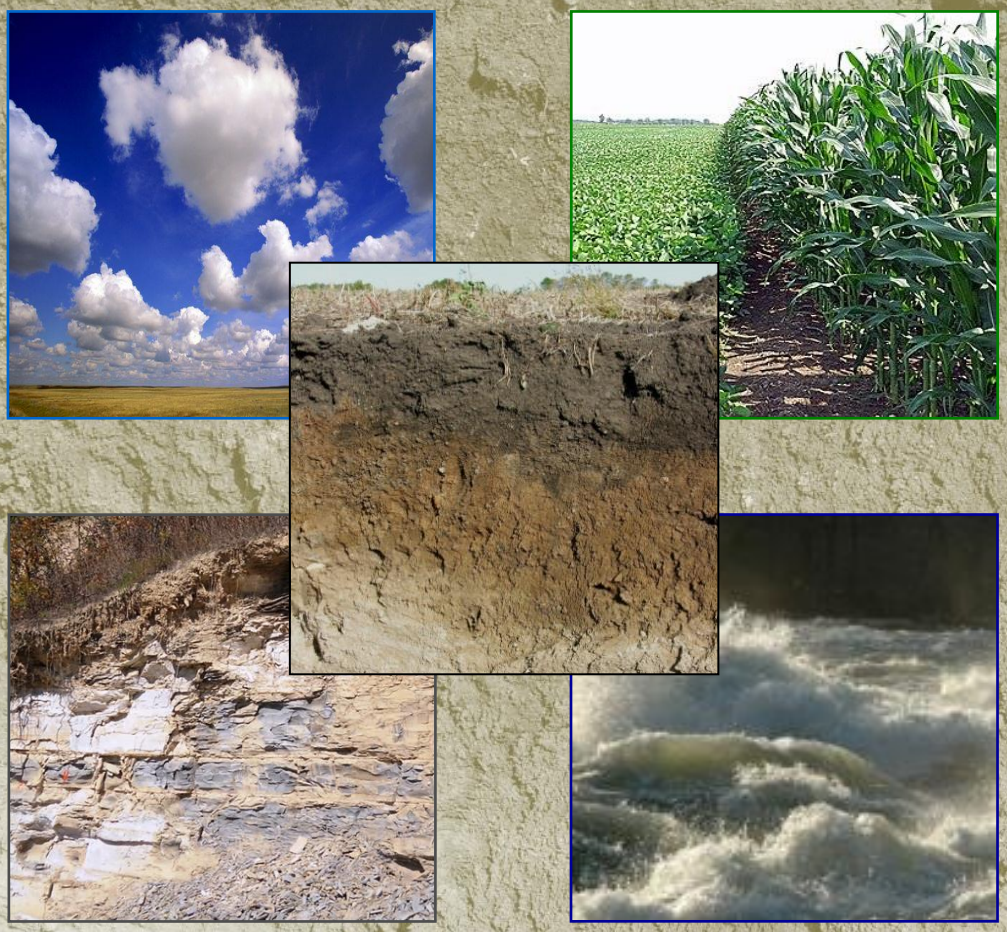
SOIL SCIENCE: THE CENTRE OF IT ALL

CSSS/MSSS/CSAFM 2013 in Winnipeg: The Heart of the Continent



Joint meeting of the

Canadian Society of Soil Science
Manitoba Soil Science Society
Canadian Society of Agricultural and Forest Meteorology
July 22-25, 2013

http://home.cc.umanitoba.ca/~tenutam/CSSS/index.html

Le Sol – Fondement de la Vie
CSSS / SCSS
Soil – Foundation of Life

Canadian Society of Soil Science

Société Canadienne de la science du sol

Manitoba Soil Science Society

csafm
Canadian Society of Agricultural and Forest Meteorology

CONTENTS

WELCOME TO WINNIPEG… THE HEART OF THE CONTINENT

SOIL SCIENCE: THE CENTRE OF IT ALL

Connections between soil, water and air continue to play a huge role in the sustainability of human civilization as well as local and global ecosystems. These connections will become increasingly stressed with growing human population and consumer demand. Soil scientists and agricultural and forest meteorologists will be challenged to find ways to increase food, fibre and biofuel production, maximize carbon sequestration and water quality while minimizing greenhouse gas emissions, industrial impacts, erosion and nutrient losses.

Towards these goals, we are delighted to host over 200 oral and poster presentations and an equivalent number of conference participants for the joint meetings of the Canadian Society of Soil Science, the Manitoba Soil Science Society, and the Canadian Society of Agricultural and Forest Meteorology. In addition to welcoming participants from across Canada, we are also pleased to welcome scientists, experts and students from many other countries around the world, including the U.S., Britain, New Zealand, Turkey and Sri Lanka, for examples. Your work and your willingness to share it with us is the core business of these meetings and we appreciate your contribution.

In addition to welcoming our guests, we also want to thank the large number of colleagues that have worked so hard to organize and support this conference, including the organizing committee, the session chairs, and the sponsors. We would not have a successful conference without you, so thanks!

Lastly, we encourage you to take full advantage of your visit to Winnipeg and Manitoba by taking the time to soak up the ambience of our historic host hotel, celebrating its 100th birthday this summer, the Forks Market and other attractions in Winnipeg and the rest of the Province.

Thanks for coming to the conference; we hope you enjoy the people, the papers and the Province!

Don Flaten, Conference Chair

Marla Riekman, Vice-Chair

Darshani Kumaragamage, Vice-Chair

Manitoba Soil Science Society

Le Sol – Fondement de la Vie / Soil – Foundation of Life

Canadian Society of Soil Science

Société Canadienne de la science du sol

csafm Canadian Society of Agricultural and Forest Meteorology

CSSS/MSSS/CSAFM 2013 ORGANIZING COMMITTEE

Conference Chair	Don Flaten
Vice-Chair (Program)	Darshani Kumaragamage
Vice-Chair (Local Arrangements)	Marla Riekman
Finances	Paul Bullock
Webmaster	Mario Tenuta
Communications Committee	Selena Randall Karin Rose Amanda Taylor
Technical Session Committee	Darshani Kumaragamage (Orals) Francis Zvomuya (Posters) Brian Amiro
CSSS Council Liason	David Lobb
Tour/Workshop Coordinator	Aaron Glenn
AV Coordinator	Brian Miller
Volunteer Coordinator	Marla Riekman/Jolene Rutter
Official Conference Photographer	Amanda Taylor
Grad Student Activity Coordinator	Jolene Rutter
Grad Student Awards Coordinator	Francis Zvomuya
Sponsorship Committee	Marla Riekman Wara Chiyoka David Hay Jason Voogt

