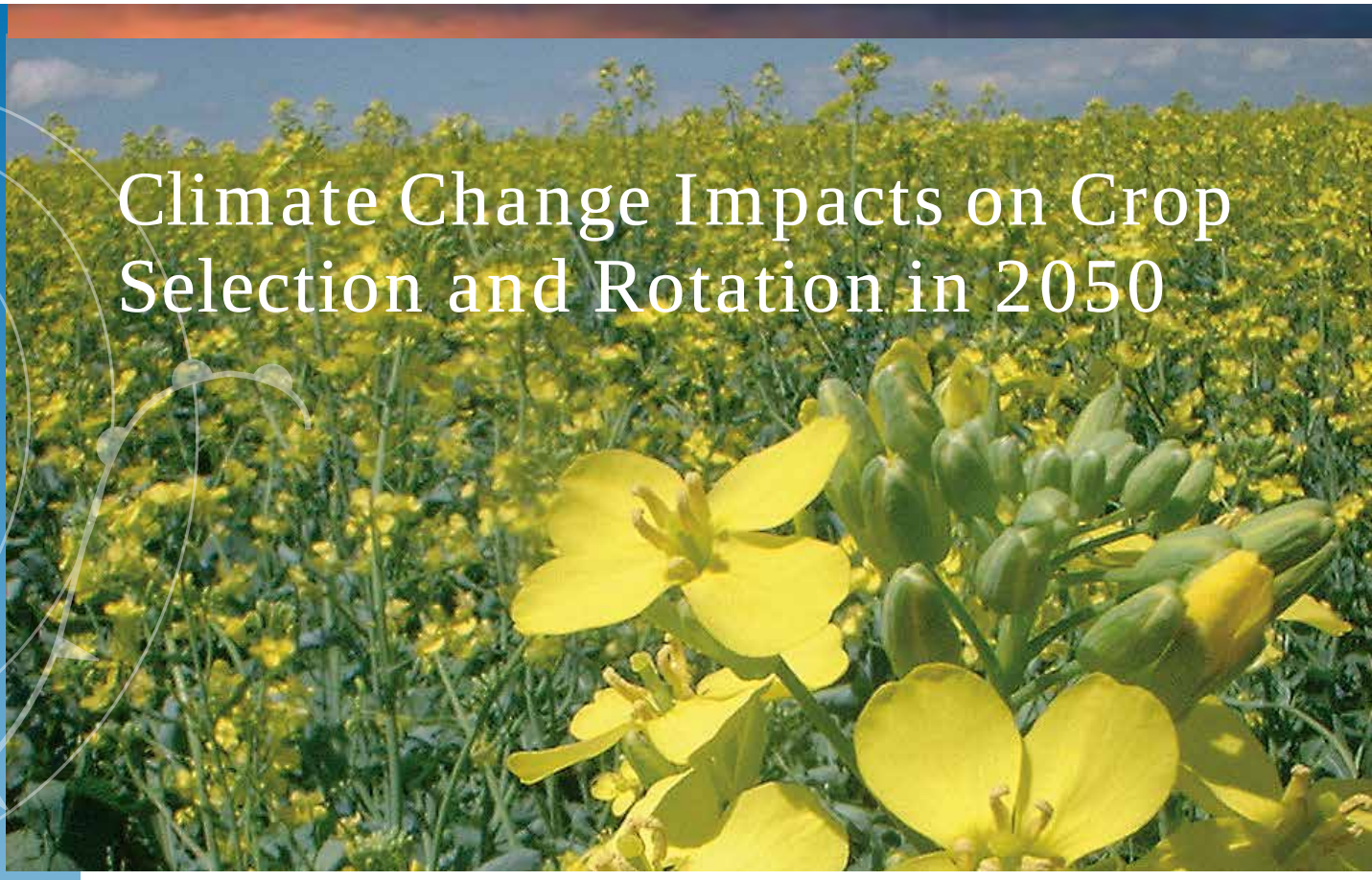
Climate Change Impacts on Crop Selection and Rotation in 2050



(credit: R. Currie)

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What's going on?

