Applying climate information to enhance wheat based farming in rain-fed areas of Pakistan

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Abstract

In Pakistan general, non-specific climate and climate forecasting information for producers is available from a range of sources. While general information is somewhat useful and of interest, it usually stops short of providing the level of detail needed in order to affect better agricultural management decisions. In case of wheat high temperature anomalies have been observed during January – April, resulting in rapid maturation of crop, and more rainfall in summer (especially late months) providing early wheat planting opportunities. Analysis of historical climate data indicated that there is opportunity for the improvements in wheat planting window and selection of a wheat varieties / cultivars to be adjusted accordingly. ENSO (El Nino Southern Oscillation) phases of the Southern Oscillation (SO) can be used in seasonal forecasting, may enhance decision-making. The ENSO based data analysis has shown that in case of the northern rain-fed regions of Pakistan, rainfall in July is of critical importance. July rains have shown to have an important relationship in respect to moisture availability for wheat during its sowing season.

Media summary

Climate forecasts and climate trends combined with simulation studies demonstrate the feasibility and potential benefits to increase the economic returns using alternatives to traditional wheat-fallow cropping in Pakistan.

Key words

Wheat, decision-making, yield simulations, climate risk analysis

Introduction

The cropped area of Pakistan consists of 20.9 mha, of which 4.8mha (24.4%) is rainfed and concentrated in Pothwar uplands, northern mountains and northeastern plains. The Islamabad zone centers on the Pothwar Plateau comprising Districts of Islamabad, Rawalpindi, Attock, and Chakwal. This zone is entirely dependant on rainfall and is characterized by diverse and complex agriculture, reflecting the interaction of land type, soil type, rainfall variability, and socio-economic factors in farmers' management. In these rainfed areas almost 60% of the total rain is received during summer (June-September) and 40% during winter (October-May). Cropping intensity is considerably low during the summer season because most land is left fallow as a soil water storage measure for winter crops.

In Pakistan, general but non-specific climate information for the agricultural sector is available for producers from a range of sources such as TV, Radio and Newspapers. However, to improve climate risk related decision making at the farm level, farmers need to improve knowledge and skills of this climate variability and predictability, which affect crop yields. This will enhance decisions by identifying possible management options based on climate information or seasonal climate forecasts. In this study a systems analytical simulation approach was applied to investigate and quantify possible opportunities.

Methods

For the analysis of long-term climatic data and cropping system analysis, a simulation modelling approach was applied. The impact of ENSO on rainfall in Pakistan has been established previously (Stone et al. 1996). Phases of the Southern Oscillation Index (SOI) to partition wheat yields and to determine if yields might differ considerably between different ENSO stages was undertaken (Stone et al. 1996).

APSIM was used to explore farmer cropping decision options given the variable climate (Keating et al., 2003). APSIM also provided opportunities for scenario analysis to explore possible cropping options and consequences for such scenarios.

Results and discussion

Analysis of actual rainfall data of Islamabad from 1961 to 2003 revealed that the long-term rainfall pattern show slight trends for increasing summer rainfall and decreasing winter rainfall over that period (Figure 1). It is unknown if these trends are unique to this location or are spatially coherent across the broader region (this requires further work). The observed trends also indicate a significant tendency towards earlier on-set and finish of the summer season, with increased rainfall in July/August but decreased rains in September (Figure 2). The mechanisms explaining this apparent trend also requires further research.

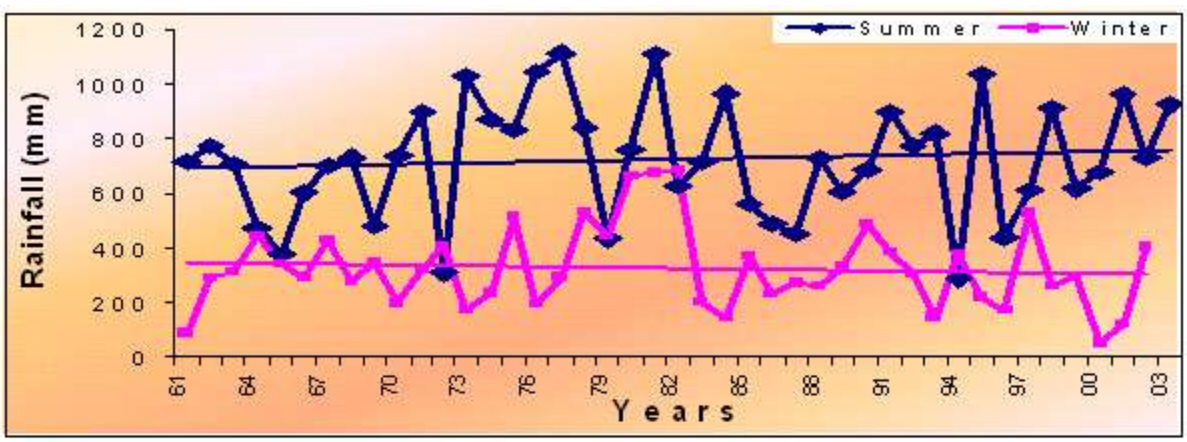

Figure 1 Rainfall trends in Islamabad during summer (June – Sep) and winter (Oct-May) season (1961-2003)

