Implications of a Total Emissions Reduction Target on Fertilizer

Analysis of Potential Direct Financial Impacts on Canadian Farmers' Fertilizer Use - Macro Analysis

Prepared for **Fertilizer Canada**

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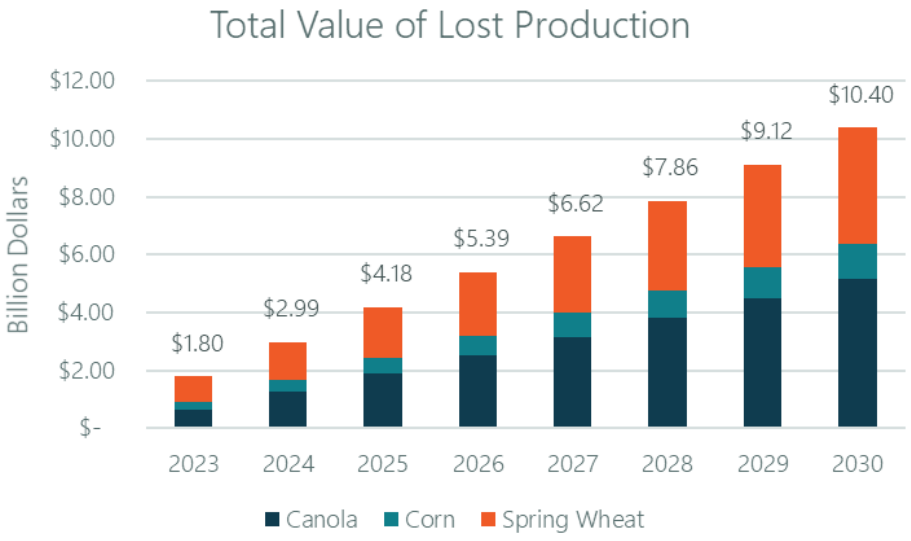
Executive Summary

Under Canada's Strengthened Climate Plan, the government of Canada is envisioning a 30% reduction in absolute emissions by the year 2030. That would include chemical fertilizer reductions used in crop production by Canadian farmers to achieve their part of those targets. In order to achieve that, one existing measure of the magnitude of actual reduction in agricultural fertilizer use would be the model proposed under the EU Green Deal which cites an actual reduction of 20% in fertilizer use compared to 2020 levels. MNP LLP was engaged by Fertilizer Canada to analyze the direct macro financial impact of lost production and has modeled a 20% rate reduction starting in 2023 and the effect on farmer output until 2030.

To meet these reductions, there may be adjustments forced on farmers' practices that will have varying degrees of net impact on farmers. This report is however based on the assumptions of continued farming practices (including crop rotation) as they are today to reflect the possibility of farmers accepting the lower production that lost nutrients would have on the production levels of their crops. The assumptions of this report summarize that effect by simply reducing the crop output and thereby presuming there is a direct correlation between available nutrients and loss in fertilizer use and impact on crop production. The analysis is focused on the effects for corn, canola, and spring wheat in Canada (three major crops that make up a major share of Canadian small grain/oilseed production), and is based on a similar number of acres for the three crops using the 5-year average, a straight-line reduction of fertilizer use starting in the year 2023 along with a straight-line reduction in yield based on industry yield response estimates for each crop, no inflation effects, and no effects of reduced crop supplies on crop prices until 2030.

A straight-line reduction in fertilizer usage results in increased differences of actual yields versus potential yields if the status quo had been continued. By 2030, yield gaps for the three crops are estimated at 23.6 bushels per acre per year for canola, 67.9 bushels per acre per year for corn, and 36.1 per acre per year bushels per acre for spring wheat. Given constant prices, the total value of lost production grows to 10.4 billion per year by 2030 and across the years 2023 to 2030 is shown for each crop as follows:



The estimated lost production has significant effects on Canada's ability to fill domestic processing capacity (e.g., canola crushing facilities) as well as export capacity. Assuming that domestic capacity will be filled first, it is estimated that by 2030 most Canadian exports of canola will not exist (only 750,000 metric tonnes of canola will be theoretically available for export compared to more than 10 million metric tonnes today). The reduction in annual spring wheat exports is estimated to be 4.2 million metric tonnes by 2030. The analysis for the three crops, as well as any potential impacts for other crops, will significantly impact Canada's ability to reach its targets for domestic sales and exports of agri-food products and thereby have a major detriment to the Canadian agri-food economy. Finally, reducing Canada's contribution to the global food supply by more than 14 million metric tonnes collectively of wheat and canola per year by 2030 would have a major impact on the global supply of food in the future. There are lots of ways farmers can react to potential economic impacts of reduced fertilizer use, including acceptance of lower productivity. This would be devastating, such that any plan to reduce carbon emissions would need to be done in a way that the future productivity of major crops is maintained.

