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Identification of Key Adaptation Practices adopted by Wheat Growing Farmers of Punjab, Pakistan: A Qualitative Approach

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ABSTRACT

Climate change has now become a subject of concern for the whole world especially for developing countries. According to Global Climate Risk Index (GCRI) 2021, Pakistan lies at eighth number amongst top ten countries of world which are facing severe impacts of climatic changes. Climate change has serious repercussions on the agriculture sector of Pakistan. Mitigation and Adaptation are considered to be options by climate change experts to counter negative impacts of climate change. By keeping above in view, the objective of this study was to identify adaptation practices adopted by farmers in Punjab, Pakistan. The Primary data was used and collected through qualitative data collection techniques i.e. In-Depth Interviews (IDIs) and Focus Group Discussions (FGDs). Based on the research plan, five IDIs were conducted with experts related to agriculture sector and with farmers of study area. Further, five FGDs were conducted in five selected districts of the study area. Based upon discussions with experts and with local farmers, key adaptation practices adopted by majority of farmers were: Rice crop residues incorporation, Change in sowing time, sowing method for wheat crop (Broadcast, Ridge sowing), certified seed varieties of wheat, change of seed rate, deep ploughing using chisel plough, laser land levelling (LLL), application of potash, changing the number of irrigations, application of farm yard manure (FYM), drainage of water from field (pumps or other means) and use of weather forecasting. NVivo qualitative data analysis software was used to depict this qualitative discussion into two types of structures i.e., Word Tree and Word Cloud.

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INTRODUCTION

Pakistan is a developing country with economy stands at 26th in terms of GDP/Capita, at 44th in terms of nominal Gross Domestic Product (GDP) and at 146th in terms of Human Development Index (UNDP, 2018). Decades of internal political disputes, war against terrorism and low level of foreign investment leads to slow growth in the

country. The country's agriculture sector has a significant role in the economy as it adds 19.2 percent in GDP and engages 38.5 percent of labor force and major contribution in reducing poverty among all sectors of economy (GOP, 2020). Reference to 6th Population and Housing Census of Pakistan 2017, the population of the country is rising at the rate of 2.4 percent per annum.

This increase in population will increase demand for agricultural products. While, agriculture sector is extremely exposed to climatic changes and climatic variability (IPCC, 2015; Chang et al., 2012; Fosu-Mensah et al., 2012; Hellin et al., 2012). According to the report of Global Climate Risk Index, 2020, developing countries are most exposed to these climate changes and Pakistan stands at 8th position in the list of most vulnerable countries of the world (German watch, 2020).

With more than 200 million people to support, it is a huge challenge to maintain food security. So, the problem of food insecurity is very alarming in Pakistan. About 37.6 million people are undernourished which is about 19.9 percent of total population of Pakistan (FAO, 2016). Climate change is a key element to affect food security issue for almost all nations of this region in next few decades (IPCC 2001, Sultana et al. 2009).

Literature showed that different studies have been conducted to estimate impact of climatic changes on crops of Pakistan (Janjua et al., 2010, Shakoor et al., 2011; Ashfaq et al., 2011, Mahmood et al., 2012). According to Janjua et al. (2010), agriculture productivity of this country is more exposed to the changed climate due to its geographical positioning. These studies focused on exploring impacts of climatic changes on crop productivity. However, Abid et al. (2014) studied farmer's perception of changes in climate change and adaptation practices adopted and also studied determinants affecting adaptation adopted. They also quantified effects of independent variables on the chance of adapting adaptation practices at farm level. Shahid et al. (2021) also explored adoption of adaptation practices in Pakistan, an adaptation index and discovered factors and barriers for adoption of adaptation practices, by conducting FGDs, Interviews with experts and household survey. History guided us that people have attuned to and dealt with variability in climate and extremes. Further, responses of people in the form of mitigation and adaptation were perceived and expected impacts of climatic changes were also observed, which could also address development objectives.

According to Intergovernmental Panel on Climate Change (IPCC, 2007) adaptation is the change in behavior, practices and living pattern of inhabitants of a specific area or community to minimize harmful impacts of the adverse changes in the climate, thus increasing their resilience to survive?"

