The National Centre for Livestock and the Environment
environmental stewardship food quality & safety
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Spring 2014

Feature Research Project

Manure is Mother Nature's fertilizer … and she likes to run the show

Now that spring has arrived, seeds will be sown, forages will revive and hungry plants will seek out the nutrients essential for healthy growth and development. We have heard it before – manure is an excellent source of nutrients for crop growth, but just like any other source of nutrients, manure can also pollute surface and ground waters if managed improperly. In their efforts to be environmentally sustainable, livestock producers are jugglers of sorts, balancing the need to apply manure to agricultural land in an agronomically and economically sound manner while also minimizing environmental risks.

Research is one tool that can help producers juggle these complex issues. Towards this goal, University of Manitoba soil fertility and chemistry professors Don Flaten and Wole Akinremi are looking at what happens to manure nutrients from different types of manure over time and how this is affected by nitrogen versus phosphorus-based manure management strategies.

Both Akinremi and Flaten lead long term manure management field trials, where solid and liquid manures are applied either annually based on crop nitrogen requirements, or intermittently to match crop phosphorus removal in both annual and perennial crop rotations. Agronomic factors such as crop yield, plant uptake and soil concentration of nitrogen, along with other nutrients such as phosphorus, are measured in both studies. From an environmental perspective, Akinremi's study is designed to assess the risk for nutrient leaching below the root zone in a sandy loam soil. Flaten's study on heavy clay soil at the National Centre for Livestock and Environment (NCLE) is mostly focused on nutrient accumulations in soil, rather than losses.

After six years of continuous measurements, both researchers can, without doubt, state that the availability of nitrogen from solid manure is overestimated when the manure application rate is calculated using Manitoba's standard formula. This formula is based on the assumption that 25% of the organic nitrogen in manure will be available for crop use in the first growing season after the manure is applied.

"Not only are we seeing lower availability, but it is also generally slower, with small amounts of organic nitrogen from repeated applications gradually becoming available over time," says Flaten. "If conditions are right, there is potential for these regularly manured soils to provide a substantial amount of N for crop use. For the perennial rotation at our site, total nitrogen uptake under annual N-based solid manure applications at year six is now comparable to synthetic fertilizer."

"But this does not always happen," he adds. "Nitrogen release from solid manure is a biological process and it can be highly variable and unpredictable from one site to another or from one year to the next." In a separate study where nutrient release was monitored for three years following beef cattle manure application to cropland, manure nitrogen availability in year two was overall superior to urea fertilizer (46-0-0) when applied to perennial crops at one site. However, at another site, there was no apparent benefit from the manure in the second or third years following application to annual cropland.

Adding to this field variability is the variability of manure itself. For example, use of extra straw in particularly cold or wet winters increases the carbon content of manure. When there is a high amount of carbon relative to nitrogen, microbial breakdown of the manure may tie up nitrogen that would otherwise be available to crops. This can delay the release of nitrogen from months to years.

Akinremi sees a bright side to this slower release. “Solid manures containing a large amount of straw may reduce the risk of nitrate leaching, particularly in a perennial system where the established root system can intercept nitrates before they move below the root zone. We observed this in our perennial plots where nitrate leaching with manure was small and no different than from plots that were not fertilized.”

Dr. Akinremi and his team are focusing on how to better predict the release rate of nitrogen from different solid manures. “By understanding how these biological processes respond to different soil and weather conditions, we should be able to better estimate nitrogen availability,” says Akinremi. Their main finding so far is that the breakdown of organic nitrogen into plant-available forms was much slower for the clay soil than for the loam-textured soil used in the study. Nitrogen release rates were less than half of the 25% estimated release rate used in Manitoba’s standard formula.

Based on these findings, Akinremi tested a modified formula for calculating N-based manure application rates using a 12% estimated release rate of organic nitrogen. His team assessed nitrogen availability and crop response for dairy manures applied according to the new formula compared to the standard calculation. While overall they observed trends in higher grain yield, nitrogen uptake and nitrogen use efficiency with the revised formula, they advise to proceed with caution. With only one year of field data in a year that had greater than normal yields, the results are preliminary.

Also important to keep in mind is that high rates or repeated applications of solid manure to the same field can have negative consequences. Compared with nitrogen, solid manures are relatively rich in plant available phosphorus and potassium. High levels of soil test phosphorus pose an increased risk to surface water quality while elevated potassium levels may pose a risk to cattle health and nutrition.