Introduction

Under Canada's Strengthened Climate Plan, the government of Canada is envisioning a 30% reduction in absolute emissions by the year 2030. That would include chemical fertilizer reductions used in crop production by Canadian farmers to achieve their part of those targets. To achieve that, one existing measure of the magnitude of actual reduction in agricultural fertilizer use would be the model proposed under the EU Green Deal which cites an actual reduction of 20% in fertilizer use compared to 2020 levels to achieve a 30% reduction in emission levels. MNP LLP was engaged by Fertilizer Canada to analyze the direct macro financial impact of lost production and has modeled a 20% rate reduction starting in 2023 and the effect on farmer output until 2030.

We have conducted this analysis based on two scenarios, i.e. business as usual given current trends in agricultural and mineral fertilizer use until 2030, and a worst-case scenario of 20% rate reduction starting in 2023. We will then provide estimated impacts of these scenarios in terms of expected levels of lost annual production output until 2030.

As such, the primary objective of this analysis was to highlight that a rate-based approach to achieving emission reductions from mineral fertilizer would be detrimental to the Canadian agricultural industry and global food supply.

Underlying Assumptions

The following assumptions were made for the analysis:

- It focused on the crops of corn, canola, and spring wheat, which make up 45% of Canadian seeded acres in 2020, and for which actual fertilizer usage data was available from Fertilizer Canada.
- The yield of these crops is assumed to be able to increase, given adequate nutrition and growing conditions, at the same as they have increased over the last 20 years (i.e., 2001-2020).
- Farmers' historical agricultural farming practices and choices for use of croplands for various crops will remain the same in going forward, including crop rotation.
- Future crop acres are therefore similar to the past 5-year average crop acres for the three crops
- The analysis assumes a straight-line reduction in fertilizer use between 2023 and 2030, as at this point in time MNP is not expecting any implementations to be made for the 2022 crop year.
- Along with a reduction in fertilizer usage for each crop, a straight-line reduction in yield is assumed for each crop based on industry yield response estimates for each crop.
- Even where less crop is projected to be available in the market, constant prices are assumed and do not include the effects of inflation.

Scenario 1: Business as Usual

Crops continue to go through genetic development that is allowing for average annual increases in yields year-over-year. There is an expectation that the potential for those yield increases has not yet plateaued and it is

reasonable to believe that yields under current cropping practices could continue to increase into 2030 and beyond. For this scenario, it is assumed that all of these current practices and trends continue.

As stated under the underlying assumptions, the trend in yield increases was modeled for the three selected crops (i.e., canola, corn, and spring wheat) based on the current fertilizer practices and the five-year average of seeded acres for these crops.[1] Yields were then projected forward using past 20-year average year-over-year increases, resulting in estimated yields by 2030 as shown in Table 1.

Table 1: Estimated crop yields by 2030 in bushels per acre

Crop	Average Seeded Acres 2016-2020	Average Year-Over-Year Yield Increase 2001-2020	Yield in 2030
Canola	21,848,486	3.8%	58.1
Corn	3,608,938	2.2%	190.7
Spring Wheat	17,137,939	4.0%	79.0

Using typical prices for these three crops (i.e. $10.00 per bushel for canola, $5.00 per bushel for corn, and $6.50 per bushel for spring wheat), it is estimated that these crops can produce $18.8 billion in 2022. This figure is projected to grow in years thereafter to create an additional year-over-year revenue for Canadian farmers and the Canadian economy of $21.7 billion on average.

Scenario 2: 20% Reduction in Mineral Fertilizer Use

In the Government of Canada's latest and strengthened climate plan, *A Healthy Environment and a Healthy Economy* that was released in December of 2020, one aspect proposed to reduce greenhouse gas emissions from fertilizer use by 30% below 2020 levels. Even though some of this reduction might stem from things like an increased use in Enhanced Efficiency Fertilizers (EEF), the majority of the reduction will have to come from Canadian farmers reducing their fertilizer usage, especially with respect to nitrogen. Following the European approach, it is assumed that a 20% rate reduction will result in a 30% absolute emission reduction. The information below provides an evaluation of that potential impact for the three selected crops on Canadian farmers' income and Canadian exports given the assumptions as stated above.

In order to model this, surveys from Fertilizer Canada on actual fertilizer use for canola and corn were used as the basis of the calculations (see Table 2). First, the actual 2020 rates as shown in Table 2 were decreased by 20% for canola and corn to arrive at estimated usage rates for 2030, which translates into an annual reduction of 2.75% starting in 2023. Second, annual national application rates in pounds per bushel were calculated for the years survey data was available based on historical yields for these years, which were then averaged for these five years. Specific results for canola and corn are further discussed below the table.

[1] Statistics Canada, Table 32-10-0359-01, Estimated areas, yield, production, average farm price and total farm value of principal field crops, in metric and imperial units.