Maladaptation is a reason of apprehension for adaptation managers as involvement in one place, sector or region could surge the susceptibility of another region or sector, or increase the vulnerability of the target group to future climate change (medium evidence, high agreement) (Climate Change, 2014 IPCC). Ecosystem-based Adaptation is a nature-based solution that harnesses biodiversity and ecosystem services to reduce vulnerability and build resilience to climate change.

In the context of climate resilience, transformative adaptation is coping and strengthens viable institutes that manage the distribution of resources. These institutes are the objective of social pressure and challenge related to change in environment and it adept in managing with several changes. These variations often motivate local players and administrations to adjust institutions that will permit them to deal with various exposures. Organizations play a key role in managing linkages between local adaptation and national level planning (Climate Change, 2014 IPCC).

Need for the Study

Farmer is key stakeholder in the adaptation process. Farmers make their decision to stick on some particular adaptation practice on the basis of benefits and costs attached with the adoption of those particular phenomena and these costs and benefits are heterogeneously distributed within the population. So the extent of the cost/benefit ratio and distribution of these costs and benefits are important to anticipate the success, failure and wide-spread adoption of the adaptation practices. The objective of this study is to identify the key adaptation practices among wheat growing farmers of the study area.

METHODOLOGY

This research is an attempt to identify adaptation practices adopted by farmers in the Punjab. This study is of applied nature in which it had been identified and explored the farm-based adaptation practices to counter negative effects by following the methodology of Yila et al. (2013). This study is developed on the basis of findings of adopting qualitative data collection techniques i.e. In-Depth Interviews (IDIs) and Focus Group Discussions (FGDs) that would help the policy makers to design policies related to adaptation practices. For developing methodological framework for this study, different research articles were studied on impact of climate change on agriculture particularly wheat crop,

adoption of adaptation practices and weak links for adoption of these adaptation practices. IDIs and FGDs were conducted for assessing farmer's understanding about climatic changes, adaptation practices and weak links in effective implementation of adaptations and along-with opinions of environmental experts.

Qualitative data analysis techniques are widely used in the literature including content analysis which is "a procedure for the categorization of verbal or behavioral data, for purposes of classification, summarization and tabulation" (Zhang and Wildemuth, 2009). Qualitative data analysis technique was used in which we move from the raw data which is discussion with government officials was used to provide explanations, understanding and interpretation of the phenomena. Content analysis comprises of coding and classifying data, also referred to as categorizing and indexing and the aim of context analysis is to make sense of the data collected and to highlight the important messages, features or findings. Content analysis is used when qualitative data has been collected through Interviews, focus groups, observations and documentary as endorsed by the Bitsch (2005).

Selection of the Study Area

This study was conducted in the Punjab province of Pakistan. The Punjab was carefully chosen due to many reasons like; Punjab has the most population among all provinces of Pakistan. Wheat yield is subject to adverse climatic impacts across the Punjab province of Pakistan. Rice-Wheat Zone exists in the southeastern area of Pakistan. This zone is exceptionally unprotected to negative effects of climate change (Iqbal et al, 2009). It receives 425-1200 mm rainfall every year. Rice-wheat zone is covered an area of 2.1 million hectare and about three-fifth of this lies in the Punjab (GOP, 2013). Considering nature of agriculture, rice-wheat cropping zone is the most climate-sensitive region of the Punjab that means producing agriculture products would be very profound to variations in rainfall and change in temperature.

The rice-wheat zone consists of five districts i.e. Gujranwala, Hafizabad, Nankana, Sheikhupura and Sialkot. It inhabits an area of 1.1-million-hectare land for growing of different crops. Most of agriculture land is utilized for two crops i.e. Wheat and Rice. About 72% of wheat crop is cultivated after harvesting of rice crop. This zone is critically linked with the issue of food security. Rice-wheat zone is called the food basket for

Pakistan because of the production of cereals i.e. Wheat and rice. Wheat is an important crop of this area. This zone contributes a crucial part in ensuring for provision of Wheat and Rice to the people.

This study is also based on secondary data information by studying research articles relevant with this study, reports and information from climate change experts and wheat growing farmers during the field visits. The extension agents from agriculture department, Govt. of the Punjab were also involved in this process. Such triangulation contributes to the internal validity and reliability of research findings. This research work also engaged primary data collection techniques i.e. In-Depth Interviews (IDIs) and Focus Group Discussions (FGDs).

