

## Impact of Rainfall Frequency during Late Spring Season on Wheat Crop in Major Agricultural Plains of Pakistan

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### Abstract

*Pakistan has an agrarian economy and Wheat is a major contributor. Agriculture in Pakistan relies not only on rainfall but also on the water supplied through melting of snow and ice in the northern areas. The interaction between meteorological parameters like rainfall, air temperature etc. and crop's growth are more pronounced at some particular phonological stages. Different weather parameters are used as an input for the purpose of yield prediction in crop modeling. Wheat is grown almost all over Pakistan in Rabi or winter season. Wheat production determines the food security, which claims three times the area and twice the value added share from the rest of the cash crops; cotton and rice. In the final stages of Wheat (March to May) more or frequent rains impacts negatively. The present study focused at the same myth an analysis has been made for the past years, especially the major agricultural plains. The purpose behind was to help generate a guide line for breeders and for the policy makers as well for better management of wheat crop. For a thorough study two different rainfall frequencies have been worked out; days with rain  $\geq 0.1$  and  $\geq 5.0$ , mm. The outcome of the study projects that fewer rains produced good yield in the end and vice versa.*

**Key Words:** Wheat crop, rainfall frequencies, phonological stages.

### Introduction

The interaction between meteorological parameters and crop growth are more pronounced at some particular phonological stages. It is weather not climate which may be used as an input for the purpose of yield prediction in crop modeling. Although the seasonal weather forecasting is a tough task but it may be the best input for a crop model. After establishing a relation between the seasonal weather pattern and final yield, a proper modeling track may be designed (Challinor et al; 2003).

Agriculture in Pakistan relies not only on rainfall but also on the water, which comes from melting of snow and ice. When this water reaches the dams, rivers and canals, it irrigates most parts of the agricultural land (Rasul et al., 2006). In fact, besides intensity the timing of precipitation is also important for hydrology and agriculture of a country. Pakistan is a country which gets the major share of its total rainfall through summer monsoon. This rainfall system provides the main contribution in Indus water network that benefits the Kharif as well as the upcoming Rabi crops (Naheed and Rasul, 2009).

In Pakistan, the total cultivable area is 34.54 Mha (39.3 % of total land area), of which 23.38 Mha areas is under cultivation. The largest cropped area is under wheat cultivation, which is over 8.6 Mha (GoP. 2008).

The life cycle of wheat crop in the plains of Pakistan approximately covers the period of October to April while in mountainous regions having December to May. Towards harvest, the crop has to ripen under a rapidly ascending temperature when hot dry winds are frequent (Howard, 1924). Wheat is very important for any country especially for country like Pakistan, where it is the source of staple food for the total population. Pakistan is one of the top 10 wheat producers of the world. Wheat is grown almost all over Pakistan on about eight million hectares in Rabi/winter season. Wheat production determines the food security, which claims three times the area and twice the value added share from the rest of cash crops; cotton and rice (Dowswell, 1989). For wheat crop although the vegetative as well as the reproductive stages are very important but the final stages are very sensitive in terms of moisture and temperature conditions.

Higher rainfall variance seems to be the main factor behind dry-land yield fluctuations. Intensity of rainfall and spatial distribution during crop season are very important. Distribution of rainfall become

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more significant for the lands with low water holding capability and also in the seasons where adequate soil moisture available at planting (Pratley, 2003).

**Table 1:** Occurrence & duration for phenological stages of wheat in Potohar (Kazmi and Rasul, 2009)

Sr. No.	PHASE	PERIOD
1	EMERGENCE	15 NOV-30 NOV
2	THIRD LEAF	01 DEC-20 DEC
3	TILLERING	21 DEC-15 JAN
4	SHOOTING	16 JAN-25 FEB
5	HEADING	26 FEB-05 MAR
6	FLOWERING	06 MAR-20 MAR
7	MILK MATURITY	21 MAR-18 APR
8	WAX MATURITY	19 APR-25 APR
9	FULL MATURITY	26 APR-28 APR

In Pakistan, winter precipitation occurs due to the western disturbances; which are generally the off-shores of mid latitude frontal systems. These disturbances move in the northeasterly direction. These disturbances pick up the moisture from Persian Gulf as well as from the Arabian Sea and not only enhance the winter rainfall but also cause rainfall over the most parts of the Pakistan during winter (Shamshad, 1988). Temperature and rainfall (moisture) are the elements which affect directly the ETo (Reference Crop Evapotranspiration) and consequently the crop water requirements. ETo is an agrometeorological parameter, its increase produce negative water balance. In a country where the consistent water availability is already a challenge, increase in water requirement stands for more disastrous conditions for local agriculture (Rasul and Kazmi, 2011).

