GHG emissions twice as high as estimates

Ground-breaking study helps understand greenhouse gas emissions

BARBARA JOHNSTONE GRIMMER

UBC applied biology professor Andy Black, left, and graduate student Patrick Pow, right, are studying greenhouse gas emissions in Delta. *SUBMITTED*

VANCOUVER – A ground-breaking study measuring greenhouse gas (GHG) emissions from vegetable, blueberry and forage crops in the lower Fraser Valley is providing information that will help researchers and farmers improve efficiencies and develop best management practices (BMP) to reduce emissions while maximizing yields.

It is the first long-term study in BC to measure GHG emissions from agricultural crops year-round.

The researchers found that directly measured GHG emissions in this study were twice as high as the estimated values that are usually used. By measuring continuously over the entire year, they also determined that the non-growing rainy season lost considerable GHG emissions from the soil.

With specialized gas measuring equipment, the researchers also evaluated different best management practices (BMPs) to identify farm practices that could reduce GHG emissions.

On the rise

Agriculture accounts for about 8.5% of Canada's GHG emissions, and agricultural soils account for 40% of emissions from the agriculture sector.

"In the last two decades, the emissions from agricultural soils have been increasing," says UBC applied biology professor Andy Black, who leads the Biometeorology and Soil Physics group. "That is the real concern."

UBC received $1.8 million in 2017 through Agriculture and Agri-food Canada's Agriculture Greenhouse Gas Program. Backed by $27 million, the program supports 20 projects across Canada researching GHG mitigation practices and technologies that can be adopted on the farm.

The four-year research project at UBC aims to quantify and mitigate GHG emissions from high value agricultural crop production systems in BC. The goal was to estimate annual net GHG emissions of major crops in the lower Fraser Valley and develop best management practices to minimize GHG emissions and maximize crop production while minimizing fertilizer use.

In addition to Black, other researchers include associate professors Maja Krzic and Sean Smukler and research associate Rachhpal Jassal. Collaborators include the BC Ministry of Agriculture, Food and Fisheries, Delta Farmland and Wildlife Trust, the Delta Farmers Institute and the Agassiz Research and Development Centre.

Greenhouse gas emissions of nitrous oxide (N20), methane (CH4) and carbon dioxide (C02) were measured using a micrometeorological approach using eddy-covariance, which measures GHG exchange, respiration and photosynthesis, at the scale of a farm field.

This technology can provide seasonal and annual farm-scale carbon sequestration estimates.

"This means that the effectiveness of soil sequestration BMPs can be assessed within a year or two of having been applied, rather than having to wait 10 years before changes in soil carbon storage are measurable by soil sampling," says Black.

The study also used flux chambers to measure GHG coming out of the soil.

The direct measurements allowed the researchers to estimate emissions by moving from Intergovernmental Panel on Climate Change (IPCC) default Tier 1 or country-defined Tier 2 emission factors to the more refined Tier 3 emission factors.

Black and his graduate student Patrick Pow used an eddy-covariance system to measure GHG fluxes every 30 minutes above a blueberry field at Emma Lea Farm on Westham Island in Delta. The 10-month study indicated that

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SOILS are losing carbon

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the field was a weak carbon sink, with moderate N20 emissions which has a global warming potential 298 times higher than C02. Methane emissions were negligible.

"It was surprising to see the field losing carbon to the atmosphere," says Black. The input of sawdust turns around the balance [creating a net gain], and the carbon [emission] source becomes a carbon sink."

Pow remarked that mowing the grass aisles reduced the amount of carbon sequestered and impacted the GHG balance. Fertilizing increased N20 emissions, as did rainfall. Emissions exceeded Tier 1 and Tier 2 estimates by two-fold.

The GHG emissions were mainly C02, with N20 at 21.7% and methane at 3.5%.

Soils are fine-textured, low-lying, flooded soils – resulting in low oxygen, increasing denitrification, and generating N20. Methane is a minor component.

Losing soil organic carbon is a real concern.

"Important result on the carbon side, it's a worrying thing, the agricultural land is losing carbon," says Black. "Photosynthesis can't keep up with what is removed as crops – we harvest a high proportion of net photosynthesis; some is decomposed which is lost as C02 to the atmosphere."

Carbon is important for healthy soils and according to Black, soils need a reasonable level. Carbon is important for microbes, aeration and holding moisture. Manure and compost are also important.

"We need to concern ourselves with cover crops, leaving plant material in the field, and consider inputs like compost and manure," says Black. "Otherwise, soils will continuously lose carbon."

Black suggests that what is needed is the coordination between animals and crops so that the system can "begin to integrate more efficiently."

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> APPLIED BIOLOGY PROFESSOR, UBC

Black says that there is potential with biochar.

"Biochar is a big advantage because it will stay in the soil for a long time, confer important properties while at the same time, change carbon balance from negative to positive," says Black.

Pow is completing three years of continuous GHG measurement from a forage study at Agassiz, utilizing manure slurry which improves the carbon balance.

Rain increases GHG emissions

Ningyu Quan, a Master's student with Black, examined GHG emissions and carbon sequestration in potato and pea fields in Delta at Reynalda Farm applying the eddy-covariance system. The Westham Island silt loam soil had 60% of its annual GHG emissions triggered from rainfall events during the non-growing season. The annual N20 emissions greatly exceeded Tier 1 and 2 estimates.

Methane emissions were low and inconsequential.

Quan suggests that BMPs such as cover crops and correct N applications that consider the 4Rs – right source, right rate, right place and right time – need to be developed.

"Carbon sequestration happens during growing season, with photosynthetic activities and different crop types, but no long-term carbon sequestration has been seen," says Quan.

Chantel Chizen, a Master's student with Krzic, examined fertilizer, temperature and moisture responses with potatoes. Fertilizer rates, moisture and temperature impacted GHG emissions. It is recommended to producers to match fertilizer rates to crop needs, avoiding residual fertilizer in the field which can increase emissions during the rains in fall and winter.

Smukler recommends adoption of several BMPs by a high proportion of producers to offset the GHG emissions from agriculture in the Fraser Valley. Nutrient management best practices (4R), winter cover crops, grassland set asides, hedgerows and woody riparian buffers all can offset annual emissions, but he cautions that it would require a high adoption rate with all available BMPs to make a difference.

"Key caveats are the huge assumptions in analysis and large uncertainties," says Smukler. "Adoption rates are key, and we need to integrate global warming potentials (GWP)."

Best management practices

Other BMPs being examined are reduced tillage, biochar, green manures like summer cover crops, alleyway management and drainage tiles.

Tile drains manage moisture and help with establishing cover crops in the fall. They can also help reduce emissions in some soils.

A Master's student of Smukler's, Paula Porto, has studied the impact of drainage on GHG emissions in blueberry fields. She has concluded that poorly drained fields emit more C02 and N20, but more research is needed to determine if this holds true for different soil types and climates. Soil moisture can lead to low oxygen, more denitrification and more N20 emissions.

"It will take widespread adoption of several best management practices to bring down these emissions," says Smukler.