SPONSORSHIP

PLATINUM SPONSORS

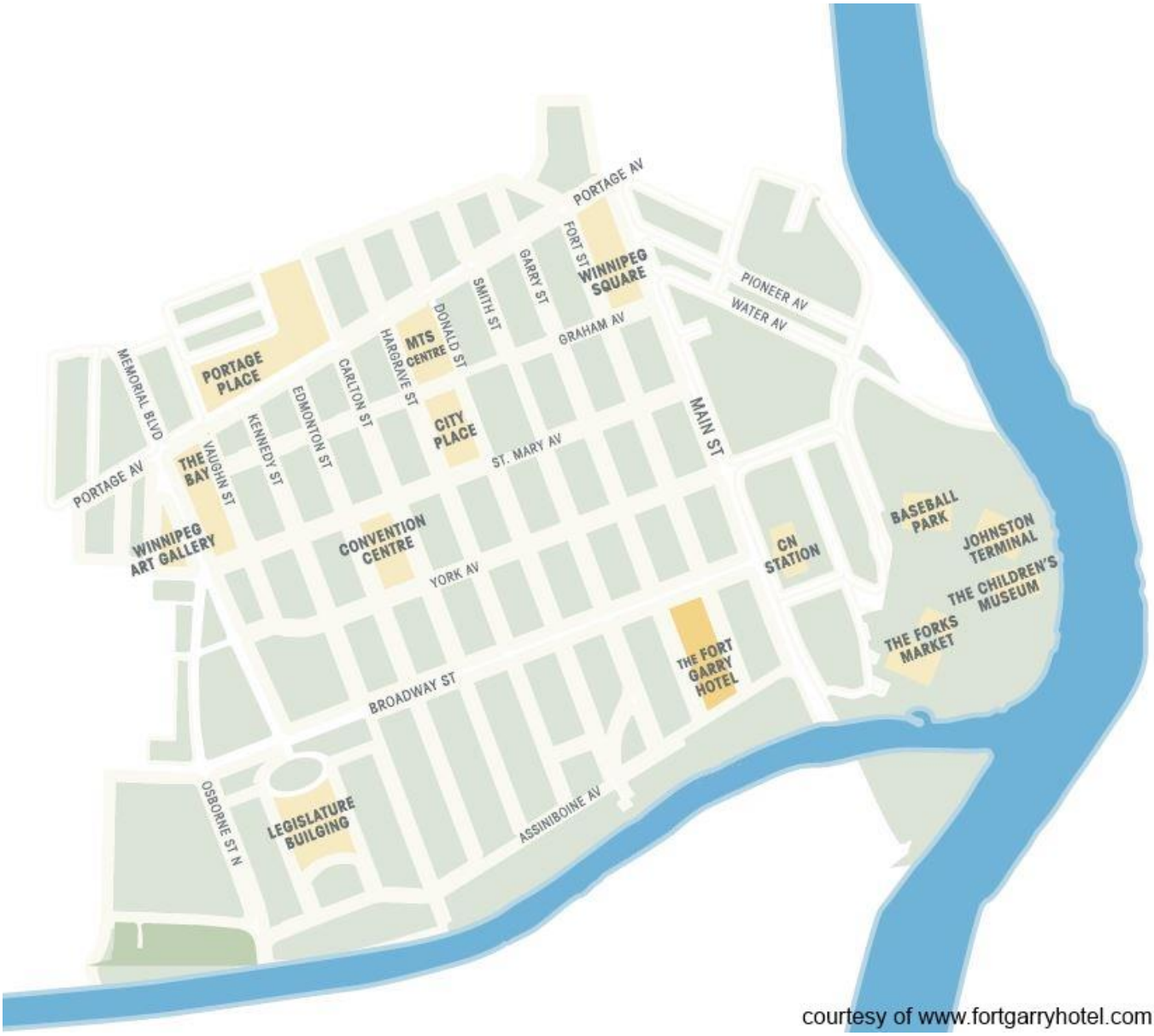
GOLD SPONSORS

SILVER SPONSORS

BRONZE SPONSORS

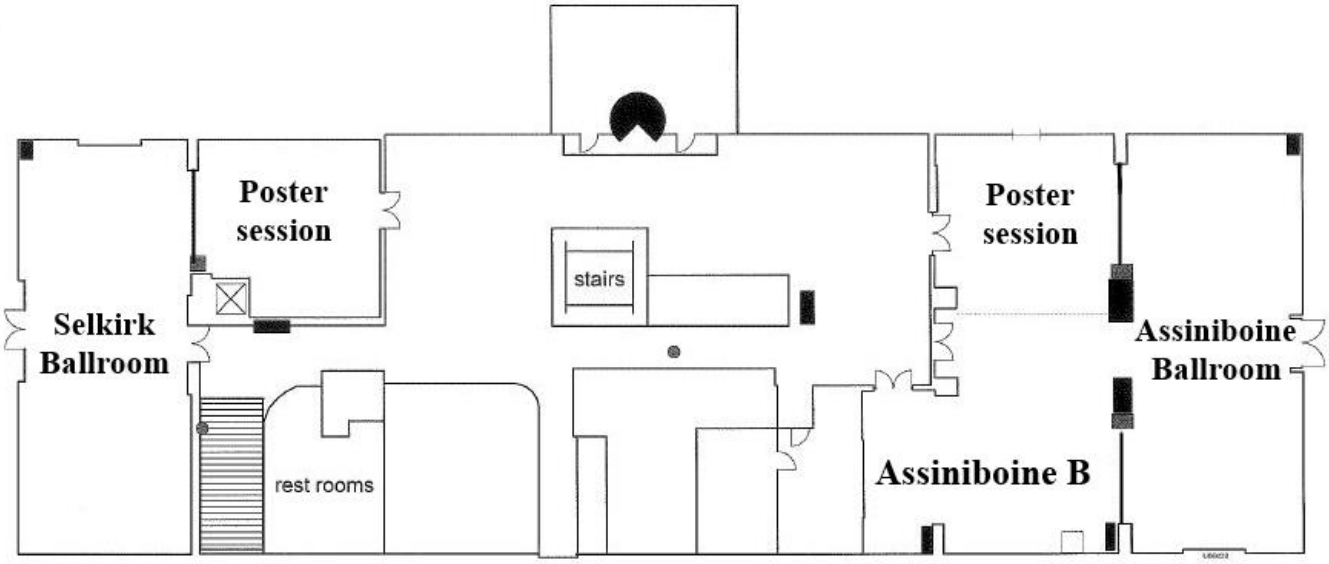
MAPS

CONFERENCE LOCATION & NEARBY ATTRACTIONS

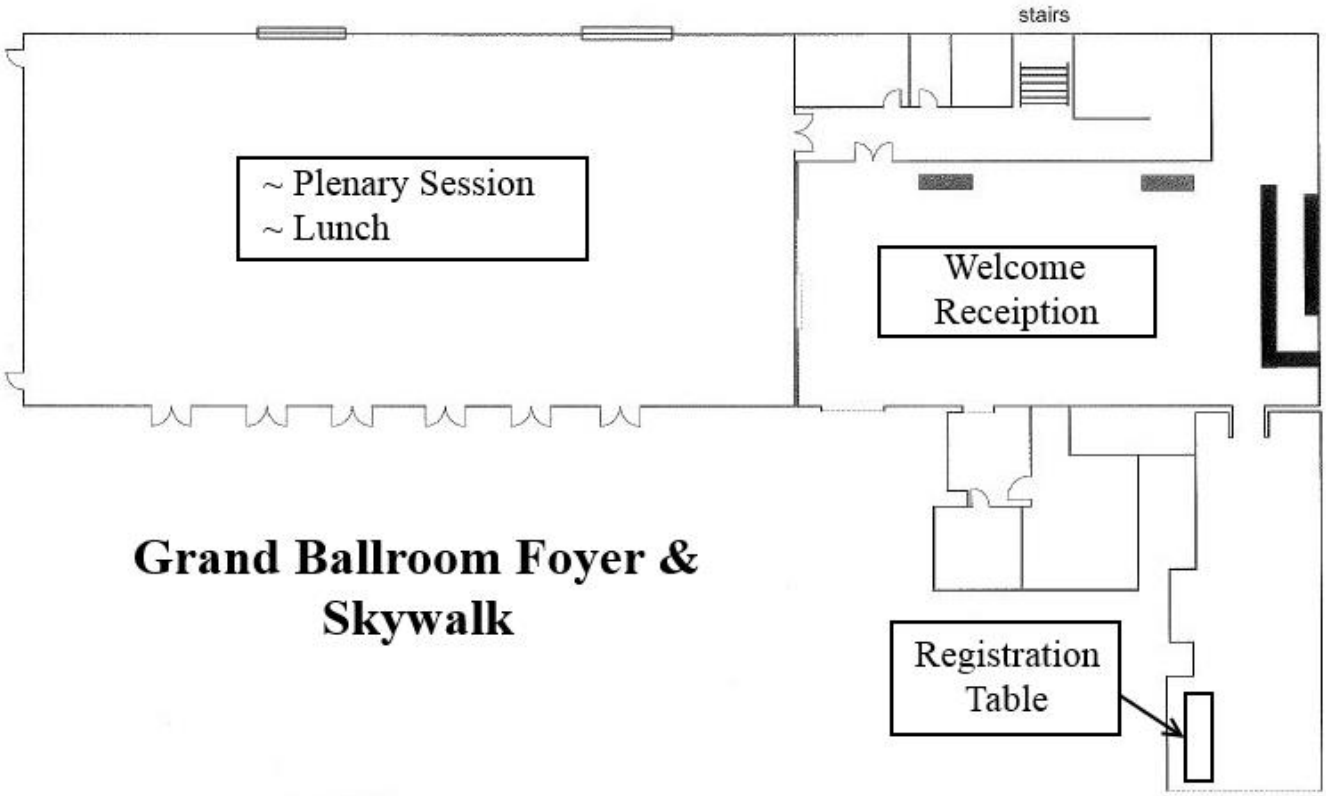


courtesy of www.fortgarryhotel.com

THE HOTEL FORT GARRY CONFERENCE CENTRE



5th Floor Conference Centre



Grand Ballroom Foyer & Skywalk

CONFERENCE PROGRAM

2013 Joint Annual Meetings of the
Canadian Society of Soil Science
Manitoba Soil Science Society
Canadian Society of Agricultural and Forest Meteorology

Unless indicated otherwise all events are in the Fort Garry Hotel and Conference Centre

Tuesday July 16 to Sunday July 21

Pre conference tour to Churchill (requires pre-registration). Organizer: Mario Tenuta (mario.tenuta@umanitoba.ca)

Monday, July 22

All Day Information Desk (Fort Garry Hotel Lobby)

Morning and afternoon

8:00 - 5:15	**Land and Watershed Tour (**departs from Fort Garry Hotel; requires pre-registration). The tour bus will leave the Fort Garry Hotel lobby at 8:00 am. Tour participants who are not staying at the Fort Garry Hotel are welcome to board the bus at 8:15 am at the Fort Richmond Liquor Mart, 2855 Pembina Highway.. Stops include the Bruce D. Campbell Farm and Food Discovery Centre at the Glenlea Research Station, the South Tobacco Creek Watershed, Steppler Dam, Twin Watersheds and Skyview Hutterite Colony along the Manitoba Escarpment. Organizer: David Lobb (david.lobb@ad.umanitoba.ca)
8:00 - 4:30	**Canadian Land Resource Network Workshop** (La Verendrye Room; requires pre-registration). Organizer: Daniel Saurette (daniel.saurette@stantec.com)
8:30 - 4:00	**Greenhouse Gas Field Workshop** (departs from Fort Garry Hotel; requires pre-registration). Morning in field at TGAS MAN Site, afternoon workshop in the Bruce D. Campbell Food and Farm Discovery Centre at the University of Manitoba's Glenlea Research Station. Times indicated are for the shuttle bus's departure from and return to the Fort Garry Hotel. Workshop participants who are not staying at the Fort Garry Hotel are welcome to board the shuttle bus at 8:45 am at the Fort Richmond Liquor Mart, 2855 Pembina Highway. Organizer: Mario Tenuta (mario.tenuta@umanitoba.ca)

Evening

5:00 - 8:00	**Poster Setup** (Fort Garry Conference Centre 5th Floor)
5:30 - 7:30	**CSSS Council Meeting (**La Verendrye Room)
7.00 - 10:00	**Registration** (Grand Ballroom Foyer)
8:00 - 10:00	**Welcome Reception** (Grand Ballroom Foyer)

Tuesday, July 23

Morning

7:30 - Noon	**Registration** (Grand Ballroom Foyer)

Plenary Session (Grand Ballroom)