In-Depth Interviews (IDIs)

The first stage involved conducting of 5 IDIs with climate change experts related to agriculture sector and 5 IDIs with farmers belong each to district Gujranwala, Sheikhupura, Hafizabad, Sialkot and Nankana, with the aim of identifying and understanding climate change pattern and major socio-economic factors might contribute towards adaptation. The extension staff of Agriculture Department, Punjab was also consulted to obtain information on national strategies for agriculture and climate change adaptation, with a more general overview of the contemporary perception of environmental changes. IDIs were also conducted with other stakeholders i.e. experts from academia, climate change experts and project managers of projects working on climate change adaptation.

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Word Tree and Word Cloud depicted in next section.

Focus Group Discussions (FGDs)

Focus group discussion is a method for getting qualitative data from a small group of people. The main objective was to get information on a specific issue. FGD is reflected as an important instrument when the researcher wants to acquire detail understanding of the topic that may involve complicated concept (Krueger and Casey 2000). FGDs have been widely used as a technique to evaluate effects of climate change on

agriculture and adaptation practices (Mazur and Bennet, 2008).

One FGD was conducted in each district of rice-wheat zone of Punjab through "Group Depth Interviews" or focused interviewers. Each FGD was comprised into two sessions. Duration of each session was 1 to 2 hours. Responses/information was recorded through audiotape after getting consent from FGD participants. Questions were consisting of both types; pre-formulated questions and open-ended questions.



Figure 1. Two-pager chart showing concept of climate change and adaptation in local language prepared for FGD farmers.

