Department of Environmental Economics
Working Paper No. 9

Seasonal Climate Forecast and Farmers Adaptation Behaviour: Case Study of Tehsil Athra Hazari, District Jhang, Punjab

Ghulam Jilani

Department of Environmental Economics
Pakistan Institute of Development Economics, Islamabad, Pakistan

Department of Environmental Economics
Working Paper No. 9

Seasonal Climate Forecast and Farmers Adaptation Behaviour: Case Study of Tehsil Athara Hazari, District Jhang, Punjab

Ghulam Jilani
Pakistan Institute of Development Economics, Islamabad

PAKISTAN INSTITUTE OF DEVELOPMENT ECONOMICS
ISLAMABAD

Note: This working paper is published in continuation of the Working Paper Series published earlier by Centre for Environmental Economics and Climate Change (CEECC), Pakistan Institute of Development Economics (PIDE), Islamabad.

Pakistan Institute of Development Economics
Islamabad, Pakistan

E-mail: publications@pide.org.pk
Website: http://www.pide.org.pk
Fax: +92-51-9248065

Designed, composed, and finished at the Publications Division, PIDE.

C O N T E N T S

List of Tables

ABSTRACT

Climate crises is a real phenomenon, proven by the number of studies. Climate crises has badly affected agriculture sector: as agriculture sector mostly depends upon natural environment. In the presence of climatic variation rising food needs from the fixed factor of production[1]is alarming. Objective of the study is to check farmers' adaptation behaviour towards climatic variation in order to minimise the associated risks. Willingness to Pay (WTP) technique is used to check the importance of Seasonal Climate Forecast (SCF) information, which will be disseminated to the farmers through agricultural extension workers. Data collected from nine union councils (UC's) of tehsil Athara Hazari, tehsil comprise of 6 UC's from irrigated land and 3 from dry land. Total numbers of respondents surveyed are 267, 224 from irrigated land and 43 from dry land. For empirical analysis logit technique has been used for dichotomous dependent variables and multiple linear regression technique for continuous dependent variable. About 79 percent respondents in the study area revealed their WTP and the mean WTP is 95 Rs Per month.

Keywords: Willingness to Pay, Seasonal Climate Forecast, Extension Worker, Logit Model, Multiple Linear Regression Model

[1] Land.

1. INTRODUCTION

> *"By 2050, the world's population is likely to reach 9 billion"* and *"which will result in increased demand for food. In best of circumstances, the challenge of meeting this demand in a sustainable manner will be enormous. When one takes into account the effects of climate change on food production, that challenge grows even more daunting"* [Nelson, *et al.* (2010)]

In Conference of Parties (COP) 21 at Paris in 2015 on global climate change it was concluded that only political actions will not suffice to tackle the threats of the global climate change, rather conservationists, social scientists and experts will have to come forward to reduce the associate risks. [Reese (2015)]. Climate variability is expected to have serious impacts on environment, economic growth and social wellbeing. In the context of agriculture, this sector is worst hit by the climate variability in developing countries as they depend on natural resources and thus directly face the adverse impacts. [Gbetibouo (2009)]. Above or below average rainfall, fluctuations in temperature and other factors[1] affect the crop yield which thus decrease the profits of farmer, affect food security and ultimately hamper overall growth of economy. [Jones, *et al.* (2000)].

If Climate variability is correctly predicted before the start of a cropping season[2] and right information is available to the farmers before the sowing of the crops, the unwanted impact of climate variability might eventually be reduced by decision modification. For reduction of adverse impacts, availability of climate variability forecast information is a prerequisite. [Tarhule and Lamb (2003)].

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 varieties 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. 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

---

[1] Wind speed, wind direction, soil moisture etc.

[2] Metrological Department forecasts climatic information for every three months.

disseminated in many countries through number of channels like radio, television, newspaper and agricultural extension worker etc.

In case of Pakistan information about Seasonal Climate Forecast does not disseminate in any proper form to the farmers. It is reported that due to extreme weather events agricultural productivity went down according to [Pakistan Economic Survey (2013-2014)], extreme weather events: droughts, floods (observed recently in the year 2014[3]), above or below average precipitation and temperature. Provision of such information earlier to the farmer, reduces the impact of extreme weather events. Seasonal Climate Forecast information: this will contain all the relevant information of the extreme weather events. Agricultural extension worker is a local person knows the local language, norms and traditions. Extension worker will visit the agriculture farm and will provide them useful information about Seasonal Climate Forecast, pesticide use, fertiliser use, suitable crop to grow and will also give advices about the crops related diseases.

