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Planting window as an adaptation option to offset the likely impacts of climate change with emphasis on Rainfed areas

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Agriculture is inherently sensitive to weather and climate. The projected climate change is expected to have a considerable impact on agricultural production. Adaptation of an appropriate management strategy is one of the likely decisions to cope with the impacts of changing climate. This study was designed with the objective to explore the adaptation potential of planting window as a management option in the compensation of the adverse impacts of climate change. The Cropping System Model (CSM)-CERES-Wheat of the Decision Support System for Agro-technology Transfer (DSSAT) Version 4.0 was used to assess the planting window as an adaptation option.

Main focus was on rainfed areas that belong to different climatic zones viz., arid, semi-arid, dry sub-humid, moist sub-humid and humid. These areas though located in Pakistan but represent the most diversified ecologies in which wheat is grown. About 55 per cent of total gross value worth of world food is produced under rainfed conditions on 70 per cent of the world's cropland, much of which is located in developing countries(1). Rainfed farming is a priority - not only does rainfed agriculture account for 60 percent of current agricultural output in developing countries, but rainfed areas are home to most of the world's poor (2). As opportunities for further agricultural growth in irrigated regions get exhausted, food security and productivity in agriculture in future will increasingly depend on improved utilization of rainfed regions thus they have to be the focus of future agriculture revival. People living in developing countries are consuming half of the world's total wheat production. In Asia it is the second most important staple, and demand has been growing much faster than for rice. In future, food security will be at the top of the agenda in developing countries because of two emerging events: growing population and many direct and indirect effects of climate change (3). While per capita wheat production in developing countries has risen more than 50 percent since the early 1970s, hundreds of millions of people are still malnourished, mostly in South Asia and sub-Saharan Africa (4). Climate change scenarios developed based on the Intergovernmental Panel on Climate Change Special Report on Emissions Scenarios (SRES) result in crop yield decreases in developing countries and yield increases in developed countries. In the wake of future climate change scenarios, this contrast between the yield change in developed and developing countries will make the situation much worse in developing countries (5). A number of possible alterations in the current baseline sowing dates of the respective zones were considered at Global Change Impact Studies Centre to see the sowing date as an adaptation option to offset the likely impacts of climate change. Five sowing dates were used as baseline dates; 15 October, 1st November, 15 November, 30 November and 15 December for humid, moist sub-humid, dry sub-humid, semi-arid and arid zones respectively. Sowing dates varied depending on the climatic conditions of the area, and the time of harvest of the previous crop. For this purpose, each zone was assigned a different baseline sowing date based on the dates used by farmers in these areas. The past 30-year (1971-2000) climatic parameters of solar radiation, maximum and minimum temperature and rainfall at the representative sites were used as baseline climatic data. Potential impacts of climate change were assessed for climate change scenarios developed from the ensemble of 17 Global Circulation Models under the Intergovernmental Panel on Climate Change Special Report on Emissions Scenarios A2 and A1B. The choice of sowing date in the rainfed areas, unlike in the irrigated areas, is highly limited because of its link with the occurrence of rainfall. The future scenarios of rainfall are very uncertain, so, by relying on the past observed data set, a comprehensive analysis of daily rainfall data was made to know the probabilities of occurrence of sowing dates in the context of the availability of pre-sowing soil moisture. The results depict that there is high probability of increased yield in later sowing dates compared to earlier ones under climate change. This indicates that the sowing date of wheat in arid, semi- arid, dry sub-humid, moist sub-humid and humid zones will shift towards cooler months with climate change. But different zones have different starting point of shift. In arid zone the current dominant time of sowing wheat is mid December, while in semi-arid zone it is the end of November. In order to compensate the probable climate change losses, the changes in sowing from mid December to late December in Arid zone while in Semi-arid from late

November (current practice of sowing) to earlier December will be beneficial in order to reduce the vulnerability. In dry sub-humid and moist sub-humid zone the probability of sowing date of early November (dominant current practice) distinctly leads toward lower yields while the sowing in late November and in December favored higher yields. In humid zone, the sowing date of 15-Nov increased the probability of higher yield compared to earlier sowing and as the climate changes further (in the later decades of this century), the probability of later sowings favors higher yields just behind the sowing of 15-Nov, such that the probability line of 30-Nov sowing overlaps with the sowing of 15-Nov. These results support the conclusion that the shift in the sowing date towards cooler months can offer an opportunity to offset the likely impacts of climate change. With each advance in sowing date the growing season length decreases compared to the previous sowing, in the baseline as well in the climate change scenarios. This suggests that alteration in the sowing date might not interfere with other crops grown during the remainder of the year, but might offer an opportunity of some additional time that can be utilized for land preparation or to grow an additional crop. Apart from this, cultivars that can take benefit of shorter durations will be beneficial. Because of high economic concerns associated with adaptation option, it will be comparatively easy to opt for the alteration in sowing date as it will most probably be at no cost decision.

Key words: Climate change, Cropping system model, wheat, planting window, adaptation, rainfed.

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