positive	90000	6000	30882.0	11843.84
WTP	Willingness to pay	Dependent	1	0	0.79	0.41
FCD	Farmer cropping decision	Dependent	1	0	0.89	0.34
MWTP	Maximum Willingness to pay	Dependent	500	0	95.22	79.75

Details are on next pages

3.8. Logit Model Specification

$$= \frac{1}{1 + e^{-(\alpha0 + \alpha1\ \text{Edu} + \alpha2\ \text{HS} + \alpha3\ \text{I} + \alpha4\ \text{Fer\_D} + \alpha5\ \text{TFL} + \alpha6\ \text{RVEW} + \alpha7\ \text{EIO} + \alpha8\ \text{IEW} + \alpha9\ \text{EM} + \alpha10\text{Lite} + \varepsilon i\ )}}$$

3.9. Econometric Model

Determinants of WTP

The general Logit regression model with multiple regressors is as follows;

$$Pr\ (WTP=1 \mid Edu, HS, \ldots EM) = F\ (\alpha_0 + \alpha_1\, Edu + \alpha_2\, HS + \alpha_3\, TFL + \alpha_4\, EIO + \alpha_5\, RVEW + \varepsilon_i) \quad (1)$$

Determinants of Farmer Cropping Decision

$$FCD = \alpha_0 + \alpha_1\, HS + \alpha_2\, EIO + \alpha_3\, RVEW + \alpha_4\, Fer\_D + \alpha_5\, IEW + \varepsilon_i \quad (2)$$

Multiple linear regression model with multiple regressors is as follows;

Determinants of Maximum WTP

$$MaxWTP = \alpha_0 + \alpha_1\, Lite + \alpha_2\, EIO + \alpha_3\, EM + \alpha_4\, Age + \varepsilon_i \quad (3)$$

WTP, FCD and Maximum WTP are the dependent variables, which is to estimate Maximum Willingness to Pay of an individual for the services of agricultural extension worker. Whereas equation (1), equation (2) and equation (3) show the independent variables that are; age of the respondent (Age) education (Edu), household size (HS), required visits of extension worker (RVEW), expected increase in output per 40kg (EIO), extension worker role (EWR), influence of extension worker (IEW). Whereas F shows cumulative probability distribution function of the Logit model.

3.10. Data and its Source

This study is based on primary data collection through questionnaire and personal interviews. The study is focused on tehsil Athara Hazari which is comprised of 9 Union council and has an approximate population of 523,226 people. (District population welfare office and AC office, Jhang, 2014). The total area under study is 1,650 square Km from district Jhang, Punjab and the data is collected in the year 2015.

3.11. Variables Construction

Dependent Variables

i. Willingness to Pay (WTP)

Willingness to Pay is the way to assess[14] the importance of information[15] to a farmer. Respondents were asked closed format questions. This variable serves as a dependent variable in equation (1). This variable appears in binomial format where it takes a value of 1, if the household is willing to pay any value in monetary terms and if don't willing to pay takes 0.

ii. Farmer's Cropping Decision (FCD)

Farmer's Cropping Decision variable will actually explain farmer's adaptability behavior regarding climatic changes[16]. Farmer will change his or her cropping decision on the basis of information regarding Seasonal Climate Forecast. This information will be disseminated to the farmers through agricultural extension worker. Its value is equal to 1 if the respondent will change his or her cropping decision and 0 otherwise this is also in binomial form. This variable represents the dependent variable in equation (2).

iii. Maximum Willingness to Pay (MWTP)

Willingness to Pay is the extent of showing Maximum Willingness to Pay for the services of extension worker (who will provide information of Seasonal Climate Forecast to the farmer).

---

[14] Through which we can infer farmer's adaptation response.
[15] Precipitation, temperature, wind speed and direction etc.
[16] Factors effecting productivity of the farm.

The open-ended format of CVM is used in this survey and questions asked from the respondents are based on it to determine their Maximum WTP for the services of extension worker.

Independent Variables

i. Education level (Edu)

This variable shows the educational level of the respondent from class one to higher educational level (M.Phil. or Ph.D.). Class one takes value 1, class two takes 2 and so on up to the higher education. This variable is expected to have a positive relationship with WTP. More educated respondents are expected to take scientific oriented decisions.

ii. Literate (Lite)

Variable literate differentiate literate and non-literate respondents. A respondent having primary or above educational level is considered as literate. This is a binary variable if the respondent is literate (primary or above) it will take value “1” otherwise “0”. It is expected that literacy will effective farmers willingness to pay.

iii. Household size (HS)

This variable represents the size of the respondent’s household i.e. the number of family members a household has. According to the reviewed literature, household size is inversely related to WTP. It is due to the fact that more family members require more funds to cover their basic needs i.e. food, clothing etc. which eventually reduces the overall purchasing power of the household.

iv. Age (Age)

This is a numeric variable and shows the age of the respondent in years. It is expected to have a positive relationship with WTP. An aged person is expected to be more experienced and thus more willing to pay for the provision of such services.

v. Required visits of the extension worker (RVEW)

This variable indicates the number of visits of an extension worker per month required by the farmer to enhance his farm productivity.

vi. Expected increase in output (EIO)

The variable explains the perception of the farmer regarding increase per maund in his farm productivity after using SCF information to his benefit.

vii. Extension worker role (IEW)

This is also a binary variable and checks whether the farmer considers the role of extension worker important or not for his farm management practices. If the farmer consider it as important and influenced by extension worker then it will take the value of "1" or otherwise "0".

viii. Exposure to media (EM)

This variable shows that if a person is exposed to radio, television, newspaper and internet sources or not. Exposure to media raises awareness and educates the respondents about the new advancements in agriculture sector. A person's Willingness to Pay increases theoretically if he is updated from media sources and vice versa.

ix. Fertility decrease of the land (Fer_D)

This variable shows information regarding fertility of the land i.e. decrease in fertility over the years. Reduction in farm productivity and income of the farmer will result in a dcreased Willingness to Pay. It is expected that there will be an inverse relationship between fertility decrease and WTP.

CHAPTER 4

Descriptive Analysis

A total of 267 respondents were selected. As major area of the tehsil comprises of irrigated land, therefore according to the population of tehsil study area is divided broadly into two categories and thus 224 respondents from irrigated land and 43 from dry land were selected proportionately. The percentages are 84 and 16 percent respectively.

Table 4.1. Socio Economic Characteristics of the Respondents (Farmers)

Variables		Minimum	Maximum	Mean	Standard deviation
Age (in years)	Dryland	25	82	45.65	12.97
	Irrigated	20	70	42.42	11.54
	Total	**20**	**82**	**42.94**	**11.81**
Education (per class)	Dryland	0	16	6.47	3.69
	Irrigated	0	18	7.20	4.87
	Total	**0**	**18**	**7.08**	**4.70**
Household Size (no. of family members)	Dryland	4	35	9.60	7.24
	Irrigated	2	40	9.05	5.18
	Total	**2**	**40**	**9.14**	**5.55**
Income (in Rs.)	Dryland	12000	55000	32580	11114.62
	Irrigated	6000	90000	30550	11974.76
	Total	**6000**	**90000**	**30882**	**11843.84**
Children under five years (in numbers)	Dryland	0	16	2.14	3.34
	Irrigated	0	17	1.90	2.39
	Total	**0**	**17**	**1.94**	**2.56**

Source: Field survey

Table 4.1 describes the socio economic characteristics of the farmers i.e. Age, Education, household size, Income level and children (under five years). These socio economic variables are considered important in primary studies and effect the decisions of household. Above results are reported category wise i.e. dryland, irrigated land and then aggregately. Results are in form of minimum, maximum, mean and standard deviation of the data. Average age of the farmers is approximately “43 years” whereas standard deviation is “11.812”. Average educational level and standard deviation of the area are “7” and “4.704” respectively. Average household size was a bit high “9.14” and variation was “5.553”. Representative mean value of the farmers’ income is “Rs. 30,882” per month whereas variation in income is considerably high. It is expressed by the value of “11,843.84”. Maximum value of the variable “children under five year” is “17” and seems very high but the average value was “1.94” and standard deviation is “2.56”.

Table 4.2. Ownership of Land[17], Tractor and Loans Taken by Farmers

Variables		Frequency	Percentage
Ownership of the land	No	34	12.70
	Yes	233	87.30
Tractor ownership	No	123	46.10
	Yes	144	53.90
Loans taken	No	232	86.90
	Yes	35	13.10

Source: Field survey

Table 4.2 reports the number and percentages of the farmers i.e. how many farmers are the owner of the land and own a tractor (tractor ownership describes how many farmers are using their own machines and shows the proportion of loans taken. Self-owned land in study area was 87.3 percent. Ownership of land is an important factor as the landlord can take decisions about their owned land more easily. Out of the total, 53.9 percent of the farmers owned a tractor. This was to check how many of the farmers are using their on machines. Loans are taken by only 13.1 percent of the farmers which is very low and the reason was none other than but non-availability of credit or they did not meet the criteria of loan issuance. A few were not interested to take loans due to religious reasons.

[17] Agricultural land

Table 4.3. Basic information of the Farmer and Land

Variables		Minimum	Maximum	Mean	Standard deviation
Farming Experience (in years)	Dryland	6	60	22.70	12.41
	Irrigated	2	50	21.72	11.44
	Total	**2**	**60**	**21.88**	**11.58**
Total Farm land (in acres)	Dryland	18	600	148.74	135.41
	Irrigated	0.5	80	13.87	16.11
	Total	**0.5**	**600**	**35.59**	**74.70**
Percentage of good Soil fertility (above 30 maund/acre)	Dryland	0.25	1	0.66	0.19
	Irrigated	0	1	0.64	0.25
	Total	**0**	**1**	**0.64**	**0.24**
Percentage of average Soil fertility (around 30 maund/acre)	Dryland	0	0.60	0.26	0.19
	Irrigated	0	0.80	0.29	0.22
	Total	**0**	**0.80**	**0.28**	**0.21**
Percentage of poor Soil fertility (below 30 maund/acre)	Dryland	0	0.40	0.08	0.12
	Irrigated	0	0.80	0.07	0.15
	Total	**0**	**0.80**	**0.07**	**0.14**

Source: Field survey

Table 4.3 describes the results in Minimum, Maximum, Mean and Standard Deviation of farming experience, Total Land and Fertility of the Land. Based upon the farmers' perception, fertility is subdivided into three categories, good fertility average and poor fertility of the land. These results are discussed for the Irrigated land, Dryland and total of the both. Farming experience on average was approximately 22 year, with standard deviation of 11.58 years. Average landholdings in the study area is 35.59 acres with standard deviation 74.6981. Land owned in dryland farmers observed higher than that of the irrigated land farmers. Data shows that approximately one third of the land is good-fertile while the rest two third is average or poor-fertile land.

Table 4.4. Major Crops and Land Distribution

Variables		Minimum	Maximum	Mean	Standard deviation
Cultivated wheat area (in acres)	Dryland	0	0	0	0
	Irrigated	0.50	55	9.28	9.59
	Total	**0**	**55**	**7.79**	**9.43**
Cultivated rice area (in acres)	Dryland	0	0	0	0
	Irrigated	0	45	7.47	8.47
	Total	**0**	**45**	**6.27**	**8.23**
Average Wheat yield (in maund/acre)	Dryland	0	0	0	0
	Irrigated	5	65	34.79	8.51
	Total	**0**	**65**	**29.19**	**14.99**
average Rice yield (in maund/acre)	Dryland	0	0	0	0
	Irrigated	0	60	34.04	9.58
	Total	**0**	**60**	**28.55**	**15.30**
average Gram yield (in maund/acre)	Dryland	80	300	198.37	56.02
	Irrigated	0	0	0	0
	Total	**0**	**300**	**31.95**	**76.37**

Source: Field survey

Table 4.4 shows descriptive statistics of the major crops for the area. These are Wheat, Rice and Gram and land allocated to these crops. Wheat and rice is mostly produced in irrigated land whereas gram is produced in the dry land. Maximum land allocated to wheat and rice is 55 and 45 acres respectively. Average production of the wheat, rice and gram was "34.79, 34.04, 198.3721" 40 kg per acre respectively.