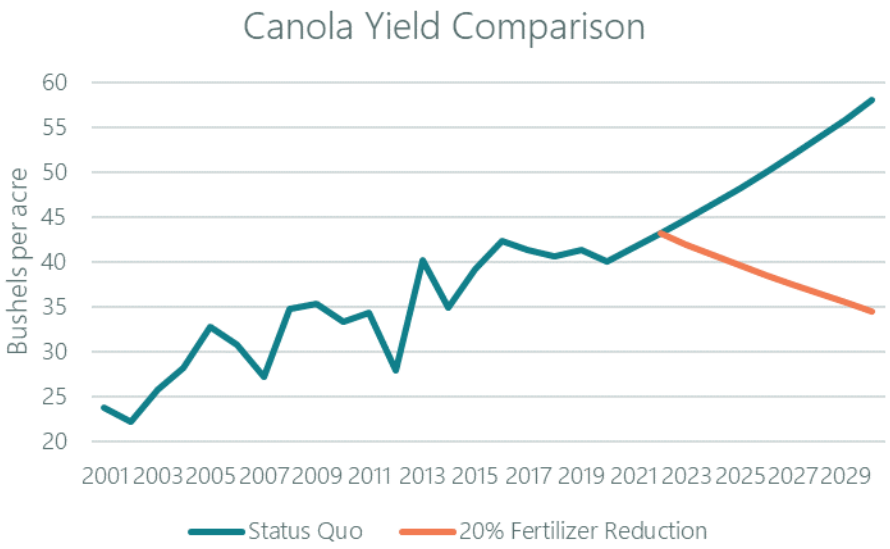
Table 2: Actual fertilizer application rates in pounds, 2016-2020

Year	Nitrogen	Phosphorus	Potash	Sulphur
Canola				
2015	100	21	7	18
2016	110	37	8	21
2017	113	37	9	23
2019	130	37	10	23
2020	121	34	10	23
Corn				
2015	148	44	70	8
2016	148	53	71	7
2017	157	57	79	10
2019	171	64	79	12
2020	172	59	79	14

Canola

The projected fertilizer application rates and the average five-year application rate per bushel for canola as described above were applied to the yield trend to be able to project yields under a fertilizer reduction scenario until 2030. As such, the average national canola yield in 2030 is projected to be 34.5 bushels per acre. Figure 1 shows the yield trends for canola under both Scenario 1 (business as usual) and Scenario 2 (20% reduction in fertilizer use), which also shows a yield gap of 23.6 bushels per acre by 2030. Any implications on Canadian farmers' income and the Canadian of economy of reducing fertilizer usage for canola will be discussed in later sections.

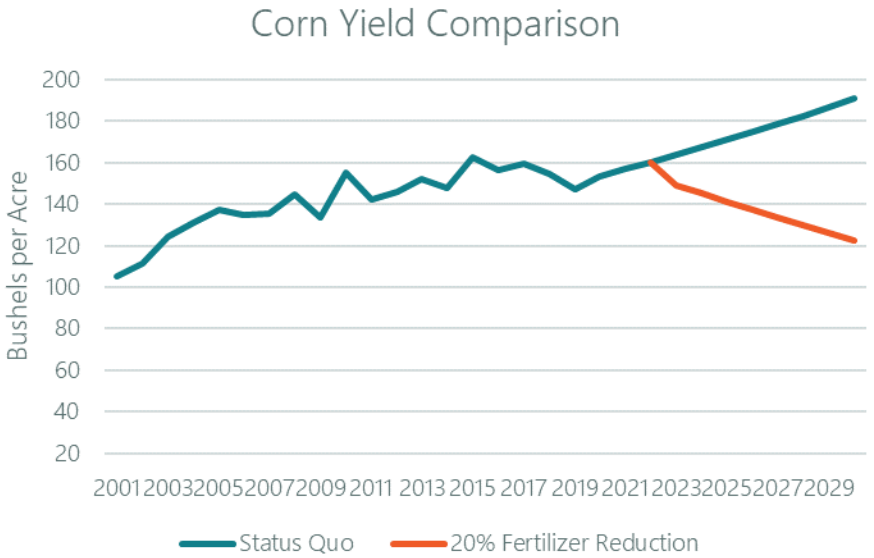
Figure 1: Differences in canola yield under both scenarios



Corn

Like for canola, the projected fertilizer application rates and the average five-year application rate per bushel for corn as described above were applied to the yield trend to be able to project yields under a fertilizer reduction scenario until 2030. As such, the average national corn yield in 2030 is projected to be 122.8 bushels per acre. Figure 2 shows the yield trends for corn under both scenarios, which also shows a yield gap of 67.9 bushels per acre by 2030. Any implications on Canadian farmers' income and the Canadian of economy of reducing fertilizer usage for corn will be discussed in later sections.