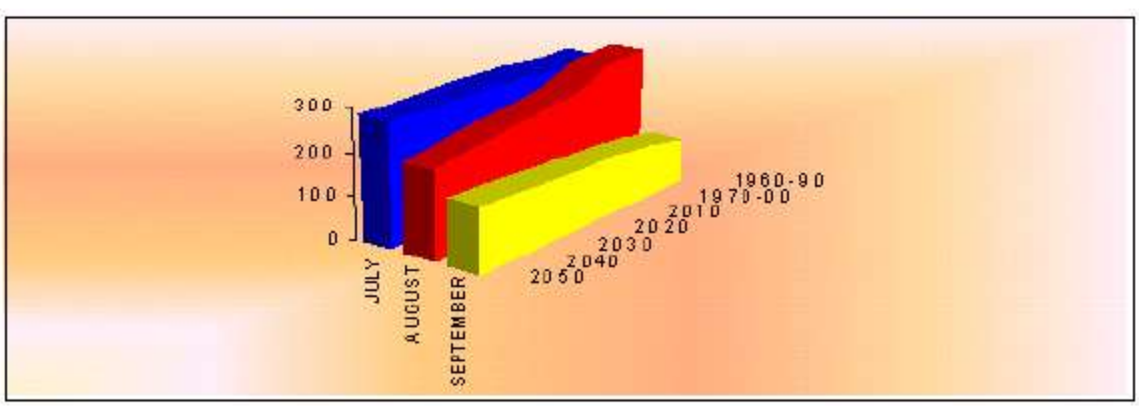

Figure 2 Historical and projected rainfall pattern for Islamabad, Pakistan (July-September)

Based on long-term data (1961-2001) we found that a Mungbean-Wheat cropping system would be more feasible and more economically viable than the traditional Fallow-Wheat system (Figure 3). Although wheat yields are somewhat lower in a mungbean-wheat rotation due to additional water use by the mungbean crop, such reductions were compensated by the mungbean yields and its better monetary returns. Data indicates (Figure 3) that the wheat-fallow system resulted in more erratic yields compared to mungbean-wheat system and also showed 5% of years where wheat yields were so low as to be regarded as a total crop failure (1987 and 1994).

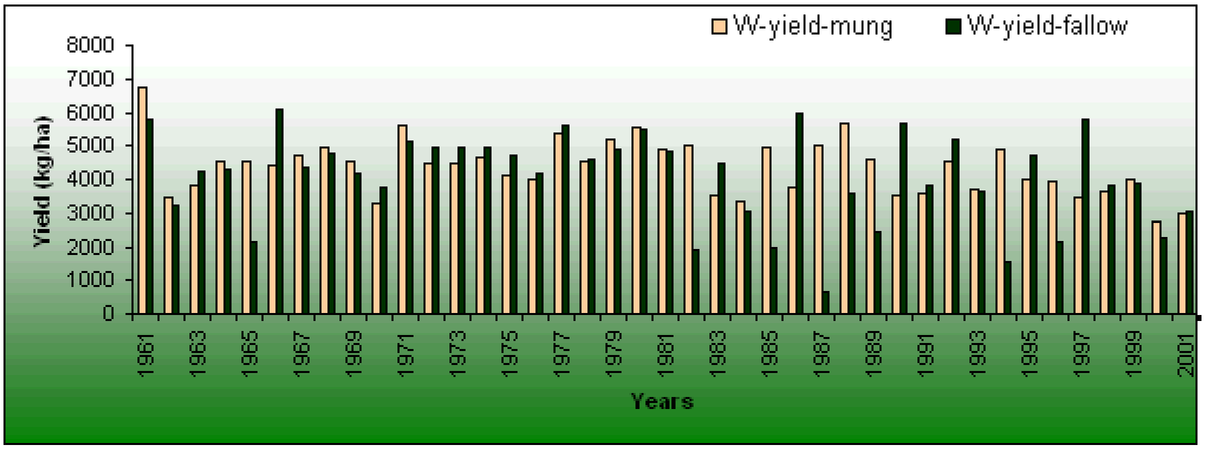

Figure 3 Simulated Wheat yield in Fallow-Wheat and Mungbean-Wheat cropping systems.