8:30 - 8:40	**Welcome and opening remarks** - Don Flaten, Conference Chair
8:40 - 9:20	**Effects of soil processes on air and water quality** - April Leytem, USDA-ARS Northwest Irrigation and Soils Research Lab, Kimberly, Idaho
9:20 - 10:00	**Earth's malleable membrane: The role of soil and atmosphere in controlling flows of carbon, nutrients, energy, and water** - Henry Janzen, AAFC Lethbridge Research Centre

Break

10:30 - 11:10 **Understanding the effects of agricultural land management on water quality** - Phil Haygarth, Lancaster University and President of the British Society of Soil Science

11:10 - 11:50 **Climate and land management effects on river discharge and water quality** - Satish Gupta, University of Minnesota.

12:00 - 1:00 **Lunch** (Grand Ballroom)

Afternoon (5th Floor)

1:00 - 3:00 **Oral Presentation - Concurrent Sessions**
Oral Session 1 - Nitrogen Cycling Across Land Uses and Ecosystems 1
Oral Session 2 - Phosphorus Behaviour and Management
Oral Session 3 - Soil Amendments and Remediation

3:00 - 4:00 **Break and Poster Session 1**
Agricultural Greenhouse Gas Emissions
Soil Ecology, Food Webs and Nutrient Cycling

4:00 - 5:00 **Manitoba Soil Science Society Annual General Meeting** (Assiniboine Ballroom)

5:00 - 6:00 **Cdn. Soc. of Agric. and Forest Meteorology Annual General Mtg.** (Selkirk Ballroom)

Evening

6:00 - 8:00 **"Hermetic Code" tour of downtown Winnipeg** (requires pre-registration)

7:00 - 10:00 **Graduate Student "Mixer"**

Wednesday, July 24

Morning (5th Floor)

8:00 - Noon **Registration** (Grand Ballroom Foyer)

8:00 - 10:00 **Oral Presentation – Concurrent Sessions**
Oral Session 4 - Agricultural Greenhouse Gas Emissions 1
Oral Session 5 - Environmental Fingerprinting and Footprinting
Oral Session 6 - Teaching and Training in Soil Science 1

10:00 - 11:00 **Break and Poster Session 2**
General Soil Science

11:00 - 12:30 **Oral Presentation - Concurrent Sessions**
Oral Session 4 cont'd. - Agricultural Greenhouse Gas Emissions 1
Oral Session 5 cont'd. - Environmental Fingerprinting and Footprinting
Oral Session 7 - Soil Quality Gradients at the Landscape Level

12:30 - 1:30 **Lunch** (Grand Ballroom)

12:30 - 2:00 **Women in Science Luncheon Workshop** (Gateway Room; requires pre-registration)
Organizer: Annemieke Farenhorst (annemieke.farenhorst@ad.umanitoba.ca)

Afternoon (5th Floor)

1:30 - 2:30 **Oral Presentation - Concurrent Sessions**
Oral Session 8 - General Soil Science
Oral Session 9 - Soil Fertility and Chemistry 1
Oral Session 10 - Measuring, Modeling and Managing Soil Carbon Exchanges