The study captures the potential benefits of Seasonal Climate Forecasts in agricultural sector. To check farmers ability to incorporate this probabilistic information of Seasonal Climate Forecast (SCF) into their decisions for minimising risks, particularly the production risks generated by climate variability. Information of SCF will be provided through agricultural extension workers[4]. Farmers WTP will also be checked if the said information is provided through the extension workers. 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.

2. REVIEW OF LITERATURE

Jost, *et al.* (2015) Used participatory approach for a socio-economics and gender analysis of the three topics: climate and weather forecasting, climate analogue approaches and climate smart agriculture, for three countries i.e. Ghana, Bangladesh and Uganda. Program and policy relevant results obtained. Smallholder farmers changed their agricultural practices due to climatic and environmental changes. It was observed that women appeared to be less adaptive because of financial or resource constraints, as because of male domination in receiving extension service and information.

Ngilangil, *et al.* (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 number. Data collection method was personal interviews and focus group

[3]In 2014 AtharaHazari hard hitted by the flood.

[4]SCF information of the local areas will be provided to extension worker by the metrological department of Pakistan.

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, *et al.* (2011) studied farmer's perspective about 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 analysed to overcome prevailing situation related to climate variability.

Ahmad (2010) aim to check the performance of wheat production in the presence of climate variability. To minimise 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 Pothwarregion, 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 fertilisers 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 minimise 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 minimise 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 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.

According to Maddison (2007) 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.

Stone and Meinke (2005) in their study used APSIM-Wheat model. It was emphasised that 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.

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 workers. 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.

3. OVERVIEW OF AGRICULTURAL CONDITIONS OF 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.

4. CHARACTERISTICS AND LOCATION OF THE STUDY AREA

Study area Athara Hazari is a tehsil of district Jhang. Distance of the study area from district Jhang is 29 Km and from Trimmu Barrage is only 5 Km. It has both irrigated and dry land areas and thus make the targeted area quite important. This area is sensitive to climatic conditions.[5] Mainly following crops are cultivated in the study area: wheat, rice, cotton, sugarcane, fodder and gram.[6]

5. DATA AND METHODOLOGY

Basically it is a primary study exploring the potential benefits of Seasonal Climate Forecast: farmer's WTP for the service of extension worker, who will provide information about SCF and allied benefits.[7] This part of study deals with econometric methodology applied to the collected data. Farmer's WTP taken into account on the provision of information by agricultural extension worker. Study has a dichotomous dependent variables of farmer's WTP and Farmers Cropping Decision (FCD). It take value "1" in case of farmer's positive response (farmer WTP and FCD change) and "0" vice versa. Logit model estimation technique used for dichotomous dependent variables and for continues dependent variable multiple regression technique applied. Information like weather and Seasonal Climate Forecast depends on experimental techniques to assess the WTP for safer food and information [Hayes, *et al.* (1995)].

6. DATA AND ITS SOURCE

As this study based on primary data collection through questionnaire. Focused on tehsil Athara Hazari has an approximate population of 523,226 people. (District population welfare office and AC office, Jhang, 2014). The total study area is 1,650 square Km. Data is collected in the year 2015.

---

[5]Floods occur due to Trimmu barrage and drought is also part of the tehsil as three union councils fall in the dry land of Tahal.

[6]Gram is cultivated in dry land.

[7]Benefits include advice for better spray, fertiliser and required quantities, suitable seeds and recommended crops to cultivate according to soil quality.

7. DATA COLLECTION METHOD

A questionnaire was designed and used as a research tool for the collection of the data for this study. 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.

8. 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. Systematic random sample technique has been used: 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 and 6 percent confidence interval. 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.

Existing Extension Worker Role in the Study Area

Researcher visited the local agriculture office of tehsil Athara Hazari to meet the agricultural 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 were of the opinion that these offices should work under Punjab government directly which would 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 farmers were unaware of the responsibilities of extension workers. Some farmers did 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 was suggested by the farmers that agriculture department and specially the extension workers should work with local community and join hands to improve their conditions.

Table 1

Union Council's Detail and Sample Chosen

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).

9. DESCRIPTIVE STATS

This subsequent section gives the description of variables being used in this study. Following are the descriptive statistics such as mean, standard deviation, minimum and maximum value of the socio-economic characteristics

of the farmers and some other variables e.g. education, household size, total farm land, expected increase in output, required visits of extension worker, exposure to media, ownership, Willingness to Pay, Farmer Cropping Decision and Maximum Willingness to Pay. Table 2 indicates that education of decision makers are suggestive that average education of decision makers are almost 7 completed years which is above primary and below middle class. Whereas average literate of decision makers are found 21 percent of the total, which shows that in study area there are less literacy rate,[8] it implies that decision makers are poorly educated.