The question of what crops will be grown in the Prairies in 2050 is a deceptively difficult subject to forecast. Decisions made by farmers in determining what crops to grow are complex. They involve not only agronomic factors, but also economic ones. The economic factors are especially difficult to predict over an extended period of time. Adding climate change to this scenario just magnifies complexity of any forecast. It is important to recognize that climate change is only one factor in determining what we will grow on the Prairies in 2050. Climate change will have both positive and negative impacts on the selection of crops that farmers can consider planting, but other factors will determine what crops are actually planted. Economic profitability, technology and government policy are likely to have huge impacts on the eventual result.

To illustrate the impact of all of these factors, one only needs to go back in history to see the changes that have happened to one crop, oats. For the first half of the 20th century, oat area in Western Canada increased rapidly; it was well suited to most growing areas and cropped area peaked at 4.6 million hectares in 1943[1]. This contrasts to the area planted to oats in the 2013 growing season of only 0.45 million hectares[1]. What happened to change the oat area over the course of time? The demand for oats has decreased dramatically since the 1940's due to the mechanization of farms. Oats were the primary feed of horses, which provided most of the power for the farm. As tractors began to replace horses on farms, the demand for oats diminished. This drop

in demand resulted in other crops taking the place of oats in most farm rotations. To summarize the situation, the introduction of new technology resulted in lower demand for a specific crop and resulted in a decrease in planted area of nearly 73%. It is very difficult to predict what transformative technologies may appear between now and 2050 that could alter the acreage mix in western Canada.

Market demand is one of the main drivers in determining what crops we grow on the Prairies. Domestic demand for crops is relatively small due to the small population compared with production. Domestic demand should increase with population growth rates in Canada, which are low at 0.77%[2]. This slow population growth should keep domestic demand for grain and oilseed products at levels that will ensure that Canada will have ample stocks to export. International demand therefore will determine to a large degree what crops are grown on the Prairies in 2050. It is beyond the scope of this document to examine in great detail the various demand changes that will occur in every country that Canada is a trading partner, but one country, China, needs to be examined in more detail.

China is the world's largest importer of agricultural commodities, especially oilseeds. The rise of China's demand for oilseeds and oilseed products is typical of an economy that has moved from a developing economy to an advanced economy. The combination of dietary changes from grains to more processed foods and the ever-increasing population of China results in a large demand for vegetable oils. Increased demand for meat and meat products also increases the need for feed grains and protein meal supplements. This demand increase by China has been felt across the world in the form of rising oilseed demand and prices. In the case of soybeans, China has transformed from being a small soybean importer in the 1990s to a major importer in 2013. USDA forecasts that Chinese soybean imports in 2013 will reach 69 million tonnes (Figure 1). To keep this in perspective, total world wheat trade (imports) in 2013 is expected by USDA[3] to reach only 127 million tonnes.

Similar types of demand increases are seen for vegetable oils and oil meal products. Although the development of the Chinese economy has played a major role in increasing demand for these products, policy changes by the Chinese government have also played a role. China's policy of self-sufficiency in rice and wheat has resulted in only a minor increase in domestic oilseed production. This has forced China to turn to the international market for soybean

