Global warming reduces wheat production markedly if no adaptation takes place

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Future global wheat harvest is likely to be reduced by six per cent per each degree Celsius of local temperature increase if no adaptation takes place. Worldwide this would correspond to 42 million tons of yield reduction, which equals a quarter of current global wheat trade.

Wheat plays an important role in feeding the world, but climate change threatens its future harvest. Without adaptation, global aggregate wheat production is projected to decline on average by six per cent for each additional degree Celsius temperature increase. Worldwide this would correspond to 42 million tons yield reduction for one 1°C global warming.

This result has been generated by an international research consortium to which Natural Resources Institute Finland (previously known as MTT Agrifood Research Finland) substantially contributed. The results were published online in the high impact journal *Nature Climate Change*.

Losses expected throughout the world

The researchers found out that in response to global temperature increases, grain yield declines are predicted for most regions in the world. Considering present global production of 701 million tons of wheat in 2012, this means a possible reduction of 42 million tons per one degree Celsius of temperature increase.

"To put this in perspective, the amount is equal to a quarter of global wheat trade, which reached 147 million tons in 2013. In addition, wheat yield declines due to climate change are likely to be larger than previously thought and should be expected earlier, starting even with small increases in temperature," says Prof. Dr. Reimund Rötter from Natural Resources Institute Finland.

"Therefore, it is essential to understand how different climate factors interact and impact food production when reaching decisions on how to adapt to the effects of climate change."

Increased variability weakens stability in grain supply

In the study, the researchers systematically tested 30 different wheat crop models against field experiments in which growing season mean temperatures ranged from 15 °C to 26 °C. The temperature impact on yield decline varied widely across field test conditions. In addition, year-to-year variability increased at some locations because of greater yield reductions in warmer years and lesser reductions in cooler years.

"Increased yield variability is critical economically as it could weaken regional and global stability in wheat grain supply and food security, amplifying market and price fluctuations, as experienced during recent years," says Professor Rötter.

In its recent Assessement Report (AR5), the Intergovernmental Panel on Climate Change (IPCC) projects that global mean temperature may rise up to 5 °Celsius by the end of this century.

"Timely and adequate adaptation, such as cultivating more heat-tolerant wheat cultivars could substantially reduce climate change induced risks," Rötter says.

Unique and multi-locational study

Agrosystems modellers, Dr. Fulu Tao, Dr. Taru Palosuo and Prof. Dr. Reimund Rötter from Natural Resources Institute Finland participated to this collaborative research under the umbrella of AgMIP, The Agricultural Model Intercomparison and Improvement Project coordinated by Columbia University, NASA and University of Florida, USA.
Apart from Finland, scientists from Germany, France, Denmark, Netherlands, Spain, UK, Columbia, Mexico, India, China, Australia, Canada and USA participated in this global study.

In a unique study set-up, the scientists first compared simulation results from a large ensemble of wheat crop growth models with experimental data, including artificial heating experiments and multi-locational field trials. They found that discrepancies between observation and simulation varied among individual models, whereby deviations increased with increasing growing season temperature.

Most reliable estimates of observed yields over the range of temperature regimes were achieved by using the multi-model ensemble median estimate. Based on these test results, scientists subsequently applied the multi-model ensemble to estimate wheat yields under increasing temperature in the main cultivation areas of the world. The outcome of this study is presented in the article "Rising temperatures reduce global wheat production", S. Asseng et al., *Nature Climate Change*, published online in December 2014.

Currently, a related, but more detailed European-wide study on adaptation options for wheat and other field crops is undertaken by the knowledge hub and project "Modelling European agriculture with climate change for food security" (MACSUR).

More information: S. Asseng et al., "Rising temperatures reduce global wheat production", *Nature Climate Change*, published online 22 December 2014. DOI: 10.1038/NCLIMATE2470

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