Table 2

Variables Description 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
EM	Exposure to Media	Positive	5	1	3.13	1.23
O	Ownership	Positive	1	0	0.71	0.45
WTP	Willingness to Pay	Dependent	1	0	0.79	0.41
FCD	Farmer Cropping Decision	Dependent	500	0	0.89	0.34
MWTP	Maximum Willingness to Pay	Dependent	500	0	95.22	79.75

Source: Field survey.

Average household size has been found almost 9-10 persons with minimum 2 persons and maximum 40 persons in a household in selected study area.

Farming related variables indicate that on average total farm land is found 36 acres, operational area with huge range of 0.5 to 600 acres. This colossal deviation is understandable because in this study, sample is from two different areas of the same tehsil one is irrigated land where mostly people have small land and the other is dry land where people have large lands. Average value of expected increase in output is found around 7 munds per acre, this results clarifies the importance of seasonal climate forecast. On an average farmers need 1 to 2 visits of agriculture extension workers. Mostly farmers using radio, television and newspaper to aware themselves about the happenings in the world. It is observed that mean value of ownership is 0.71 which means 71 percent farmers own land. Around 79 percent of the respondents are willing to pay for the service of agricultural extension worker and 89 percent of the farmers are willing to change their farm cropping decision in light of agricultural extension workers guidance. Mean value of Maximum Willingness to Pay is 95 Rs Per month.

[8] A person with primary education is considered as literate.

Econometric Model

Determinants of WTP and FCD

Logit regression function for Willingness to Pay used by Lal and Takau (2006) to evaluate Willingness to Pay in Tonga. Arene and Mbata (2008), Chuen-Khee and Othman (2010) used logit regression technique to check the determinants of the farmers' Willingness to Pay for the use of metropolitan organic waste as manure. Logit regression analysis is specified as considering Willingness to Pay as dependent variable and other variables being independent variables are explained as under;

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

$$Pr\ (WTP{=}1 \mid Edu, HS,..O) = F\ (\alpha_0 + \alpha_1\ Edu + \alpha_2\ HS + \alpha_3\ TFL + \alpha_4\ EIO + \alpha_5\ RVEW + \alpha_6\ O + \varepsilon_i) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

$$FCD = \alpha_0 + \alpha_1\ Edu + \alpha_2 HS + \alpha_3\ EIO + \alpha_4 O + \alpha_5 TFL + \varepsilon_i \quad \ldots \quad (2)$$

Logit Model Specification

$$= \frac{1}{1 + e^{-(\alpha 0 + \alpha 1\ \mathrm{Edu} + \alpha 2\ \mathrm{HS} + \alpha 3\ \mathrm{TFL} + \alpha 4\ \mathrm{EIO} + \alpha 5\ \mathrm{RVEW} + \alpha 6\ \mathrm{O} + \alpha 7\ \mathrm{EM} + \varepsilon \mathrm{i}\ )}}$$

Determinants of Maximum WTP

Multivariate analysis used by Chodhury (1999), Begum, Siwar, Pereira, and Jaafar (2006) for Willingness to Pay, the multiple regressions function was specified as the maximum Willingness to Pay amount mentioned by the respondents is function of the socio-economic characteristics of the respondent, as

Multiple linear regression model with multiple regressors is as follows;

$$MWTP = \alpha_0 + \alpha_1\ HS + \alpha_2\ EM + \alpha_3\ EIO + \alpha_4\ O + \varepsilon_i \quad (3)$$

WTP, FCD and Maximum WTP are the dependent variables, which estimate WTP, FCD and Maximum WTP of an individual for the services of agricultural extension worker. Whereas Equation (1), Equation (2) and Equation (3) show the independent variables that are; education of the respondent (Edu), household size (HS), required visits of extension worker (RVEW), expected increase in output per 40kg (EIO), exposure to media (EM), Ownership (O). Whereas F shows cumulative probability distribution function of the Logit model.

10. VARIABLES CONSTRUCTION

Dependent Variables

(i) *Willingness to Pay (WTP)*

WTP is the way to assess the importance of information (SCF) 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 explain farmer's adaptability behaviour regarding climatic changes[9]. 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.[10] It takes value "1" if the respondent change his or her Farmer Cropping Decision and "0" otherwise this is also a binomial variable.