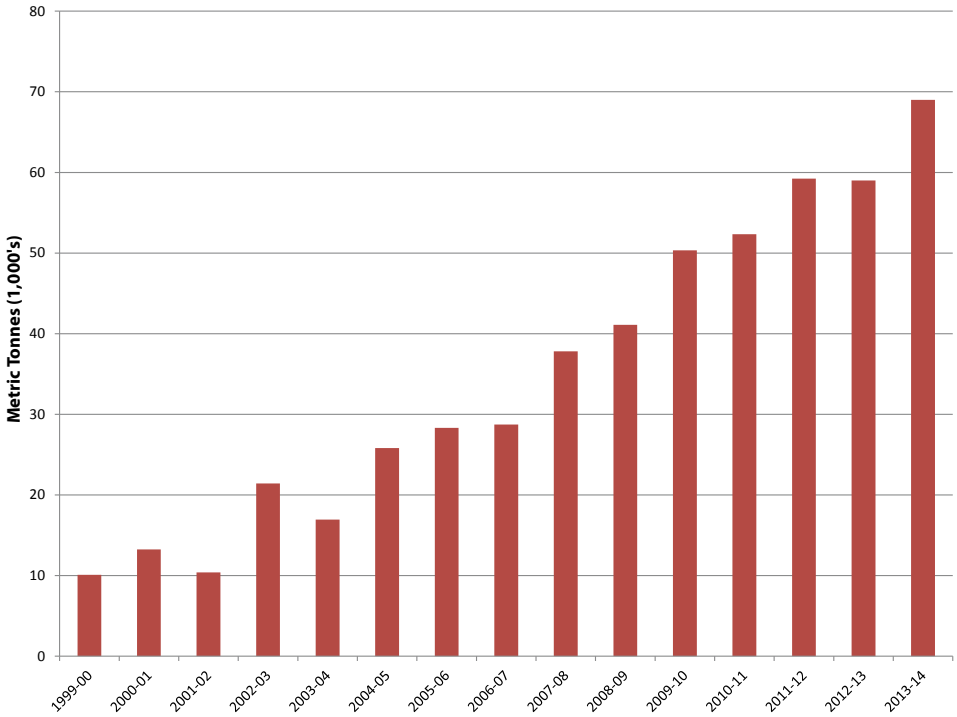

Figure 1: *Soybean imports by China*[3].

supplies. This demand from China for oilseeds has boosted the area devoted to oilseeds around the globe. This trend is likely to continue in the future, unless policy changes are made in China. This assumption is supported by the last global outlook published by the Food and Agricultural Research Institute[4] that projected strong oilseed demand into 2022.

International trade is going to be influenced by global warming as well. Two of the world's largest agricultural producing countries, China and India, are also the most populous. China and India rely on irrigation to maintain high

(credit: D. Flaten)

