THE CARBON FOOTPRINT

OF ORGANIC FARMS

By Tanya Brouwers

These days it's all about lowering your carbon footprint or the total greenhouse gas (GHG) emissions caused by an action, product or individual.

This all-encompassing definition makes it clear: this diet isn't going to be as easy as parking the car and walking to the mailbox. It's going to involve an energy and GHG emissions analysis of everything from that shirt you bought yesterday right down to the glass of milk you drank this morning before rushing out the door.

Let's look more closely at that glass of milk. Like all foodstuffs, its carbon footprint is measured in terms of its total food chain energy use and GHG emissions produced; in other words, the energy and associated GHG emissions involved with getting the milk from the cow to your fridge. It sounds simple enough, but every step must be considered, including the energy to grow the animal feed, house the animals, transport the milk, and even power the grocery store.

More energy is used to produce food conventionally than to produce the same food organically.

Interestingly, of the total food chain energy in that glass of milk, anywhere from 30–70% of it is generated at the farm. Clearly, the agricultural aspect of that dairy beverage is a good place to start cinching the belt. The good news is that researchers have determined that many organic farming practices have the potential to lower a farm's total energy consumption, its GHG emissions and, therefore, its carbon footprint.

Drs. Derek Lynch, Rod MacRae and Ralph Martin, in cooperation with the Organic Value Chain Round Table, published a review of over 130 European and North American studies comparing farm energy use and global warming potential on both organic and conventional farms.[1] The review concluded that "the evidence strongly favours organic farming with respect to whole-farm energy use and energy efficiency both on a per hectare and per farm product basis."

"We're not [just] talking about how much energy is used daily by the farmer, like running the tractor," said Lynch during a recent interview. "We're actually talking about things like the fertilizer coming in or the manure, if you're an organic farmer. Those add up to much larger amounts of energy in a farming system than what you lose on your tractors and machines."

Whereas organic farmers rely on more energy-efficient sources of nitrogen like manure and legumes, conventional operators use chemical nitrogen fertilizers. These are highly energy-intensive, and produced using large amounts of natural gas and coal. This explains, in large part, why more energy is used to produce food conventionally than to produce the same food organically.

"Organic farms are just bringing in less energy," reiterates Lynch.

He's quick to point out, however, that the study is one of an 'overall' nature and that energy use variables exist within the organic industry itself. In some areas, like the organic poultry and fruit sectors, energy use was not significantly lower than their conventional counterparts.

Lynch explains that the energy efficiency varies by the type of crop rotation. Perennials in rotation,

Farms generate an impressive 30–70% of the total food chain energy use. Transportation accounts for only 11%, on average.

for example, are much more energy efficient than annuals.

Aside from energy efficiency, there is also the question of GHG emissions as an indicator of the carbon footprint. Field and livestock systems produce substantial amounts of carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4). It has been well documented that organically farmed fields store more carbon than conventional and release a lower amount of GHGs to the atmosphere.

Plants convert atmospheric CO_2 into carbohydrates, or sugars, during photosynthesis. As the plants use the sugar to grow, some of the carbon is released back into the atmosphere as CO_2. The rest of the carbon is returned to the soil through decaying plant matter or, if the plant was consumed by an animal, through manure. Some agricultural practices, however, are better at accumulating and retaining (sequestering) soil carbon than others.

The review concludes that the "common practices in organic systems, including soil incorporation of legume cover crops and animal manures, can result in mitigation of global warming potential and GHG [emissions]...primarily by increasing soil carbon." Agricultural practices that sequester soil carbon, many of them routinely practiced by organic farmers, include:

- incorporating green and animal manures;
- seed drilling to minimize soil disturbance;
- keeping soil covered rather than left fallow;
- including perennials in crop rotations; and
- rotational livestock grazing.

Legume green manures release nitrous oxide into the atmosphere. The amount released is still unclear but timing of incorporation appears important.

At this point in the carbon footprint discussion, the majority of the research pointing towards the benefits of organic agriculture is European or American-based. The good news is that scientists, including Lynch and his colleagues, are working hard to develop a Canadian body of evidence. This will help convince policy makers of the benefits of organic agriculture to current and future generations of Canadians.

Measuring GHG emissions*

There are three subprojects to this OSC study operating in conjunction with Canadian universities and Agriculture and Agri-Food Canada.