Table 4.5. Extension Worker and Expected Increase in Output[18]

Variables		Minimum	Maximum	Mean	Standard deviation
Required visits of extension worker (per month)	Dryland	0	2	0.98	0.34
	Irrigated	0	5	1.30	0.73
	Total	**0**	**5**	**1.25**	**0.69**
Expected increase in output (per 40 kg)	Dryland	0	10	4.38	2.57
	Irrigated	0	25	7.27	4.37
	Total	**0**	**25**	**6.80**	**4.26**

Source: Field survey

[18] Farmer's Perception Based

Extension worker in agriculture plays a vital role. The table 4.5 describes descriptive statistics regarding the number of visits required by the farmers. Farmers reveal their expected increase in output if the extension worker visits them appropriately. Productivity increases by the intervention of the extension worker as he guides farmers scientifically according to the demand of soil, atmospheric conditions of the area and also by providing them accurate and proper information regarding precipitation, temperature, wind speed and direction etc. On an average 1.25 visits of extension worker per month are required by the farmers in order to enhance their productivity. Land productivity can be increased on an average by 7.27 maund per acre in irrigate land which as compared to 4.38 maunds in dryland. These results show the potential benefits of extension worker. If extension worker provide SCF to farmers, then it can affect agricultural productivity positively.

Table 4.6. Hinders Towards Adoption of Adaptation Strategy

Variables		**Frequency**	**Percentage**
Do not adapt due to	lack of money	40	15
	lack of information	87	32.60
	shortage of labor	1	0.40
	lack of money and lack of information	125	46.80
	lack of money and shortage of labor	5	1.90
	shortage of labor, lack of money and information	9	3.40
Total	-	**267**	**100**

Source: Field survey

Why the farmers are not adapting according to the changing situation of the climate? Details are reported in table 4.6. Results show that 125 farmers are not adapting due to lack of money and lack of information about the climate changing scenarios over time. Out of these 87 farmer suggested that lack of information about weather and climate forecast is the sole reason for non-adaptation.

Table 4.7. Extension Worker and Farmer Cropping Decision

Variable		Frequency	Percentage
Extension worker (EW) role[19]	No	32	12
	Yes	235	88
Influence of extension worker[20]	will not be influenced by EW	45	16.90
	Will be influenced by EW	222	83.10
Farmer cropping decision(FCD)[21]	FCD will not be changed	30	11.20
	FCD will be changed	237	88.80

Source: Field survey

Table 4.7 shows the role and influence of extension worker and it also describes the Farmer Cropping Decision (FCD). It shows the farmers changed their cropping decision on the basis of information provided to them by the extension workers. Majority of the farmers recognized importance of extension worker i.e. 235 out of 267. Farmer (about 83 percent) were of the view that extension worker, through information, can influence them. Farmer Cropping Decision (FCD) should depend on changing scenarios, results of FCD shows that 88.8 percent changes according to the prescribed situation.

Table 4.8. Farmers' Perception about Weather Forecast and Sources of Information

Variable		Frequency	Percentage
Weather Forecast knowledge	do not know forecast	6	2.20
	Knows forecast	261	97.80
Traditional Forecast (Farmers' experience based)	always correct	22	8.20
	sometimes correct	88	33
	often correct	22	8.20
	often incorrect	103	38.60
	always incorrect	32	12
Forecast info taking from	T.V	186	69.70
	Radio	3	1.10
	based on traditional knowledge	7	2.60
	T.V & news paper	31	11.60
	T.V & radio	16	6
	T.V & traditional	4	1.50
	T.V, radio & traditional	3	1.10
	T.V, newspaper & radio	17	6.40

Source: Field survey

[19] Can extension worker play a role in agricultural practices?
[20] Will farmers be influenced by agricultural extension worker?
[21] After getting information from EW, will they change their farm cropping decisions

Table 4.8 showed farmer's knowledge about forecast[22] i.e. what they think about traditional forecast in terms of accuracy. It also shows various sources farmer gathers his forecast information from. The information is presented in the form of percentage and numbers in the above table. Farmers already had some knowledge about weather forecast as 261 farmer said they idea about it. Whereas 103 of the total farmers said that traditional forecast is often incorrect. Highest number of farmers, exactly 31, sourced this information from T.V and newspaper.

Cross Tabulation

Cross tabulation of willingness to pay (WTP) and farmer cropping decision (FCD) with different indicators i.e. Age, Education, Household Size, Income, Total land and Expected increase in output. These are discussed and presented below.

Table 4.9. Willingness to Pay (WTP) by Age

Variable		**Age**						**Total**
		0-20	21-30	31-40	41-50	51-60	60 and above	
Willingness to pay	**No**	0	7	9	20	13	6	55
	Yes	1	45	71	50	33	12	212
Total		1	52	80	70	46	18	267
Percentage WTP		0.37	16.85	26.59	18.75	12.36	4.49	79.40

Table 4.9 shows that a high fraction of respondents are WTP for this information regarding Seasonal Climate Forecast. Most of them in the age group 21 year to 60 year. It shows that age is an important factor in case of adaptation to new knowledge, particularly with reference to climate.

[22] Forecast weather and seasonal, most of the farmers were unaware about seasonal forecast.

Similarly Willingness to Pay at various levels by age are given in appendix table 1, depicts that 150 out of 267 respondents fall in the range of 31-50. A total of 211 farmers are Willing to Pay for the services of extension worker. However, 20 percent of the farmers are not Willing to Pay for this service. The WTP ranges between Rs. 25 per month to Rs. 200 per month. About 2 percent of the farmer willing to pay 25 rupees per month, 20 percent are WTP Rs. 50 per month, 23 percent Willing to Pay Rs. 100 per month, 17 percent of them Willing to Pay Rs. 150 per month, 11 percent from total farmers, Willing to Pay Rs. 200 per month and only 3 percent are Willing to Pay more than Rs. 200 per month. With reference to age Maximum Willingness to Pay decreases to some extent with increase in age.

Table 4.10. Willingness to Pay by Education

Variable		**Education**						**Total**
		less than 1	2-5	6-8	9-10	11-14	15 and above	
Willingness to Pay	**no**	39	12	2	2	0	0	55
	yes	18	46	34	65	41	8	212
Total		57	58	36	67	41	8	267
Percentage WTP		6.74	17.23	12.73	24.34	15.36	3.00	79.40

Table 4.10 shows that as education of the respondents increases their Willingness to Pay increases. Higher numbers of the respondents are in the range of 9-10 years of education, where 65 respondents are Willing to Pay out of 67. Overall 79 percent are to Pay for the services of SCF through extension worker.

Education affects Willingness to Pay[23] (with higher level of education WTP increases) shows in appendix table 2. People with higher education are more conscious and technology dependent. Therefore, they want to adjust with changing technology. Maximum number of the respondents

23 ranges between Rs. 25 per month to Rs. 200 per month

is 67[24]. The qualification of such respondents ranges from 9th - 10th grade which is Secondary School Certificate and 95 percent of the farmers in this range are Willing to Pay. Their Willingness to Pay varies from level to level (sort of bids) and respondent to respondent (farmer). Hence, education has an influence on decision making process.

Table 4.11. Willingness to Pay by Household Size

Variable		**Cross tabulation of Household size and WTP**						**Total**
		less than 2	3-7	8-12	13-15	16-25	26 and above	
Willingness to Pay	**no**	1	18	25	5	2	4	55
	yes	1	104	81	15	2	9	212
Total		2	122	106	20	4	13	267
Percentage WTP		0.37	38.95	30.34	5.62	0.75	3.37	79.40

Household size shows that majority of the respondents fall in the groups of household sizes 3-7 and 8-12 and in percentage the can be shown as, 45 and 38 percent respectively and their Willingness to Pay is 38.95 and 30.34 percent respectively.

Most of the respondents i.e. 122 have 3-7 family members. Table 3 in appendices shows their Willingness to Pay which ranges between Rs. 25 per month to Rs. 200 per month. WTP depends upon household size (family members). Results show that respondent with large household size are not going to adapt new techniques i.e. farmer's Willingness to Pay decreases is less if they have a big family to support.

[24] See appendix table 2

Table 4.12. Willingness to Pay by Income

Variable		Income							Total
		less than 6000	6001-15000	15001-25000	25001-35000	35001-45000	45001-75000	75001 and above	
Willingness to Pay	**no**	1	8	29	7	4	5	1	55
	yes	0	14	61	72	42	18	5	212
Total		1	22	90	79	46	23	6	267
Percentage WTP		00	5.24	22.85	26.97	15.73	6.74	1.87	79.40

As shown in table 4.12, most of the respondents, 169 exactly, are with an income falling in range of Rupees 15,000 to Ruprrs 35,000. An increasing trend of WTP can be observed with an increase in income.

Appendix table 4, illustrates that maximum respondents (80 percent) have an income ranging between Rs. 15,001 to Rs.45,000 and respondents of this group are willing to pay between Rs. 25 to Rs. 200 per month. This demonstrates that increase in income results in higher Willingness to Pay and that income plays an important role in adoption of new techniques.

Table 4.13. Willingness to Pay by Total Land (in acres)

Variable (in acres)		Total land						Total
		less than 1	2-4	5-10	11-30	31-100	101 and above	
Willingness to pay	**no**	1	22	14	16	0	2	55
	yes	7	39	59	55	35	17	212
Total		8	61	73	71	35	19	267
Percentage WTP		2.62	14.61	22.10	20.60	13.11	6.37	79.40

Most of the respondents, exactly 144, have land between 5-30 acres. Table 4.13 also shows that those farmers who have more land are Willing to Pay more. Appendix table 5 shows that maximum number of famers, 73 exactly, have land between 5 to 10 acres. About 80 percent of the respondents showed their Willingness to Pay which ranges between Rs. 25 to Rs. 200 per month.

Table 4.14. Willingness to Pay by Expected Increase (output)

Variable (potential production gain)		Expected increase in output (in maund per acre)					Total
		less than 1	2-5	6-10	11-15	16 and above	
Willingness to pay	**No**	35	15	4	0	1	55
	Yes	1	100	85	19	7	212
Total		36	115	89	19	8	267
Percentage WTP		0.37	37.45	31.84	7.12	2.62	79.40

Table 4.14 shows that an expectation of higher output increases respondent's Willing to Pay which ranges between Rupees 25 to Rupees 200. Most of the respondents think that their output will increase if extension worker starts visiting them and shares proper set of information. Appendix Table-6 describes that maximum number of the farmers in groups, 99 out of 115, reported Willingness to Pay for a productivity increase by 2 maund to 5 maund per acre. Results describe that as expected farm productivity increases, farmer are more Willing to Pay.