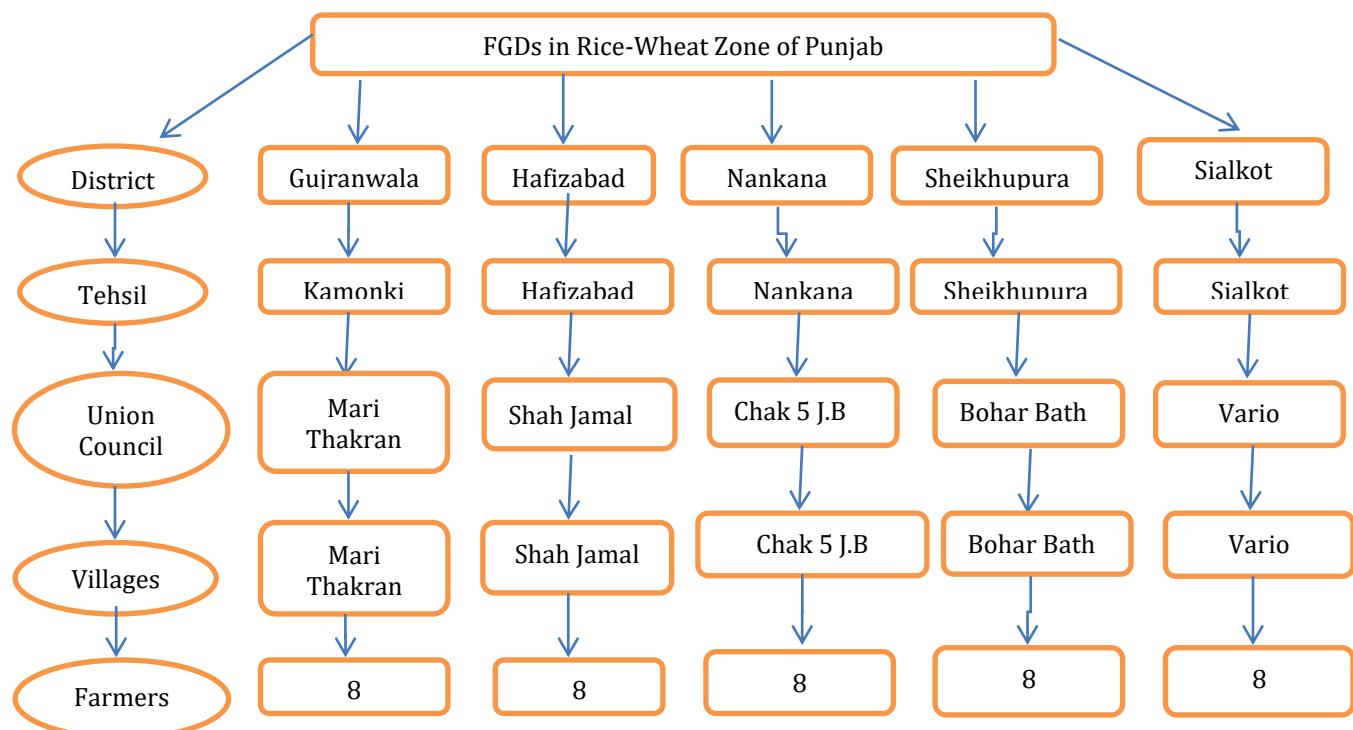


Figure 2. Focus Group Discussions (FGDs) framework for Rice-Wheat zone of Punjab, Pakistan.

Before conducting FGDs, a two pager-chart was prepared showing basic concept about climate change and adaptation practices for wheat crop in order to facilitate FGD participants i.e. farmers (Figure 1). In this study, FGDs were performed with farmers to discover their behavior towards climate change impacts and possible adaptation practices. FGDs were held to assess awareness level of farmers regarding climate change in five districts. Through this process of discussion, the researcher tried to identify adaptation practices practiced. Questions were asked related to perception about climate change and adaptations which are adopted by farmers. Initially, five districts named as Sheikhupura, Gujranwala, Hafizabad, Sialkot and Nankana were randomly selected as depicted in Figure 2. Then, one tehsil from each district was selected through simple random sampling (SRS). Following this, one Union council from each tehsil was randomly selected for collecting information/data through IDIs and FGDs.

RESULTS & DISCUSSION

The outcome of In-Depth Interviews (IDIs) with officials

of Agriculture Department, Punjab and climate change experts and findings of Focus Group Discussions (FGDs) with climate change experts and farmers with the objective of identification of adaptation practices adopted is described below:

Outcome of IDIs with Officials of Agriculture Department, Punjab and Climate Change Experts

The basic question is to clarify the concept of climate change. It's an integrated and complex question to explore the scientific phenomenon. The ecological balance has disturbed because of rapid urbanization, population and industrialization from the last one century. The earth was working as sink for all emission of pollutants, air as liquids or any type of discharge in the environment. There was ecological balance in the environment in respect to degradation, decomposition and recycling processes. Our earth has a carrying capacity even it persists at regional level. Due to exceeding burden than the carrying capacity of earth, the ecological balance has disturbed.

