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# Climate Change Brief

## Climate Change, Agriculture and Food Security in Pakistan: Adaptation Options and Strategies

Munir Ahmad, Muhammad Iqbal, and M. Azeem Khan

PAKISTAN INSTITUTE OF DEVELOPMENT ECONOMICS
ISLAMABAD

# Farmers' Perceptions and Adaptations

## I. Introduction

Pakistan is among the countries most vulnerable to climate change impacts.[1] Changing temperature, erratic precipitation, humidity concentrations and extreme weather conditions pose serious threats to natural ecosystem of the country disrupting the performance of various sectors of the economy—agriculture being the most affected.

Gauging the impacts of climate change on agriculture has attracted increased attention the world over generating voluminous literature on the issue. Adaptation to the changing climate is reckoned to be the most important element of strategic responses to the posed threats of climate change. Studies have shown that without proper adaptation strategies, climate changes may have significant adverse impact on agriculture. The extent of negative effect of climate change to which an agricultural system is affected depends mainly on capacity of its stakeholders[2] to adapt.

Literature on adaptation to climate change brings the evidence suggesting that farmers are found responding to the changing situation(s). However, adaptation practices exercised by the farming communities in Pakistan remain least explored. In absence of such information, the design of climate change policy and generation of new technologies are likely to be least relevant to the end users. This in turn may hinder achievement of improved agricultural productivity.

Against this backdrop, knowledge of farmers' perceptions about climate change and alternative adaptation strategies is crucial in order to properly address the impacts of climate change. This brief, filling the void, presents perceptions of farmers about climate change and the adaptation strategies exercised as identified through Rapid Rural Appraisal (RRA) undertaken in eighteen selected districts representing all important agro-ecological/cropping-systems of Punjab, Sindh and Khyber Pakhtunkhwa (KP) provinces.

The list of districts includes Chakwal, Attock, Faisalabad, Bhakkar, Multan, Bahawalpur, Vehari, Gujrawala and Sialkot from Punjab; Umarkot, Hyderabad, Khairpur, Nawabshah and Larkana from Sindh; and Nowshehra, D.I. Khan, Kohat and Mansehra from KPK. Two villages from each district within 10-20km radius of the Met station were selected. A multi-disciplinary team was constituted comprising agricultural economists, bio-physical scientists from provincial research systems, local extension and other development partners. Group interviewing technique was used to get collective wisdom of the targeted farming communities. A lot of 15-20 farmers representing different farm sizes and age groups—including some educated and well-informed practicing farmers participated for 2-3 hours in each village.

The rest of the document is organized in four sections. Section II encapsulates farmers' perceptions about climate change. Major conclusions emerging from past research on the issue in Pakistan are

1. Pakistan is ranked 16th in list of countries most vulnerable to climate change.
2. The important stakeholders include farmers, agri-businesses, research/education institutions, and provincial and federal governments.

summarized in Section III while the adaptation strategies adopted by the farmer are outlined in Section IV. Section-V concludes the brief.

## II. Farmers' Perceptions About Climatic Change

The evidence from RRA is suggestive that the farming communities in various regions of Pakistan widely perceive that:

- Duration of seasons has changed—winter has shortened (sets in late and ends early) while summer has prolonged.
- Average temperature both in summer and winter has increased.
- Rainfall received in various regions has declined significantly and became more erratic.
- Monsoon rains occur late and are heavier in certain areas especially in Sind and KP. Winter rains, on the other hand, have declined.
- Droughts and floods are occurring not only more frequent now but are also more intensive.
- Canal water falls short especially at the time of rice sowing in Sindh and first irrigation of wheat crop in Punjab.
- Frost incidence has declined[3] in most of the areas and has become more uncertain—usually occurs in late winter months (i.e. in February) causing significant reduction in yields of wheat and mustard/canola crops, sugarcane, and fruits.
- Snowfall declined at low altitude mountains for example in Mansehra district of KP.
- Fog incidence is generally less frequent but occurs with greater intensity especially in rice-wheat and mixed cropping systems of north-eastern and central Punjab.

- The frequency of winds and hailstorms has declined. However frequent changes in wind direction are observed—keeping tunnel farmers very alert all the time.
- Intensity of heat has declined in rice belt as well as in mixed cropping systems of Punjab.