2:30 - 3:15	**Oral Presentation - Concurrent Sessions** Oral Session 10 cont'd. - Measuring, Modeling and Managing Soil Carbon Exchanges Oral Session 11 - Fate of Trace Metals in the Environment Oral Session 12 - Soil Ecology, Food Webs and Nutrient Cycling 1
3:15 - 4:30	**Break and Poster Session 3** Nitrogen Cycling Across Land Use and Ecosystems Organic Amendments General Soil Science
4:30 - 5:30	**Canadian Society of Soil Science Annual General Meeting** (Assiniboine Ballroom)

Evening (Crystal Ballroom)

5:30 - 6:30	**Cash bar**
6:30 - 9:00	**CSSS/MSSS/CSAFM Banquet**

Thursday, July 23

7:30 - 8:30	**Canadian Society of Agricultural and Forest Meteorology Breakfast meeting**

Morning (5th Floor)

8:00 - Noon	**Registration** (Grand Ballroom Foyer)
8:30 - 9:30	**Oral Presentation - Concurrent Sessions** Oral Session 13 - Agricultural Greenhouse Gas Emissions 2 Oral Session 14 - Soil Fertility and Chemistry 2 Oral Session 15 - Nitrogen Cycling Across Land Uses and Ecosystems 2
9:30 - 10:00	**Oral Presentation - Concurrent Sessions** Oral Session 13 cont'd. - Agricultural Greenhouse Gas Emissions 2 Oral Session 15 cont'd. - Nitrogen Cycling Across Land Uses and Ecosystems 2 Oral Session 16 - Soil Survey and Classification
10:00 - 10:30	**Oral Presentations - Concurrent Sessions** Oral Session 13 cont'd. - Agricultural Greenhouse Gas Emissions 2 Oral Session 15 cont'd. - Nitrogen Cycling Across Land Uses and Ecosystems 2 Oral Session 19 - Teaching and Training in Soil Science 2

Break

11:00 - 12:15	**Oral Presentations - Concurrent Sessions** Oral Session 17 - Agricultural Meteorology and Soil Physics Oral Session 18 - Soil Ecology, Food webs and Nutrient Cycling 2 Oral Session 19 cont'd. - Teaching and Training in Soil Science 2
12:15	**End of Regular Sessions for Conference**

Afternoon (5th Floor)

1:30 - 4:30	**Agricultural Greenhouse Gas Program (AGGP) Workshop** (Assiniboine Ballroom; requires pre-registration). Organizer: Brian Amiro (brian.amiro@umanitoba.ca)

PLENARY SPEAKERS

April Leytem

Dr. April Leytem is a research scientist at the United States Department of Agriculture Agricultural Research Service in Kimberly, Idaho. She holds a Ph.D in soil chemistry from North Carolina State University. Over the past 14 years Dr. Leytem has written broadly on nutrient cycling in plant-animal-soil-water systems and conducted research to help assure sustainable animal production while better protecting water and air quality. Her research projects have focused on understanding feed management, manure application methods and timing, and soil processes that affect phosphorus cycling and off site transport from livestock-crop production systems. For the past eight years, she has led several projects related to air quality and emissions from both dairy production systems and land application of dairy waste, and development of strategies to reduce the impact of large scale animal operations on air quality. Dr. Leytem is also involved in research aimed at improving process based models and development of tools to better estimate on farm emissions of ammonia and greenhouse gasses from animal production systems. Dr. Leytem is the founder and lead of the newly formed ARS workgroup entitled Livestock GRACEnet which is focused on ammonia and greenhouse gas emissions from animal production facilities.

Soil processes from macro to micro: how they influence our sustainability

April B. Leytem*
USDA-ARS, Northwest Irrigation and Soils Research Laboratory, Kimberly, ID, USA
* april.leytem@ars.usda.gov

Soil is a complex mix of minerals, air, water, organic matter and microorganisms. Soil is a living, breathing entity that supports life on this planet, and without it mankind would not survive. Soil is the basis for food production, clean water, support for our infrastructure and may hold the keys to human health. As populations increase there will be more demands put on soil to increase food production, supply clean water, and resist climate change. The effects of soil management and soil processes on both air and water quality/quantity need to be investigated and understood in order to protect this vital resource and ourselves. In this talk we will explore soil processes at both the macro and micro scale and discuss how these processes will influence and possible shape our future. We will investigate why soil science is truly the center of it all.

Henry Janzen

Henry Janzen is a Soil Biochemist with Agriculture and Agri-Food Canada in Lethbridge, Alberta, Canada. His research focuses on the cycles of carbon and nitrogen in agricultural ecosystems, with emphasis on preserving resilience, maintaining productivity, and reducing net greenhouse gas emissions. In exploring the links between farmlands and the global carbon cycle, he has participated in various national and international research activities, including contributions to earlier reports of the Intergovernmental Panel on Climate Change (IPCC). Current and prospective research activities seek to broaden past objectives to encompass also other facets of impending global change, such as food security, biodiversity, and energy, all from a long-term ecosystem perspective.

Earth's malleable membrane

Henry Janzen*
Agriculture and Agri-Food Canada, Lethbridge, AB T1J 4B1
*henry.janzen@agr.gc.ca

Soil is land's membrane – the interface between earth and sky, between living and inert, between firm and fluid. The planetary flows of carbon, nutrients, energy, and water all are mediated by this membrane; it is a meeting place, a confluence of all these ceaseless streams that silently sustain the biosphere. And this membrane is malleable, ever changing and evolving, molded slowly and subtly by timeless interwoven forces – wind and water, plants and creatures, sun and ice – converging uniquely upon countless landscapes, none the same. To these forces, now, is added one even more capricious and pervasive – our own burgeoning presence – which shapes the membrane in novel ways. My aim is to contemplate Earth's malleable membrane, especially how it mediates fluxes between earth and air, hoping to educe collective conversations on how we might further study soil as biospheric 'meeting place'; and how we might elevate this function in studies beyond our discipline. If soil really is a crucial interface, then facing successfully the biosphere's impending stresses will depend on how well soil's humble prominence is nurtured and sustained, not only within Earth's ecosystems, but also in human minds

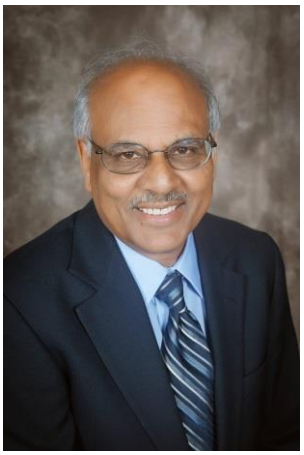
Phil Haygarth

Prof Phil Haygarth has a Chair in Soil and Water Science in the Environment Centre at Lancaster University (LEC) (http://www.lec.lancs.ac.uk), one of the 'top 10' Universities in the UK. He currently leads one of three National Demonstration Test Catchment Consortiums for the UK Government, Defra (Eden Demonstration Test Catchment- http://www.edendtc.org.uk). Phil has experience in biogeochemistry, specializing in the link between soil and farm processes in the landscape and the potential impacts on water quality at the catchment scale. He is particularly known for his studies on phosphorus biogeochemistry. Phil is currently President of the British Society of Soil Science and is a keen blogger and tweeter of his research (http://landwaterblog.blogspot.co.uk/ and @ProfPHaygarth).

Understanding the effects of agricultural land management on water quality

Phil M. Haygarth*
Environment Centre, Lancaster University, UK
*p.haygarth@lancaster.ac.uk

Understanding the connection between agricultural systems and catchment water quality has always presented a challenge that has fascinated me. In this lecture, I will use my experiences as a student of soil and water quality and outline the insights I have gained along the way. I will describe a conceptual model for understanding land and water quality and consider some of the fates and transport processes in the environment. I shall then widen my focus to describe the various approaches designed for helping the UK government (via Defra) to try to mitigate nutrient pollution from agriculture. My involvement in more recent initiatives, such as the UK Demonstration Test catchments and related projects will also be mentioned, considering in particular the value of 'the catchment platform', and how this helps draw in the involvement of stakeholders, and find collective and ideally co-owned solutions.