(iii) ***Maximum Willingness to Pay (MWTP)***

WTP is the extent of showing Maximum WTP for the services of extension worker (who will provide information of Seasonal Climate Forecast to the farmer).The open-ended format of CVM is used in this survey and questions asked from the respondents were 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 (MPhil. or PhD.). 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) ***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.

(iii) ***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 farm land productivity.

---

[9]Factors effecting productivity of the farm.

[10]Will acquire information from metrological department of Pakistan. This information will be of the local area i.e. tehsil level.

(iv) *Expected Increase in Output (EIO)*

This variable explains the perception of the farmer regarding increase in output per maund in his farm land, after using SCF information to his benefit. It is expected to have a positive relationship with WTP.

(v) *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 WTP increases theoretically if he is updated from media sources and vice versa.

(vi) *Total Farm Land (TFL)*

It is a continuous variable. It is expected theoretically that if total farm land increases will increases the WTP. Increase in total farm land means more land more resources, willing to pay more.

(vii) *Ownership (O)*

Ownership is binary variable. It takes value "1" if farmer owns land and otherwise "0". It is observed in number of studies that owner of the land shows more WTP than the non-owner. As owner can take all the decisions freely.

11. RESULTS AND DISCUSSION

In order to assess the above mentioned Equations (1, 2 and 3) and to check the impact of different independent variables on WTP and FCD being binary variables, 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 allied benefits.[11]

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 3. The impact of education, household size, total farm land, expected increase in output in maunds per acre, extension worker's visits and Ownership are taken as determinants of WTP.

Empirical findings in Table 3 explains that with the assumption of ceteris paribus, if educational level increases, 0.44 percent is a chance that willingness to pay will increase, which is statistically significant at 1 percent level. This shows a positive relationship between the variables.

[11]Allied benefits means information about suitable pesticides, new seed varieties, agricultural land requirements etc.

Table 3

Willingness to Pay and Seasonal Climate Forecast

Method: Binary Logit Dependent Variable: Willingness to Pay Independent Variables	Coefficient	Std. Error	P > [Z]
Education (Edu)	0.44	0.08	0.00***
Household Size (HS)	–0.06	0.05	0.25
Total Farm Land (TFL)	0.01	0.01	0.50
Expected Increase in Output (EIO)	0.37	0.9	0.00***
Required Visits of Extension Worker (RVEW)	0.93	0.48	0.05**
Ownership (O)	2.63	0.60	0.00***
Constant	–3.90	0.95	0.00***

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

This might be because of educated respondents are more cognizant about the latest development in their concerned fields. If household size increases 0.06 percent is a chance that WTP will go down. 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 Chodhury (1999). Total farm land of the household is statistically insignificant. This shows that if total farm land of the household increases, 0.01 percent is a chance that WTP will increase. Expected increase in output is statistically significant at 1 percent. It is observed that if EIO increases than 0.37 percent is a chance that WTP will increase. There is a positive relationship between WTP and Expected increase in output. Ownership is significant at 1 percent and having a positive relationship with WTP. This implies that if a farmer owns land is more likely to pay more. Overall probability value is 0.7941. This shows that 0.79 percent is a chance that farmer willing to pay for the said information. These results are in line with the studies of Sidrat and Lohano (2014), Spash (2006), Sattar and Ahmad (2007 and Anjum (2011).

Farmer Cropping Decision and Seasonal Climate Forecast

In this section change in Farmers Cropping Decision is analysed on the basis of different independent variables like education, household size, expected increase in output, landownership and total farm land.

Table 4 shows that if education increase by a year than 0.12 percent is a chance that Farmer Cropping decision will change. It is statistically significant at 10 percent and having a positive relationship. Household size is also statistically significant at 10 percent. If household size increase than 0.07 percent is a chance that FCD will not change. There is a negative relationship between household size and FCD. It is observed that if expected increase in

output increase than 0.36 percent is a chance that FCD will change, which is statistically significant at 1 percent level. This shows a positive relationship between expected increase in output and FCD.