## III. Climate Change Related Research Findings

- The research on the subject regarding Pakistan mainly focuses on analysis of trends of changing climate; case studies of glacier melting and its impact on river flows; crop modeling incorporating climatic factors like temperature and rainfall changes etc. Study of impact of various stresses on crop yield and development of crop varieties tolerant to biotic and abiotic[4] stresses including those related to climate changes is another important area of research. The conclusions emerging from the research, in general, are as follows:

3. Except in D.I. Khan where it has increased.
4. Includes stresses like heat, drought, and salinity etc.

## (a) Climate Change Trends

- The temperature increases in Pakistan are expected to be higher than the global average (TFCC, 2010) resulting in reduced national agricultural productivity.
- The minimum and maximum temperatures have increased both in summer and winter seasons almost throughout Pakistan (Afzaal et al., 2009).
- The winter season has registered more warming trend than the summer during the last decade—reducing the winter season on both ends resulting in prolonged summer season. Night temperatures have shown larger increase than the day temperatures (Rasul et al., 2012).
- The mean temperature increased by 1.15, 0.56, and 0.09°C in Baluchistan, Punjab, and Sindh respectively over the period 1960 to 2007 (Chaudhry et al., 2009).
- The heat wave duration has increased by 31 days over the period 1980-2007 (Chaudhry et al., 2009).
- Global warming, resulting in rapid melting of glaciers, may have serious repercussions for river- flows in Pakistan—more water will be available in the first few decades causing floods and severe droughts afterwards (Sheikh, et al., 2011).
- A decreasing trend in precipitation is observed in Sindh during the period 1961-2007(Chaudhry et al. 2009). It is also reported that the overall rainfall shows increasing trend in Punjab, however, after 1997 a sharp decline is observed in monsoon rainfalls in the

It is hard to believe that minute changes in temperature and precipitation over a long period are noticeable by the farmers/individuals. It seems that farmers' perceptions about changes in temperature are mainly influenced by consistently higher warming trends observed in the last decade and/or by the significant increase in heat wave duration observed. Similarly, frequent droughts in the past decades and erratic rainfalls in certain areas of KP and Sindh had greater effect on farmers' perceptions about precipitation.

## (b) Climate Change and Agriculture: Impact Assessment

- The evidence suggests that an increase of 1°C in mean temperature would reduce wheat yield, a major food staple, by 5–7 percent in Pakistan (Sivakumar and Stefanski, 2011).
- Results of a more recent study show that 1°C increase in average temperature during the sowing stage (November and December) would reduce the wheat yield by 7.4 percent. The estimated increase in temperature normal during the study period for the months of November-December was projected to be 0.765°C. Therefore, the overall potential wheat yields got depressed by 5.67 percent during the last three decades (Ahmad, Siftain and Iqbal, 2014).
- Growing season length for major cereals will decline with increase in the temperature in all agro-ecological zones of Pakistan (Iqbal, et al., 2009b, 2009c).
- Wheat yield will increase in northern mountainous region for each degree increase up to 4°C change in temperature; however, wheat yield will decline in other zones for each degree increase in temperature (Iqbal et al., 2009a).
- Shortened growing season may result in decline of yields by 6-11percent in wheat

and 15-18 percent in basmati rice by 2080. However, Northern Mountainous areas may experience 40-50 percent increase in wheat productivity (Ali, 2011).

- Livestock production could decline by 20-30 percent due to rising temperature—creating crises in milk, meat and poultry supplies pushing prices beyond reach of the average Pakistani (ICUN, 2009).
- On average agriculture sector of Pakistan would lose 2-16 billion dollars per annum due to change in climate by the end of 21st century (Mendelsohn et al., 2001).

### (c) Climate Change Adaptive Production Technologies Developed by NARS

- Pakistan has a sizeable National Agricultural Research System (NARS) comprising of federal and provincial research institutions of which, with few exceptions no one has a separate section dealing the issues of climate change. These institutions, as a part of their routine research activities, have released certain innovations for adaptation of agriculture to climate change. The adoption of such innovations may reduce the adverse effect of climatic variability on crop yields. The major contributions of NARS in this regard are listed below.
- Development of water and soil conservation technologies including efficient micro irrigation techniques, water harvesting, moisture management, green manuring, gully plugging, check damming, precision leveling, and bio-fertilizers etc.
- Introducing technologies for reclamation of saline and water-logged soils.
- Developing high yielding, heat- and cold tolerant, drought resistant, and short duration varieties of field crops.
- Developed cultural practices aiming at soil and water conservation—ridge-sowing, zero-tillage, intercropping, and direct seeding of rice etc.

## IV. Adaptation at the Farm Level: Results from RRA

- Adaptations to climate change exercised by farmers are summarized below

### (a) Adaptations in Barani/Rainfed Region

- Use of deep tillage for rainwater harvesting and preserving moisture.
- Building of small check dams infrastructure
- Installation of dug wells/turbines increased to minimize drought impacts
- Diversion of river/spring/stream water through private water channels.
- Low-delta/low-input requiring and deep rooted mustard crop adopted as a drought resistant specialized oilseed crop.
- Shift in sowing time of crops—sowing of wheat and mustard delayed by 15-30 days.