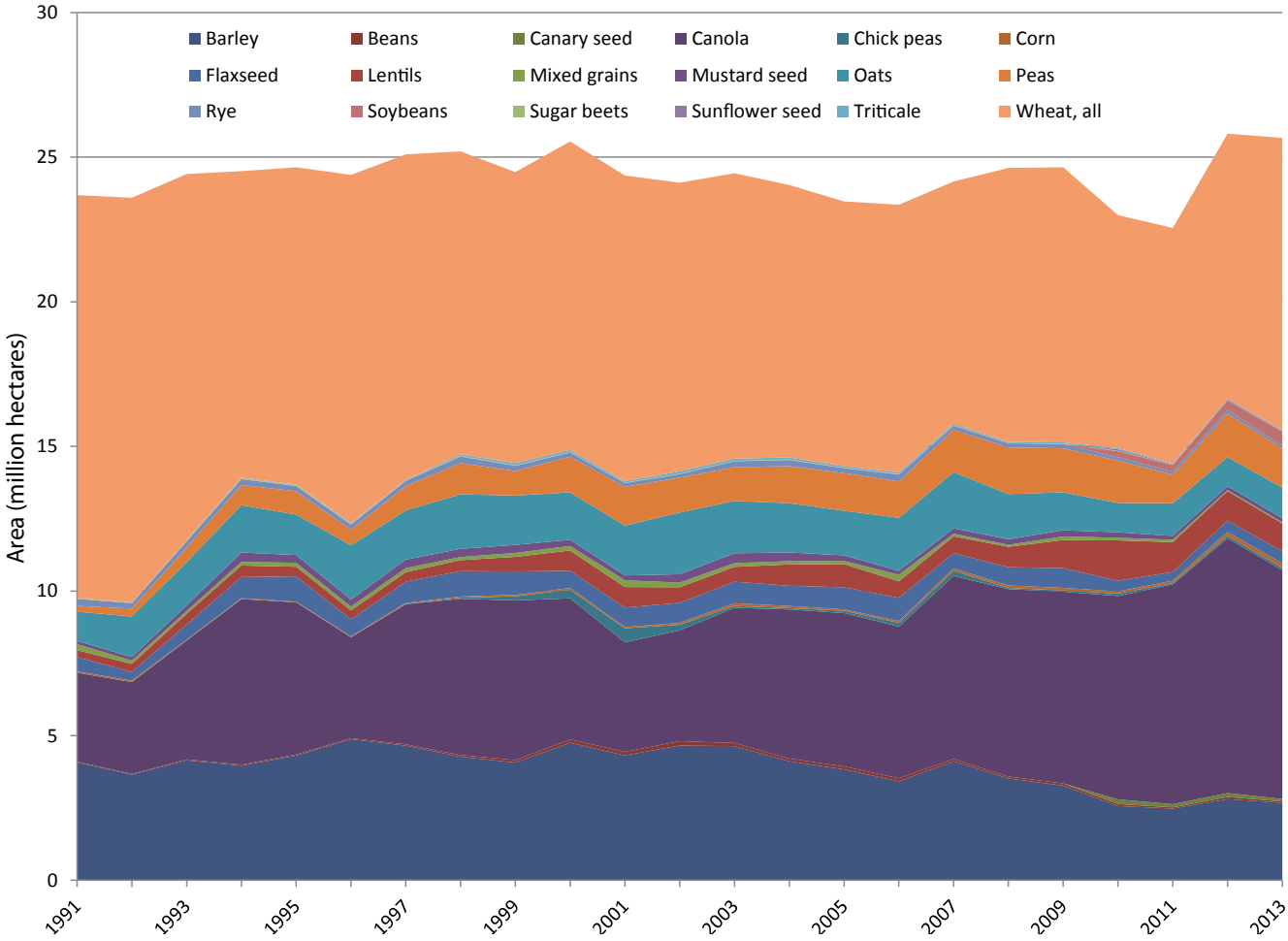

Figure 2: *Area of major crops on the Canadian Prairies (read legend from left to right).*

productivity. Any change in the ability of either country to meet the needs of the population will result in increased demand for Canadian (among other countries) imports. India is a major pulse importer and China imports canola, barley and wheat from Canada. These countries are expected to remain key customers of Canadian grain, oilseeds and pulses in 2050. Any climate change in either country that is negative for production will result in larger imports.

The number of crops available for Prairie farmers to grow is quite large. Statistics Canada follows the production of 17 crops, which represent the bulk of the area sown on the Prairies. The total sown area of these crops has ranged between 23 and 26 million hectares over the past decade (Figure 2). There are also a large number of smaller crops from buckwheat to hemp that are climatically suited to the current Prairie climate. Wheat, barley and canola have accounted for 79% of the area over the past five years. This percentage has been relatively constant over the past 20 years with increases in canola being offset by decreases in barley and wheat. Area devoted to these three crops is likely to continue to occupy the bulk of the sown area in 2050. Despite the emergence of some new crops due to a changing climate, it is not expected that the increase in these crops will be enough to dislodge the three largest crops currently grown in the Prairies.

What is coming up?

The question of what the climate will look like in 2050 has been studied by a number of groups. For the purpose of this paper, the following scenario outlined by Sauchyn et al.[5] will be used. This is generally consistent with the latest IPCC reports[6], but provides more regional detail. The major changes in climate related to crop production are:

- Growing degree days expected to increase by 25 to 50% from 1961-1990 levels
- Hot spells hotter by 1 to 2 ^{0}C; cold spells colder by 2 to >4^{0}C
- Growing season increases from 15 to 50 days
- Precipitation extremes increase (wet and dry)
- Amount of precipitation little or no change, but annual moisture deficits increase due to increased evaporation and transpiration.