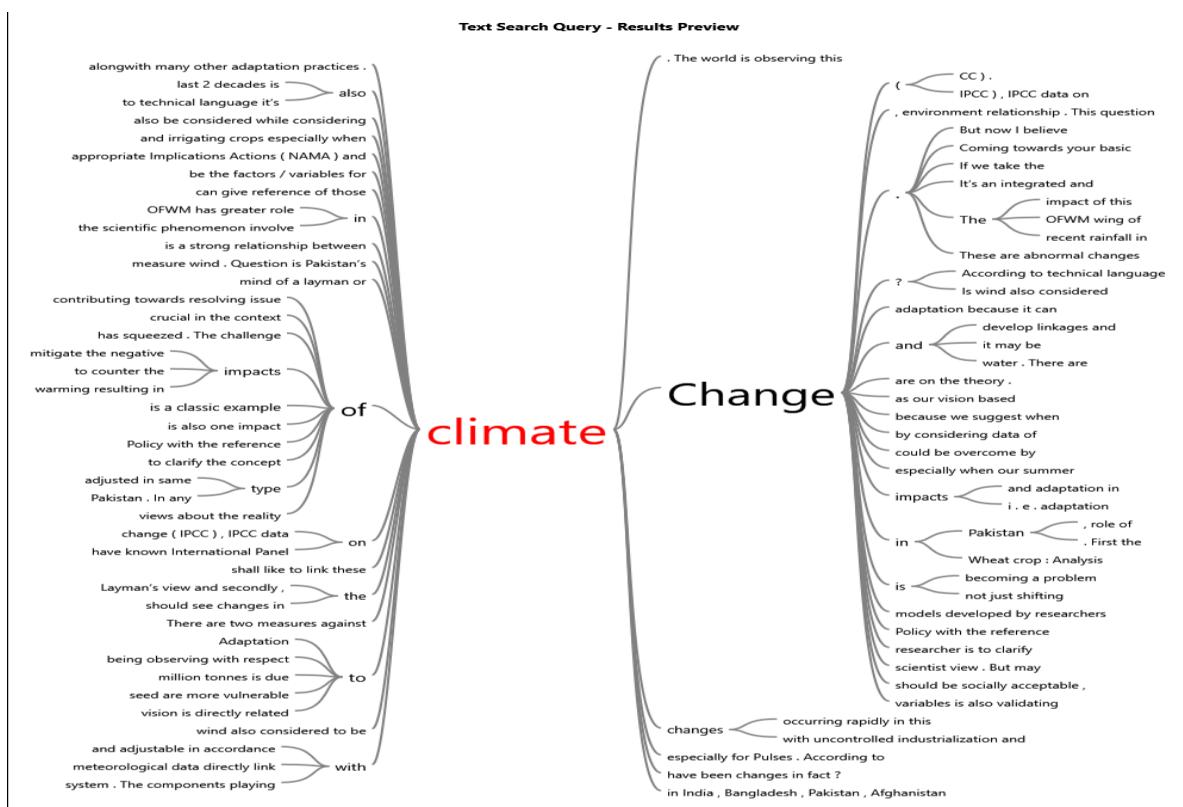


Figure 3. Word Tree Structure of IDIs with officials of Agriculture Department, Punjab and Climate Change Experts.

Climate change is not just shifting the rainfall pattern or change in temperature, but windstorm, hailstorm and

breeze-cum-rain are also factors contributing towards climate change. The recent rainfall in the month of

March 2014 all over the Punjab with strong winds has resulted into negative impact on the yield of wheat crop. The officials participated in In-Depth Interviews (IDIs) stressed that other factors along with temperature and rainfall should also be considered for climate change impacts and adaptation practices in wheat crop. QSR Nvivo 11 Software was being used in this study to depict qualitative data into two types of structures i.e., Word Tree and Word Cloud as shown in Figure 3 & 4.

Outcome of IDIs with Local Farmers of Study Area

Farmers, a significant stakeholder were depressed with the loss that they bear in the form of low yield due to excessive rains at grain formation stage of the Wheat crop. Farmers claimed that average yield of Wheat crop remained (27 maunds* per acre) in the growing season 2014-15 as compared with (45 maunds per acre) in the growing season 2013-14 with a decrease of 18 maunds per acre. On the other side, prices of Rice have also been very low during this year (Rs. 700-1000 per Maund) so they also bear huge loss in the market and could not even covered the rent of land and cost of inputs (Seed, Fertilizer, Pesticides). One maund is used to equate to 40 kilo gram in Pakistan. Local farmers who participated in IDIs shared adaptation practices like altering sowing time of Wheat and ridge sowing of wheat to counter the situation of rainfalls about 12-15 times during months of February and March. Their past experience did not depict rainfall during these months normally. Wheat crop needs one rain at the start of February but due to weather changes, it rained continuously. They were strongly convinced that they have to adapt this adaptation practice

because it's situation of survival for them. One of them suggested that fellow farmers should also adopt this technique on experiment basis for sowing of wheat on ridges for at least three years to wait for positive outcome of this technique. According to FGD participants, high frequency of off-seasonal rains in the month of February and March is disturbing due to grain-formation stage of Wheat crop. While, late ending of rainy season is being observed by local farmers particularly in Hafizabad district. Most farmers highlighted rainy spell usually starts in mid-June and ends in late September, but since early 2000s onwards, the rainy season started late in the

month of May and ended in early September. Participants of these FGDs showed varied response on basic questions like climate change issues, concerns about climatic changes, decisions related to adaptability of farmers to mitigate the impacts of climatic changes. FG1 was conducted in the village of Mari Thakran of District Gujranwala according to approved methodological framework. FG2 was conducted in the village of Shah Jamal of district Hafizabad. FG3 was conducted in the village of Chak No. 5 G.B of district Nankana. FG4 was conducted in the village of Bohar Bath of district Sheikhupura. FG5 was conducted in the village of Vario of district Sialkot. Participants belonging to FG5 and FG1 believe that their farming operations changed with percentage of 65 percent and 50 percent respectively during last ten years showing relative correlation with decisions were taken by farmers of districts of Sialkot, Gujranwala and Hafizabad by taking into count climate change having an impact on wheat.