### (b) Adaptations in Irrigated Agriculture

- Installation of tube-wells increased for a greater control over water—though very harmful in brackish water areas and has declined its use in certain areas as soil conservation strategy.
- Low-delta/ and low-input requiring crops adopted—canola/mustard crop is adopted as a drought resistant oilseed crop alternative to wheat especially in water stress areas of Sindh (Umarkot and Hyderabad districts).
- In partially rainfed area (low intensity zone), mungbean has replaced guar seed and cotton crops to a large extent and has been adjusted as a full season crop sown in May—two months earlier than before.

- Wheat sowing has generally been delayed by 15-20 days to avoid higher temperature level (above the normal) from mid-October to early-November.
- Hybrid maize cultivation in February–March in certain areas especially in Okara, Pakpattan and Sahiwal districts of Punjab
- Watering and smoking are practiced to reduce impacts of frost in certain areas.
- Cotton sowing on ridges to manage water scarcity, sowing cotton earlier (in March) before the weather gets very hot, and wheat in standing cotton are gaining popularity.
- Tunnel farming became more attractive for growing offseason vegetables and even crops like cotton in tunnels—warmer winters being a blessing.
- Superi[5] is adopted as a heat tolerant and short duration variety while super basmati is planted late season—planted three weeks late in third week of July.
- Direct seeding of rice is gaining popularity to save water and input cost (transplanting labor) and ensure proper plant population.
- Farmers are substituting sugarcane and rice for cotton in Khairpur and Nawabshah—in fact rice is the restricted crop for this area.
- Wheat sowing is delayed in Sindh up to 15-20 days, while cotton sowing is done earlier (shifted to March from May-June).
- Intercropping wheat in sugarcane and mustard in cotton is done to save resources. September sown sugarcane is intercropped in onion and after harvesting onion wheat is sown in sugarcane—three crops in the same field yielding very high returns in Tando Allahyar (Sindh).

- Rapeseed and mustard requiring low inputs increased in certain areas—in Sindh sowing shifted from September to October.
- Herders in Sindh deserts migrate quite often along with their animals to the neighboring districts, while women and children stay behind.
- Rain water is harvested for animal and human drinking in desert. Government has also given access to water in some of the villages for human and animal consumption.

*Lined up animals waiting for their turn to drink water in deserts of Umarkot*

- Hybrid rice—short duration (90 days) is replacing long duration varieties (110days) like Irri-6 and DR-83.
- Zero-till use is increasing for sowing wheat where rice is harvested late especially in rice-wheat belt of Punjab.
- Fish farming is getting popular on waterlogged lands.
- Sugarcane and banana cultivation is increasing in Hyderabad area. Also

5. A non-recommended but high yielding, early sown and short duration variety of rice

plantation of date palm is on the rise in Khairpur and Nawabshah.

- Cut flowers crops have been introduced in Hyderabad and supplied to Karachi.
- Wheat, gram and rice sowing delayed by15-30 days in KP.
- Maize sowing in Nowshehra has been delayed by about one month.
- Sugarcane acreage is reduced in areas facing water shortage and problem of termites.
- Area under short duration crops like local maize and tobacco has increased in Peshawar valley
- Hybrid maize replaced local maize in order to vacate fields early for garlic sowing in irrigated Kohat.
- Building small check dams and private irrigation canals for irrigated agriculture (in Kohat, Peshawar valley and Mansehra district).
- High value crop production and vegetable growing increased in certain areas of KP due to warmer winters than before.
- Agro-forestry adopted on large scale in Peshawar valley and Mansehra district of KP. It helps reduce the impact of rising temperature.

Surprisingly, the research institutions and extension department still keep recommending completion of wheat sowing by 20th of November. Further, the recommendation stands the same for all regions.
In case of rice crop, the sowing of nursery before 20th of May is prohibited according to Punjab Agricultural Pest Ordinance 1959 in order to control multiplication of notorious pests on early rice nurseries sown which may infest the seasonal rice crop with greater intensity. Consequently, the provincial department of extension discourages sowing of rice nursery earlier than 20th of May each year.
Canal closure schedules do not match with the adaptation needs of farmers confronting climate changes.

## V. Conclusion

Pakistan is vulnerable to threats of climate change, which are likely to have adverse impacts on crop production. The evidence is suggestive that perceptions of Pakistani farmers regarding climate change, to a reasonable extent, are in agreement with empirical findings regarding the issue. The NARS has developed promising technologies at a reasonable pace for adaptation of agriculture to climate change. It is crucial to test these technologies rigorously for applicability and scope of implementation. Future research must explore also the role of socio-economic factors in shaping responses to climate change.

The farmers are found responding to climatic variability. Especially, adoption of crops with low-delta and low-input requirements (canola/mustard) in water stress area; delay of wheat sowing by 15-30 days in regions where October and November temperature normals have increased; and laser leveling, ridge sowing, zero-tillage, inter-cropping, and direct seeding of rice for soil and water conservation are the promising adaptations by the farmers.

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