Table 4.15. Farmer Cropping Decision (FCD) by Age

Variable		Age						Total
		0-20	21-30	31-40	41-50	51-60	60 and above	
FCD	**FCD will not be changed**	0	3	4	13	8	2	30
	FCD will be changed	1	49	76	57	38	16	237
Total		1	52	80	70	46	18	267
Percentage FCD change		0.37	18.35	28.46	21.35	14.23	6.00	88.76

Farmer Cropping decisions by age show that maximum, exactly 150 out of 267, respondents lie in the range of 31-50 years. Overall 237 farmers will change their cropping decisions due to the services of extension worker vis-à-vis information regarding Seasonal Climate Forecast. Almost 89 percent of the farmers will not only recognize this information as important but will also incorporate this information in their cropping decisions. The reason could be that the respondents in younger age have more capability to adapt to new techniques around them.

Table 4.16. Farmer Cropping Decision by Education

Variable		**Education**						**Total**
		less than 1	2-5	6-8	9-10	11-14	15 and above	
FCD	**FCD will not be changed**	19	5	2	3	1	0	30
	FCD will be changed	38	53	34	64	40	8	237
Total		57	58	36	67	41	8	267
Percentage FCD change		14.23	19.85	12.73	23.97	14.98	3.00	88.76

Education plays a vital role in determination of one's behavior. People with higher level of education are more conscious and technology dependent. As they are well aware of changes taking place around the globe, therefore they want to adjust with changing scenarios. Maximum number of the respondents reported in table 4.16 is 67 with an education level of Secondary School Certificate.

Table 4.17. Farmer Cropping Decision by Household Size

Variable		**Household size**						**Total**
		less than 2	3-7	8-12	13-15	16-25	26 and above	
FCD	**FCD will not be changed**	0	7	16	4	1	2	30
	FCD will be changed	2	115	90	16	3	11	237
Total		2	122	106	20	4	13	267
Percentage FCD change		0.75	43.07	33.71	6.00	1.12	4.12	88.76

Farmers’ Cropping Decision by household size is presented in table 4.17 as above. Most respondents, exactly 122, have 3 to 7 family members. Table 4.17 give the mix responses of the farmers regarding FCD while having household size (family members). To some extent it can be said that with large household size they are not going to adapt new techniques i.e. farmers are not going to change cropping decision, accordingly changes in climate variability.

Table 4.18. Farmer Cropping Decision by Income

Variable		Income							**Total**
		less than 6000	6001-15000	15001-25000	25001-35000	35001-45000	45001-75000	75001 and above	
FCD	**FCD will be not changed**	0	3	13	8	2	3	1	30
	FCD will be changed	1	19	77	71	44	20	5	237
Total		1	22	90	79	46	23	6	267
Percentage FCD change		0.37	7.12	28.84	26.59	16.48	7.49	1.87	88.76

Table 4.18 illustrates that maximum response are in the range of income from Rs. 15001-45000 these are 215 farmers out of total 267 farmers. It shows, Farmers’ Cropping Decision changes as income increases i.e. 28.84 respondents will change FCD with income range of Rs. 15,001-25,000, 79 respondents are in the range of Rs. 25,001-35,000 and 16.48 percent of the respondents from the range of Rs. 35001-45000 of the income. By this it can be said that income also having a role in decision making process.

Table 4.19. Farmer Cropping Decision by Total Land Cultivated (in acres)

Variable (in acres)		Total Land						Total
		less than 1	2-4	5-10	11-30	31-100	101 and above	
FCD	FCD will not be changed	0	12	8	8	1	1	30
	FCD will be changed	8	49	65	63	34	18	237
Total		8	61	73	71	35	19	267
Percentage FCD change		3.00	18.35	24.34	23.60	12.73	6.74	88.76

Farmer Cropping Decision by total land cultivated in table 4.19 showed that 237 farmers from 267 reported positively. Similarly for each category of land holdings a rising higher fraction responses positively. That the farming decision take into account the information provided by extension worker.

Table 4.20. Farmer Cropping Decision by Expected Increase in Output

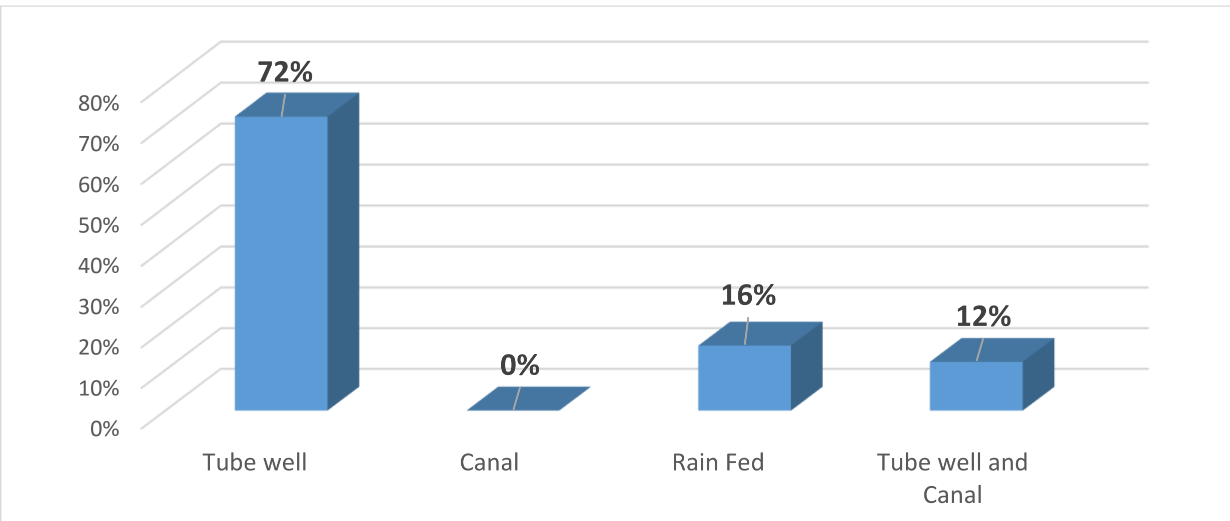
Variable (potential production gain)		Expected Increase in output in maund per acre					Total
		less than 1	2-5	6-10	11-15	16 and above	
FCD	FCD will not be changed	19	8	3	0	0	30
	FCD will be changed	17	107	86	19	8	237
Total		36	115	89	19	8	267
Percentage FCD change		6.37	40.07	32.21	7.12	3.00	88.76

Farmer Cropping Decision by expected increase in output in table 4.20 it shows that maximum number of the farmer 107 out of 115 in table 4.20 are of the view that their productivity (perceived) will increase by 2 maund to 5 maund per acre, if they change their cropping patterns according to the advice of extension worker who will provide all relevant information plus Seasonal Climate Forecast. These results shows that as their expected increase in output will increase (which will ultimately increase their farm income) will change their FCD.

Graphical Description of the Results

Graphical description of data show each data category in a frequency distribution, displays relative numbers or proportions of multiple categories, summarizes a large data set in visual form, clarify trends better than tables, estimate key values at a glance, permit a visual check of the accuracy and practicality of calculations. Thus making the study easy to understand for readers.

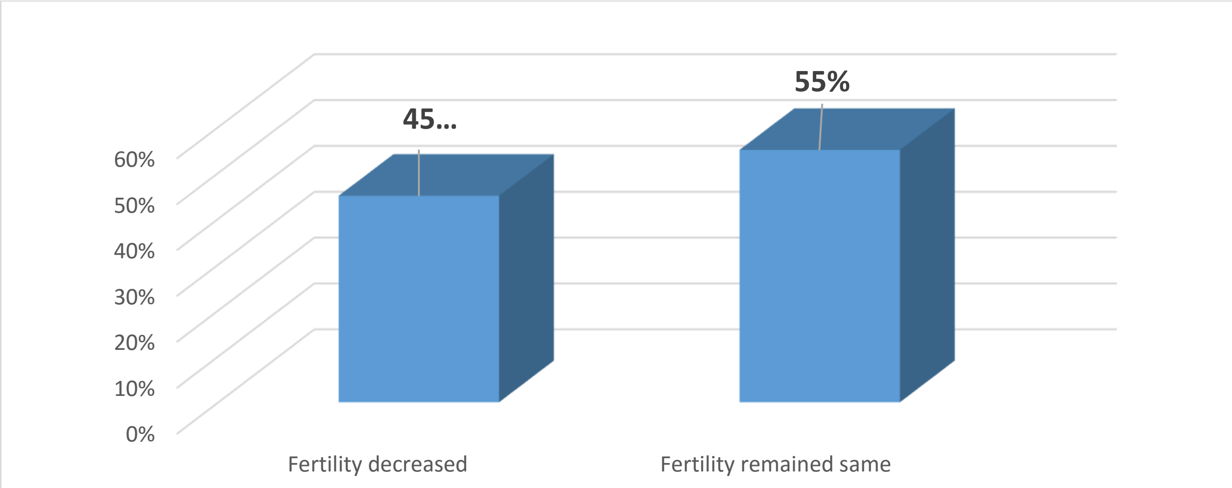
Graph 4.1. Mode of Irrigation Used by Respondents of the Study Area



Source: Field survey

Above bar chart in figure 4.1 depicts the detail of mode of irrigation used by the farmers in our study area. Out of the total respondents 72 percent were using only tube well water for cultivation. Not a single farmer is using canal water for irrigation, whereas 12 percent of the respondents were using canal water plus tube well for the cultivation of their crops.

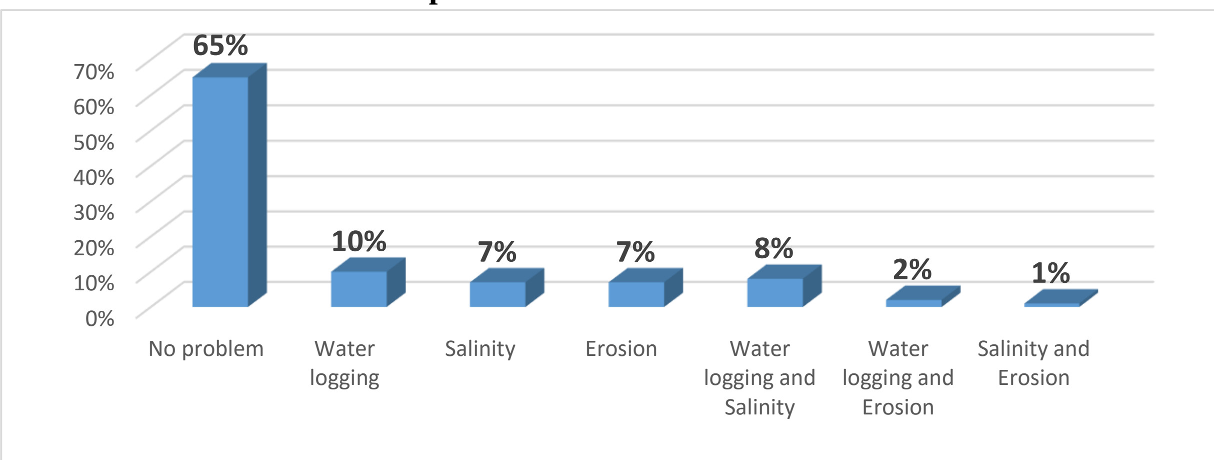
Graph 4.2. Change in Fertility of Land over Time (usually 5 to 15 year)



Source: Field survey

When it was asked from the farmers regarding the fertility depletion in land over time, out of total respondents 45 percent respondents confirmed a reduced fertility over time[25]. Whereas 55 percent of the farmers were of the view that fertility has not decreased. Those who opined that fertility has decreased termed over use of the land, water logging, salinity and erosion are as responsible for fertility decrease.

