MANAGEMENT SUGGESTIONS FOR INCREASING THE PRODUCTIVITY OF WHEAT AGAINST CLIMATE CHANGE –A CASE STUDY OF BHAGALPUR DISTRICT (BIHAR).

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ABSTRACT

The effect of temperature change and planting date on the productivity of wheat yield for the winter and spring cultivar has been studied through DSSAT model. Weather data, soil data and management practices are used to calibrate the model CERES-Wheat. Deviation in wheat yield is observed through DSSAT model for half degree increase in temperature from 3605 Kg/ha to 980 Kg/ha for winter variety and 1666 to 364 Kg/ha for spring variety. Adverse temperature effect is minimized through change in planting date from 15 November to 30 November for optimum condition. For winter variety there is change in yield from 2956 Kg/ha (without irrigation) to 3605 kg/ha (with 60 cm irrigation) under same temperature.

INTRODUCTION:

In the coming decades, global agriculture has to deal with climate change challenges in addition to that of a growing population. The potential effects of climate change on crop yields have a bearing on world food supply and consequent risk of hunger. Besides being second largest in the world, population wise, India also is the second largest in wheat consumption. Still the average yield Wheat in India is 2.6 t/ha which is less than half of that of China with 5.5 t/ha.

With land and water resources being finite, the alternative left with agriculture sector is to increase the productivity only. On the other hand the affect of global climatic change on productivity also need to be analysed to ensure better management practices on irrigation, tillage etc., for increasing the yield of wheat to meet the growing demand. The responses of crop yield to climate change are estimated from crop growth models such as DSSAT. In Bhagalpur district, the average yield of wheat is 1.9 t/ha against national average of 2.6 t/ha. Agricultural practices such as time and method of sowing, crop density and geometry, crop varieties (cultivar), dose, method and time of fertilizer application, time and method of irrigation have pronounced effect on productivity of a corp.

Crop productivity in many environments is highly dependent upon weather and climate. This is particularly so in tropical regions, which are often monsoon environments with low levels of crop management technology [11].

CROP MODEL-DSSAT:

Crop models which contribute to a common input and output data set-up have been developed and set in a software package called the Decision Support System for Agro technology Transfer (DSSAT). The DSSAT itself (Jones, 1993; IBSNAT, 1994; Tsuji et al., 1994) is a shell that allows the user to systematise and control crop, soil and

weather data and to run crop models in various ways and analyse their outputs. The models running under DSSAT include the CERES model for wheat. [1]

Crop simulation models are essential tools to design management practices to moderate adverse conditions. They can be used to predict crop yield expectancies under limited data availability and various management scenarios. This paper aimed to evaluate the DSSAT crop model in Bhagalpur district (Bihar, India) for wheat. DSSAT crop model is based largely on Weather Data (Maximum and Minimum Temperature, Rainfall, Solar Radiation), Soil profile and Management conditions (Irrigation practices, Fertilizers usage and Farming techniques). The model is used as a management tool to determine an optimum planting date and cultivar variety, taking into account the variability of temperature due to climatic change. Weather data [7, 8], soil data [9] and management practices [10] are used to calibrate the model CERES-Wheat.

As per the studies conducted on effect of fertilizer application on crop yield in North West India by Y Singh et al., Wheat yield without fertilizer has remained nearly the same (1.4 t /ha) and at 40 kg/ha N level, the yield did not change significantly, though higher yield was maintained. At higher levels of N (80 and 120 kg/ha), there was significant improvement in wheat yield over the years, particularly at 120 kg N/ha (which is adopted in this study). This could be ascribed to improvement in management practices and change in variety [2]..

STUDY AREA DESCRIPTION:

- Population 3032226 (2011 census) [3]
- Geographical area: 257000 ha [4]
- Net Area shown: 185000 ha [4]
- Net irrigated area: 66600 ha [4]
- Major soil type: Vertisols,inceptisols,entisols [4]
- Average annual rainfall: 1148.52 mm [4]
- Average land use for the wheat production: 40000 ha [5]

