Sharing valuable insights

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FARE Share

What's Inside?

Each article in this issue of *FARE Share* touches on the subject of environmental impact in agriculture, starting with Dr. Alan Ker's insights into crop insurance and on-farm climate change mitigation.

Inside, you'll read about soybean yield trends in Southern Ontario and genomic selection for feed efficiency in the Canadian dairy industry.

On the back cover, researchers examine the issue of phosphorus loading into Lake Erie and farm fertilizer application levels.

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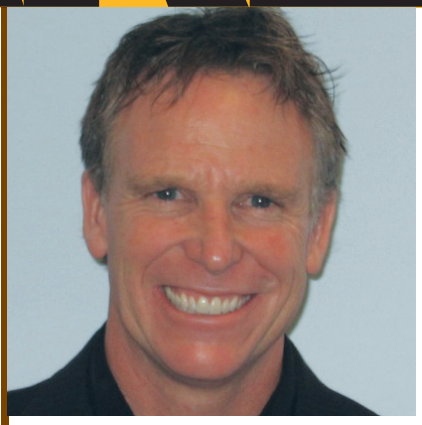
The FARE Share Newsletter features research and analysis from faculty and students in the Institute for the Advanced Study of Food and Agricultural Policy in the Department of Food, Agricultural and Resource Economics (FARE).



Will Publicly Subsidized Crop Insurance Prevent On-Farm Climate Change Mitigation?

By: Dr. Alan P. Ker, Professor and Director, Institute for the Advanced Study of Food and Agricultural Policy, University of Guelph

The sheer magnitude and growth of public monies directed toward farm-level risk management programs in developed countries is staggering. Canadian Business Risk Management (BRM) subsidies were just under $1.4 billion in 2014 (U.S. premium subsidies totalled $6.2 billion). Risk management has become the backbone of many countries' agricultural programs and the vehicle of choice to funnel monies to agricultural producers: it's both a relatively easy political sell (to both the general public and agricultural constituency) and in compliance with trade agreements.

Public multi-peril crop insurance has been heavily subsidized to encourage participation and reduce the need for ad hoc disaster aid. In many countries, Canada included, subsidies average roughly two-thirds of the actuarially fair premium rate. As a result, crop insurance has been an attractive on-farm tool to take care of the economic and financial consequences of poor yield outcomes (as evidenced by participation rates). From a farm management standpoint, subsidized crop insurance necessarily reduces the incentive for producers to spend additional monies to reduce the probability of poor yield outcomes. Empirical evidence has shown this to be true in the United States with respect to the application of pesticides and adoption of risk-reducing seed technologies (no similar study has been undertaken in Canada).

Many predict that changing climate will increase the year-to-year volatility of yields for most crops and regions. Ontario is no exception. Given that producers have the financially attractive option to purchase subsidized crop insurance, should producers invest in costly on-farm climate change mitigation technologies? In general, no.

We have analyzed how crop yield distributions are changing through times. Interestingly, we consistently found that yields are increasing, but that lower yields are increasing slower than average and high yields. That is, the lower tail of the yield distribution is increasingly lagging behind the middle and upper tails of the yield distribution. Is this phenomenon because innovations are targeted at only pushing the middle and upper tail further upwards, or, is it because the innovations that increase the lower tail (e.g. drought resistant seeds) are not being adopted?

Continued on page 4

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Soybean Yield Trends

By: Glenn Fox, Professor, FARE; Dan McKenney, Chief, Landscape Analysis and Applications, Great Lakes Forestry Centre, Natural Resources Canada; and Qin Xu, PhD, Graduate Student, FARE

In *FARE Share* Issue #14, we reported results from our crop yield modeling for grain corn in Southern Ontario. According to our estimates, grain corn yields have not yet reached a plateau in Southern Ontario. These findings confirm the earlier work by Rickard and Fox (1999). In this issue, we turn our attention to soybean yields.