Graph 4.3. Land Related Problems

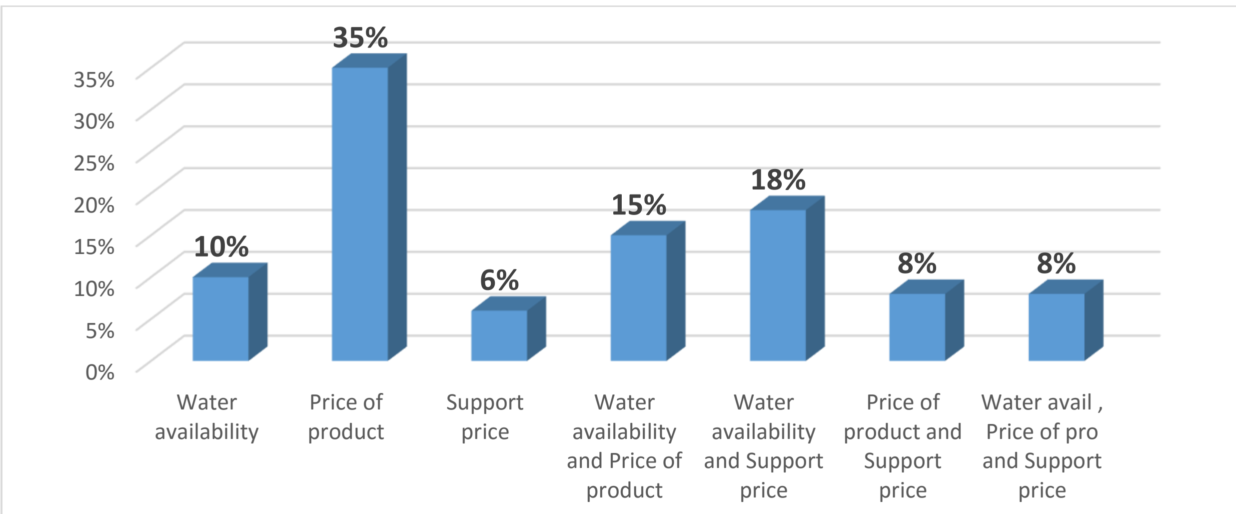


Source: Field survey

[25] For this it was suggested to them to compare the current situation with past 5-15 years.

Farmers were also asked about land related issues and problems they usually faced. Results are presented in above bar chart 4.3 which show that 65 percent of the total farmers had no issues, while 35 percent recorded their land related issues as 10 percent faced water logging, 7 percent faced salinity issues, 7 percent had soil erosion issues, 8 percent had both water logging and salinity, 2 percent had both water logging and erosion and only 1 percent of the farmers faced both salinity and erosion problems. These problems occur due to the frequent occurrences of floods and droughts.

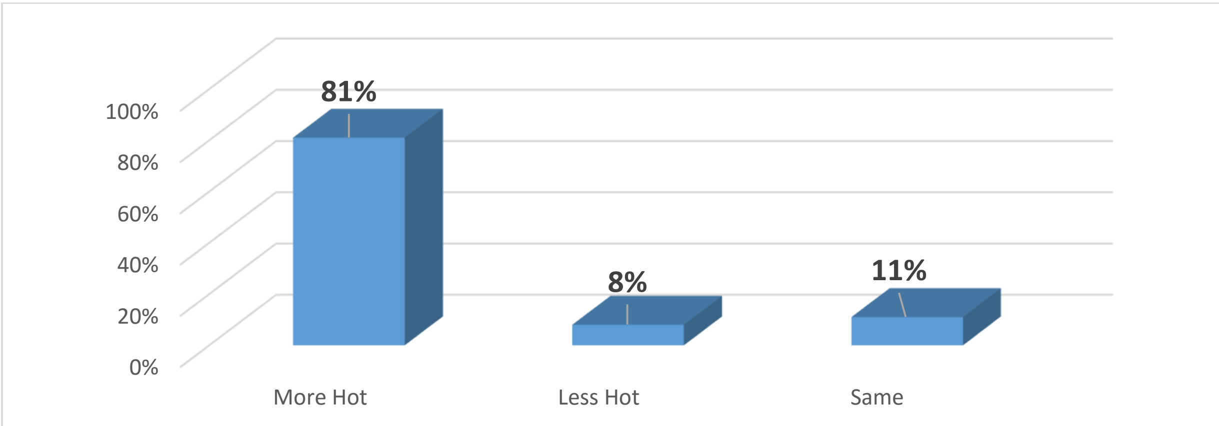
Graph 4.4. Factor Influence Farmers' Decision about Crop Cultivation



Source: Field survey

Factors which influence farmers' decision regarding crop cultivation were also observed and their results are shown Graph 4.4 given as above. Respondents who were of the view that water availability determines which crop to grow were 10 percent. While, 35 percent farmers, the highest percentage response, said that selling price of the crop influences their decision for sowing a particular crop. Support price effects 6 percent of the farmers, 15 percent of the respondents thought that water availability and price of product are major determining factors, 18 percent said that they consider water availability and support price, 8 percent are of the view that price of product and support price are important factors and 8 percent said that water availability, price of product and support price all effect their cropping decision.

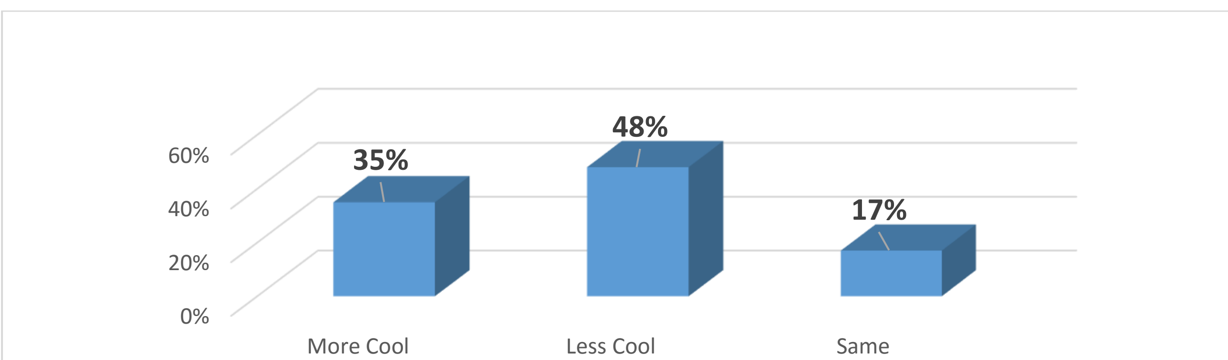
Graph 4.5. Change of Summer Season over Time



Source: Field survey

There was a mixed response when farmers were asked to compare the current summer season with the previous. Their responses are presented in the above bar chart 4.5 which shows that 81 percent of the total farmers said that current summer season is hotter than the previous one, 8 percent said that it was less hot and 11 percent said that they have observed no change. Majority of the respondents reported observed change, which shows that variability in climate over time is there as summer season in the study area has been reported warmer than that of previous.

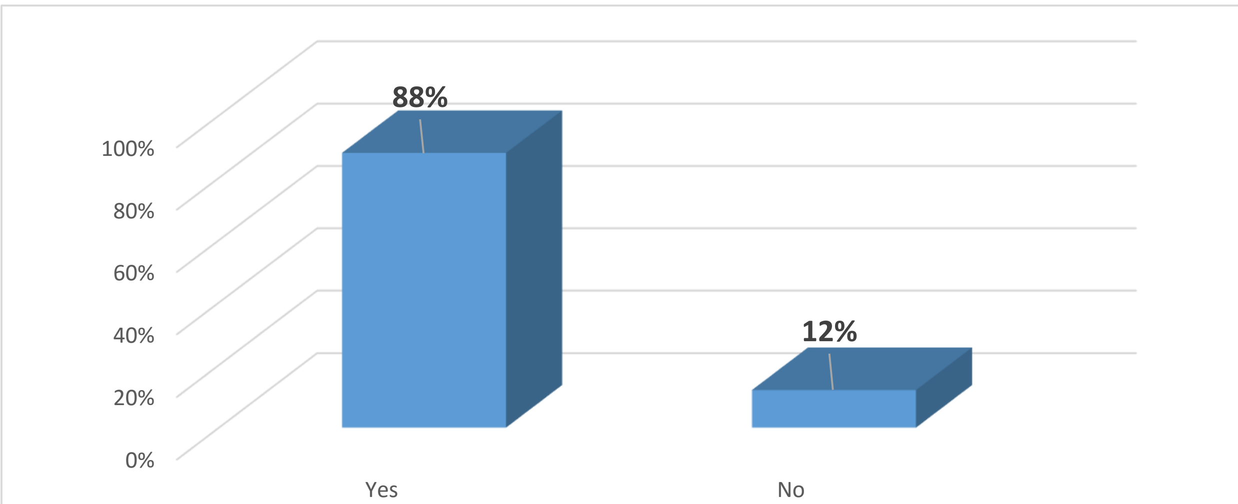
Graph 4.6. Change of Winter Season over Time



Source: Field survey

Graph 4.6 explains changes in winter season. When farmers were asked regarding their observations in changes in winter season over the years, 35 percent said that winter season is colder as compared to the previous winter seasons, 48 percent said that winter season is less cold, while17 percent of the farmers reported no change in winter season. Mode value is 48 percent i.e. less cool.

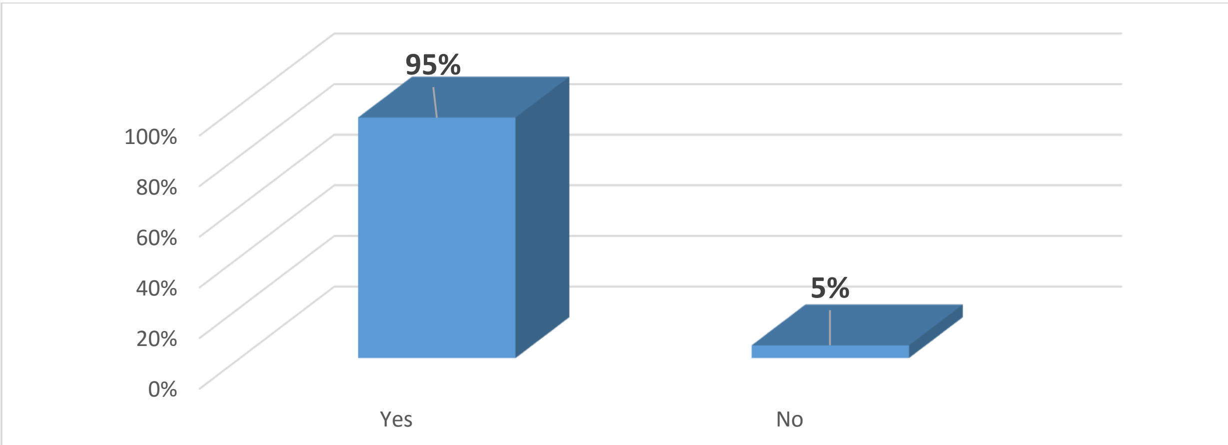
Graph 4.7. Change of Rainfall Patterns (heavy rainfall at once) over Time



Source: Field survey

Rainfall pattern has also changed. This argument can be supported through above bar chart. In graph 4.7 the evidence shows that a majority, 88 percent of the farmers, observed a heavy rainfall in recent times which ultimately disturbs their cropping pattern and farm productivity. On the other hand, 12 percent reported no change in the rainfall pattern.