Satish Gupta

Dr. Satish Gupta is a Raymond Allmaras Professor of Emerging Issues in Soil and Water at the University of Minnesota. He received his B.Sc. and M.Sc. degrees in Soil Science from India in 1966 and 1968, and a Ph.D. degree in Soil Physics from Utah State University in 1972. After graduation, he worked as a Research Fellow for five years at the University of Minnesota and then as a Soil Scientist for eight years with the USDA-Agricultural Research Service in St. Paul. In 1985, he rejoined the University of Minnesota as an Associate Professor in the Department of Soil Science now named as Department of Soil, Water, & Climate. In 1988, he was promoted to full Professor. His expertise includes water and contaminant transport through soil; unsaturated soil mechanics; soil erosion; soil compaction; and tillage, residue, manure, and other waste management. His recent research deals with quantifying river bank erosion using laser scanning, river bank materials as a carrier of phosphorus pollution, climate and land management effects on river flows, fate and transport of manure applied antibiotics, antibiotic uptake by plants, and use of recycled materials in road construction. Dr. Gupta has mentored 30 Graduate students, 16 post docs, and 13 visiting scholars. He has published over 150 research papers including over 100 peer reviewed articles and 17 book chapters. Currently, he teaches courses on Contaminant Hydrology, Vadose Zone Hydrology, and Advanced Soil Physics. Dr. Gupta has served as a Chair of Division S-11 (Soil and Environmental Quality) of the Soil Science Society of America (2010); an Associate Editor of the Soil Science Society of America Journal (1987-90) and the Journal of Environmental Quality (2003-2008); and an Editor-in-Chief for the journal Soil and Tillage Research (1991-1995). He has received several awards including Fellow of the Soil Science Society of America and the American Society of Agronomy.

Climate and land management effects on river discharge and water quality

Satish Gupta*, and Andrew Kessler
Department of Soil, Water, & Climate, University of Minnesota, St. Paul, MN 55127
* sgupta@umn.edu

Environmental groups, regulatory agencies, and recent studies in the Midwestern United States are blaming land management changes such as tile drainage and cropping systems for recent increases in river flows and in turn increased sediment and nutrient loads in rivers. In this presentation, I will describe a study that deciphers climate and land management effects on river discharge and base flow for 45 HUC 8 watersheds in the Midwestern United States. The procedure involves comparing relationships between annual river discharge or annual base flow vs. annual precipitation for two periods; prior to 1975 and after 1976. Mid 1970s is chosen as breakpoint because this was the time period when plastic tile line started to receive wide spread use for agricultural drainage. The premise of the comparisons is that land management changes such as tile drainage will significantly increase flow for a given amount of precipitation. Results show that the relationship between annual discharge or annual base flow vs. precipitation for several heavily tile drained watersheds are statistically similar for the periods prior to 1975 and after 1976, indicating the dominance of precipitation and absence of land management effects on river flows. For some watersheds, the relationships between flow and precipitation are statistically different for the two periods; however, the increase in flow is minor relative to the large shift due to increased precipitation. Additional analysis of the river flow data shows that evapotranspiration hasn't changed since 1916, thus suggesting an absence of cropping system effects on the water balance. I will discuss recent studies that have wrongly characterized climate effects as land management impacts by overemphasizing statistics and ignoring the physics of infiltration, runoff and evapotranspiration. I will further discuss the implications of this climate effect on sediment loads in Minnesota Rivers.

CSSS/MSSS/CSAFM WINNIPEG 2013 - TECHNICAL SESSION PROGRAM

Tuesday July 23 afternoon

Time	1. Nitrogen Cycling Across Land Uses and Ecosystems 1 Venue: Assiniboine Ballroom Chair: Scott Chang		2. Phosphorus Behaviour and Management Venue: Assiniboine B Chair: Don Flaten		3. Soil Amendments and Remediation Venue: Selkirk Ballroom Chair: Annemeike Farenhorst	
1:00 - 1:15 pm	330	**Understanding natural nitrogen enrichment in subtropical acid forest soils and effects of land use by examining nitrogen transformation dynamics** Jinbo Zhang, Zucong Cai*, Tongbin Zhu, Wenyan Yang, Christoph Müller	203	**Assessing the relationship between pH and phosphorus behaviour in central Ontario soils** S.R. Baker*, S.A. Watmough, and M.C.Eimers	261	**Bacterial profiles of agricultural soil fertilized with solid pig and dairy manure, and synthetic N fertilizer** Ainsley Hamm*, Mario Tenuta, Denis Krause, Kim Ominski, Ehsan Khafipour, Don Flaten
1:15 - 1:30 pm			281	**Phosphorus release from flooded soils in relation to soil test P and degree of P saturation** Geethani Amarawansha*, Darshani Kumaragamage, Don Flaten, Mario Tenuta, Wole Akinremi and Francis Zvomuya	250	**The fate effect of Ciprofloxacin presence on 17 β-estradiol or 17 α-ethinylestradiol in sewage sludge and stabilized biosolids** Karin Rose* and Annemieke Farenhorst
1:30 - 1:45 pm	220	**Distinct soil nitrogen transformation patterns in adjacent forest and grassland ecosystems in central Alberta, Canada**	283	**Anion competition by sulphate affects P solubility and speciation in calcareous soils: a ^{31}P MAS NMR and S K - edge XANES investigation** Mihiri C.W. Manimel Wadu*, Yongfeng Hu, Scott Kroeker and Olalekan O. Akinremi	262	**Influence of composted cattle and separated hog solids manure and soil fumigation on potato yield, quality and suppression of Early Dying disease in Manitoba** Oscar Molina*, Mario Tenuta, Jolene Rutter, Katherine Buckley, Fouad Daayf

1:45 - 2:00 pm		Scott X. Chang*, Man Lang, Yi Cheng, Bruno Mary, Jin-bo Zhang, Zu-cong Cai	308	**Comparison of colorimetric and ICP methods of phosphorus determination in soil extracts** O.O. Adesanwo*, D.V. Ige, L. Thibaul, D.N. Flaten and O.O. Akinremi	290	**Degradation kinetics of spiked vs. excreted chlortetracycline, sulfamethazine and tylosin during composting of beef cattle manure** I.D. Amarakoon*, S. Sura, F. Zvomuya, T. McAllister, F. Larney, D. Degenhardt, A. Cessna and S. Xu
2:00 - 2:15 pm	213	**Effect of variability in cattle manure application on soil nutrients and crop yield** Tom King*, Jeff Schoenau, Joy Agnew and Hubert Landry	244	**Nitrate and phosphorus leaching on a loamy sand soil at two rates of liquid swine manure and fertilizer** Rezvan Karimi Dehkordi*, Wole Akinremi,and Katherine Buckley	274	**Value enhancement of municipal organics compost through the addition of effective microorganisms** Basanti Bandekar* and G.W. Price
2:15 - 2:30 pm	226	**Nitrogen dynamics in an organic rotational no-till system in Southern Manitoba** C. Halde*, R. H. Gulden, A. M. Hammermeister, K. H. Ominski, M. Tenuta and M. H. Entz	279	**Managing losses of dissolved phosphorus by time and place of application** Tom Bruulsema*	205	**Role of organic ligands in lead phytoremediation** Muhammad Shahid*, Camille Dumat, Eric Pinelli
2:30 - 2:45 pm	286	**Labile organic nitrogen transformations in clay and sandy-loam soils amended with ^{15}N-labelled faba bean and wheat residues** Mervin St. Lucea*, Joann K. Whalen, Noura Ziadi, Bernie J. Zebarth, Martin H. Chantigny	207	**Seed-placed phosphorus and sulphur fertilizers: effect on canola plant stand and yield** Laryssa Grenkow*, Donald Flaten, Cynthia Grant, and John Heard	245	**Effects of citrate and DFOB siderophore on nickel sorption by palygorskite, sepiolite and calcite minerals** Ahmadreza Sheikhhosseini Esfahani*, Hossein Shariatmadari, and Mehran Shirvani
2:45 - 3:00 pm	219	**Model estimates of the variation in organic, inorganic and volatilized N in manure** Steve Sheppard* and Shabtai Bittman	300	**Manure-based struvite for reduced seedling toxicity and enhanced phosphorus use efficiency in canola production** Katanda, Y*, F. Zvomuya, D. Flaten, and N. Cicek	254	**Wetland and traditional phytoremediation approaches for the decommissioning of municipal lagoons** Adenike Hassan*, Francis Zvomuya and Lisette Ross
3:00 - 4.00 pm	**Break and Poster Session**					