Our data cover the period from 1950 to 2013. Our econometric soybean yield model includes climate, economic and technology variables, which we regress on county level average soybean yields. We were able to use spatial climate data, obtained from Natural Resources Canada, that were not available for the previous study. Our results are consistent with our previous findings for grain corn – soybean yields in Ontario exhibited an increasing trend over this time period and do not appear to have reached a plateau. This model is part of the PhD dissertation research of Qin Xu (forthcoming). The thesis will report yield modeling results for grain corn, soybeans, winter wheat and hay, the four largest crops by land area in Ontario. These yield models are part of a spatial economic crop production and water use model that can simulate the effects of alternative climate change scenarios on crop production in Ontario.

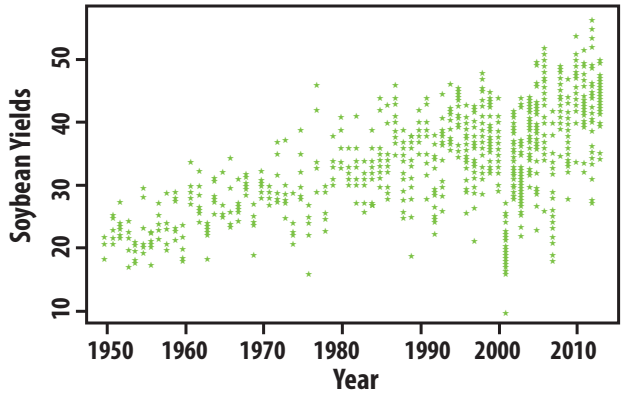
Figure 1 illustrates county average yields for soybeans from 1950 to 2013. The number of data points in each year increases as soybean production expanded into more counties in the province. Dorrf (2007) attributes this expansion to advances in crop breeding. But our data indicate that the length of the growing season also increased during this period of time, which may account for some of the increase in both area planted and yields. Soybean yields increased from approximately 20 bushels/acre in 1950 to around 40 bushels/acre in 2013. Soybean yields fell in Ontario in 2001, an effect that Bohner (2015) attributes to soybean aphids.

The main climate factors in our model are available moisture and solar energy. Both growing season precipitation and heat units have positive coefficients in our econometric model.

Economic factors are also a consideration. Our results indicate that the soybean yields are positively related to the soybean price lagged one year and are negatively related to the fertilizer price, as one might expect.

We include a time trend and a squared time trend as a representation of the effects of technological progress in soybean production. Given that we also include climate variables and, as the growing season has expanded, this could have had an effect on yields, our time trend measures technological advance separately from climate effects. This was not possible in previous research. The coefficients on both the time trend and the squared time trend were positive and significant, suggesting that there is a statistically significant upward trend in soybean yields and that this trend is not slowing down.

Figure 1: County Average Soybean Yields for 29 Counties in Ontario 1950-2013



Source: Authors' calculations based on Agricultural Statistics for Ontario, 1950-2013 Notes: 1. Soybean yield is measured in bushels per acre.

FARE Talk

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The Softwood Lumber War

In this podcast, Dr. Daowei Zhang, George Peak Jr. Professor of Forest Economics and Policy at Auburn University School of Forestry and Wildlife Sciences and FARE Professor Brady Deaton discuss the contemporary and historic trade dispute between Canada and the United States regarding softwood lumber: i.e., "The Softwood Lumber Wars." The more than 30-year trade dispute continues and Dr. Zhang gives listeners historic, economic and political insight into the matter. A good portion of the podcast discusses his book, "The Softwood Lumber War: Politics, Economics, and the Long U.S.–Canadian Trade Dispute."