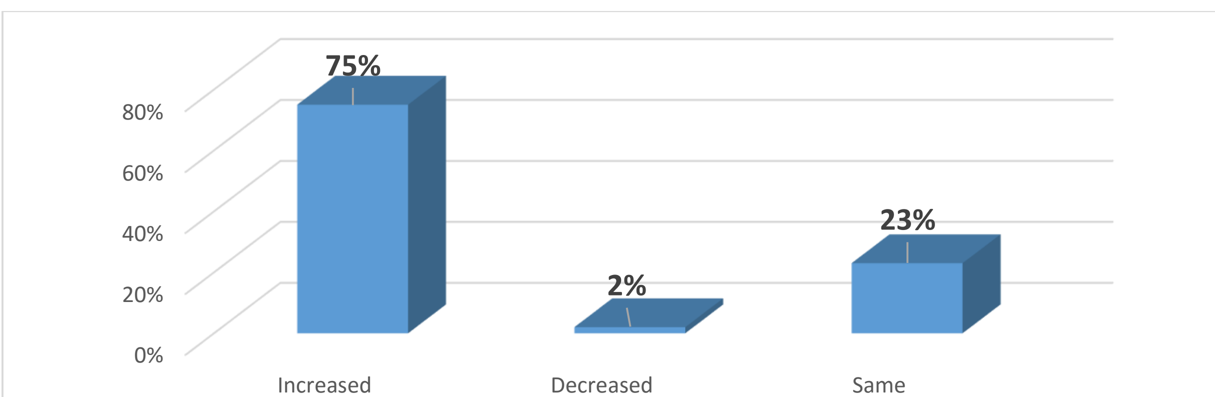
Graph 4.8. Change of Rainfall Patterns (unusual rainfall) over Time



Source: Field survey

When farmers were asked about the changes in rainfall patterns,[26] their responses were noted and presented in above bar chart 4.8. About 95 percent of the farmers said yes they have witnessed rise in unusual and untimely rainfall over time while only 5 percent of the respondents said that there is no change.

Graph 4.9. Change of Flood Frequency over Time

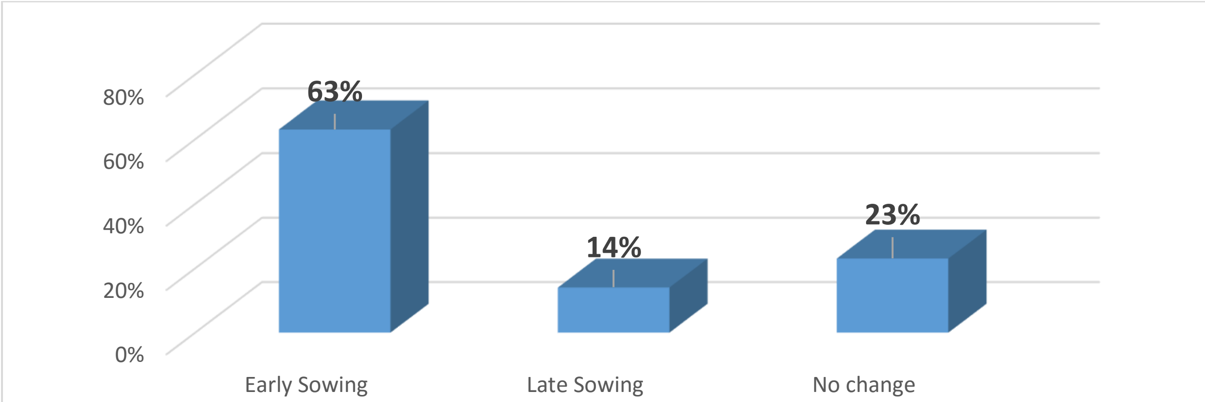


Source: Field survey

Similarly flood frequency has increased according to 75 percent of the respondents, presented in bar chart 4.9. Whereas 23 percent said that they have noticed no changes.

[26] Untimely and unusual rainfall.

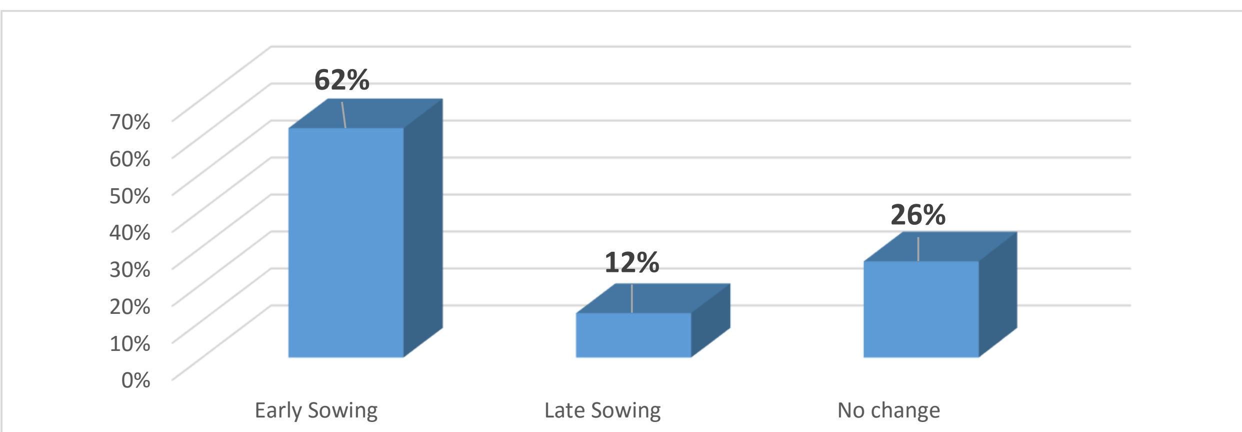
Graph 4.10. Change of Wheat Sowing (time) over Time



Source: Field survey

When it was asked from the farmers about their sowing patterns change over time in response to changes in weather conditions, about 63 percent said they are now sowing wheat earlier, 14 percent said they are sowing late and 23 percent farmers said they are sowing at the same time (see bar chart 4.10).

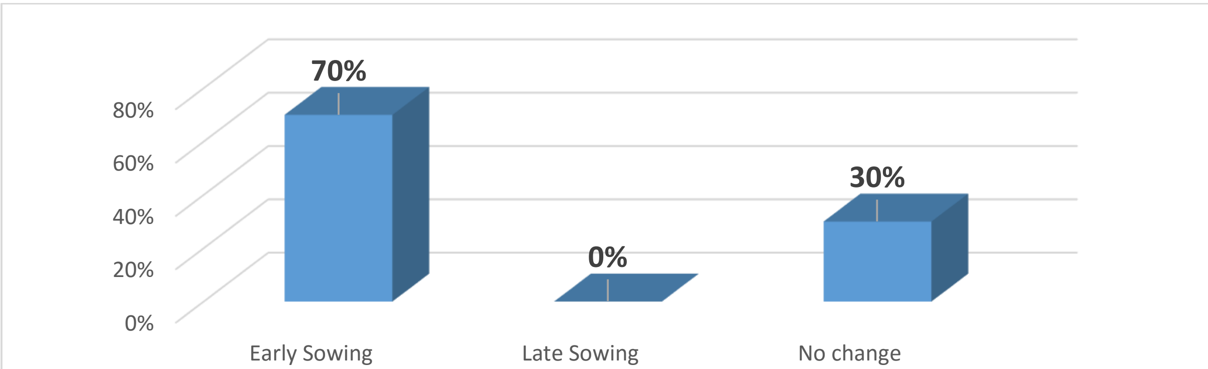
Graph 4.11. Change of Rice Sowing (time) over Time



Source: Field survey

Rice sowing pattern has also changed. This is presented in the above bar chart 4.11. Most of the farmers report that they have changed their sowing pattern as 62 percent said they are sowing rice earlier and 12 percent farmer are sowing late. So, 74 percent of the total farmers have changed their sowing time in case of the rice crop. Whereas, 26 percent of the farmers reported no change. These changes occurred due to the climatic variability.

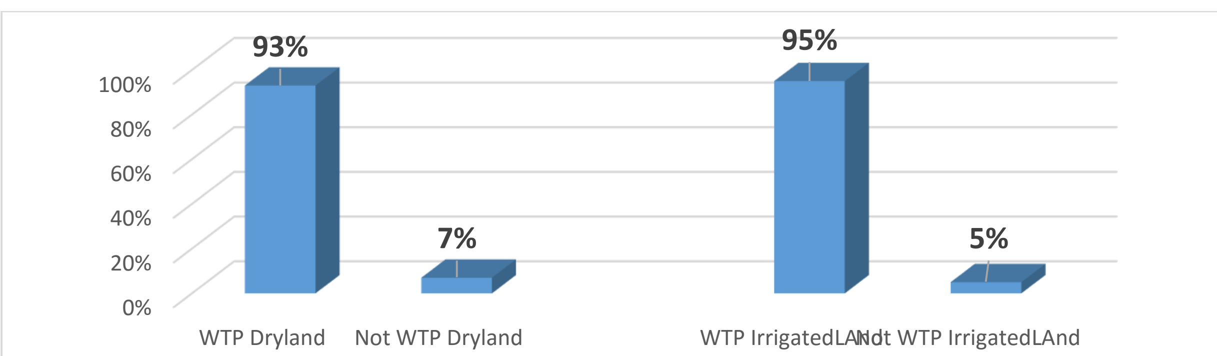
Graph 4.12. Change of Gram Sowing (time) over Time



Source: Field survey

Third major crop of study area is gram. It is mostly cultivated in dry land area. Its pattern has also been changed over the time. It is presented in the above bar chart 4.12 that 70 percent of the respondents have started earlier sowing of the gram. Surprisingly no one opted for a late sowing and 30 percent of the respondents said there is no change in the sowing pattern. As this crop is cultivated in dryland, its dynamics are also different for cultivation.

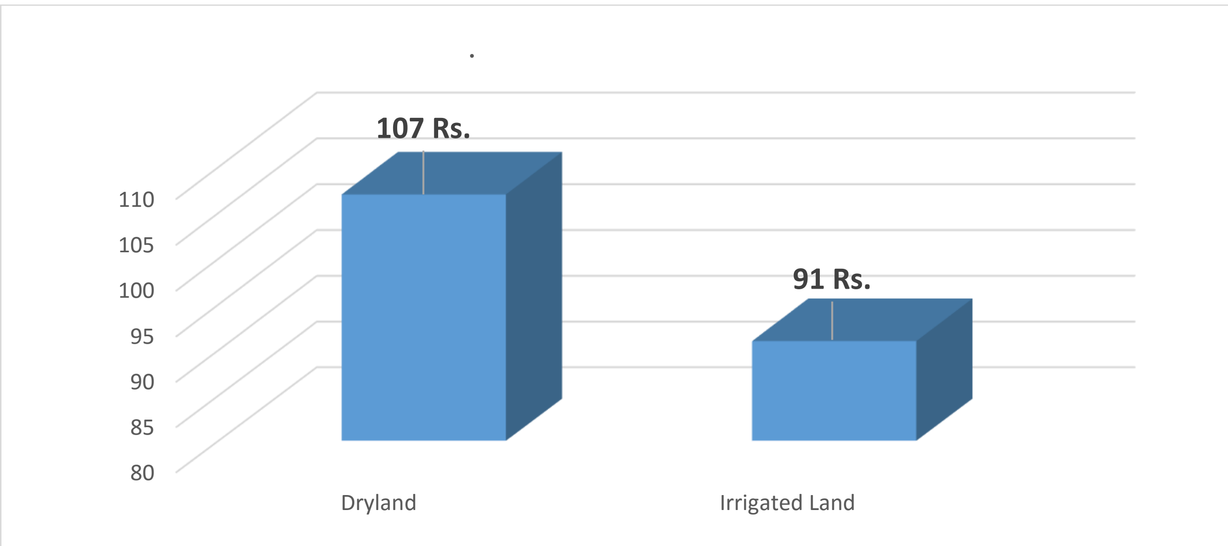
Graph 4.13. Willingness to Pay in the Dry Land and Irrigated Land



Source: Field survey

Above bar chart in Table 4.13 separately reports the Willingness to Pay for the dryland and irrigated land farmers. It reveals that out of total irrigated land 212 farmers are Willing to Pay whereas 12 i.e. 95 percent where not Willing to Pay. In dry land out of total 40 i.e. 93 percent respondents are Willing to Pay for the services of extension worker while 3 are not Willing to Pay. There is no significant difference in overall responses between two land types. Difference is minor i.e. 2 percent which can be attributed to the small sample size.

