

# Canadian Agronomist

DIGGING INTO RESEARCH



## Assessing yield gaps in wheat

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The gap between actual wheat yield and potential wheat yield has remained relatively stable since 1960 in the top 10 wheat producing countries. Understanding yield gaps between actual and potential yield is a tool to help increase wheat production around the world.

Estimates indicate that an additional 1 billion metric tonnes per year of cereals will be needed by 2050 to feed the world's growing population. To achieve this increase in cereal production, the potential yield of crops must be increased, and/or the yield gap between potential production and actual production needs to be narrowed.

The objective of this study was to evaluate the yield gaps in the 10 major wheat growing regions of the world to determine the limitations to productivity using yield gap analysis. The study serves as the foundation for developing strategies to decrease the yield gap for the major wheat producing areas.

Wheat production data was primarily sourced from the Food and Agriculture Organization Statistics (FAOSTAT) for the 10 top wheat producing countries: China, India, United States, Russia Federation, France, Canada, Germany, Australia, Pakistan and Turkey. Area harvested, yield and total production was collected from 1961 through 2017. In the United States, data was also analyzed for the top 3 producing states of Kansas, North Dakota and Washington from 1950 through 2018. Further detailed analysis was conducted on three counties in Kansas from 1950 through 2007.

Statistical analysis was conducted to find attainable/potential yield and actual yield, with the difference indicating the yield gap, and whether that gap was growing or narrowing.

### **Yield trend increasing**

All countries have increased wheat production since 1960 but there are differences between attainable and actual wheat production. For example, China wheat yields have increased by an average of 1.3 bu/ac/year (88.3 kg/ha/year), while the attainable yield has grown by 1.48 bu/ac/year (99.8 kg/ha/year). The variability in wheat production from year to year was also relatively small. This shows that China has benefited from improvements and adoption in technology, and that their environment is relatively stable for consistent wheat production.

By comparison, in Canada, the United States and Australia, variability in actual yield is larger, resulting in attainable yields increasing more than actual yield since 1960. In Canada, actual yield production since 1960 has increased by 0.47 bu/ac/year (31.7 kg/ha/year) while the attainable yield potential has increased by 0.62 bu/ac/year (41.8 kg/ha/year).

Conversely, France and Germany have the largest increase in attainable yield and actual yield compared to all countries. Germany, for example, has increased wheat production by 1.39 bu/ac/year (93.4 kg/ha/year), and attainable yield has increased by 1.67 bu/ac/year (112 kg/ha/year). This indicates that these countries have a favourable climate where actual production can keep up with technological advances in wheat production.