Figure 4. Word Cloud Structure of IDs with officials of Agriculture Department, Punjab and Climate Change Experts.

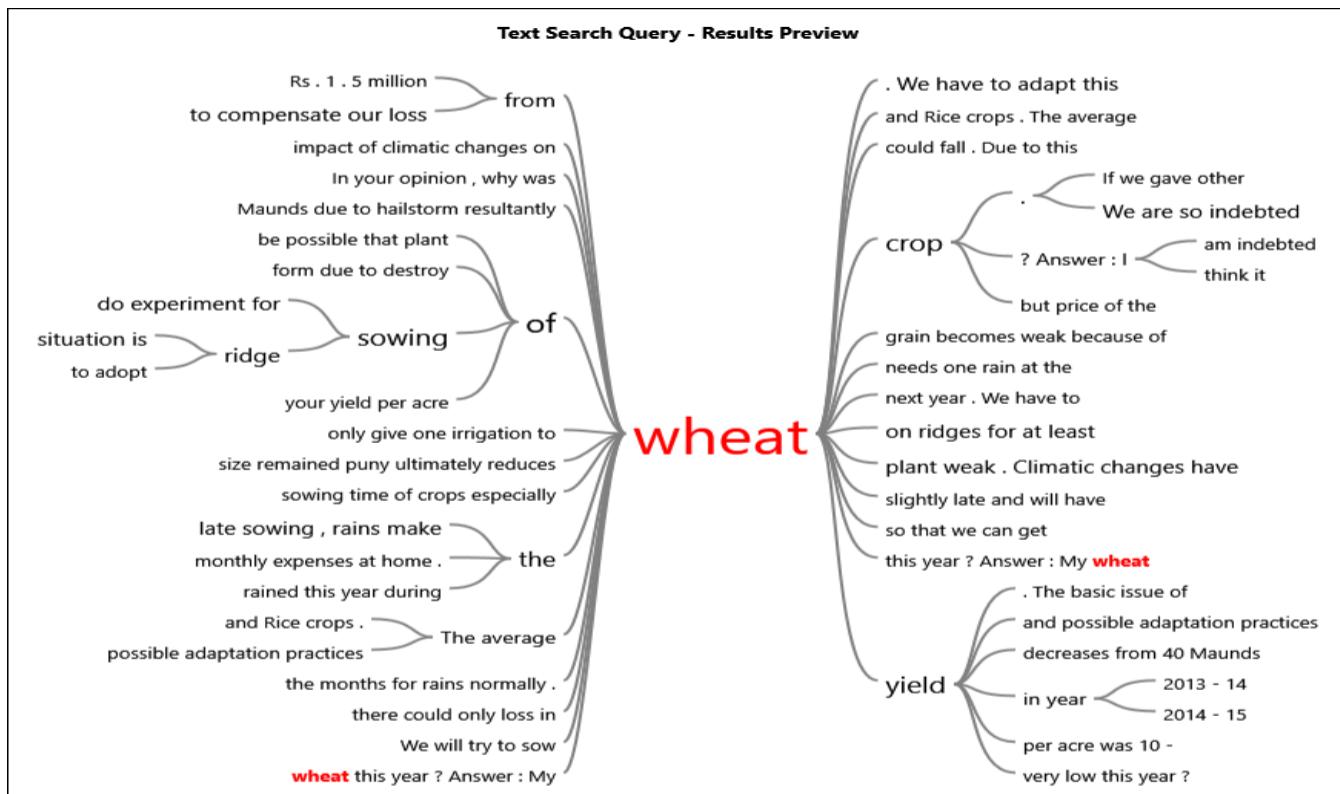


Figure 5. Word Tree Structure of IDIs with local farmers of study area.



Figure 6. Word Cloud Structure of IDIs with local farmers of study area.