Graph 4.14. Mean of MWTP in Irrigated Land and Dry Land in Rs.



Source: Field survey

Above bar charts in Table 4.14 shows that respondents from irrigated land are less WTP as compared to the respondents from dry land respondent. The mean Maximum Willingness to Pay (MWTP) is Rs. 91 and Rs. 107 respectively. This explains that dynamics of dry land require SCF information more than that of irrigated land farmer and dry land farmers are more dependent on natural climate as compared to the irrigated.

CHAPTER 5

Results and Discussion

In order to assess the above mentioned equations in chapter 3, to check the impact of different independent variables on WTP and Farmer Cropping Decision binary logit model is applied as the dependent variables can take only two values “1” or “0”. Multiple linear regression technique is used to see the dependence of Maximum WTP on different independent variables. These techniques are used for the services of extension worker (EW) who will provide the information of Seasonal Climate Forecast and their allied benefits[27].

5.1. Willingness to Pay for Seasonal Climate Forecast

The influence of different independent variables on WTP for the service of agricultural EW in study area is given in table 5.1. The impact of education, household size, total land of the farmers, expected increase in output in maund and extension worker’s visits are taken as determinants of WTP.

Empirical findings in Table 5.1 show that at ceteris paribus education coefficient is 0.41, which is statistically significant at 1 percent level. If education level increases by one year, there will be a 0.41 unit increase in WTP. This shows direct relationship between the variables. This might be because of educated respondents are more cognizant about the latest development in their concerned fields. Coefficient of household size is -0.08 and this is insignificant at 10 percent level but significant at 11 percent level. While keeping other variables constant it implies that if there is one unit increase in household size then there will be a 0.08 unit decrease in WTP. This shows the negative or inverse relationship between household size and WTP which is insignificant at 10 percent level but significant at 11 percent level.

---

[27] Allied benefits are the expert opinion of the extension worker on most suitable crop cultivation in line with SCF, quantity of fertilizers, pesticide medicines etc.

Table: 5.1. Willingness to Pay for Seasonal Climate Forecast

Method: Binary Logit			
Dependent variable: WTP			
Independent Variables	**Coefficient**	**Std. Error**	**P > [z]**
Education(Edu)	0.41	0.07	0.00***
Household size (HH)	-0.08	0.05	0.11
Total land of farmer (TL)	0.01	0.01	0.08*
Expected Increase (EI)	0.42	0.09	0.00***
Extension worker visits (EWV)	0.81	0.43	0.06*
Constant	-2.58	0.75	0.00***

* Significant at 10 percent level, ** Significant at 5 percent level, *** Significant at 1 percent level

This negative relationship is because of an increase in expenditure on overhead of the household to meet their food, educational and clothing expenditures etc. Some of them were of the view that this is government's responsibility to provide such services. These results are consistent with the study of Chodhuri (2003). Total farm land of the household is statistically significant at 10 percent and coefficient value is 0.01. This shows that by keeping other variables constant, one acre increase in farm land shall increase the WTP by 0.81 unit, Overall probability value is 0.7941. These results are in line with the studies of Sidrat & Lohano (2014), Spash (2006), Sattar & Ahmad (2007 and Anjum (2011).

5.2. Farmer Cropping Decision and Seasonal Climate Forecast

In this section change in Farmers Cropping Decision is analyzed on the basis of different independent variables like household size, expected increase in output, extension worker visits, fertility decrease and influence of extension worker.

Table 5.2 shows, the coefficient value of variable household size is -0.06 which indicates that by keeping other variables constant, if the household size increases by one unit then FCD decreases by 0.06 units. There is a negative relationship between household size and FCD and is statistically insignificant. The coefficient value of Expected increase in output is 0.26, which is statistically significant at 1 percent level. While assuming other variables constant, one unit increase in expected productivity (one maund) will increase FCD by 0.26 units and shows a positive relationship between expected increase in output and FCD. The coefficient value of variable extension worker visits is 0.04 and is statistically insignificant. Coefficient value of the variable "fertility–decrease" is -0.84, it is also statistically significant. By keeping all other variables constant, a unit increase in variable fertility decrease will lead to a decrease in FCD by 0.84 units showing a negative relationship between the variables. Influence of extension workers' coefficient value is 2.29 which is statistically significant at 1 percent level. Assuming all other variables constant, an increase in the influence of the extension worker will increase the FCD by 2.29 unit. There is a positive relationship between the influence of extension worker and FCD. Overall probability value is 0.8876. Similar findings were reported by Shankar (2011).

Table: 5.2. Farmer Cropping Decision and Seasonal Climate Forecast

Method: Binary Logit			
Dependent variable: FCD			
Independent variables	**Coefficient**	**Std. Error**	**P > [z]**
Household size (HH)	-0.06	0.04	0.13
Expected Increase (EI)	0.26	0.10	0.01***
Extension worker visits (EWV)	0.04	0.36	0.91
Fertility Decrease (F_Dec)	-0.84	0.51	0.09*
Influence Extension Worker (IEW)	2.29	0.61	0.00***
Constant	0.49	0.55	0.37

* Significant at 10 percent level, ** Significant at 5 percent level, *** Significant at 1 percent level

5.3. Maximum Willingness to Pay and Seasonal Climate Forecast

In order to capture the impact of different independent variables on Maximum willingness to pay, multiple regression model has been used. Independent variables are literate, expected increase, exposure to media and age of the respondent.

Table: 5.3. Maximum Willingness to Pay and Seasonal Climate Forecast

Dependent variable: MWTP			
Method: Least Square			
Observations: 267			
Independent variables	**Coefficient**	**Std. Error**	**P > [z]**
Literate (Lite)	83.56	44.96	0.06*
Expected Increase (EI)	18.89	4.00	0.00***
Exposure to media (EM)	17.99	5.72	0.00***
Age (Age)	1.98	1.57	0.21
Constant	-159.10	78.42	0.04**
R-square	0.11	**Adjusted R-squared**	0.10
Mean Dependent Variable		94	

* Significant at 10 percent level, ** Significant at 5 percent level, *** Significant at 1 percent level

Empirical results are given in the Table 3.5. The coefficient value of the variable literate is 83.56 which is statistically significant. It shows a unit increase in literacy[28] there will result in an increase of 83.56 units in Maximum Willingness to Pay while keeping other variables constant. It shows a direct relationship between the variables. The variable expected increase in output has a coefficient value 18.89 and is significant at 1 percent level. Assuming all other variables constant, if there is one unit increase in the variable "expected increase" there will be a 18.89 units increase in the Maximum Willingness to Pay of the farmers. There is a positive relationship between the dependent and independent. Coefficient value of the variable exposure to media is 17.99 which is statistically significant at 1 percent level. If other variables remain the same, a unit increase in exposure to media will increase Maximum Willingness to pay by 17.99 units. It also shows positive relationship. Coefficient value of the variable age is 1.98. Assuming all other variables constant, increase in age by one year there will result in the increase in Maximum Willingness to pay by Rs. 1.98 which is statistically insignificant. Results are in line with Acquah and Onumah (2011).

[28] A unit increase in literate means, one more person who gets primary education

CHAPTER 6

Conclusion and Policy Implications

6.1. Conclusion

This research is undertaken with the objectives to find out the determinants of willingness to pay for the services of extension worker to acquire information of SCF and in light of this information; would they alter their management and cropping decisions or not.

Study includes two different farm lands; dry land and irrigated land. Farmers of the dry land are willing to pay Rs. 107 more than the farmers from irrigated land which is Rs. 91 per month. Overall Mean Maximum willingness to pay is Rs. 94. Bar-charts, cross tabulation, descriptive analysis, logit and multiple linear regression models were used for the empirical analysis. Expected increase in output, education and role of extension worker were significantly affecting farmers' willingness to pay and their cropping decision. Whereas, household size is negatively affecting their WTP and FCD. Results of seasonal climate forecast information is positive and proven in this study like many other studies worldwide. Farmer needs this information along with other scientific information.

It is observed that respondents are willing to pay for enhancing their farm productivity. This will ultimately boost up their living standards. Study area respondents have limited options to deal with climate variability. It is concluded that farmer are willing to adopt new techniques. Which shows their adaptation behavior towards seasonal climate forecast.

This study is a way forward to enhance agricultural productivity. Study also highlights the importance of interdisciplinary approach it also encourages different sectors, institutions and departments to work jointly for enhancing overall agricultural productivity.

6.2. Policy Implications

This section suggests some of the recommendations that may increase agricultural productivity by efficient and effective use of SCF information in agriculture sector. These are listed below.

- As per this study cross discipline approach is indispensable. The concerned authorities should consider it as soon as possible.
- Role of research and development is required by every sector therefore agriculture is no exception to it.
- Extension worker channel has been chosen in this study for the delivery of the seasonal climate forecast information. This sector should be reorganized and properly monitored.
- Extension worker should be well equipped with up to date information, experience and knowledge in order to make them more effective while they disseminate this information and suggest practical activities on farm.
- Proper offices and transportation along with other facilities are required by the extension workers to play their role effectively.
- To aware the farmers with latest technologies and techniques, practical activities should be done i.e. workshops, training sessions and focus group discussions should be arranged.

References

Acquah, H., & Onumah, E. E. (2011). Farmers' perception and adaptation to climate change: An estimation of willingness to pay. *Agris on-line Papers in Economics and Informatics*, *3*(4), 31-39.

Ahmad, M., Akram, M., Rauf, R., Khan, I. A., & Pervez, U. (2007). Interaction of extension worker with farmers and role of radio and television as sources of information in technology transfer: a case study of four villages of district Peshawar and Charsadda. *Sarhad Journal of Agriculture*, *23*(2), 515.

Ahmed, M. (2010). "Climatic Resilience of Wheat Comparing Modeled and Observed Crop Yield in Pothwar/East of Pakistan." International Journal of Climate Change: Impacts and Responses, Volume 2, Issue 2, pp.31-48.

Anjum, R. (2013). *Willingness to Pay for Solid Waste Management Services: A Case Study of Islamabad* (No. 2013: 03). Pakistan Institute of Development Economics.

Barnston, A. G., van den Dool, H. M., Rodenhuis, D. R., Ropelewski, C. R., Kousky, V. E., O'Lenic, E. A., ... & Leetmaa, A. (1994). Long-lead seasonal forecasts-Where do we stand? *Bulletin of the American Meteorological Society*, *75*(11), 2097-2114.