### Statement of the Problem

Generally, for any crop including wheat rainfall is favorable but at some particular stages like the maturity it may affect negatively. Spring covers the maturity stage of wheat where it is desired to have more sunlight in order to obtain drier and larger grains. Particularly, it is the frequency which may lead to drastic change in final yield. Suitable time is required by the crop to be dried out in case of any rainfall in this particular season. For this core reason this study was initiated.

### Data and Methodology

- Daily rainfall data for the period 1981-2009, for five stations of Punjab (important for Wheat production) has been incorporated, as provided by Pakistan Meteorological Department.
- Wheat Yield data for the period 1982-09, as produced by Agriculture Statistics of Pakistan, has been incorporated.

Definition of rainy day mainly depends on the season, location and the purpose behind the activity for which this information would be incorporated. For farmer at the time of sowing and harvesting requirements are different as per demand of the field operation. For example for crop harvesting dry weather is pre requisite; as a small amount of rainfall for a single day may cause huge damage to the crop yield that may cause a delay in harvesting. In the present study, the impact of rainfall occurrence on the wheat growth has been analyzed at the final stages; when the crop is ready to harvest. For a detailed analysis two different rainfall frequencies have been worked out; rainy days with rain  $\geq 0.1$  and  $\geq 5.0$ .

### Result and Discussion

In Pakistan there are more than one hundred districts but in the wheat context some of them have importance. Central Punjab is the most important area for wheat crop; therefore analysis for wheat crop production has been carried out for Faisalabad. The following graphs (Figure 1) for frequency of rainfall are for equal or more than 0.1 and 5 mm rainfall (respectively) in the month of April for the study period. It can be seen that with the passage of time trend the frequency of rainfall is showing decreasing but comparatively the final yield for wheat approaching to the high values. Kazmi and Rasul, 2009 stated that bright sunshine is desirable at the last stages of wheat life cycle. The revealed fact has been supporting this idea that enhanced sunshine or dryness is mandatory for the healthy growth of wheat crop at the specific time (i.e. April). The long term data projects that the dryness or low rains produced good final yield in the end.

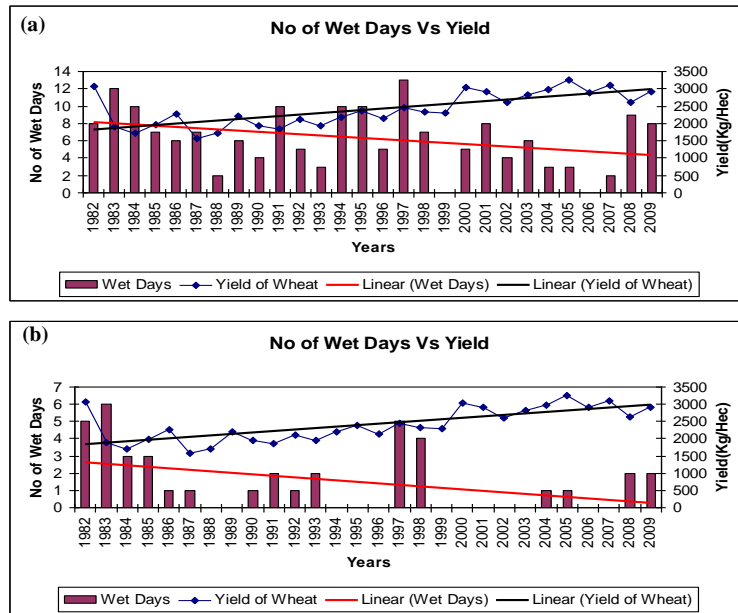


Figure 1: (a) Rainy days frequency ( $\geq 0.1$  mm) and (b) ( $\geq 5$  mm) versus wheat yield, for Faisalabad (April, 1982-09).