Figure 2: Differences in corn yield under both scenarios

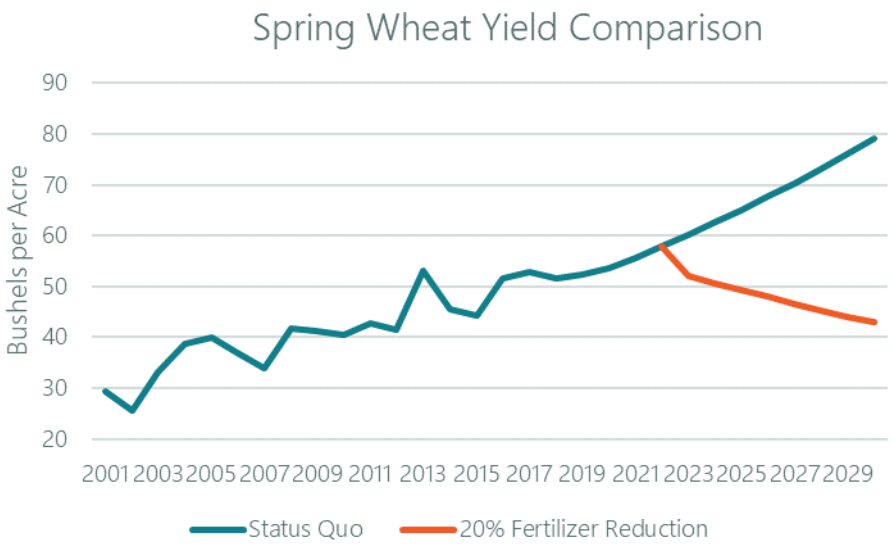


Spring Wheat

Since actual fertilizer usage was not available from the 2020 Fertilizer Canada Survey for spring wheat, theoretical rates of 107 lbs. of N, 40 lbs. of P, 5 lbs. of K and 0 lbs. of S were used as the basis of our calculations[2], and decreased these by 20% to arrive at estimated usage rates for 2030. This also translates into an annual reduction of 2.75% starting in 2023. Given the theoretical rates and the 2020 national yield for spring wheat, the application rate per bushel resulted in 2 lbs. of N per bushel, which is in line with other estimates.[3] This rate per bushel was then applied to the yield trend to be able to project yields under a fertilizer reduction scenario until 2030. As such, the average national yield for spring wheat in 2030 is projected to be 42.9 bushels per acre. Any implications on Canadian farmers' income and the Canadian of economy of reducing fertilizer usage for spring wheat will be discussed in later sections.

Figure 3 shows the yield trends for spring wheat under both scenarios, which also shows a yield gap of 36.1 bushels per acre by 2030. Any implications on Canadian farmers' income and the Canadian of economy of reducing fertilizer usage for spring wheat will be discussed in later sections.

Figure 3: Differences in spring wheat yield under both scenarios



Impacts

Given the estimates presented above, in this section further impacts of reducing fertilizer by 20% are shown in terms of annual production, farm cash receipts, other effects on the Canadian agri-food economy, and other social and policy implications.

[2] https://umanitoba.ca/faculties/afs/agronomists_conf/media/7__1_30_PM_DEC_14_MANGIN_MAC_2017_NOV23.pdf

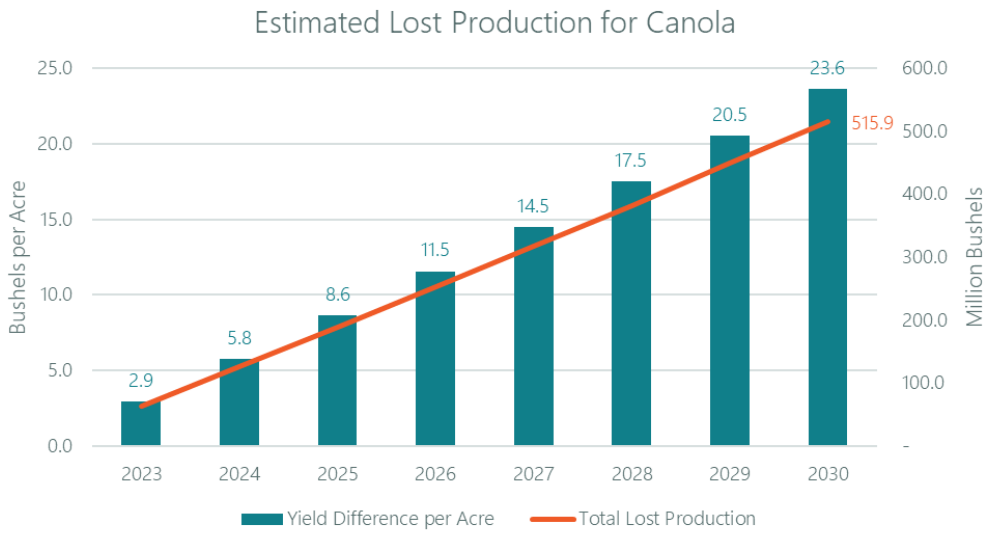
[3] https://www.gov.mb.ca/agriculture/crops/soil-fertility/soil-fertility-guide/pubs/soil_fertility_guide.pdf

Expected levels of lost annual production output and reduced farmer economics until 2030