To listen to the complete conversation and other podcasts, visit the FARE website: https://www.uoguelph.ca/fare/FARE-talk/index.html#softwood

Dr. Brady Deaton, Professor, FARE

Genomic Selection for Feed Efficiency

By: David Worden, Research Assistant, FARE, and Getu Hailu, Associate Professor, FARE

Recent advances in genomic technologies will soon make it possible for farmers to selectively breed dairy cattle for increased feed efficiency – a trait that is difficult and expensive to measure. Not all dairy cattle are created equal in converting consumed nutrients into final products. Feed efficient dairy cattle consume less feed while holding life-time production efficiency, health and conformation traits constant in the dairy production process. Recently, a Canadian-led international group of dairy scientists started to identify genomic-based cost-effective methods of selectively breeding dairy cattle for feed efficiency. As feed is often the largest variable expense for dairy producers and feed consumption is closely correlated with methane emissions from ruminant livestock, selectively breeding for feed efficiency is an important economic and environmental sustainability consideration. With the growing global population and the growing demand for food, improved feed efficiency also has a positive food security impact.

"As feed is often the largest variable expense for dairy producers and feed consumption is closely correlated with methane emissions from ruminant livestock, selectively breeding for feed efficiency is an important economic and environmental sustainability consideration."

Meanwhile, there are noteworthy challenges that producers need to consider in the adoption of genomic selection for feed efficiency. First, estimates of how feed efficient the selected animals will be in comparison to the average dairy cow are still being refined. If the difference in feed intake between the two is not significant enough for producers to notice in their feed expenses then adoption is unlikely. Second, the accuracy of genomic prediction for feed efficiency trait is lower than for milk production traits (e.g., milk, protein and fat) because the trends linking genetic markers and physical trait expression are less well established.

According to a previous study, the accuracy of genomic prediction for similar traits is roughly 30 to 60 percent. Importantly, the accuracy of prediction is continuously improved as the link between genetic markers and physical traits becomes more robust. Novel traits such as feed efficiency is only recently tracked using genomic selection and it is likely that the accuracy of selection will improve significantly over the next decade. However, some farmers may choose to wait to adopt this new technology until the accuracy of prediction for the feed efficiency trait is higher.

In this study, we examine the economic feasibility of adopting genomic technologies to select for feed efficiency and reduced methane emissions for a representative dairy farm that initially has 78 cows. Using a stochastic multi-year farm budgeting model, we estimate the return from investing in genomic technologies and identify how management decisions may change post-adoption and what constraints may hamstring adoption.

We find an average financial benefit of $330,000 from reduced feed requirements for representative producers that adopt genomic selection for feed efficiency over a 25-year horizon. This estimate does not consider the benefit that comes from reducing methane emissions, which means the net benefit to society is likely higher. The federal government estimates the social cost of methane at $1,165 per tonne and we estimate an average reduction of 48 tonnes per farm over 25 years.

That said, the uncertainty surrounding predicted feed consumption, heritability, and the accuracy of selecting for the trait may motivate more cautious farmers to delay adoption until the uncertainties are resolved. When we model the accuracy of the prediction of genomic selection for feed efficiency, we find that producers are exposed to risk of a loss – negative returns – approximately 13 percent of the time. Realizing a higher benefit from adoption is also constrained by whether a producer can increase the scale of their operation, which is challenging given quota prices. Lastly, the premiums that will be charged for the feed efficiency trait in the artificial insemination market are currently unclear. A study that surveys dairy producers across Canada to assess the premiums they are willing to pay for an increased feed efficiency trait is underway.

Genomic technology has already changed the Canadian dairy industry. While in early stages, recent advances on novel traits such as feed efficiency and reduced methane output should give dairy producers opportunities to further improve their productivity and benefit from carbon trading, while at the same time contributing to environmental sustainability and food security. As prediction accuracy improves it is likely that selecting for economically beneficial traits such as increased feed efficiency will become common practice.

Continued from page 1

Co-Insurance

Consider the following situation facing producers. They have access to a variety of seeds but can only plant one type of seed per field. Do they choose a drought resistant-type seed that will perform average in regular conditions and better in drought conditions or do they choose a racehorse type seed that will perform poor in drought conditions but markedly better in ideal conditions? Given the presence of highly subsidized multi-peril crop insurance, the racehorse type seed becomes a significantly more attractive option. With respect to a changing climate, subsidized multi-peril crop insurance decreases the economic incentives to adopt costly on-farm mitigation technologies. Given this and the widespread use of subsidized multi-peril crop insurance, it is not surprising if research and development (private) investment in such on-farm mitigation technologies (e.g., drought-resistant seeds) will correspondingly be reduced while investment in more volatile and climate susceptible technologies (e.g., racehorse seeds) be increased.