Simulation analysis further showed that these failed wheat crops were a direct consequence of (a) soil moisture use by the preceding mungbean in the summer season combined with a subsequent failure of the winter season rainfall (Figure 4). Improved knowledge and skills of climate variability and seasonal forecasting can play an important role in the design of improving wheat cropping in Pakistan.

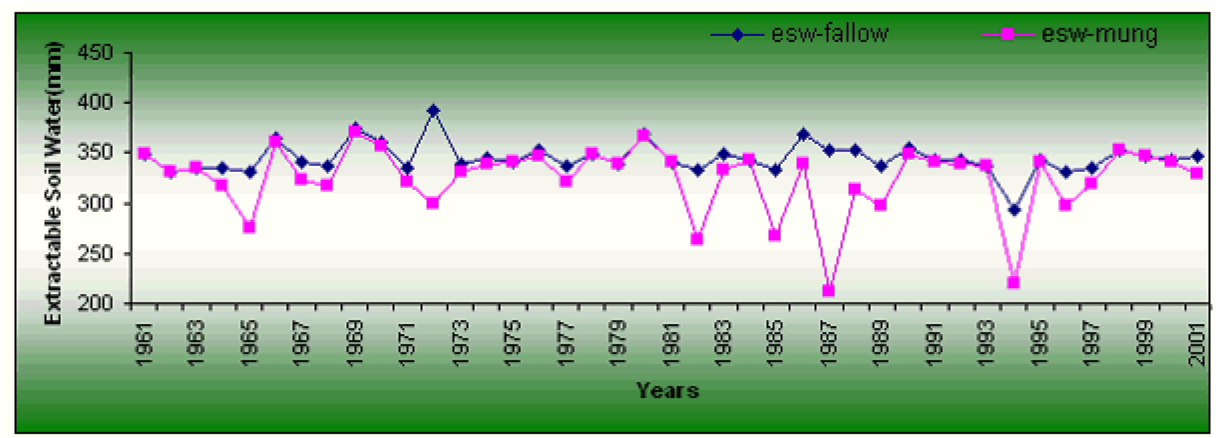

Figure 4 Simulated extractable soil water for wheat crops after (a) fallow (esw-fallow) or (b) following a mungbean crop.

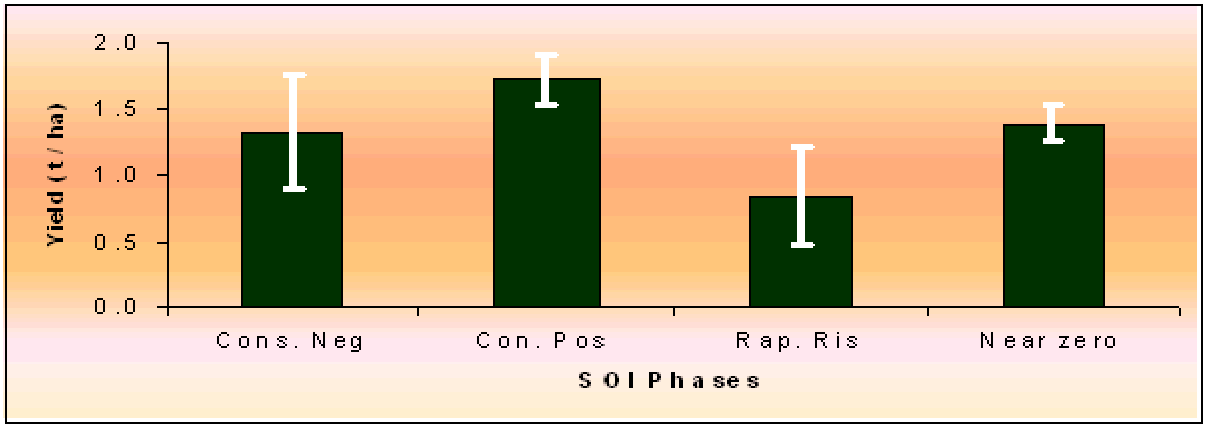

Figure 5 Wheat yields (grown Oct-May) partitioned by SOI Phase during the preceding July (i.e. 3 months before wheat is sown)

Figure 5 shows considerably lower wheat yields following a rapidly rising SOI phase in July. We are now investigating the scope of how this forecast information might be used to determine the risk and opportunities for mungbean rotation within other wheat farming areas of Pakistan.

Conclusions

It may be concluded that for rainfed areas of Islamabad, the option of mungbean-wheat rotation has advantages over the traditional fallow-wheat rotation. However, for the mungbean-wheat system, the optimal wheat planting window and suitable cultivars needs further study integrating climate and weather data, before recommendation to farmers.

References

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