Canola

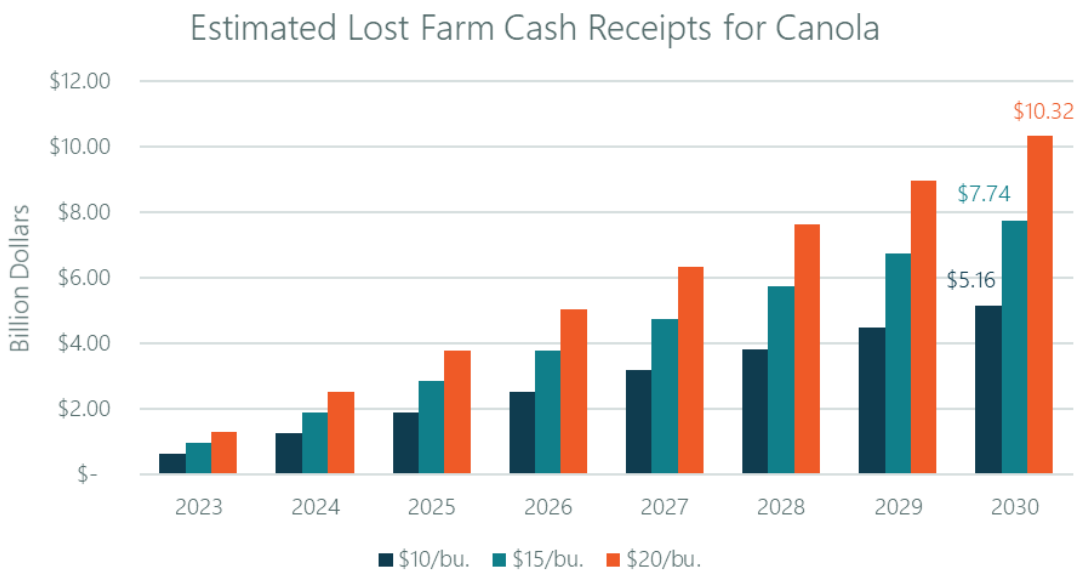
Under the assumption that national canola acreage will be somewhat equal to the 5-year average (i.e. approximately 21.8 million acres, see Table 1) in going forward, both the annual and cumulative lost production were estimated based on the loss in yield when reducing fertilizer usage by 20%. As such, it is estimated that by 2030 the difference in canola yield between the two scenarios is 23.6 bushels per acre. It is further estimated that lost production by 2030 is approximately 515.9 million bushels or 17.1 million metric tonnes, and that cumulative lost production over the period 2023-2030 amounts to approximately 2.3 billion bushels or approximately 151 million metric tonnes. Figure 4 shows annual production and yield losses in more detail.

Figure 4: Estimated effects on production and yield for canola, 2023-2030



Any lost production will have result in a loss of farm cash receipts. Using a typical average canola price of $10.00 per bushel, it is estimated that a 20% reduction in fertilizer use translates into a $5.16 billion loss of farm cash receipts by 2030 and a cumulative loss of $22.9 billion over the period 2023-2030. However, the cumulative loss increases to $34.4 billion and $45.9 billion if the canola price is closer to today's price (i.e. $15.00 per bushel) or even higher (i.e. $20.00 per bushel) as lost production will in turn have an effect on global inventories. Figure 5 shows annual losses in farm cash receipts for canola in more detail.

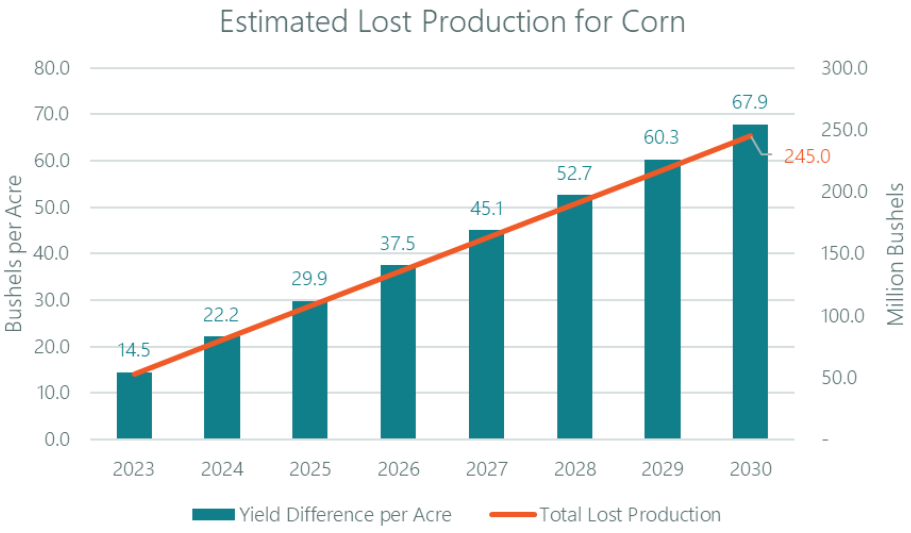
Figure 5: Estimated effects on farm cash receipts for canola, 2023-2030