Sargodha is the 2<sup>nd</sup> most important station in terms of Wheat production, in Punjab as well on country level. It is located at the start of agricultural plains in northern Punjab. The graph for Sargodha

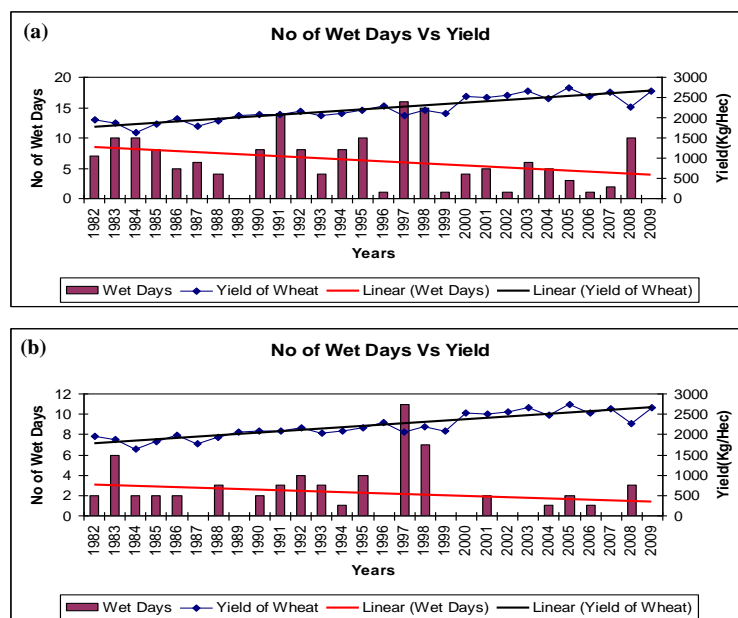


Figure 2: (a) Rainy days frequency ( $\geq 0.1$  mm and (b) ( $\geq 5$  mm) versus final wheat yield, for Sargodha (April, 1982-09).

in Figure 2 with rainfall  $\geq 0.1$  mm and  $\geq 5$  mm shows that in April fewer rains are supporting good yield of wheat crop. In other words, clear skies and bright sunshine remained favorable for optimum wheat yield. The time series is indicating the inverse proportion between the rainfall and final yield of wheat.

In northern Punjab, Jhelum is a significant district for wheat crop. Jhelum consists of irrigated as well as rainfed agriculture. The Figure 3 for  $\geq 0.1$  and  $\geq 5$  mm of rain follows same pattern of inverse proportion for rainy days and final wheat yield.

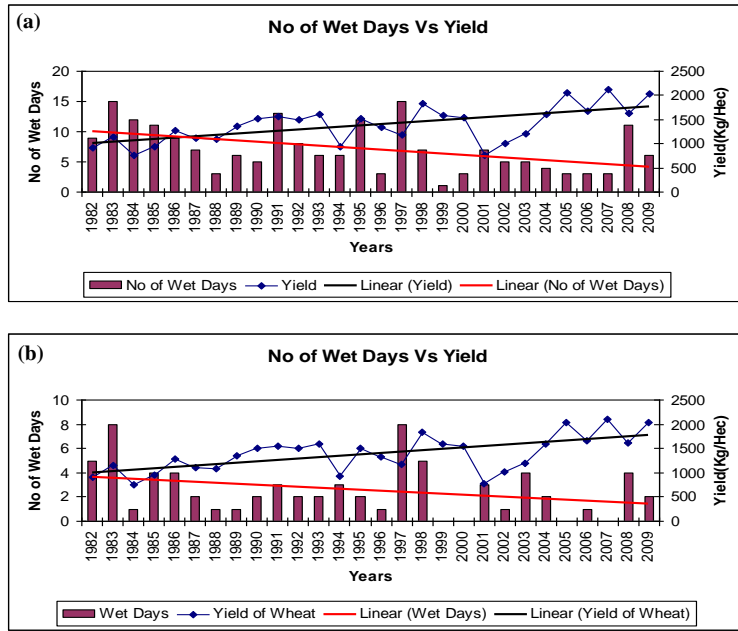


Figure 3: (a) Rainy days frequency ( $\geq 0.1$  mm) and (b) ( $\geq 5$  mm) versus final wheat yield, for Jhelum (April, 1982-09).

Islamabad/Rawalpindi, is an important area for wheat production in Potohar region, represents the rain fed area of Punjab. This area is not a major contributor for wheat at province level. However, wheat, being a prominent agricultural product of the area, the local farmers are concerned about the production of this crop for their domestic use and sale of surplus. In this region wheat is the major crop during Rabi season besides Mustard and Barley.