After six years of annual N-based applications of solid manure at both long term sites, soil test phosphorus in the upper layer of soil has risen to levels that would trigger a shift from N-based to P-based manure management practices. This increase did not occur with intermittent applications of manure based on crop removal of phosphorus.

At the NCLE site soil test potassium increased over time in proportion to the amount of manure applied. While this increase could be beneficial for potassium-deficient soils, it could induce nutritional problems in cattle if forage is grown on soils with excessive amounts of potassium.

What’s next? As of this spring, there are several new research reports from University of Manitoba scientists on the risks and rewards of managing different manures in different ways for crop production in Manitoba. The next step, a work in progress, is determining appropriate adjustments to manure application rate recommendations. We look forward to working closely with producers, research colleagues, manure management practitioners and government representatives in developing a revised suite of recommendations.

The research presented in this article was made possible by financial support from Manitoba Beef Producers, Dairy Farmers of Manitoba, Manitoba Pork Council, the Canada-Manitoba Agri-Food Development Initiative (ARDI), the Manitoba Rural Adaptation Council (MRAC), and the Canada Foundation for Innovation (CFI). Thank you for your continuing support.

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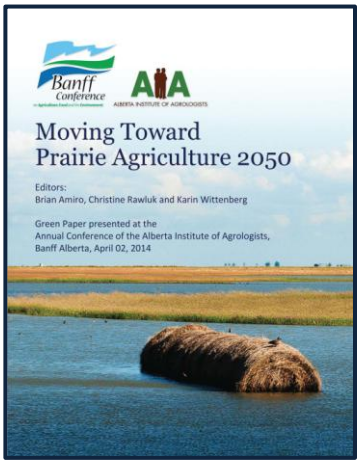
Instant Update

NCLE releases new Green Paper "Moving Toward Prairie Agriculture 2050"



The year is 2050, and food production on the Prairies is successfully adapting in response to changes in climate and resources, as well as other drivers including new technologies, markets, trade and policies. The paper presents perspectives addressing a broad range of issues related to water, livestock production, cropping systems, pests, food quality and insurance. The goal for this report is to generate discussion so that we can prepare ourselves to ensure a strong Prairie agriculture industry into the future.

The invited paper was presented at the 10th annual Alberta Institute of Agrologists Conference on Agriculture, Food and the Environment, held April 1-3 and attended by 500 professional members and industry. The paper is the product of contributions from 23 authors from the three Prairie Provinces.

Download the Green Paper at http://umanitoba.ca/faculties/afs/ncle/news_events.html

New infrastructure will benefit cattle-forage and laying hen housing systems research programs

The new cattle-forage equipment expands our capacity to collect in-field data from cattle and will aid the forages evaluation program starting this spring. New laying hen and pullet infrastructure complements the existing enriched housing system, facilitating scaling up from individual bird responses to the whole barn environment. Funding provided through the Growing Forward II Growing Innovation Capacity and Knowledge Development program. Thank you to Manitoba Agriculture Food and Rural Development for their continuing support of NCLE initiatives.

Graduate student with forage-beef program named a Cattlemen's Young Leader for 2014

Kristine Blair, MSc student in the forage-beef research program with **Kim Ominski**, has been named to the Canadian Cattlemen's Association Cattlemen's Young Leaders Program (CYL). The CYL pairs participants with a mentor for an eight-month mentorship. **Carollyne Kehler**, MSc candidate with **Kim Ominski**, was the 2013 recipient.

Winnipeg hosts World Congress on Conservation Agriculture, June 22-25, 2014

Plan to attend to *discover why sustainable agriculture is good for us all*. Featuring Dr. David Montgomery, Howard Buffett, Dr. Dwayne Beck and other well-known conservation superstars, the Congress highlights latest developments in research, success stories of farmers and the policy issues that confront governments and societies around the world. To learn more, visit http://wcca6.org, or contact Marla Riekman at marla.riekman@gov.mb.ca. The Congress is geared towards producers, agronomists, extension staff, students and academics, so there will be something for everyone!