Corn

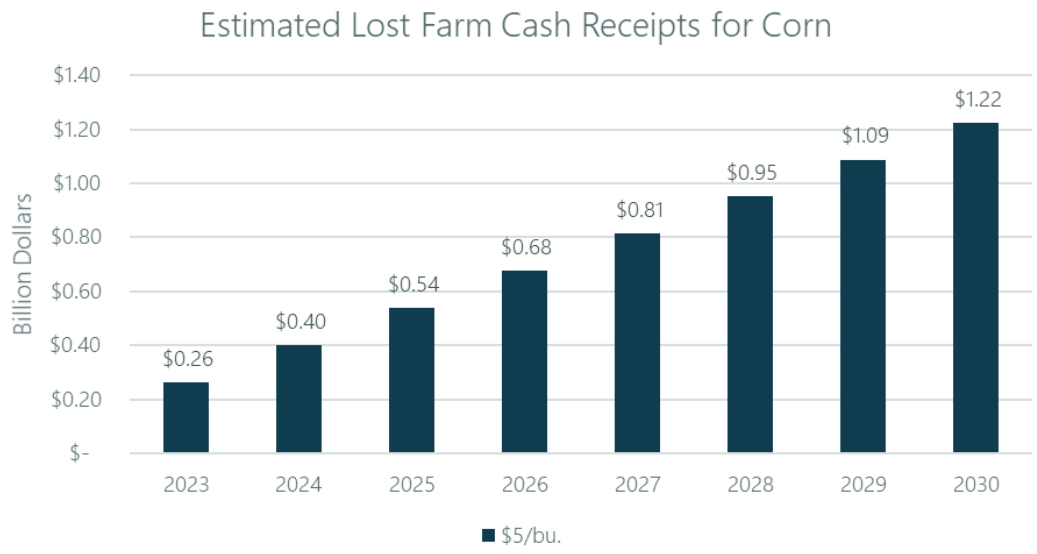
Again under the assumption that national acres for corn will be somewhat equal to the 5-year average (i.e. approximately 3.6 million acres, see Table 1) in going forward, both the annual and cumulative lost production were estimated based on the loss in yield when reducing fertilizer usage by 20%. As such, it is estimated that by 2030 the difference in corn yield between the two scenarios is 67.9 bushels per acre. It is further estimated that lost production by 2030 is approximately 245 million bushels or 6.2 million metric tonnes, and that cumulative lost production over the period 2023-2030 amounts to approximately 1.2 billion bushels or approximately 30.3 million metric tonnes. Figure 6 shows annual production and yield losses in more detail.

Figure 6: Estimated effects on production and yield for corn, 2023-2030



Since the decrease in Canadian corn production does not have a significant effect on global corn prices, the effect on farm cash receipts is only calculated using a typical average of Canadian corn prices, i.e. $5.00 per bushel. As such, it is estimated that the loss in farm cash receipts ranges from $262.4 million in 2023 to $1.2 billion in 2030, with a cumulative loss of $5.9 billion over the period 2023-2030.

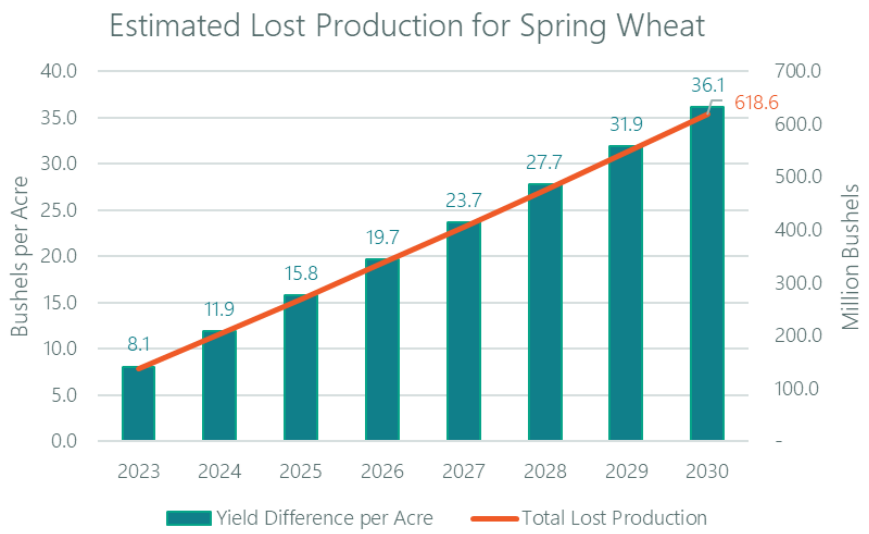
Figure 7: Estimated effects on farm cash receipts for corn, 2023-2030