Belliveau, S., Bradshaw, B., Smit, B., Reid, S., Ramsey, D., Tarleton, M., & Sawyer, B. (2006). Farm-level adaptation to multiple risks: Climate change and other concerns. *Occasional paper*, (27).

Blacket, D. (1996). *From teaching to learning: social systems research into mixed farming*. Department of Primary Industries.

Bryant, C. R., Smit, B., Brklacich, M., Johnston, T. R., Smithers, J., Chjotti, Q., & Singh, B. (2000). Adaptation in Canadian agriculture to climatic variability and change. *Climatic change*, *45*(1), 181-201.

Calheiros, V. R. and Antonio, A. M. (1990). "Nowcasting for Agriculture with the Sao Paulo Radar Network." Weather Radar Networking, ECSC, EEC, EAEC, Brussels and Luxembourg.

Carberry, P., Hammer, G., Meinke, H., & Bange, M. (2000). The potential value of seasonal climate forecasting in managing cropping systems. In *Applications of seasonal climate forecasting in agricultural and natural ecosystems* (pp. 167-181). Springer Netherlands.

Chahine, T. M., *et al.* (2006) "Improving Weather Forecasting and Providing New Data on Greenhouse Gases." Bulletin of the American Meteorological Society - BULL AMER METEOROL SOC, vol. 87, no. 7

Chodhury, N. T. (1999) Willingness to Pay for Water in DHAKA SLUMS: A Contingent Valuation Study. IUCN, The world Conservation Union.

Ding, Y. (2009). "The Impact of Weather Extremes on Agricultural Production Methods: Does Drought Increase Adoption of Conservation Tillage Practices?" Journal of Agricultural and Resource Economics, Vol. 34, No. 3, pp. 395-411.

Doblas-Reyes, J. F., *et al.* (2013). " Seasonal climate predictability and forecasting: status and prospects." WIREs Clim Change 2013, 4:245–268.

Downing, T.E. (1992). "Climate Change and Vulnerable Places: Global Food Security and Country Studies in Zimbabwe, Kenya, Senegal and Chile." Oxford: Discussion Paper, Environmental Change Unit, University of Oxford.

Easterling III, W. E., Crosson, P. R., Rosenberg, N. J., McKenney, M. S., Katz, L. A., & Lemon, K. M. (1993). Paper 2. Agricultural impacts of and responses to climate change in the Missouri-Iowa-Nebraska-Kansas (MINK) region. *Climatic Change*, *24*(1-2), 23-61.

Everingham, Y. L., Muchow, R. C., Stone, R. C., Inman-Bamber, N. G., Singels, A., & Bezuidenhout, C. N. (2002). Enhanced risk management and decision-making capability across the sugarcane industry value chain based on seasonal climate forecasts. *Agricultural Systems*, *74*(3), 459-477.

Fraisse, C. W., Breuer, N. E., Zierden, D., Bellow, J. G., Paz, J., Cabrera, V. E., ... & O'Brien, J. J. (2006). AgClimate: A climate forecast information system for agricultural risk management in the southeastern USA. *Computers and Electronics in Agriculture, 53*(1), 13-27.

Frederick, K. D. and Schwarz, G. E. (2000). "Socioeconomic Impacts of Climate Variability and Change on U.S. Water Resources." Resources for the Future Discussion Paper 00–21.

Gbetibouo, G. A. (2009). *Understanding farmers' perceptions and adaptations to climate change and variability: The case of the Limpopo Basin, South Africa* (Vol. 849). Intl Food Policy Res Inst.

Hammer, G. (2000). A general systems approach to applying seasonal climate forecasts. In *Applications of seasonal climate forecasting in agricultural and natural ecosystems* (pp. 51-65). Springer Netherlands.

Hansen, J. W. (2002). Realizing the potential benefits of climate prediction to agriculture: issues, approaches, challenges. *Agricultural Systems*, *74*(3), 309-330.

Howden, S. M., Soussana, J. F., Tubiello, F. N., Chhetri, N., Dunlop, M., & Meinke, H. (2007). Adapting agriculture to climate change. *Proceedings of the National Academy of Sciences*, *104*(50), 19691-19696.

Huda, A.K.S. and Packham, R.G., ed (2004). "Using seasonal climate forecasting in agriculture: a participatory decision-making approach". ACIAR Technical Reports No. 59, 52p.

International Food Policy research Institute, annual report (2007-2008).

IPCC, 2001. Third Assessment Report, Climate Change 2001

IPCC, 2007. Fourth Assessment Report, Climate Change 2007 (AR4)

Jones, J. W., Hansen, J. W., Royce, F. S., & Messina, C. D. (2000). Potential benefits of climate forecasting to agriculture. *Agriculture, ecosystems & environment*, *82*(1), 169-184.

Jyotirmayee, K. and Mahamaya K. (2008). “Environment and Changing Agricultural Practices: Evidence from Orissa, India”; Indus Journal of Management & Social Sciences Vol.2, No. 2:-119-128.

Komba, C., & Muchapondwa, E. (2012). Adaptation to Climate Change by Smallholder Farmers in Tanzania (No. 299).

Latif, M., Anderson, D., Barnett, T., Cane, M., Kleeman, R., Leetmaa, A., & Schneider, E. (1998). A review of the predictability and prediction of ENSO .*Journal of Geophysical Research*, *103*(C7), 14375-14393.

Maddison, D. J. (2007). The perception of and adaptation to climate change in Africa. *World Bank Policy Research Working Paper*, (4308).

Malik, J. S. and Randhawa A. S. (2006). “Agriculture in Pakistan and the Doha Development Agenda, Challenges and opportunities.” International Trade Centre, BAS/TS/PAK/E/06/01

Meinke, H. (2001) Management responses to seasonal climate forecasts in cropping systems of South Asia's semi-arid tropics: Final Report. *APN 2000-017*.

Meinke, H. and Stone, C. R. (2005). “Seasonal and Inter-Annual Climate Forecasting: The New Tool for Increasing Preparedness to Climate Variability and Change in Agricultural Planning and Operations.” Climatic Change 70: 221–253.

Ngilangil, E. L., Olivar, O. S., & Ma. Liezel A. Ballesil, A. L. M. (2013). Farmers’ Awareness and Knowledge on Climate Change Adaptation Strategies in Northern Luzon, Philippines. *E – International Scientific Research Journal, VOLUME – V, ISSUE – 3, ISSN 2094 – 1749.*

Nicholls, N. (1999). Cognitive illusions, heuristics, and climate prediction. *Bulletin of the American Meteorological Society*, *80*(7), 1385-1397.

Nizami, A., Robledo. C. (2010). Natural Resource Management and Climate Change Mitigation, Adaptation and REDD+: *Intercooperation Pakistan.*

Oram, P.O., 1989. Sensitivity of agricultural production to climatic change, an update. In: Climate and Food Security. IRRI, Manila, the Philippines, pp. 25–44.

Pakistan Economic Survey (2013-2014).

Patt, A., Suarez, P., & Gwata, C. (2005). Effects of seasonal climate forecasts and participatory workshops among subsistence farmers in Zimbabwe. *Proceedings of the National Academy of Sciences of the United States of America*, *102*(35), 12623-12628.

Planning Commission, Government of Pakistan (2010). “Task Force on Climate Change.” Final report.

Reilly, J. M., & Schimmelpfennig, D. (1999). Agricultural impact assessment, vulnerability, and the scope for adaptation. *Climatic change*, *43*(4), 745-788.

Sah, R. K. (1987). *Tropical economies and weather information*. Yale University, Economic Growth Center.

Sattar, A., Ahmad, E., & Pant, K. P. (2007). Willingness to Pay for the Quality of Drinking Water. *The Pakistan Development Review*, 767-777.

Sayuti, R.H. (1999). “Group dynamics and sustainable agricultural development practices. A case study of dryland areas. Komunitas.” Journal of Rural Studies. Vol 3 (1)

Shankar, K. R., Nagasree, K., Venkateswarlu, B., & Maraty, P. (2011). Constraints and suggestions in adopting seasonal climate forecasts by farmers in South India. *Journal of Agricultural Education and Extension*, *17*(2), 153-163.

Sidrat, A., & Lohano, D. H. (2014). Households’ Willingness to Pay for Improved Tap Water Services in Karachi, Pakistan

Skoufias, E., Rabassa, M., & Olivieri, S. (2011). The poverty impacts of climate change: a review of the evidence. *World Bank Policy Research Working Paper Series, Vol*.

Smit, B., & Skinner, M. W. (2002). Adaptation options in agriculture to climate change: a typology. *Mitigation and adaptation strategies for global change*, *7*(1), 85-114.

Spash, C. L., & Vatn, A. (2006). Transferring environmental value estimates: Issues and alternatives. *Ecological Economics*, *60*(2), 379-388.

Stern, P. C., and W. E. Easterling, Eds., (1999). Making Climate Forecasts Matter. National Academy Press, 175 pp.

Tarhule, A., & Lamb, P. J. (2003). Climate research and seasonal forecasting for West Africans: Perceptions, dissemination, and use. *Bulletin of the American Meteorological Society*, *84*(12), 1741-1759.

Thurlow, J., Zhu, T., & Diao, X. (2009). The impact of climate variability and change on economic growth and poverty in Zambia.

Vulnerabilities in Agriculture in Pakistan IUCN report (2009).

Wall, E., & Smit, B. (2005). Climate change adaptation in light of sustainable agriculture. *Journal of sustainable agriculture*, *27*(1), 113-123.

Ziervogel, G., Bithell, M., Washington, R., & Downing, T. (2005). Agent-based social simulation: a method for assessing the impact of seasonal climate forecast applications among smallholder farmers. *Agricultural Systems*, *83*(1), 1-26.

Appendix

Table 1

Willingness to pay (WTP) at various levels[29] by Age

Variable		Age						Total
		0-20	21-30	31-40	41-50	51-60	60 and above	
WTP at various levels	not pay	0	7	9	20	14	6	56
	25 pay	0	2	1	2	0	0	5
	50 pay	0	10	22	11	10	3	56
	100 pay	0	16	16	19	9	3	63
	150 pay	0	13	14	8	9	3	47
	200 pay	0	4	14	7	2	3	30
	more than 200 pay	1	0	4	3	2	0	10
Total		1	52	80	70	46	18	267

Source: Field survey

Table 2

Willingness to pay (WTP) at various levels by Education

Variable		Education						Total
		less than 1	2-5	6-8	9-10	11-14	15 and above	
WTP at various levels	not pay	39	12	2	3	0	0	56
	25 pay	0	0	0	3	2	0	5
	50 pay	10	14	11	16	4	1	56
	100 pay	3	17	7	23	12	1	63
	150 pay	5	10	9	9	12	2	47
	200 pay	0	4	5	9	9	3	30
	more than 200 pay	0	1	2	4	2	1	10
Total		57	58	36	67	41	8	267

Source: Field survey

[29] WTP ranges from Rs. 25 to Rs. 200 per month

Table 3

Willingness to pay (WTP) at various levels by Household size

Variable		Household size						Total
		less than 2	3-7	8-12	13-15	16-25	26 and above	
WTP at various levels	not pay	1	19	25	5	2	4	56
	25 pay	0	1	3	0	0	1	5
	50 pay	0	25	23	5	1	2	56
	100 pay	1	31	22	6	1	2	63
	150 pay	0	24	19	2	0	2	47
	200 pay	0	19	8	1	0	2	30
	more than 200 pay	0	3	6	1	0	0	10
Total		2	122	106	20	4	13	267