These changes should have a significant impact on crops that are grown in the Prairies. The main concern is that although the growing season will lengthen, the amount of available water to grow crops is likely to remain the same or increase slightly at best. The increase in growing season is of interest as it increases the potential for crops grown only in the southern Prairies to move northward. The two crops showing the most potential are corn and soybeans. The one misconception is that the climate change in 2050 will result in the Prairies experiencing a climate that is similar to the U.S. Midwest. Unfortunately, the scenario outlined calls for a climate that would be much more like South Dakota than that of Illinois. It is for this reason that total corn and soybean acreage is unlikely to challenge those of the current three largest crops.

One of the biggest concerns will be the variability of the climate in 2050. Extreme events (floods or droughts) are very difficult for agricultural systems to adapt to. In the past decade, a series of very heavy rainfall events in Saskatchewan and Manitoba during the spring have resulted in large drops in seeded area[1]. These types of events present a threat to all crops grown on the Prairies. Drought during the 2000 to 2003 period caused severe losses of yield and seeded area. These events have a limited impact on the long-term sown acreage choices.

Crop productivity is likely to increase by 2050 due to expected improvements in genetics and management. Yields of all crops have increased dramatically over the past decades. There will be some yield drag caused by the climate conditions experienced in 2050, but these limitations are expected to be overcome by improved genetics and the arrival of new crops more suited to the environment. An example of this expected productivity improvement is the Canola Council's 2025 target for production at 26 million tonnes[7]. This estimate is based on a yield of 52 bushels per acre, which would exceed the current record by 30%. Similar productivity increases are expected in the cereal crops over the same period of time. This productivity improvement makes the expected increases or decreases in acreage less important than the projected productivity increases. This is not to dismiss the impact of climate change on the crops: the ability to maintain the rate of yield increases will be hampered by the changing climate conditions.

What can we expect?

Crop selection and rotation is the core of our Prairie production system. Here, we provide some thoughts on a potential outlook for selected crops over the next few decades.

Wheat – Wheat area likely to remain the largest of any single crop. Winter wheat area likely to increase as winters become milder and crop stress increases in summer months. Market outlook is not compelling large increases in area, but world demand should be steady for the crop.

Canola – Canola area likely to increase slightly. Soybeans will cannibalize southern growing areas from canola, but central and northern growing areas will still be predominately canola growing regions. Strong oilseed demand will keep canola as one of the most profitable cropping alternatives.

Barley – Area likely to be under pressure as the humid, cooler growing areas are shrinking in the 2050 climate scenario. Barley is in direct competition with canola and wheat, the area likely to shrink. International demand is expected to be constant, but domestic use will be under pressure from increasing corn supplies.

Pulse crops – Pulse area likely to increase in the drier, more arid growing environments that are expected in 2050. Strong international demand structure is a positive for pulse crops.

Soybeans – The transition to larger soybean area in the Prairies is already underway with former marginal areas in southern Manitoba and Saskatchewan now growing the crop in a regular rotation. Strong international demand is expected to continue to support area growth.

"Wheat, barley and canola will still dominate the landscape"

Corn – The movement of corn is also underway to parts of southern Manitoba and southern Alberta, but the transition expected to take a longer time period than soybeans. This is primarily due to the fact that the international demand structure for corn is not as strong as that for soybeans. Corn will also be limited by the dryness in parts of the southern Prairies. Corn has large moisture requirements to produce economically attractive yields.

Sorghum and millet – Sorghum and millet are two possible crops to move into the drier areas of the Prairies in 2050. These crops represent a possible feed grain for the driest areas, but sensitivity to frost will limit area even with increased growing season. International demand for sorghum and millet is mixed, but domestic use as a feed grain is a possibility.

In conclusion, the cropping patterns on the Prairies in 2050 will be a mixture of new crops and existing old crops. Wheat, barley and canola will still dominate the landscape in the northern growing areas. In southern areas, the regular rotations will be supplemented with a significant amount of soybean and corn crops. Strong oilseed demand should be the primary factor in keeping oilseed area relatively high in relation to the cereal crop area. Pulse crops will also see strong international demand, which should in a drier, warmer climate result in a larger adaptive area.