Can the disincentives to adopt risk-reducing on-farm technologies of multi-peril crop insurance be reduced while maintaining the beneficial tenants of a multi-peril crop insurance program? Yes. Co-insurance, where the insured maintains a percent of the losses below the guarantee, is a common feature of insurance contracts to incentivize the insured to engage in risk-reducing activities. Co-insurance is not common in multi-peril crop insurance throughout the world and is not a feature of Ontario's production insurance program. AAFC and Agricorp should investigate the notion of introducing a level of co-insurance in their crop insurance programs.

Nutrient Application Rate Decisions

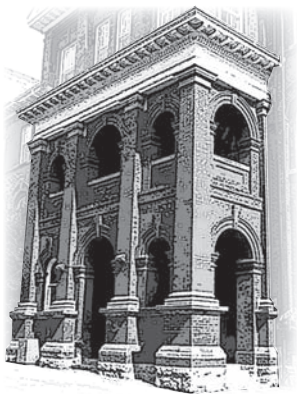
By: Jennifer Leslie, Research Assistant, FARE, and Alfons Weersink, Professor, FARE

The regions surrounding Lake Erie have pledged to reduce phosphorus loadings by 40 percent over the next decade. Given that agriculture accounts for nearly half of total phosphorus loadings into Lake Erie, the desired reduction in loadings will require an understanding of how fertilizer application levels can be reduced by farmers. This paper compares farmers' actual nutrient application rate decisions to the rates that would minimize excess loadings while meeting crop requirements referred to as the "NMAN standard" in Ontario. Actual application rates similar to or less than NMAN would suggest that total cropland area would have to be reduced in order to meet the target. However, actual rates greater than NMAN would imply that farmers' decisions about the amount applied per hectare could be modified as the means to achieve the objective. If this is the case, then understanding the factors influencing the reasons for the excess nutrient application rate can guide policies to lower those rates.

"While the majority of farms are applying fertilizer, particularly nitrogen, at rates close to the minimum crop requirements, there are a few farms that apply much more than recommended."

Our analysis shows that farmers' decisions to apply in excess of the recommended NMAN rate are linked to nutrient and crop type. Nitrogen application rates are highest on corn but the difference between actual and NMAN rates are statistically insignificant as some farmers apply less than the crop requires. In the case of wheat, nitrogen application rates are statistically higher than NMAN rates. The pattern for phosphorus differs from nitrogen for both corn and winter wheat. Actual phosphorus application rates are rarely less than NMAN rates and are frequently substantially higher. At a watershed level, excess nutrient applications as a percentage of total nutrient applications are much higher for phosphorus than nitrogen and higher for wheat than for corn.

Since we observed considerable variability across farms, we examined the factors contributing to the deviations between actual application rates and NMAN application rates. Using decision rules such as profit maximization and yield maximization result in higher rates than NMAN but do not explain the outliers that apply significantly more than the NMAN rates. Excess nutrient applications increase with farm size and decrease with field size. Using beneficial management practices, such as a complex rotation or manure, lowers the NMAN rate but also tends to lower the difference between the actual and recommended rate suggesting farmers using these BMPs are aware of their fertility benefits. Finally, increases in target yield reduce the difference between actual and recommended rates, particularly for nitrogen. Within the Gully Creek watershed, none of the 16 farms in the data set were regulated under the Nutrient Management Act (NMA), and consequently none were required to submit Nutrient Management Plans and determine the associated NMAN rate. Despite not being a requirement, many of the farmers apply their fertilizer at rates close to that recommended by NMAN and some at rates significantly less. While the majority of farms are applying fertilizer, particularly nitrogen, at rates close to the minimum crop requirements, there are a few farms that apply much more than recommended. Policy and research efforts should be directed toward targeting these individuals that appear to be the primary contributor to the nutrient loading issue.



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