In the first project, researchers will study N_2O emissions from red clover green manures in four-year crop rotations.[2] Legumes fix nitrogen from the atmosphere. When soil microorganisms convert the nitrogen to plant-available forms, N_2O is released. The amount of N_2O is not well documented but deserving of investigation. Although atmospheric concentrations of N_2O are much lower than concentrations of CO_2, the global warming potential of N_2O is nearly 300 times greater.

The project will also measure nitrates in groundwater. When red clover is tilled into the soil, it decays and releases nitrates. Nitrate is desirable for crop growth because it can be taken up by plants. On the downside, because nitrate doesn't attach itself to soil particles, it can move easily with water and pollute groundwater. Excess nitrates in groundwater have been linked to environmental and human health problems.

The organic dairy and grain sectors show energy efficiency improvements of 20% or more over their conventional counterparts.

Canadian scientists have developed a fully automated, cutting edge technology that will track water leaving a test field. They hope to get a precise measure of nitrate leaving fields of legume green manures.

Organic field systems store more carbon than conventional, and release a lower amount of GHGs to the atmosphere.

The second aspect of the project will measure GHG emissions from the feces and urine deposited by livestock on pastures. The outcome should help farmers determine optimal stocking rates and improve pasture management practices for reduced emissions.

The Holos model is a computer-generated program that will help dairy farmers determine their climate change rate.

* Researchers: Derek Lynch, David Burton, Philippe Rochette, Henry Janzen, A. Bedard-Haughn, Mike Main

Finally, the team will work with organic dairies in Eastern Canada, Ontario and Quebec to improve the functionality of the 'Holos model' for organic farmers. The Holos model is a new tool developed by Agriculture and Agri-Food Canada to estimate whole farm, life cycle greenhouse gas emissions.

"It's very user friendly," notes Lynch. "It's designed for farmers to do their own self-assessment."

The Holos model will ask a dairy farmer to enter information like the crop rotation and quantity of manure produced. The model uses this information and provides a number associated with the farm's overall rate of GHG emissions or Global Warming Potential.

Organic agriculture is a win-win scenario for both the environment and, ultimately, all Canadians.

The model has never been tested on organic farms up until now. That's where Lynch and his team enter the picture. They will work with organic dairy operators to determine the gaps in a model designed for conventional dairies.

"We know it won't be perfect," points out Lynch. "It's not sensitive enough and it doesn't ask the right questions to pick up the differences in how organic farms are managed."

He and his team believe that, with some tweaking, the Holos model will become a valuable tool for organic dairies to estimate and reduce their greenhouse gas emissions and lower their overall carbon footprint.

Researchers aim to identify the factors that help or deter conventional farmers from making the transition to organic farming.

Programming the future: A model to hasten transition*

Dr. Rod MacRae of York University, along with fellow researchers, is designing an innovative modeling system to track GHG reductions during the transition to organic systems.[3] The long term goals of the project are (1) to encourage farmers to make the transition and (2) to influence policy makers to support the environmentally beneficial aspects of organic agriculture.