Research Update

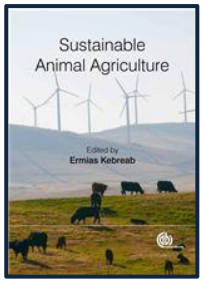
Recently completed projects:

Enhancing sustainability of grassland systems receiving pig manure on coarse texture soil

Since 2003, the La Broquerie Manure and Grassland Management Study (http://www.umanitoba.ca/afs/labroquerie/) has been the site for integrated sustainable livestock production system research for grassland systems on coarse textured soil. In this second phase, Mario Tenuta and colleagues focused on sustainable management of nitrogen and phosphorus over time with sustained pig slurry application in this system. This research has resulted in specific recommendations that are directed to producers with similar production and management systems and soil as those used in this study. Read the Executive Summary here.

Optimizing phosphorus utilization by dairy cows: A case study of dairy farms

Findings of a recent on farm survey of Manitoba dairy farms showed a risk for phosphorus accumulation on farm as imports of P generally exceeded export of P off farm. In a follow up study, Kees Plaizier and colleagues set out to identify factors that affect how efficiently dairy cows use phosphorous. Their results showed that even when a safety margin is used, the P content in the diet of dairy cows can safely be reduced. Read the summary here.



Recent Publications:

K.A. Beauchemin and **E.J. McGeough**. 2013. *Life Cycle Assessment in Ruminant Production*, pages 212-237 *in* Sustainable Animal Agriculture (Editor: E. Kebreab). CABI Publishing.

J.C. Plaizier, G. Legesse, K.H. Ominski and **D. Flaten**. 2014. *Whole-farm budgets of phosphorus and potassium on dairy farms in Manitoba*. Can. J. Anim. Sci. 94: 119-128.

K. Bouchard, K.M. Wittenberg, G. Legesse, D.O. Krause, E. Khafipour, K.E. Buckley and **K.H. Ominski**. 2014. *Comparison of feed intake, body weight gain, enteric methane emission and relative abundance of rumen microbes in steers fed sainfoin and lucerne silages under western Canadian conditions*. Grass Forage Sci. doi: 10.1111/gfs.12105.

V. Tkachuk, D. Krause, N. Knox, A. Hamm, F. Zvomuya, K. Ominski and **T. McAllister**. 2014. *Targeted 16S rRNA high-throughput sequencing to characterize microbial communities during composting of livestock mortalities*. J. Applied Micro. 116: 1181–1194. Doi: 10.1111/jam.12449.

D.G. Brewin, M. Undi, S. Kulshreshtha, K. Wittenberg, M. Tenuta and **K.H. Ominski**. 2014. *Integration of forage, beef, and hog production systems in Western Canada: An economic assessment*. Agricultural Systems. 127: 1-8. Online at: http://www.sciencedirect.com/science/article/pii/S0308521X13001613

Extension and Outreach Update

Producer meeting presentations:

Laurie Connor gave two invited presentations on sow group housing at London Swine Conference in London, Ontario, March 27. Presentation titles: "Group Sow Housing – the Facts" and "Success with Group Housing." In this image of grouped sows at the Farm & Food Discovery Centre, Electronic Sow Feeders provide individual animal care in a group setting.

Kim Ominski and **Jason Morrison**, forage-beef research program, presented their work on needle free injection, including an injection demonstration, at producer meetings in Vita, Plumas and Austin this winter.

Student-focused activities:

Farm & Food Discovery Centre kicks off spring with new learning programs

Elementary Students! Come explore *The World of Wheat*, *The Science of Spuds*, *Extraordinary Eggs* and *Dairy Day*! High School Students! The Grade 10 Social Studies curriculum comes to life as you learn about *Food From the Land* on this issues-based field trip. This series brings awareness, interest and a balanced perspective to some of the key issues Manitoba farmers are facing. Learn more about these programs at http://FFDC.ca

Learning about agriculture is a *gas* at the National Centre for Livestock and the Environment

As part of the University's **Science, Engineering and Technology (SET) Day** on February 21, NCLE hosted Grade 11 and 12 students as they explored **"Greenhouse Gases from Agriculture: Microscopic activities of atmospheric proportions."** Special thanks to learning station hosts: Brian Amiro, Brad Sparling, Taryn Dickson, Amanda Taylor, Ashley Soloway, Dept. of Soil Science, and Kim Ominski, Ehsan Khafipour, Shucong Li and Allan Kotz, Dept. Animal Science.