Table 4

Farmer Cropping Decision and Seasonal Climate Forecast

Method: Binary Logit Dependent Variable: Farmer Cropping Decision Independent Variables	Coefficient	Std. Error	P > [Z]
Education (Edu)	0.12	0.06	0.07*
Household Size (HS)	–0.07	0.04	0.08*
Expected Increase in Output (EIO)	0.36	0.09	0.00***
Ownership (O)	1.18	0.51	0.02**
Total Farm Land (TFL)	0.01	0.01	0.34
Constant	0.08	0.51	0.87

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

Ownership is statistically significant at 5 percent and having a positive relationship with FCD. If total farm land increases than there is 0.01 percent chance that FCD will change. There is a positive relationship between TFL and Farmer Cropping Decision. Overall probability value is 0.8876. This means that 0.88 percent is a chance that FCD will change. Similar findings were reported by Shankar (2011).

Maximum Willingness to Pay and Seasonal Climate Forecast

In order to capture the impact of different independent variables on Maximum WTP multiple regression model has been used. Independent variables are household size, exposure to media, expected increase in output and ownership of the respondent.

Empirical results are given in the Table 5. The coefficient value of the variable household size is –1.18 which is statistically insignificant. While keeping other variables constant, it shows one more person in a household, decreases the Maximum Willingness to Pay by 1.18 rupees. There is a negative relationship between MWTP and household size. Coefficient value of the variable expected increase in output is15.37, it is statistically significant at 1 percent. Assuming all other variables constant, if there is one unit increase in the variable expected increase in output there will be 15.37 units increase in the maximum WTP of the farmers. There is a positive relationship between the dependent and independent. Coefficient value of the variable exposure to media is 17.63, which is statistically significant at 1 percent level.

Table 5

Maximum Willingness to Pay and Seasonal Climate Forecast

Method: Multiple Linear Regression Dependent Variable: Maximum Willingness to Pay Observations: 267 Independent Variables	Coefficient	Std. Error	P > [Z]
Household Size (HH)	–1.18	3.27	0.72
Exposure to Media (EM)	17.63	5.77	0.00***
Expected Increase in Output (EIO)	15.37	4.15	0.00***
Ownership (O)	60.51	41.77	0.15
Constant	–65.45	51.54	0.21

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

If other variables remains same, farmer get information from any source like TV, newspaper, radio and internet than he will be considered as exposed to media. Exposure to media will increase Maximum WTP by 17.63 rupees, it also shows positive relationship. Coefficient value of the variable ownership shows if a farmer is owner than his Maximum Willingness to Pay is 60.51 rupees other than the non-owner, it is statistically insignificant.

12. CONCLUSION

All developing nations are facing the negative impacts of macroeconomic factors like inflation, unemployment, and poverty. Inhabitants of study area are no exception to these macroeconomic factors. Yet farmers are willing to pay for improvement to enhance their farm productivity which will ultimately boost up their living standards. Respondents of study area have limited options to deal with climate variability.

This study is a way forward to enhance agricultural productivity. While highlighting the importance of interdisciplinary approach it also encourages different sectors, institutions and departments to work jointly for enhancing overall agricultural productivity of the country. Results of the study also support the argument presented in the objective. Farmer community of the study area expect government help in the form of an extension worker for scientific guidance. This sector needs upgradation and improvement. Government authorised extension worker will greatly influence their cropping decisions. Education also plays a vital role in execution and materialisation of this phenomenon.

Descriptive stats, regression analysis through logit model and linear regression techniques completely support and prove the research objectives. 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.

13. POLICY IMPLICATIONS

This section will give some of the recommendations so that it may effectively use especially for the betterment of society and particularly for the advancement 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 also of the need.
- Extension worker channel has been chosen in this study for delivery of the seasonal climate forecast information, so this sector should be reorganised and properly monitored.
- Extension worker should be well equipped with information, experience and knowledge, there for will be more effective while disseminating information and performing practical activities on farm.
- Proper offices and transportation along other facilities are required by the extension workers to play their role actively.
- For the awareness of latest technologies and techniques for the farmers, practical actives should be done.

APPENDIX

Seasonal Climate Forecast and Farmer's Adaptation Behaviour

Survey Questionnaire

The survey is being conducted to help the Farmers to improve farm productivity while incorporating the information provided by Metrology department via agricultural extension workers. This questionnaire will be mainly focused on farmer's perception and willingness to pay about the extended role of extension worker and new technology of forecasting (Seasonal Climate Forecast). Please take a few minutes to express your views to conserve environment in your community. Your cooperation is highly valuable for successful completion of this study. This information and identity of respondent will be kept confidential. The information will only be used for research and not for any other purpose.

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.				
3.				
4.				
	Rabi			
1.				
2.				
3.				
4.				

4. Farm Mechanisation 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	
9. Others	

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		

e) 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?