Source: Field survey

Table 4

Willingness to pay (WTP) at various levels by Income

Variable		Income							Total
		less than 6000	6001-15000	15001-25000	25001-35000	35001-45000	45001-75000	75001 and above	
WTP at various levels	not pay	1	8	29	8	4	5	1	56
	25 pay	0	0	2	0	2	0	1	5
	50 pay	0	4	23	17	6	6	0	56
	100 pay	0	7	16	23	12	3	2	63
	150 pay	0	2	12	18	9	5	1	47
	200 pay	0	1	6	9	10	3	1	30
	more than 200 pay	0	0	2	4	3	1	0	10
Total		1	22	90	79	46	23	6	267

Source: Field survey

Table 5

Willingness to pay (WTP) at various levels by Total Land (in acres)

Variable		Total Land						Total
		less than 1	2-4	5-10	11-30	31-100	101 and above	
WTP at various levels	not pay	1	22	14	16	1	2	56
	25 pay	0	0	1	0	3	1	5
	50 pay	3	15	16	13	6	3	56
	100 pay	3	15	21	12	6	6	63
	150 pay	1	4	13	16	9	4	47
	200 pay	0	4	6	10	7	3	30
	more than 200 pay	0	1	2	4	3	0	10
Total		8	61	73	71	35	19	267

Source: Field survey

Table 6

Willingness to pay (WTP) at various levels by Expected Increase in output

Variable		Expected Increase					Total
		less than 1	2-5	6-10	11-15	16 and above	
WTP at various levels	not pay	35	16	4	0	1	56
	25 pay	0	4	1	0	0	5
	50 pay	1	43	12	0	0	56
	100 pay	0	30	27	4	2	63
	150 pay	0	14	25	6	2	47
	200 pay	0	5	17	6	2	30
	more than 200 pay	0	3	3	3	1	10
Total		36	115	89	19	8	267

Source: Field survey

Survey Questionnaire

1. Household Profile:

a) Name of respondent ______________________________ S/o ________________________

b) Age of the respondent ___________________ c) Education _________________________

d) Relationship with the farm decision maker ____________ (son=1; brother=2; nephew=3; cousin=4; farm manager=5; self=6; father=7; uncle=8; other specify_____________)

e) Respondent gender _______________ (male=1; female=2)

f) Name of farm decision maker _____________ g) Age _______ (years)

h) Education ________________ i) Farming experience __________________ (years)

j) Total family size _____________ (Number)

k) Children less than 1 year _________; 1 to 5 year _________; above 5 year ________ (Number)

l) How long have you been farming in this area? (Tick) Less than 30 years ______ over 30 years___

m) Total monthly expenditure per month (Rs) _________ n) Total monthly savings (Rs) __________

2) Farm Profile:

a) Farm size:

Title to the operational area	**Area**	**Rents and shares**	**Amount/percentage**
1.Total area owned			
2.Area leased out		8.Rent obtained (Rs/acre)	
3.Area leased in		9.Rent paid (Rs/acre)	
4.Area shared out		10. Share in outputs (%)	
5.Area shared in		11. Share in inputs (%)	
6.Area not accounted above*			
7.Waste Area**			

*Common land etc. **land not suitable for cultivation.

b.) Tenancy status: (Owner=1; Owner-cum-tenant=2; Tenant=3) _______________

c.) Did you hire seasonal labor in previous Kharif and Rabi? _________ (Yes=1; No=2)

If yes, than answer the following

1. Number of days hired: _______ 2. How many hours worked per day __________________

2. Total cash payment: (Rs) _______________

3. Food cost: (Rs/month) __________ 4. Other benefits (specify) ________________________

5. Value (Rs.) ______________

d.) Operational area by irrigation source

Source	**Area**	**Expenditure per acre by irrigated status (Rs)**
1.Canal Irrigated		
2.Tube-well irrigated		
3.Canal + Tube-well irrigated		
4.Well irrigated		
5.Rain fed		
6.Other (specify)		

e.) Operational area by soil fertility (% of operational area)

1. Poor fertility: __________ % 2. Average fertility: __________ % 3. Good fertility: ___________ %

4. Do you think land fertility has decreased during last 5 years _______________________ if yes than why ____

5 Do you think land fertility has decreased during last 10 years _______________________ if yes than why ____

6. Do you think land fertility has decreased during last 15 years _______________________ if yes than why ____

f.) Soil problems:

Soil problem	Area	Proportion of area severely affected (%)	Proportion of area moderately affected (%)
1.Water logging			
2.Salinity			
3.Erosion			

g.) Problems related to irrigation water availability:

1. No bad experience	
2.Water in wrong direction	
3.Less water	
4.Less than expected rainfall	
5.Problem with irrigation canal	
6.Water Problem related with Shortfall	

3. **Major crops grown at your farm in Kharif and Rabi (% of area allocated to a certain crop out of total cropped area in the season)**

Currently	**10 years back**	**20 years back**	**30 years back**	**Reasons for change***
Crop name (% area)	Crop name (% area)	Crop name (% area)	Crop name (% area)	Crop name (% area)
	Kharif			
1.				
2.				
	Rabi			
1.				
2.				
3.				

4. Farm mechanization status:

Machines	Machine owner=1 Otherwise=0	Use Yes=1; No=0	Machines	Machine owner=1 Otherwise=0	Use Yes=1; No=0
1.Tractors			11.Seed drill		
2.Trolly			12.Laser land leveler		
3.Combine Harvester			13.Chisel Plough		
4.Powere Sprayers			14.Disk Plough		
5.Zero-till drill			15.Cultivator		
6.Maize Sheller			16.Tractor mounted sprayer		
7.Reaper			17.Common land leveler		
8.Thresher			18.Other		
9.Ridger			19.Other		
10.Rotavator			20.Other		

5. Determinants of cropping pattern

Cropping Decision *	
1.No answer	
2.Water availability	
3.Price of product	
4.Suport prices	
5.Refer to other (neighboring) farmer	
6. Refer to government recommendation	
7. Water availability and price of output	
8. Water availability and recommendation	

Cropping Decision* relevant answer yes=1 in relevant cell Otherwise=0 in cell

6.

a) **During the last 30 years what is your observation about summer and winter season temperatures in this area?**

Summer temperature now as compared to that it used to be 20-30 years ago	**More hot=1; Less hot=2; Same=3**	**Winter temperature now as compared to that it used to be 20-30 years ago**	**More cool=1; Less cool=2; Same=3**
i)Summer season is		i)Winter season is	
ii)Summer days are		ii)Winter days are	
iii)Summer nights are		iii)Winter nights are	

b) **If compared now with the situation 30 years ago, what do you think about the followings?**

Comparison	**Increased=1; Decreased=2; No change=3**
i)Number of extremely hot days in summer has	
ii)Number of hot nights in summer has	
iii)Number of extremely cool days in winter has	
iv) Number of extremely cool nights in winter has	

c) **Experience shows that seasons have changed. What do you think about the followings?**

Summer/winter season	**Early=1; Late=2; No change=3**	**No of days (0, 1, 2…)**	**Summer/winter season**	**Yes=1; No=0**	**No of days (0, 1, 2…)**
i)Summer starts			i)Has Summer prolonged		
ii)Summer ends			ii)Has summer shortened		
iii)Winter starts			iii)Has winter prolonged		
iv)Winter ends			iv)Has winter shortened		

d) Rainfall pattern has changed due to climate change. What do you think about the followings?

Summer/monsoon rains:	**Early=1; Late=2; No change=3**	**No. of days (0, 1, 2…)**	**Winter rains:**	**Early=1; Late=2; No change=3**	**No of days (0, 1, 2…)**
Monsoon rain's season starts			Winter rains season starts		
Monsoon rain's season ends			Winter rain season ends		
	Yes=1; No=0			**Yes=1; No=0**	
Longer monsoon seasons			Longer winter rain seasons		
Shorter season and low rainfall			Shorter season and low rainfall		
Shorter season but heavy rainfall			Shorter season but heavy rainfall		
Heavy rainfall at once			Heavy rainfall at once		
Unusual and untimely rainfalls			Unusual and untimely rainfall		

a) **What trend did you observe in other climate change indicators and hazards in this area during the last 30 years?**

Sr. No.	Hazards	Frequency: Same=0; Increased=1; Decreased=2	Intensity: Same=0; Increased=1; Decreased=2	Number of consecutive days: Same=0; Increased=1; Decreased=2	Which of the following were frequently (Rank high to low)	How much was your household affected: (Rank high to low)
1	Droughts					
2	Floods					
3	Too much rains					
4	Early rains					
5	Late rains					
6	Extreme cold					
7	Extreme heat					
8	Wind storm in winter					
9	Wind storm in summer					
10	Fog					
11	Frost					
12	Hailstorms					

No. of rainy days in a seasons: __________________

i) What are the reasons for not adopting any strategy to reduce the impact of climate change:

i) Lack of money ___________________ (Yes=1; No=0)
ii) Lack of information _______________ (Yes=1; No=0)
iii) Shortage of labor _________________ (Yes=1; No=0)
iv) Other [specify] ___________________ (Yes=1; No=0)

j) Who gets the information and benefits from support information?

Land holdings	**Yes=1; No=0**	**Types**	**Yes=1; No=0**
i)Big farmers		v)Owner of land	
ii)Average farmers		vi)All the farmers	
iii)Small farmers		vii)Other specify	
iv)Women farmers		viii)No response	

k) Where do you get weather information? (Could be multiple choices)

Source	**Yes=1; No=0**	**Source**	**Yes=1; No=0**
i)Radio		vi)based on traditional knowledge	
ii)Newspaper		vii)Department of agricultural	
iii)TV		viii)Don't care about weather predictions	
iv)Neighbor		ix)Other specify	
v)Family members		x)No response	

l) Which way extension worker should inform you about Seasonal climate forecast:

____

____

5. For Yes=1; No=0

a) Farmers' knowledge of climate forecast methods.

i) No answer	
ii)Have knowledge	
iii)Do not have knowledge	

b) Farmers' opinions about traditional weather forecasting.

i)No answer	
ii)Always correct	
iii)Sometimes correct	
iv)Often correct	
v)Often incorrect	
vi)Always incorrect	

c) Farmers' response to new methods of climate forecasting.

i)No answer	
ii)Learn new method first and then try it	
iii)Refuse new method because a farmer's way is better	
iv)Others	

d) Influence of extension worker on type of crop

i)No answer	
ii)Influenced by extension workers	
iii)Not influenced by extension workers	

e) What sort of information famer needs from extension worker?

----

f) How many visits of extension worker is required by the farmer?

----

g) Expected increase in income due to seasonal climate forecast?

6. Willingness to pay

If agricultural Extension workers can provide information regarding Seasonal Climate Forecast (forecasting for a seasons about precipitation, temperature, wind speed and direction) and new agricultural techniques, verities and news regarding new innovations to the farmers at least twice a month for further incorporation into their farming practices, what will be their willingness to pay per month for acquiring such services at their village level?

a) **Would you be willing to pay Rs 50 /month on provision of SCF (Seasonal climate forecast) information through agricultural Extension worker (will also provide other new techniques and ideas)?**

Yes __ (Go to Question b) No__ (Go to Question c)

b) If yes, would you then pay Rs 100/month? ____

c) If not, then would you pay Rs 25/month? ____

d) If not then how much would you be willing to pay?

Rs…............/ month

e) What is your maximum willingness to pay?

Rs…………/ month

f) If you are not willing to pay anything, explain why not?
