Feloria Mohammadi

School of Environmental Sciences, University of Guelph

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Predicting climate changes on grain yield under SRES emissions and socio-economic scenarios

Parry and et al (2004) predicted future climate change effects on grain yields, including wheat, taking into account coming socio-economic changes in the world. For this purpose, they have used the future climate scenario derived from Change Special Report on Emissions Scenarios (SRES) namely A1FI, A2, B1, and B2 which has conducted using the UK Hadley Centre third-generation coupled atmosphere-ocean global climate model (HadCM3) (Johns et al., 2003). As well as to introduce the conditions of future economic-social development, they have benefited from the Intergovernmental Panel on Climate Change Special Report on SRES (Arnell et al., this issue).

Given that crop yields response to future climate changes is different in various parts of the world due to different agro-climatic and socio-economic conditions (such as soil type, temperature, population, and level of income), this study has predicted grain yield changes based on different future climate change scenarios and specific regional conditions, considering the complex relationships between them.

Another important factor considered in this study was the effect of increasing CO2 concentration on crop yield. CO2 plays an important role in photosynthesis by reducing transpiration and increasing water efficiency in plants (Kimball et al.,2002). However, since predicting the direct and certain effect of increasing CO2 on plant growth is complex and difficult, to evaluate the crop yields in this study, two cases were considered: with the effect of increased CO2 and without it.

Table 1 presents information and predictions about the change in percentage of the cereal yields in Canada for 2020, 2050 and 2080 compared with 1990 (the base year) under the HadCM3 SRES A1FI Scenario with and without CO2 effects.

According to Table 1, assuming high CO2 concentration, it is predicted that cereal yields will increase to 10% in 2050, and then they will decrease and reach 0% in 2080. Without CO2 effects, expected cereal yield will witness a steady decline over the given period (by -2.5, -10 in 2050 and 2080, respectively).

Table 2 shows information and predictions about the change in percentage of the cereal yields in Canada for 2020, 2050 and 2080 compared with 1990 under the HadCM3 SRES A2 (A2a) Scenario with and without CO2 effects.

Base on the data in the table in scenario A2 (A2a) with the positive effects of CO2, It is estimated that cereal yields will see a fluctuation trend which rises to a high of 20% in 2050, over the given period. Without CO2, cereal yields will see no change from 2020 to 2050, and then they will fall to 5% in 2080.

Table 3 demonstrates information and predictions about the change in percentage of the cereal yields in Canada for 2020, 2050 and 2080 compared with 1990 under the HadCM3 SRES A2 (A2b) Scenario with and without CO2 effects.

Regarding table 3, with CO2 effects, it is forecast that cereal yield will remain steady compared with 2020 at +10, and then fall down to +2.5 in 2080. Without CO2 effects, it is expected that cereal yield will witness a sharp downward trend, which reaches -10 by 2080.

Table 4 illustrates information and predictions about the change in percentage of the cereal yields in Canada for 2020, 2050 and 2080 compared with 1990 under the HadCM3 SRES A2 (A2c) Scenario with and without CO2 effects.

Considering data of table 4, with CO2 effects, it is expected that there will be a slight upward trend in cereal yield by 2050 which continues to remain the same at +10 by 2080. Without CO2 effects, cereal yields will not change in 2050 compared with 2020 but will continue to reach a low of -10 in 2080 with a significant downward trend.

Table 5 presents information and predictions about the change in percentage of the cereal yields in Canada for 2020, 2050 and 2080 compared with 1990 (the base year) under the HadCM3 SRES B1(B1a) Scenario with and without CO2 effects.

Base on the information in table 5, with CO2 effects, it is predicted that cereal yields in 2050 will remain the same at +10 that they began in 2020, after which they will

drop significantly by +5 in 2080. Without CO2, cereal yield will see a gradual fall over the given years.

Table 6 illustrates information and predictions about the change in percentage of the cereal yields in Canada for 2020, 2050 and 2080 compared with 1990 (the base year) under the HadCM3 SRES B2(B2a) Scenario with and without CO2 effects.

About the data of the table, without CO2 effect, there will be a negligible upward trend in cereal yield, which reaches +5 in 2050 compared with 2020. Without the CO2 effect, cereal yield will remain the same in 2050 compare with that of in 2020.

Table 7 shows information and predictions about the change in percentage of the cereal yields in Canada for 2020, 2050 and 2080 compared with 1990 under the HadCM3 SRES B2 (B2b) Scenario with and without CO2 effects.

Considering table 7, with CO2 effects, it is expected that cereal yield will see a significant decline in 2050 (by +5) compared with 2020 (+10), and then they will remain steadily by 2080. Without CO2 effects, there will be a considerable downward trend in cereal yield over the given period.

Table 1- potential changes (%) in Canada cereal yields for the 2020, 2050 and 2080 (compared with 1990) under the HadCM3 SRES A1FI Scenario with and without CO2 effects

CO_2 Effects	2020	2050	2080
Yes	+10	+10	0
No	+10	-2.5	-10

A1FI: Very rapid economic growth, low population growth, rapid introduction of new and more efficient technologies, Excessive use of fossil fuels with the expected high increase in temperature.

Table 2- potential changes (%) in Canada cereal yields for the 2020, 2050 and 2080 (compared with 1990) under the HadCM3 SRES A2 (A2a) Scenario with and without CO2 effects

CO_2 Effects	2020	2050	2080
Yes	+10	+20	+10
No	+2.5	+2.5	-5

A2(a-c): A world of independently operating, self-reliant nations. Continuously increasing population. Regionally oriented economic development. High emissions

Table 3- potential changes (%) in Canada cereal yields for the 2020, 2050 and 2080 (compared with 1990) under the HadCM3 SRES A2 (A2b) Scenario with and without CO2 effects

CO2 Effects	2020	2050	2080
Yes	+10	+10	+2.5
No	+5	0	-10

Table 4- potential changes (%) in Canada cereal yields for the 2020, 2050 and 2080 (compared with 1990) under the HadCM3 SRES A2 (A2c) Scenario with and without CO2 effects

Table 5- potential changes (%) in Canada cereal yields for the 2020, 2050 and 2080 (compared with 1990) under the HadCM3 SRES B1(B1a) Scenario with and without CO2 effects

CO2 Effects	2020	2050	2080
Yes	+10	+10	+5
No	+5	+2.5	0

Table 6- potential changes (%) in Canada cereal yields for the 2020, 2050 and 2080 (compared with 1990) under the HadCM3 SRES B2(B2a) Scenario with and without CO2 effects

CO2 Effects	2020	2050	2080

CO2 Effects	2020	2050	2080
Yes	+10	+5	+5
No	+5	0	-5
Yes	+5	+10	+10
No	+2.5	+2.5	-2.5

Table 7- potential changes (%) in Canada cereal yields for the 2020, 2050 and 2080 (compared with 1990) under the HadCM3 SRES B2(B2b) Scenario with and without CO2 effects

Considering results, cereal yields in future are so dependent to exist or no exist CO2 effects. On the other hand, with the Co2 effect, it is expected that cereal yields will remain constant in most of the cases, or increase in some cases by 2050. Without the CO2 effect, it is forecast that cereal yields will decrease in most of the cases or remain constant in some cases. which will continue to remain the lowest at -10 in 2080