REFERENCES

Ahmad, M., M. Akram, R. Rauf, I. A. Khan, and U. Pervez (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* 2: 2, 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.

Arene, C. J. and G. I. Mbata (2008) Determinants of Profitability and Willingness to Pay for Metropolitan Waste-Use in Urban Agriculture of the Federal Capital Territory, Abuja, Nigeria. *Journal of Tropical Agriculture, Food, Environment and Extension* 7:1, 41–46.

Begum, R. A., C. Siwar, J. J. Pereira, and A. H. Jaafar (2006) Factors and Values of Willingness to pay for Improved Construction Waste Management—A Perspective of Malaysian Contractors. *Waste Management* 27, 1902–1909.

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

Chuen-Khee, P. and J. Othman (2010) Household Demand for Solid Waste Disposal Options in Malaysia. *International Journal of Business and Economic Sciences* 4:2, 229–234.

Fraisse, C. W., N. E. Breuer, D. Zierden, J. G. Bellow, J. Paz, V. E. Cabrera,and J. J. O'Brien (2006) AgClimate: A Forecast Information System for Agricultural Risk Management in the Southeastern USA. *Computers and Electronics in Agriculture* 53:1, 13–27.

Gbetibouo, G. A. (2009) Understanding Farmers' Perceptions and Adaptations to Climate Change and Variability: The Case of the Limpopo Basin, South Africa (Vol. 849). International Food Policy Research Institute.

Hayes, D. J., J. F. Shogren, S. Y. Shin, and J. B. Kliebenstein (1995) Valuing Food Safety in Experimental Auction Markets. *American Journal of Agricultural Economics* 77:1, 40–53.

Howden, S. M., J. F. Soussana, F. N. Tupelo, N. Chhetri, M. Dunlop, and H. Meinke (2007) Adapting Agriculture to Climate Change. *Proceedings of the National Academy of Sciences* 104:50, 19691–19696.

IPCC (2001) Third Assessment Report. Climate Change 2001.

Jones, J. W., J. W. Hansen, F. S. Royce, and C. D. Messina (2000) Potential Benefits of Climate Forecasting to Agriculture. *Agriculture, Ecosystems and Environment* 82:1, 169–184.

Jost, C., F. Kyazze, J. Naab, S. Neelormi, J. Kinyangi, R. Zougmore, and S. Nelson (2015) Understanding Gender Dimensions of Agriculture and Climate Change in Smallholder Farming Communities. *Climate and Development* 1–12.

Jyotirmayee, K. and K. Mahamaya (2008) Environment and Changing Agricultural Practices: Evidence from Orissa, India. *Indus Journal of Management and Social Sciences* 2:2, 119–128.

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

Lal, P. and L. Takau (2006) Economic Costs of Waste in Tonga. SPREP and the Pacific Islands Forum Secretariat.

Maddison, D. J. (2007) The Perception of and Adaptation to Climate Change in Africa. World Bank Policy Research Working Paper (4308).

Nelson, G. C., M. W. Rosegrant, A. Palazzo, I. Gray, C. Ingersoll, R. Robertson, and S. Msangi (2010) *Food Security, Farming, and Climate Change to 2050: Scenarios, Results, Policy Options* (Vol. 172). International Food Policy Research Institute.

Ngilangil, E. L., O. S. Olivar, A. Ma. Liezel, and A. L. M. Ballesil (2013) Farmers' Awareness and Knowledge on Climate Change Adaptation Strategies in Northern Luzon, Philippines. *E–International Scientific Research Journal* 5:3, 2094–1749.

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

Patt, A., P. Suarez, and C. Gwata (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.

Reese, G. (2015) Common Human Identity and the Path to Global Climate Justice. *Climatic Change* 1–11.

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

Shankar, K. R., K. Nagasree, B. Venkateswarlu, and P. Maraty (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. and D. H. Lohano (2014) Households' Willingness to Pay for Improved Tap Water Services in Karachi, Pakistan.

Spash, C. L. and A. Vatn (2006) Transferring Environmental Value Estimates: Issues and Alternatives. *Ecological Economics* 60:2, 379–388.

Stone, R. C. and H. Meinke (2005) Operational Seasonal Forecasting of Crop Performance. *Philosophical Transactions of the Royal Society of London B: Biological Sciences* 360:1463, 2109–2124.

Tarhule, A. and P. J. Lamb (2003) Climate Research and Seasonal Forecasting for West Africans: Perceptions, dissemination, and Use. *Bulletin of the American Meteorological Society* 84:12, 1741–1759.