IMPACT OF ELEVATED CO_2 ON THE FOOD PRODUCTION OF NEPAL

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ABSTRACT

The three cereal crops rice, maize and wheat cover over 75% of the total food production of Nepal. All the three crops rice, maize and wheat showed increased yield with doubling the CO_2 level but also followed a declined tendency at the elevated temperature. Among the three crops, maize was the most affected by the rise in temperature although increased CO_2 level could increase the crop yield. The Terai plains and the hills of Nepal were more affected. The mountains, on the other hand, showed a favorable tendency.

INTRODUCTION

Agriculture is the mainstay of Nepal, which commands nearly 40 percent of the total Gross Domestic Product (GDP). Rice, maize and wheat are the major cereal crops, which command over 75 % of the total food production (ABP&SD, 2003). Several reports indicate that the global warming might adversely affect the crop productivity particularly in the tropical and sub-tropical regions of the world [*Parry and Swaminathan,* 1992; *Rao et al*., 1994; *Saseendran et al*., 2000]. IRRI scientists report that rice yields declined by 10% for each 1°C rise in growing-season minimum temperature in the dry season [*Shaobing et al.,* 2004], a matter of concern that could jeopardize the food security of a nation.

The models CERES-Rice, CERES-Wheat and CERES-Maize were used to study the effects on rice, wheat and maize crops respectively under the scenarios of double the CO_2 (580ppm), with incremental changes of temperature (+1 ^{0}C, +2 ^{0}C, +4 ^{0}C) and +20% rainfall from the Ambient (DSSAT, 1998). The study delineates three ecological belts: Terai plain (60 to 600 m), hill (600 to 2000 m), and mountain (2000 to 4000 m) above sea level. Site-specific estimates of yield changes were aggregated to each ecological belt. Crop yields, both potential and actual (given condition), were measured in percent change from the Ambient.

RESULTS AND DISCUSSION

The rice actual yield increased by 9.5 % under the double the CO_2 but dropped to 3.4 % under 4 ^{0}C and in the Terai plains; continued to increase to 17.9 % in the hills and to 36.1 % at +4 ^{0}C rise in the mountains (Fig. $1a_1$). CO_2 increase had thus more positive impact on the rice yield in the mountains. The rice potential yield, rose by an average of 19.4 % in the Terai plains, 17.8% in the hills and 18.9% in the mountains under double the CO_2 but dropped to 4.9 % in the Terai plains, -4.5 % in the hills at 4 ^{o}C but further increased by 30.1% till 2 ^{0}C rise in the mountains (Fig. $1a_2$). The rice yield would thus be more adversely affected in the Terai plains and the hills but remained more favorable in the mountains. Additional rain tended to negate the yield in the plains, not much in the hills but again was found to be favorable in the mountains.

The wheat actual yield rose to 41.5 % under the double the CO_2 level and continued to decline to -1.77 % at 4 ^{0}C rise in the Terai plains; rose to 24.4 % under the double the CO_2 but dropped to 5.3% at 4 ^{0}C in the hills whereas showed favorable impact in the mountains (Fig. $1b_1$). The wheat yield increased from 21.2 % to 33.3% even under the elevated temperature in the mountains. Further, the additional rains had also favorable impacts on the wheat yield. Similar trends were observed for the wheat potential yields. The wheat potential yield rose to 56% in the Terai plains, 26.6% in the hills and 21.8% in the mountains under the double the CO_2 concentration (Fig. $1b_2$). But again, continued to decline to -3.5 % in the Terai plains, to -1.64 % in the hills and to 1.9 % in the mountains. The winter rains were expected to gain wheat yield in all the regions.

The effect of elevated CO_2 had little effect on raising the maize yield. The maize actual yield rose only by 9.0 % in the Terai plains, 4.9 % in the hills and 15.5 % in the mountains (Fig. $1c_1$). However, the maize yield continued to decline and reached -26.4 % in the Terai plains, -9.3 % in the hills but rose to 26.8 % in the mountains. The effect of additional rain did not vary much in the Terai plains and hills but was more favourable in the mountains. The maize potential yield rose again by 6.9 % in the Terai plains, 7.5 % in the hills and 6.7 % in the mountains (Fig.