Wednesday July 24 morning

Time	4. Agricultural Greenhouse Gas Emissions 1 Venue: Assiniboine Ballroom Chair: Claudia Wagner-Riddle		5. Environmental Fingerprinting and Footprinting Venue: Assiniboine B Chair: David Lobb		6. Teaching and Training in Soil Science 1: Engaging Students to Meet Future Challenges Venue: Selkirk Ballroom Chair: Fran Walley/ Tom Yates	
8:00 - 8:15 am	224	**Measuring carbon exchange over three cropping systems in Manitoba** Amanda M. Taylor*, Brian D. Amiro, and Trevor J. Fraser	332	**What is the policy value of a 'virtual phosphorus footprint'?** Phil M. Haygarth	325	**Soil science needs to get dirtier** Dan Pennock
8:15 - 8:30 am	239	**System-specific greenhouse gas budgets for irrigated and dryland cropping systems in Saskatchewan** Cody David*, Richard Farrell, and Warren Helgason				
8:30 - 8:45 am	260	**Magnitude and significance of the N_2O priming effect associated with long-term applications of manure** Ryan Pearce*, Bobbi Helgason, Reynald Lemke, Richard Farrell	289	**The watershed observatory system: status and prospects** Henry David Venema	327	**Group project in RRM: more than one with the course** Tom Yates
8:45 - 9:00 am	266	**Effect of nitrogen fertilizer practices on nitrous oxide emissions from irrigated potato in Manitoba** Sally Parsonage*, Mario Tenuta, Alison Nelson, Dale Tomasiewicz, Ramona Mohr	311	**Validating the wind erosion risk indicator model using ^{137}Cs** Carolyn Baldwin*, David A. Lobb, Brian G. McConkey, Sheng Li and Phil N. Owens	247	**Engaging students on water and sanitation security in First Nations communities** Annemieke Farenhorst*, Helen Fallding, Karen Busby, Brenda Elias, Chris Metcalfe, Selvin Peter,and Ross McQueen

9:00 - 9:15 am	272	**Earthworms reduce soil nitrous oxide emissions during drying and rewetting cycles** Chen Chen*, Joann K. Whalen, Xiaobin Guo	335	**Mixing models: using environmental tracers to identify source apportionment** B. Semmens	225	**Questogo:bringing mobile technology into outdoor classroom** Carolyn King*, Julia Dordel, Maja Krzic, Suzanne Simard, Les Lavkulich
9:15 - 9:30 am	292	**Over-winter dynamics and associated losses of N_2O to air and drainage water following spring and fall plowdown of red clover in Truro, Nova Scotia** Brian Wallace*, David Burton, Derek Lynch, and Angela Bedard-Haughn			329	**Climate change or zombie apocalypse? Teaching environmental science at the tipping point** Fran Walley* and Tom Yates
9:30 - 9:45 am	306	**Continuous measurements of methane fluxes, environmental variables and manure properties from stored dairy manure over 16 months on a commercial farm** Gudmundur Johannesson*, Claudia Wagner-Riddle, Andrew VanderZaag, Rob Gordon, and Chris Duke	227	**Phosphorus loss in water observed during Alberta's BMP evaluation project** Barry Olson*, Janna Casson, Jollin Charest, Andrea Kalischuk, and Lynda Miedema	257	**Equity in education: a case study of under-representation at a Canadian university** Jenna O. Rapai*, Annemieke Farenhorst, Janice Dodd, Janice Ristock, Christine Van Winkle
9:45 - 10:00 am	307	**Bulking agents effects on greenhouse and nitrogen gas losses during composting of solids separated from hog slurry** Jolene Rutter*, Mario Tenuta, Matt Gervais, Gerry Dubé, Christine Rawluk	336	**Use of ^{137}Cs to determine role of riparian buffers in trapping sediment and phosphorus from agricultural fields** Philip N. Owens, David A. Lobb*, Katrina A. Caley, Carolyn Baldwin	297	**Effects of grassland set-asides on selected soil properties in the western Fraser Valley of British Columbia** Dru Yates*, Maja Krzic, David Bradbeer, Sean Smukler
10:00 - 11:00 am	**Break and Poster Session**					

Time	4. Agricultural Greenhouse Gas Emissions 1 (continued) Venue: Assiniboine Ballroom Chair: Elyn Humphreys		5. Environmental Fingerprinting and Footprinting (continued) Venue: Assiniboine B Chair: David Lobb		7. Soil Quality Gradients at the Landscape Level Venue: Selkirk Ballroom Chair: David Hopkins	
11:00 - 11:15 am	315	**Effect of shelterbelts for abating agricultural greenhouse gas emission across the Boreal Plains and Prairie eco-zones of Saskatchewan, Canada** Chukwudi Amadi*, Rich Farrell, Ken Van Rees	223	**Deciphering P sources in Lake Pepin** Ashley Grundtner and Satish Gupta*	267	**Spatio-temporal modeling of soil redistribution induced by sheet erosion using the Universal Soil Loss Equation** Brandon Heung*, Laurens Bakker, Suzana Dragićević, and Margaret Schmidt
11:15 - 11:30 am	320	**Can inclusion of 4 years of perennial forage in an annual crop rotation within the Red River Valley of the Canadian Prairies increase soil carbon storage and reduce nitrous oxide emissions?** K.L. Hanis*, M.Tenuta, B.D. Amiro, A.J. Glenn, S.E. Maas, and M. Gervais	296	**Tracking channel-floodplain sediment exchange with conservative and non-conservative geochemical tracers**	214	**Relationship of crop yield and protein content to soil properties in an undulating landscape in south central Saskatchewan** Elliott Hildebrand* and Jeff J. Schoenau
11:30 - 11:45 am	326	**Spatial distribution of greenhouse gas fluxes in drip and microspray-fertigated vineyards and orchards in the Okanagan Valley, British Columbia** Mesfin M. Fentabil* and Craig Nichol		Patrick Belmont*, Justin Stout		