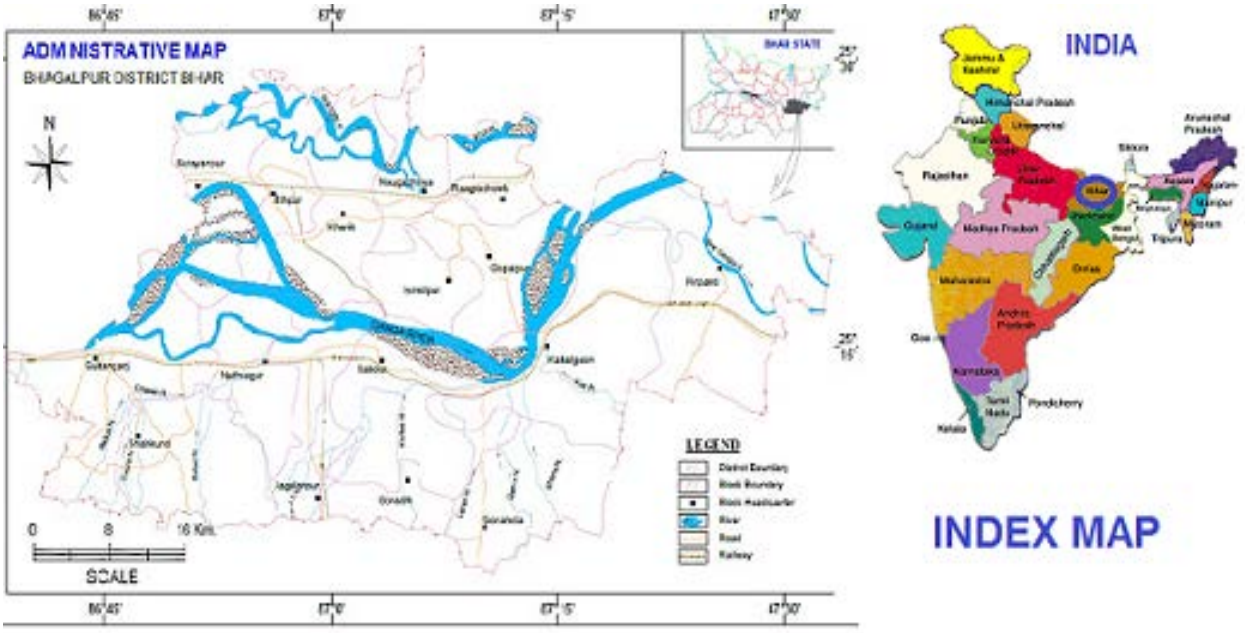

Figure 1 INDEX MAP [4]

In the study area of Bhagalpur district temperature [7, 8] change during crop period (November to March) in the years 1983 to 2011 is seen to follow an increasing trend as shown below. Average temperature during crop period (November to March) is increased to 20.34^0 C (1983-1984) to 21.39^0 C (2010-2011).

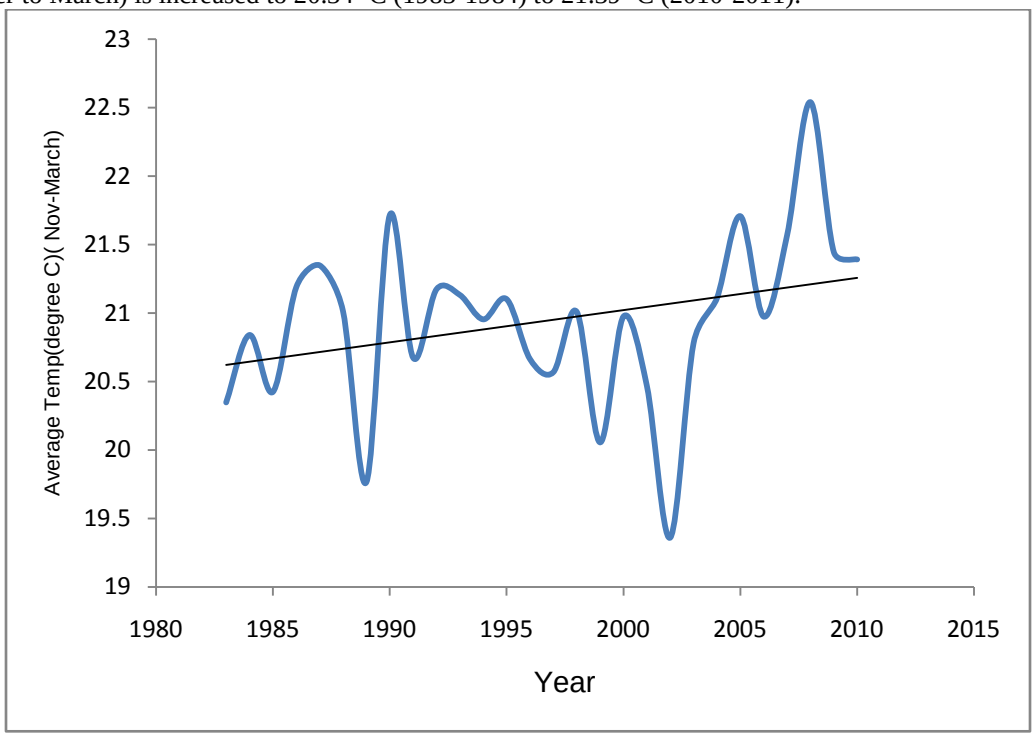

Figure 2 Temperature Variations in Bhagalpur (NOV-MAR)