Spring Wheat

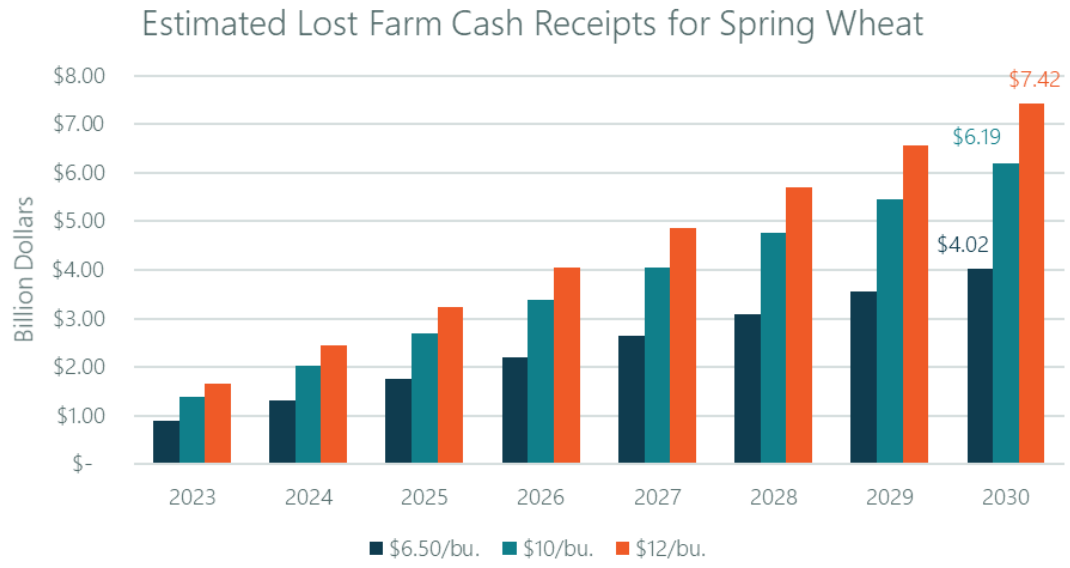
Again under the assumption that national acres for spring wheat will be somewhat equal to the 5-year average (i.e. approximately 17.1 million acres, see Table 1) in going forward, both the annual and cumulative lost production were estimated based on the loss in yield when reducing fertilizer usage by 20%. As such, it is estimated that by 2030 the difference in yield for spring wheat between the two scenarios is 36.1 bushels per acre. It is further estimated that lost production by 2030 is approximately 618.6 million bushels or 16.8 million metric tonnes, and that cumulative lost production over the period 2023-2030 amounts to approximately 3 billion bushels or approximately 81.5 million metric tonnes. Figure 8 shows annual production and yield losses in more detail.

Figure 8: Estimated effects on production and yield for spring wheat, 2023-2030



Using a typical average spring wheat price of $6.50 per bushel, it is estimated that a 20% reduction in fertilizer use translates into a $4.02 billion loss of farm cash receipts by 2030 and a cumulative loss of $19.5 billion over the period 2023-2030. However, the cumulative loss increases to $30.0 billion and $36.0 billion if the wheat prices increase to $10.00 per bushel and $12.00 per bushel due to the effect of lost production on global supply. Figure 9 shows annual losses in farm cash receipts for spring wheat in more detail.

Figure 9: Estimated effects on farm cash receipts for spring wheat, 2023-2030

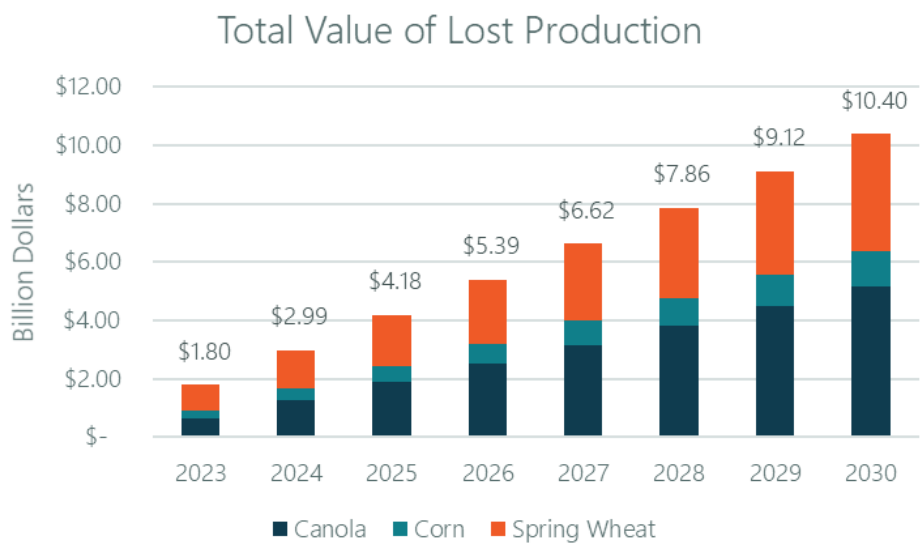


Total

Given a 20% reduction in fertilizer usage for these three selected crops, it is estimated that the loss in farm cash receipts could be $10.4 billion per year and growing by 2030 and that the total cumulative lost farm cash

receipts amount to $48.4 billion over the period 2023-2030 using the typical prices for the three selected crops. Figure 10 shows annual losses in farm cash receipts for these three crops in more detail, in which the values reflect the total annual losses of these crops.