11:45 - 12:00	201	**Alternative statistical distributions and transformation of nitrous oxide soil flux data** Alan P. Moulin*, Aaron Glenn, Mario Tenuta, David A. Lobb , Adedeji S. Dunmola, and Priyantha Yapa	291	**Investigating the role of connectivity and scale in assessing the sources of sediment in an agricultural watershed in the Canadian prairies using sediment source fingerprinting** Alexander J. Koiter*, Philip N. Owens, Ellen L. Petticrew, David A. Lobb, Kevin D. Tiessen and Sheng Li	319	**Use of a GIS/stratigraphic model to predict zones of elevated cadmium and other metals in soils derived from Cretaceous Pierre Shale on the Pembina Escarpment, Cavalier County, North Dakota** D. G. Hopkins*, A. L. Steffen, B. Sani-Eidukat, R. E. Utter
12:00 - 12:15 pm	228	**Linking soil profile greenhouse gas concentrations to surface emissions in a prairie pothole agricultural landscape** Xiaopeng Gao*, Nandakumar Rajendran, Mario Tenuta, Adedeji Dunmola, and David L. Burton	337	**Evaluation of dynamic image analysis for characterizing clast particles derived from bedrock outcrops in the South Tobacco Creek Watershed** Cenwei Liu*, David A. Lobb, Sheng Li	271	**Changing soil salinity gradients: an integrated approach to remediating brine-contaminated soils** R. G. Eilers, T.B. Goh, Jennifer I Nielsen*
12:15 - 12:30 pm	230	**Eddy covariance measurements of methane fluxes over arable land in Southern Ontario** Shannon E. Brown* and Claudia Wagner-Riddle			305	**Predicting the Potholes: digital soil mapping in the Prairie Pothole Region** Angela Bedard-Haughn*, Chuck Bulmer, Grace Frank, Eve Flager, Scott Smith
12:30 - 1:30 pm	**Lunch**					

Wednesday July 24 Afternoon

Time	8. General Soil Science Venue: Assiniboine Ballroom Chair: Joann Whalen		9. Soil Fertility and Chemistry 1 Venue: Assiniboine B Chair: Mehdi Sharifi		10. Measuring, Modeling and Managing Soil Carbon Exchanges Venue: Selkirk Ballroom Chair: Paul Bartlett	
1:30 - 1:45 pm	269	**Predicting macropore flow at the watershed scale with a re-conceptualized SWAT** David Poon*, Aubert Michaud, Joann Whalen, Simon-Claude Poirier, and Isabelle Beaudin	265	**Effects of biochar and biochar feedstock on soil microbial biomass, soil carbon and niotrogen mineralization and greenhouse gas emissions from soil** H. Zhang*, P. R. Voroney and G. W. Price	240	**Assessing carbon dynamics using diffuse reflectance infrared Fourier transform (DRIFT) spectroscopy in cover crop systems** Lance Ouellette*, R. Paul Voroney, and Laura L. Van Eerd
1:45 - 2:00 pm	232	**What if Luvisols ain't?** Dan Pennock* and Kendra Purton	212	**Canola yield and nutrient uptake as affected by biochar addition to a brown chernozem** Hasan Ahmed* and Jeff Schoenau	251	**A first order plus logistic (FLOG) model for soil respiration and soil mineral nitrogen dynamics following incubation with organic residues** J. Daniel Gillis *, and Gordon W. Price
2:00 - 2:15 pm	233	**Multiple working hypotheses for the genesis of a Brunisolic Gray Luvisol Catena in central Saskatchewan** Kendra Purton* and Dan Pennock	280	**Wood chip biochar effects on soil phosphorus dynamics in low phosphorous chernozemic soils** Surani Chathurika, Darshani Kumaragamage*, Francis Zvomuya and Don Flaten	246	**The organic carbon content and decomposition potential of tundra soil eroding into a thermokarst lake** Christina Z. Braul, Elyn Humphreys* and Pascale Roy-Léveillée
2:15 - 2:30 pm	209	**Subsoiling an irrigated and dryland brown chernozem: effects on soil density, moisture, yield and economic return** B. Ewen*, J. Schoenau and M. Grevers	263	**Soil phosphorus dynamics under annual vs. single applications of alkaline treated biosolids** Weixi Shu*, Gordon Price, Mehdi Sharifi, and Barbara Cade-Menun	324	**Understanding bio-physicochemical mechanisms of soil carbon protection using STXM-NEXAFS** Pavithra Pitumpe Arachchige*, Ganga Hettiarachchi, Chammi Attanayake and Charles Rice

	11. Fate of Trace Metals in the Environment Venue: Assiniboine Ballroom Chair: Steve Sheppard		12. Soil Ecology, Food Webs and Nutrient Cycling 1 Venue: Assiniboine B Chair: Adl Sina		10. Measuring, Modeling and Managing Soil Carbon Exchanges (continued) Venue: Selkirk Ballroom Chair: Paul Bartlett	
2:30 - 2:45 pm	310	**Mass balance of arsenic from poultry feed to poultry litter** Sanjay Gupta*, Martin Zuidhof, Gary Kachanoski and Tariq Siddique	304	**Aggregate-scale spatial heteogeneity of arbuscular mycorrhizal fungi in response to commercial mycorrhizal inoculation** M.A.K.Wijesinghe*, P. Voroney, J.N. Klironomos, M.M. Hart, and K.E. Dunfield	323	**Microbial and carbon dynamics in a buried A horizon from an eroded catena at St. Denis National Wildlife Area** H.J. Konschuh, A. Bedard-Haughn, A. J. VandenBygaart and B.L. Helgason*
2:45 - 3:00 pm	249	**Total and bioavailable metals in compost, soil, and leachate from waste gypsum wallboard composting** Chris Richards* and G. W. Price	217	**Effect of short term forage legumes on phosphorus availability to a following winter crop** Mikrigul Rehmut*, Jeff Schoenau, and Paul Jefferson		
3:00 - 3:15 pm	321	**Potential for transfer of lead, arsenic and polycyclic aromatic hydrocarbons from urban soils to vegetables and humans** Chammi Attanayake*, Ganga Hettiarachchi, Sabine Martin, and Gary Pierzynski	302	**Phosphorus uptake by ryegrass in response to rate and type of P amendment in soils under long-term organic, organic manure-amended, conventional and native prairie management** T Fraser*, D Lynch, J Nimmo, M Entz, and K Dunfield		
3:15 - 4:30 pm	**Break and Poster Session**					