On the other hand, FG5, FG2 and FG1 participants with 65 percent, 60 percent and 55 percent believe that their farming decisions were related to minimize effects with suitable practices. When the question was asked to FGD participants regarding any change in the amount of moisture, winter temperature and extreme weather

events in last ten years, farmers belonging to FGD5, FGD2 and FGD1 showed maximum response about 65, 55 and 55 percent consecutively. While participants belong to these districts also showed deep concern about climate change and its variable impacts on all crops especially Wheat crop.

The other side of the picture is that 35 percent and 25 percent participants belonging to FGD2 and FGD1 are rating their abilities and capabilities to adapt against climate change impacts. These all changes perceived by FGD participants should be linked with identification of long-term strategies to moderate the impact of climatic changes like change in rainfall pattern, increase in temperature, etc. Farmers were also asked questions about their sources of information regarding concept of climate change and about adaptation to adverse impacts of climate change. FGD participants shared their preferred adaptation practices adopted by them by assigning ranks.

Identification of Adaptation Practices

The objective of FGDs was to identify the key adaptation practices among farmers of rice-wheat zone of Punjab, Pakistan who grows wheat on their farms. The researchers gone through the process focus groups in each district of study area and tried to analyze farmer's perception regarding climate change and the particular response against climate change impacts in the shape of

adaptations.

After detailed discussion with FGD participants, following adaptation practices were identified and were adopted by majority of farmers to counter negative impacts of climate change:

1. Rice crop residues incorporation
2. Change in sowing time of wheat
3. Sowing methods for wheat crop (Broadcast, Ridge sowing)
4. Certified Seed varieties of wheat
5. Change of Seed rate
6. Deep Ploughing using Chiesel Plough
7. Levelling of land (Laser Land Levelling or Traditional method)
8. Usage of other fertilizer than Urea, DAP (e.g. Potash, Zinc, etc.)
9. Changing number of irrigations in wheat crop
10. Application of Farm Yard Manure (FYM)
11. Drainage of water from field (Pumps, or other means)
12. Use of Weather Forecasting

Table 1. Basic Characteristics of FGD Participants (Percentage).

Variable	Category	FGD1	FGD2	FGD3	FGD4	FGD5
Have your farming operations changed during last 10 years	Yes	50	30	45	40	65
	No	35	55	40	25	15
	Not Sure	15	15	15	35	20
Any decisions related to climate change	Yes	55	60	40	30	65
	No	30	30	40	60	15
	Not sure	15	10	20	10	20
Have moisture, winter temperature, extreme weather events or growing season changed in last ten years	Extremely Changes	55	55	45	35	65
	Many Changes	25	30	30	30	25
	Some Changes	15	10	20	25	10
	Limited Changes	5	5	5	5	0
	Few Changes	0	0	0	5	0
	No Change	0	0	0	0	0
How much concerned are you about climate change	Extremely Concerned	60	60	40	45	65
	Many Concerned	30	30	40	40	25
	Some Concerned	10	10	15	15	10
	Limited Concerned	0	0	5	0	0
	Few Concerned	0	0	0	0	0
	Not Concerned	0	0	0	0	0
How much are you capable to adapt climate change impacts	Extremely Capable	25	35	15	20	25
	Many Capable	35	25	30	35	35
	Some Capable	30	25	40	25	20
	Not Capable	10	15	15	20	20

Rice Crop Residues Incorporation

Farmers normally burn stubbles of rice crop with ease because they have very less time to grow Wheat crop.

But during discussions with FGD participants, it was found that some farmers buried the remaining residues after harvesting of rice crop. According to them, it helps

to enhance fertility of the soil that ultimately helps in increasing yield of Wheat crop.

Sowing Time of Wheat

Sowing time for Wheat crop is very critical in determining the health of a plant and ultimately getting good yield. According to FGD participants, they face difficulty for sowing of Wheat in time due to bad weather i.e., temperature and rainfall fluctuations. They still feel that by changing the sowing time according to situation of temperature and rainfall with having proper and true information of weather forecasting, they can overcome this issue.