$1c_2$). The potential yield continued to fall and reached -29.8 % in the Terai plains, -15.8 % in the hills but showed improved trend in the mountains at 4 ^{0}C rise. There were some improvements in the mountains.

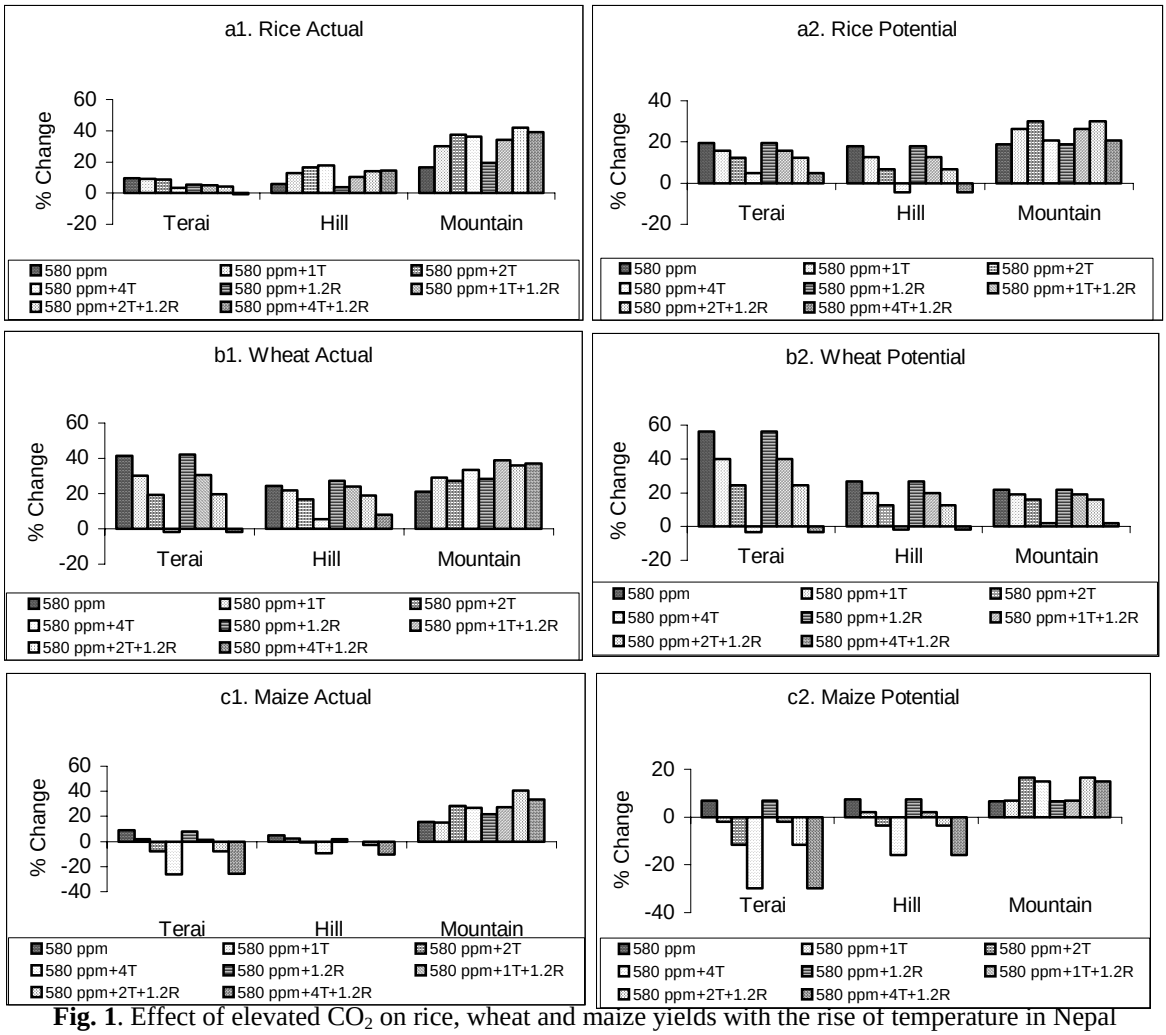

Fig. 1. Effect of elevated CO_2 on rice, wheat and maize yields with the rise of temperature in Nepal

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