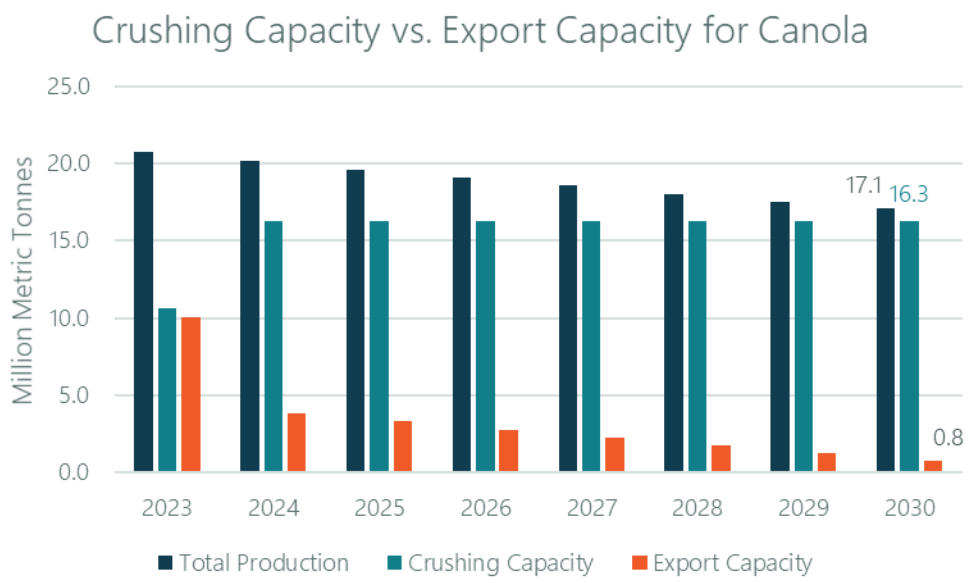
Figure 10: Estimated effects on farm cash receipts for selected crops, 2023-2030



Economic impact upstream and downstream in the Canadian agri-food economy

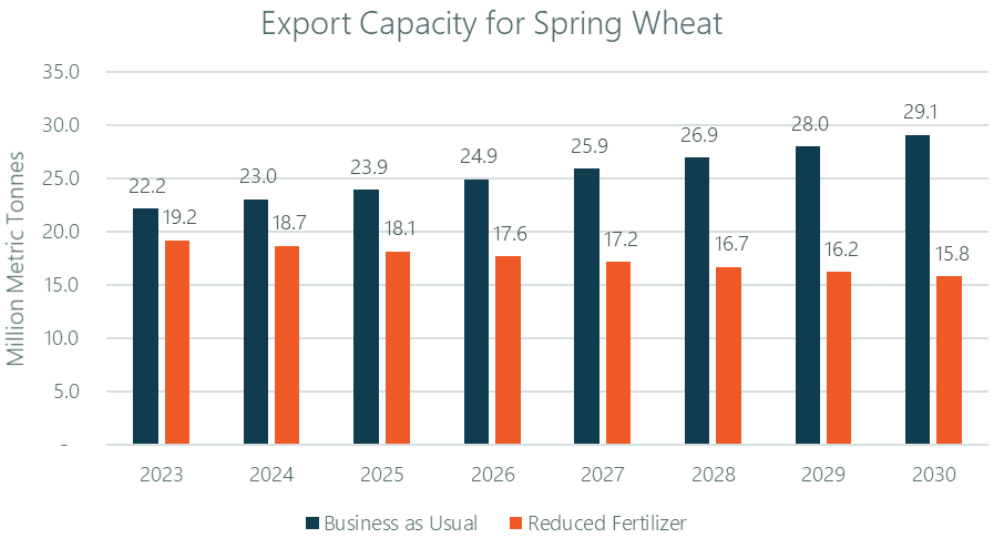
Given the large value for lost production shown in Figure 10 there will undoubtedly be a larger economic impact. Upstream examples would be equipment manufacturers, equipment dealers, tire and repair shops, along with many other places that farmers spend their money. The less money farmers make the less they are able to put back into the economy at these businesses. Downstream examples of industries that could be impacted would be grain companies, grain transportation (truck, rail, boat), food prices, etc. For canola, given the figures presented in Figure 1, there will be further implications for the Canadian agri-food economy. Approximately 50% of today's canola production is crushed domestically, while the remaining 50% is exported. In addition, new crushing plants are in the process of being built and coming online in 2024, increasing Canadian crushing capacity from 10.7 million metric tonnes to 16.3 million metric tonnes annually. However, if annual production will be reduced, the question becomes whether or not there will be enough canola produced to fill this capacity. This in turn also has significant effects on the ability to export the remaining canola. Under Scenario 2 MNP estimates that, by 2030, about 95.9% of canola production will be processed domestically, resulting in just over 750,000 metric tonnes being available for export. Figure 11 shows annual effects on crushing and export capacities for canola in more detail, in which it can be clearly seen that the amount of canola available for export is going to be limited to only a shadow of current levels. The reduction in fertilizer usage might also have implications for the ability to sustain domestic crushing capacity.

Figure 11: Estimated effects on crushing and export capacity for canola, 2023-2030



In terms of wheat, approximately 78.9% of Canada's production is exported[4], where as the remainder is used domestically. Assuming these rates will remain constant in going forward, the amount of wheat available for export will have to take into account the loss in production for 100% if fertilizer usage is being cut. Figure 12 shows the difference in the amount available for export given the two scenarios.

Figure 12: Export capacity for spring wheat under both scenarios, 2023-2030



[4] Statistics Canada, Table 32-10-0008-01, Exports for grains, by final destination.

As the majority of corn produced in Canada is used domestically for livestock feed and can be more readily replaced by US imports, a similar analysis was not conducted for corn. The sections above demonstrated a major economic loss from the reduction in corn production, that will likely have an effect on other sectors in the Canadian economy relying on the corn sector.

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