RESULTS:

16 model has been run for two varieties of wheat (winter and spring) under half degree of temperature increase throughout the year and under the application of 60 cm irrigation with 120 kg/ha nitrogen application. Different eight conditions are given as:

Condition No	Variety	Code	Description
1	Winter	1	Winter variety without irrigation with planting date 15 November
2	Winter	2	Winter variety with irrigation with planting date 15 November
3	Winter	3	Winter variety without irrigation with planting date 30 November
4	Winter	4	Winter variety with irrigation with planting date 30 November
1	Spring	5	Spring variety without irrigation with planting date 15 November
2	Spring	6	Spring variety with irrigation with planting date 15 November
3	Spring	7	Spring variety without irrigation with planting date 30 November
4	Spring	8	Spring variety with irrigation with planting date 30 November

Table 1: Conditions for model run

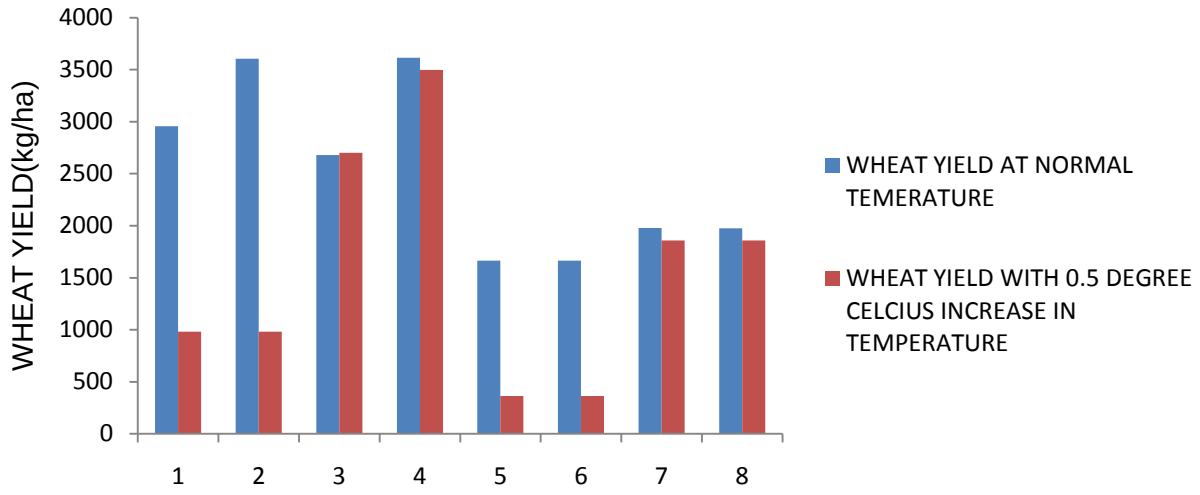

Figure: 2 Wheat Yield (Kg/ha)

SUMMARY AND DISCUSSION:

From the results, it is seen that with a possible 0.5^0C increase in temperature due to climatic change, the yield of wheat has reduced under irrigated (from 3605 kg/ha to 980 kg/ha) as well as under rain fed agriculture (from 2956 kg/ha to 980 kg/ha) .Ball., through multiple regression using climate parameters as independent variables of statistical model in Punjab India in 2004, indicated that 69% wheat yield changes is as are cult of changes' in daily minimum temperature and growing degree-days [6] . Strangely, if the crop period is advanced by a mere 15 days i.e., from 15 November to 30 November, there is no significant change in yield with 0.5^0C increase in temperature The yield of spring cultivator is seen to be much less than winter variety. The effect of temperature change and planting date on the productivity of wheat yield for the winter and spring cultivar has been studied through DSSAT model. Weather data, soil data and management practices are used to calibrate the model CERES-Wheat. Deviation in wheat yield is observed through DSSAT model for half degree increase in temperature from 3605 Kg/ha to 980 Kg/ha for winter variety and 1666 to 364 Kg/ha for spring variety. Adverse temperature effect is minimized through change in planting date from 15 November to 30 November for optimum condition. For winter variety there is change in yield from 2956 Kg/ha (without irrigation) to 3605 kg/ha (with 60 cm irrigation) under same temperature.

By predicting probable temperature change optimum planting date may be determined with model study for different areas based on prevailing soil conditions and management practices. Further studies involving more varieties of cultivars and crop varieties other than wheat, need to be carried out to assess the effect of increase in temperature consequential to probable climatic changes, to a reasonable degree of reliability, and evolve practical recommendations for implementation by agriculturists so that the yield per ha is not adversely affected and put the food security of the nation at peril.

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