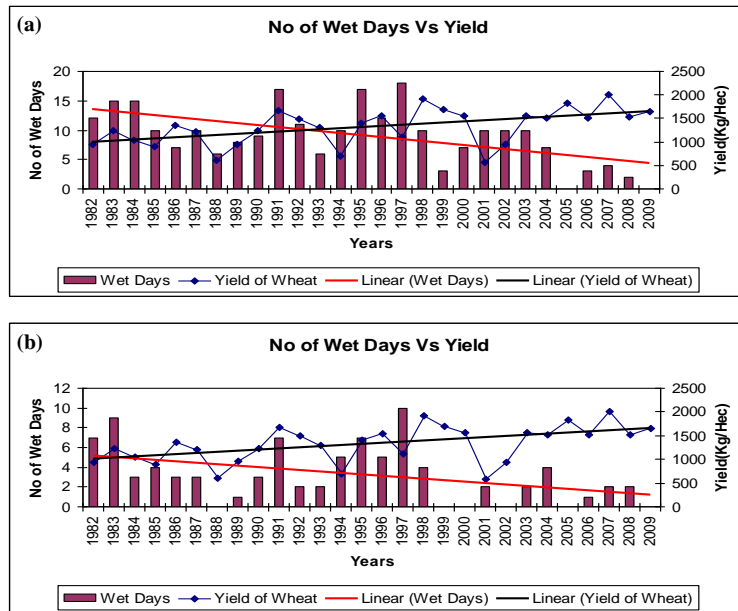
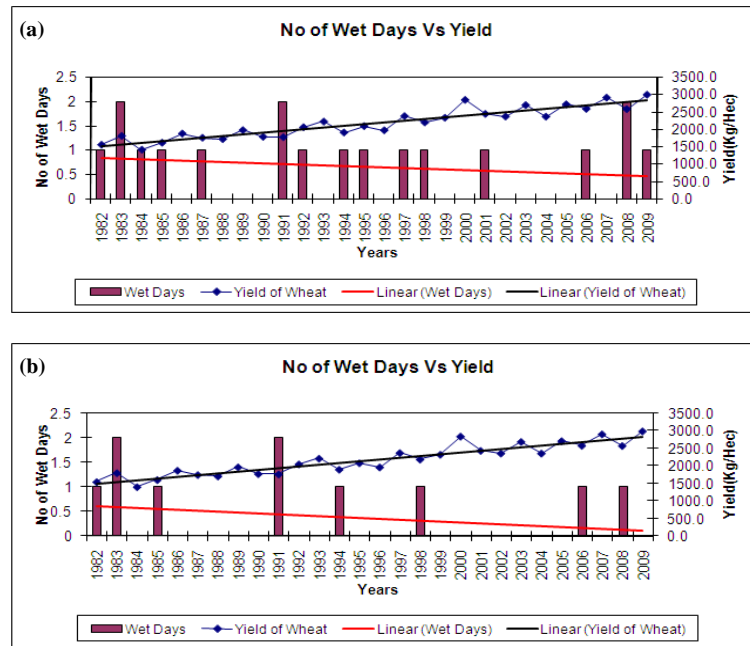


Figure 4: (a) Rainy days frequency ( $\geq 0.1$  mm) and (b) ( $\geq 5$  mm) versus final wheat yield, for Islamabad/Rawalpindi (April, 1982-09).

Sunshine also plays a vital role in the final stages of wheat crop. It has been observed in various cases that more bright sunshine duration or clear skies produce good yield in the end. It has been revealed that especially during March, more bright sunshine projects good wheat yield (Kazmi and Rasul, 2009). This parameter is considered an insignificant contributor for wheat growth as well as final yield. But it has shown a noticeable correlation with the final yield in this particular period of time, on long term basis.



**Figure 5:** (a) Rainy days frequency ( $\geq 0.1$  mm) and (b) ( $\geq 5$  mm) versus final wheat yield, for Bahawalpur (April, 1982-09).

Apart from upper and central Punjab, Bahawalpur is located in south corner of the province. Situated southerly make it holding early summer as compare to the rest of stations, discussed earlier. Accordingly, wheat in this part is generally harvested prior to mid of April. Likewise Figure 5 depicts the similar results that are in agreement with the agro-climatic perception. Therefore, the observational analysis reveals that in this region as well, more rainy days may have negative impact on the final wheat yield.

## Conclusion

This study analyzed the relationship between the frequency of rainfall in spring season and production of wheat crop in major agriculture plains of Punjab. From the study following conclusions have been derived:

- More is rainfall occurrence, fewer will be the quantity of wheat yield and vice versa for wet days  $\geq 1$ mm.
- For wet days  $\geq 5$ mm the trend lines also show the same above said pattern.
- The threshold values for irrigated land is 05 wet days, if the rainy days increase then less yield would be produced. This may be due to relevant increase in temperature.
- Moreover, the threshold value for rain-fed areas is 15 days.

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