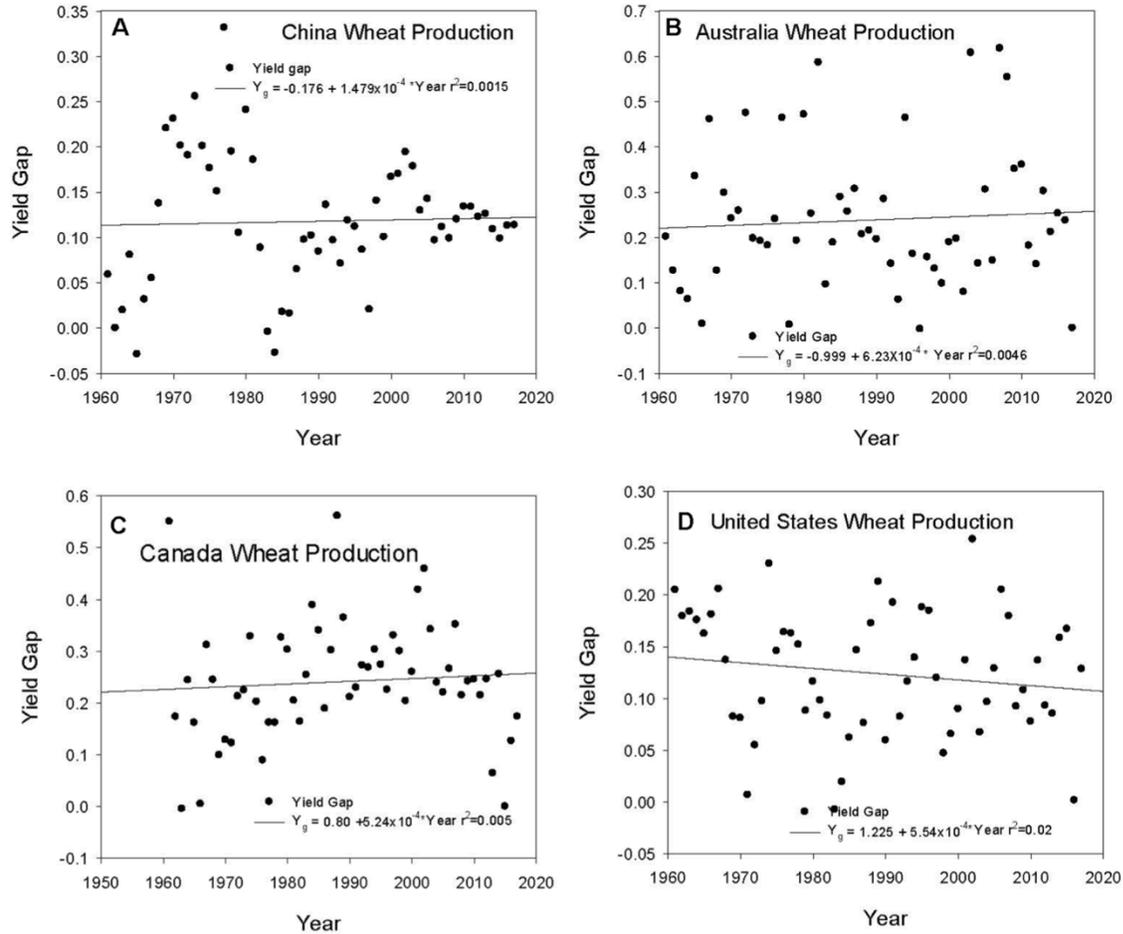
### **Yield gap trends**

While each country has increased wheat yields over the years, the yield gap has remained relatively constant over the years, but differs by country. The yield gaps ranged from 0 in Germany to 0.24 (24%) in Canada and Australia.

Australia has the widest range of yield gap values, often exceeding 0.5, due to the larger variation in growing conditions over the years, but averages at 0.24 and the value hasn't changed since 1960.

The yield gap in Canada has increased slightly since 1960, while the 0.12 yield gap in the United States has decreased slightly but the trend there is not significant.

## Yield gap trends from 1960 to 2017 for China, Australia, Canada, and United States



Source: Hatfield and Beres. 2019

On a regional level, the actual yields in Kansas, North Dakota and Washington have increased over time. However, the yield gap has not decreased during the same time period. The three Kansas counties also showed the same trend, with increasing wheat production but no change in the yield gap.

Analysis of wheat production in Saskatchewan found the same trend as in the rest of Canada; increasing wheat production, but with a slight increase in the yield gap as well.

Overall, in the 10 countries analyzed, actual wheat production continues to increase, but not at the same level as attainable wheat yields. This indicates that agronomic and genetic technology continues to outpace actual production. Since the yield gap has not decreased, the researchers feel that weather is the major limiting factor in closing the yield gap.

As a result, wheat producers will have to adopt practices locally to address the yield gap. Individual producers could consider the interactions of genetics x environment x management when making decisions, and could benefit from a better understanding of how soil and agronomic practices can increase productivity to help close the yield gap.

### **On-going research**

Since this research was conducted, further studies are delving into the wheat yield gap in Canada. It is part of an international effort, called the [Global Yield Gap Atlas](#) project, to estimate yield gaps on a regional, national, and international basis. So far the global project covers 70 countries and 90 per cent of rice, 84 per cent of maize, 56 per cent of wheat and 82 per cent of soybean crops grown in the world.

In western Canada, yield gaps have been estimated in 27 zones, which represent 50 per cent of the national wheat area. The average yield gap was estimated at 33 per cent on rainfed and 32 per cent on irrigated land.

An On-Farm Prairie CWRS Management Survey is being conducted to help look at factors that may be contributing to wheat yield gaps on the Prairies. These results may provide the basis for a better understanding of how to manage genetics x environment x management to improve wheat production for a growing world demand. The survey is expected to be completed by the end of 2022.

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Hatfield JL and Beres BL (2019) Yield Gaps in Wheat: Path to Enhancing Productivity. Front. Plant Sci. 10:1603. Open Access: <https://doi.org/10.3389/fpls.2019.01603>