Sowing Method for Wheat Crop (Broadcast, Ridge Sowing)

Majority farmers are sowing Wheat through traditional method i.e., Broadcast method since many decades. This traditional method of Broadcast has become ineffective due to climatic changes particularly more rainfall in Rice-Wheat cropping Zone. This horizontal type soil and land structure is unable to reduce the dropping of Wheat plant that becomes a reason of low yield. While, adopting Ridge Sowing method, it helps to avoid water in damaging the plant from heavy rains in winter season as compared to Broadcast Sowing method.

Certified Seed Varieties of Wheat

Seed is an important input for cultivation of all crops including Wheat. Farmers usually use previous year's wheat grains as a Seed because it was very easy for them to utilize it with no consumption of effort and money. According to Federal Seed Certification and Regulatory Authority (FSC&RD), simple grains are not seed while certified seed must be approved/clarified from FSC&RD. On the other hand, certified seed varieties enhance resistance and fitness of crop to heat, humidity and early maturing crop species.

Change of Seed Rate

Sowing time of Wheat and seed rate both are inter-related in a sense that late sowing of Wheat will guide farmers to change the seed rate for getting germination. As Extension & Adaptive Research wing of Agriculture Department, Punjab recommended 15th November particularly for Rice-Wheat zone. So, change of seed rate is an adaptation to adjust the time of sowing through changing seed rate.

Deep Ploughing Using Chisel Plough

Ploughing is also important farming practice that makes upper layer of soil more soft and fertile. While chisel plough machinery developed by agriculture engineers

used for deep ploughing and it is key in this climate affected zone of Punjab. Deep ploughing enhances seepage in the soil and due to heavy rainfall during winter season; it increases the soil capacity to absorb more water. It is also pertinent here that standing water in wheat may damage the crop so this deep ploughing technique through chisel plough reduces the chances of damage and enhances yield per acre.

Laser Land Levelling (LLL)

Levelling of land is also considered to be very important farming practice. FGD participants were of the view that farmers perform leveling of land to irrigate smoothly throughout the acreage and it also reduces cost of irrigation. According to agriculture scientists, levelling of land bring-up a change of 5-7 percent in yield per acre.

Application of Potash

Fertilizer is key for providing necessary nutrients to the soil and for crop plants for getting yield per acre. By changing fertilizer applications, like Potash help plant to give strength to the stem to decrease chances of dropping of plant under heavy rains.

Changing the Number of Irrigations

Climatic changes bring fluctuations in temperature and rainfall pattern. Both conditions guide farmers to change number of irrigations to avoid from any damage to the Wheat crop. FGD participants shared that they increased number of irrigations during high temperature condition while, they decrease number of irrigations in case of rainfalls.

Application of Farmyard Manure (FYM)

Farm Yar Manure (FYM) is a natural-cum-organic fertilizer possessing nutrients which are critical for the fertility of the soil. It is used as an adaptation practice for increasing the seepage of water which will ultimately strengthen the plant. Potash and FYM both farming practices used by farmers with the intention of enhancing seepage/absorption of the soil that will lead towards increasing yield.

Drainage of Water from Field (Pumps or other Means)

Climate change has disturbed the farmer's farming operations in many ways like in case of heavy rainfall, it become very cumbersome for him to evacuate water. If he didn't opt to go for drain excess water for Wheat field, it will damage the crop. Wheat is not a water loving crop. So, farmers used traditional technique using machinery like pumps or other means to drain the water from field to avoid the losses due to rain.

Use of Weather Forecasting

The negative impacts of climate change on wheat have guided local farmers to adopt modern technology to avoid from the loss in shape of low yield per acre. Farmers participated in FGDs were convinced about adoption of advanced ICT technique in order to have timely information about expected forecasts about rainfall, temperature and other parameters.

CONCLUSION AND RECOMMENDATIONS

In light of findings of the research study, the Government should emphasis on improving the ability, skills and efficiency of the extension service, which become a facilitator for the campaigning of appropriate adaptation practices coping to climate change and strategies. Farmers should be trained about the relevant and beneficial adaptations in wheat crop, problems related to these adaptations and their solution to boost up wheat yield. At village or union council level, diverse trainings should be arranged by Punjab Agriculture Department to promote education about climate change and associated risks and their solution for wheat crop. In addition, monthly meetings should be arranged to update farmers' level of understanding towards benefits of adaptations.

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