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ADAPTING DRYLAND WHEAT PRODUCTION SYSTEMS OF IRAN TO CLIMATE CHANGE

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Introduction

Rainfed wheat accounts for about 60-65% of the cultivated wheat area and contributes 30-35% of wheat production in Iran. While the demand for wheat is predicted to be over 20 Mt in 2025, results of impact studies have shown average country level yield reduction of 18 and 24% for target years of 2025 and 2050, respectively (Nassiri et al., 2006). Adapting to climatic variability will have a substantially greater effect in reducing impact than will mitigation. However, adaptive measures for dry land systems of Iran are poorly investigated. The purpose of this study was predicting the effects of adaptation and evaluating these strategies based on adaptation costs and benefits.

Methodology

This study concentrated on the 12 major rainfed areas of rainfed wheat production in west, northwest, northeast, and north central parts of Iran. Climatic data were collected from the nearest weather stations to the rainfed growing areas from 1968 to 2000. Weather data generated from mean monthly values were used with UKMO General Circulation Model. The adopted UKMO climate change scenarios in this study for years 2025 and 2050 are based on recently published data for the country (Koocheki et al., 2006). [CO_2] for these targeted years have been reported to be 425 and 500 ppm (IPCC, 2001). To satisfy the spatial resolution of the crop model, statistical downscaling method was used.
The World Food Study (WOFOST) v 7.1 crop growth model was used (Boogard et al., 1998) for simulation of rainfed wheat yield under current and .predicted climatic conditions for the target years, after validation (Nassiri et al., 2006). Wheat yield was also simulated under future climatic conditions with adaptation strategies such as changing cultivars and planting dates. Changes in site yield (t ha^{-1}) were scaled to regional productivity (tons) using the existing average regional production statistics and the change in yield under a given global change scenario. For example, the production is summed and the total is multiplied by the change in yield predicted by the simulation model with and without adaptation. Regional crop value is calculated from the regional productivity and the revised crop value. This was compared with baseline values with no global change. These regional values were then aggregated to give national production.

Results

National mean yield predicted for the base-line climate (1968-2000) was 900 kg ha^{-1} ranging from 500 kg to 3.5 t ha^{-1}. In 2025 and 2050, the geographical distribution of yield potential was not predicted to change, but the yield in all areas was predicted to decrease, with possibly greater decreases to the North West (Fig. 1). For all studied sites, yield was reduced by about 19 to 28% for 2025 and 2050, respectively. This yield reduction is mainly due to decreased length of growth period and increased water deficit days (Koocheki et al, 2006) leading to earliest harvest time of currently sown cultivars. Therefore, potential improvements in wheat adaptation for climate change in Iran may include introduction of new cultivars and changing management practices like sowing dates. Including such an adaptation strategies in the simulation model was led to considerable yield improvement under climate change scenarios (Fig. 1).
On a national basis, mean wheat production may decrease in the years 2025 and 2050 by 24 and 31% from current levels, respectively (Table 1). When adaptations of changing varieties and changing planting windows (to take advantage of drought risk) were simulated across the wheat growing regions for the target years, there was a marked offsetting of the negative impacts of global change (Table 1). Similarly for value of production, when management was adapted to cope with climate change, mean value of production was higher than when no adaptations were used. The grain prices assumed in this study will change by the target years due to changes in both global supply and demand and we have used these prices for comparative purposes only.

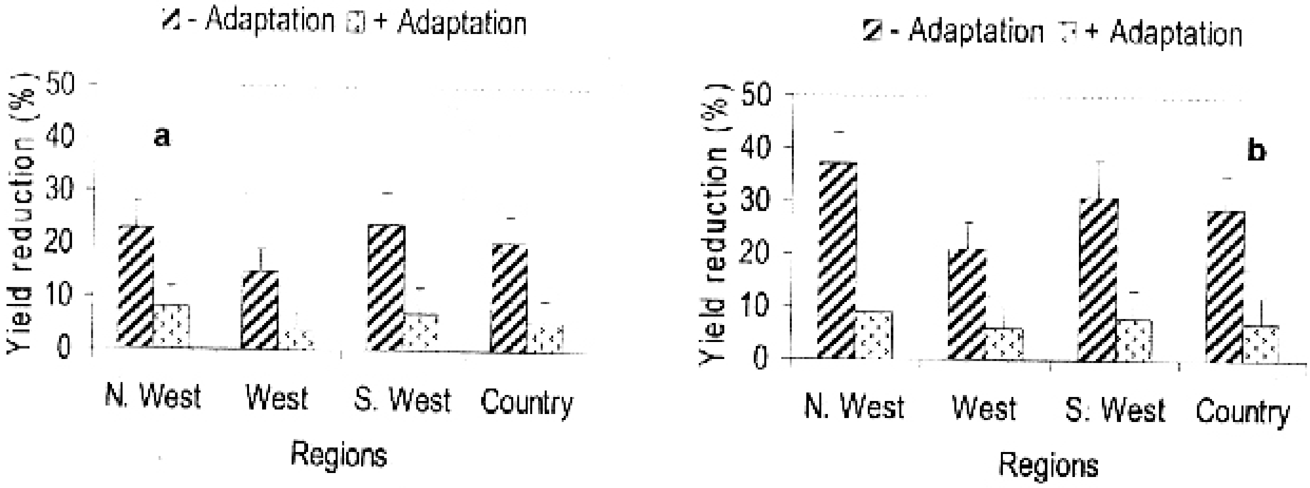

Figure 1: Simulated reduction of rainfed wheat yield in the major wheat growing regions of Iran under climate change conditions compared to national yield average. a) Year 2025; b) year 2050. (Vertical bars show SE of sites within each region).

However, studies of possible climate change impacts on global supply and demand (e.g. Rosenzweig and Parry 1994) suggest only relatively minor changes in prices due to similar changes in both factors.

Table 1: Effect of climate change for the years 2025 and 2050 on percent change in average production and value of production assuming either current management practices or adapted management practices. The values in parentheses are the maximum and minimum values.

		Year 2025		Year 2050	
Production	- current	-24.3	(± 6.8)	-31.8	(+9.5)
	- adapted	-8.0	(± 5.3)	-9.9	(+ 6.1)
Value of production	- current	-22.1	(± 7.2)	-37.2	(± 11.2)
	- adapted	-9.4	(± 4.2)	-11.2	(± 8.7)

Conclusions

Simulation results obtained by WOFOST model showed that among different studied strategies, using new rainfed wheat cultivars with higher tolerance to drought/higher water use efficiency and changing planting dates are the most efficient management practices and prevent yield reduction under defined future climate scenarios up to 85%. The results indicated that Investment in developing adaptation strategies could be highly effective. Use of these readily implemented adaptation strategies are profitable based on the available resources by improving both national rainfed wheat production and value of production compared to the same climatic scenarios without adaptation.

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