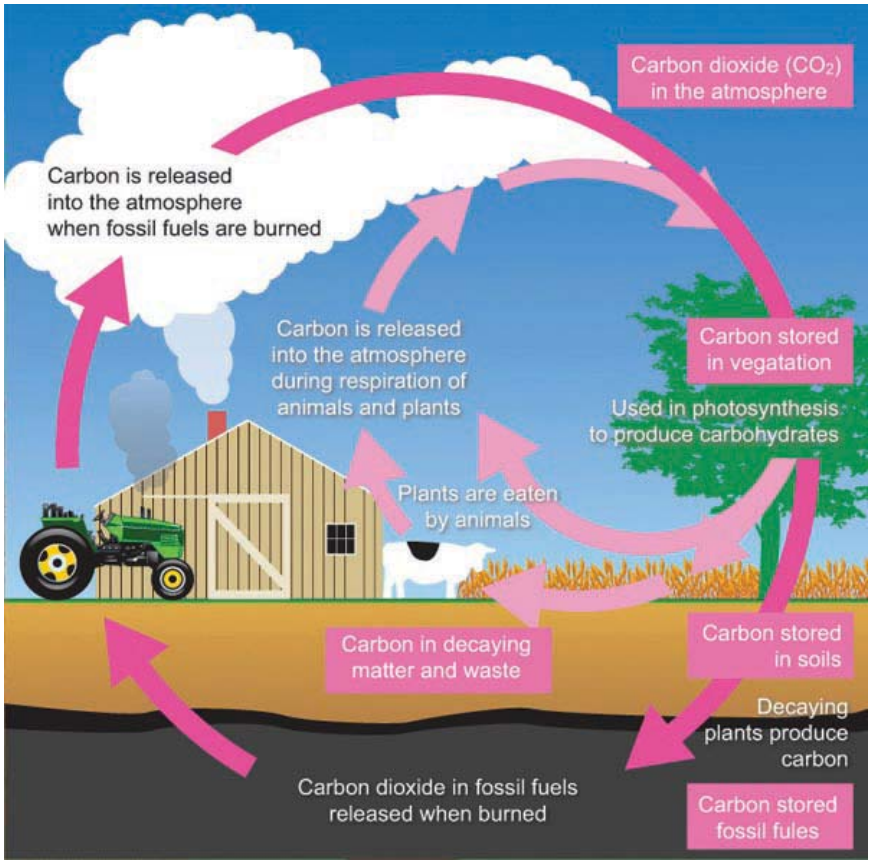
The curious thing about the project is that it takes place entirely within the confines of computers. No farm visits are necessary. Instead, a myriad of variables including location, geographic data, type of agricultural sector, and even a farmer's hypothetical financial situation are entered into a computer program to provide estimates of transition time and GHG emissions reductions. It all sounds very sci-fi.

"This is called an alternative futures study," MacRae says. "Most studies are about what is... we're trying to study what could be."

The other unique aspect of this study is the emphasis on human behaviour. The researchers aim to identify the factors that help or deter conventional farmers from making the transition to organic farming. The underlying premise is the assumption that greenhouse gas emissions will be reduced with the adoption of organic farming methods.

The literature has identified more than 15 factors that impede the transition process, most of them being psycho-social, such as

* Researchers: Rod MacRae, Martin Bunch, Derek Lynch



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'What will my neighbours think?', 'Are there trusted advisors to impart information?' and 'What are the implications for my family'?

A main barrier to encourage transition, MacRae admits, "is obviously financial." He is referring to the need for financial support for farmers during the often difficult transition process.

"We're trying to find out what level of policy and regulatory inputs have to be used to potentially hasten the [transition] process," states MacRae. He admits, however, that any supports must appeal to both the farmer and the policy maker.

"One of the big problems in our system is the assumption by a lot of policy people that the invisible hand of the market will drive this [transition to organic] so, therefore, no particular supports are required," states MacRae.

"The reality is, of course, that the food marketplace is so dysfunctional that none of the traditional signals that are supposed to allocate resources efficiently are working. Unless somebody intervenes, both in information and resource allocation, [a full scale conversion to organic] won't happen."

Researchers, including MacRae and Lynch, are working hard to create the experiments, analysis and body of evidence necessary to convince policy makers and the general public that organic agriculture is a win-win scenario for both the environment and ultimately, all Canadians.

"Organic agriculture has so much to offer," Lynch says emphatically. "If we can make people aware of that, we can say, 'Look, you want a lower carbon footprint?' Then buy organic."

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References:

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2. Wallace B, D Lynch, D Burton & A Bedard-Haughn. 2012. Synchronizing N supply with crop uptake in spring wheat crop rotations by altering green manure management strategies. *Proceedings of the 2012 Canadian Organic Science Conference.*

3. Ghaffari A, M Bunch, R MacRae & J Zhao. 2012. Tools for geospatial and agent based modeling to evaluate climate change in an agricultural watershed in transition to organic agriculture. *Proceedings of the 2012 Canadian Organic Science Conference.*

Canada's Organic Science Cluster (OSC) is part of the Canadian Agri-Science Cluster Initiative of Agriculture and Agri-Food Canada's Growing Forward Policy Framework.

Growing Forward, a federal-provincial-territorial initiative

The Science Cluster Initiative is led by the Organic Agriculture Centre of Canada (OACC) and the lead industry applicant, the Organic Federation of Canada.