Thursday July 25 Morning

Time	13. Agricultural Greenhouse Gas Emissions 2 Venue: Assiniboine Ballroom Chair: Richard Farrell		14. Soil Fertility and Chemistry 2 Venue: Assiniboine B Chair: Darshani Kumaragamage		15. Nitrogen Cycling Across Land Uses and Ecosystems 2 Venue: Selkirk Ballroom Chair: Scott Chang	
8:30 - 8:45 am	241	**Nitrous oxide and carbon dioxide emissions from aerobic and anaerobic incubations: effect of core length** Xiaobin Guo*, Craig F. Drury, W. Daniel Reynolds, Xueming Yang, and Ruqin Fan	218	**Variation in growth response of lentil to zinc fertilization and residual Zn availability to wheat in ten Saskatchewan soils** Muhammad A Maqsood*, Jeff Schoenau, Albert Vandenberg, Ron Urton and Cory Fatteicher	211	**Nitrogen budget and nitrogen fertilizer use efficiency in China** Xiaoyuan Yan* and Chaopu Ti
8:45 - 9:00 am	258	**Greenhouse gas flux from western U.S. agroecosystems: Synthesis of mitigation opportunities** M.A. Liebig*, and A.D. Halvorson	204	**Soil nitrate and phosphate after fourteen years of liquid swine manure addition in north western Saskatchewan** J.J. Schoenau*, T. King and S.S. Malhi		
9:00 - 9:15 am	273	**Farm-scale assessment of greenhouse gas mitigation strategies in dairy livestock-cropping-systems** Claudia Wagner-Riddle*, Kari Dunfield, Craig Drury, Robert Gordon, John Lauzon, Bill Van Heyst, and Andrew VanderZaag	299	**Effects on soil chemical parameters and crop yields over five years of land applying an alkaline treated biosolid** G.W. Price, and K. Liu	234	**Assessment of modified Swiss sandwich system of ground cover for supplying nitrogen to an organic apple orchard** Mehdi Sharifi*, Zahidul Alam, Julia Reekie and Andrew Hammermeister
9:15 - 9:30 am	275	**Farming 4R Climate: Utilizing 4R Nutrient Stewardship to Reduce Greenhouse Gas Emissions from the Application of Fertilizer and Other Crop Nutrients** Clyde Graham, Kristian Stephens*, Cassandra Cotton, Amanda Giamberardino, Bruce Ringrose, Shahira Esmail, and Dan Heaney	208	**Conversion of conservation tillage to rotational tillage resulted in reduced loads of phosphorus during snowmelt runoff in the Canadian Prairies** Kui Liu*, Jane A. Elliott, David A. Lobb, Don N. Flaten, and Jim Yarotski	237	Nitrogen leaching from sheep grazed hill country in New Zealand Coby Hoogendoorn*, Rogerio Cichota, Iris Vogeler, Brian Devantier and Catherine Lloyd-West

	13. Agricultural Greenhouse Gas Emissions 2 (continued) Venue: Assiniboine Ballroom Chair: Richard Farrell		16. Soil Survey and Classification Venue: Assiniboine B Chair: Marla Riekman		15. Nitrogen Cycling Across Land Uses and Ecosystems 2 (continued) Venue: Selkirk Ballroom Chair: Scott Chang	
9:30 - 9:45 am	294	**Carbon balance of an organic cropland in southwestern Manitoba** Aaron Glenn* and Henry Wilson	259	**Detailed soil survey in the municipalities of Blanshard and Hamiota** Sheila Cook	264	**Overwinter transformation and fate of fall-applied nitrogen in various Canadian ecozones** Martin H. Chantigny*, Frank J. Larney, Denis A. Angers, Shabtai Bittman, David Lapen, Philippe Rochette
9:45 - 10:00 am	202	**Estimating greenhouse gas emissions using experimental data** Ahmad S. Mat Su*, Viacheslav I. Adamchuk, Chandra A. Madramootoo, Joann K. Whalen, and Hsin-Hui Huang	303	**Soil survey information vital for increasing productivity and sustainability in the RMs of Ritchot and Springfield, Manitoba** Yi Zhang	276	**Growing season denitrification losses impacted by land management practices, soil properties and weather conditions in manure-amended perennial hayfield and corn-soybean-wheat rotations in Atlantic Canada** Keith D. Fuller*, David L. Burton, Craig F. Drury, Mark G. Grimmett, Bernie J. Zebarth, Jeffrey L. Franklin, Vernon Rodd, Jack Van Roestel, Ed St. George
					19. Teaching and Training in Soil Science 2: Emerging Approaches in Teaching and Learning in Soil Science Venue: Selkirk Ballroom Chair: Maja Krzic	
10.00 - 10.15 am	328	**Emissions of ammonia, methane and nitrous oxide from dairy production facilities in southern Idaho** April B. Leytem*, Robert S. Dungan, and David L. Bjorneberg	295	**Soil development and management in the south-western Manitoba** Ronggui Wu*, Sheila Cook, Yi Zhang and Lynn Manaigre	333	**Video-conferencing to deliver a graduate course on agricultural sustainability** Don Flaten*, Henry Janzen, Kim Ominski and Amanda Taylor

10.15 - 10:30 am	285	**Life cycle assessment of greenhouse gas impacts of different overwintering strategies for beef production in Western Canada** Goretty Dias*, Kumudinie Kariyapperuma, Gudmundur Johannesson, Matthew Wiens, Steve Young			235	**Field handbook for the soils of western Canada - an update** Kent Watson*, Dan Pennock and Paul Sanborn
10.30 - 11.00	**Break**					
	17. Agricultural Meteorology and Soil Physics Venue: Assiniboine Ballroom Chair: Paul Bullock		**18. Soil Ecology, Food webs and Nutrient Cycling 2** Venue: Assiniboine B Chair: Adl Sina		**19. Teaching and Training in Soil Science 2: Emerging Approaches in Teaching and Learning in Soil Science (continued)** Venue: Selkirk Ballroom Chair: Maja Krzic	
11:00 - 11:15 am	248	**Determinants of summer weather patterns on the Canadian Prairies: implications for long-lead forecasting of grain yields** Ray Garnett* and Madhav Khandekar	229	**A tale of two trees: soil biogeochemistry in the boreal mixedwood** Sylvie A. Quideau*, Emily Lloret, Mathew J.B. Swallow, and Charlotte E. Norris	282	**Development of research and extension opportunities on soil health in North Dakota** Abbey F. Wick*, Francis X.M. Casey and G. LaPlante
11:15 - 11:30 am	256	**Testing the ability of MODIS-NDVI models to forecast crop yields on the Canadian Prairies** M.S. Mkhabela* and P.R. Bullock	318	**Soil food web controls on nitrogen mineralization: Can these be integrated into measures of the soil nitrogen supply?** Joann K. Whalen*, Maria Kernecker, Ben W. Thomas, Vanita Sachdeva and Christopher Ngosong	270	**Location-based tool brings soil science out of the classroom through mobile technology** M. Krzic*, K. Watson, S. Dyanatkar, J. Wilson, C. Crowley, P. Sanborn, A. Bedard-Haughn and N. Basiliko

11:30 - 11:45 am	221	**A generalized analysis for the variable-head borehole permeameter test** Dan Reynolds*, Craig Drury, Xueming Yang and Jingyi Yang	268	**Fine-scale, in-situ phosphatase activities are not associated with specific fungal communities** Aaron Godin and Melanie Jones*	309	**Land reclamation international grad school (LRIGS)** M. Anne Naeth
11:45 - 12:00	293	**The effect of freeze-thaw cycles on atterberg limits of clay soils** Daryl Dagesse	238	**Tracing C and N through soil food webs with stable isotopes** Sina Adl*, and Felicity Crotty	236	**BC regional soil description and interpretation short courses 2009-2013** Kent Watson* and Shannon Berch
12:00 - 12:15 pm			255	**Effects of long-term and recently imposed tillage on the concentration and composition of amino sugars in a clay loam soil** Bin Zhang, Craig F. Drury *,Xueming Yang, W. Daniel Reynolds, Xudong Zhang		

POSTER SESSIONS

Poster Session 01 Tuesday July 23, 3:00 - 4:00 pm		
Presenting Author		**Poster Title**
61	Chukwudi Amadi	The impact of a shelterbelt on soil properties and greenhouse gas emission in an adjacent crop field
69	Paul Bartlett	Soil respiration in a deciduous mixedwood forest near Borden, Ontario
54	Sebastian Cambareri	Nitrous oxide emissions as affected by timing and method of dairy manure application in corn
28	Scott X. Chang	Soil carbon pools in different size and density fractions in three agroforestry and adjacent agricultural ecosystems in central Alberta
93	Tom Forge	Use of dairy manure solids as mulch for establishment of red raspberry: influences on soil nematode communities and N and P availability
52	Trevor Fraser	Soil phosphorus turnover in long-term organic and conventional management systems
14	Xiaopeng Gao	Greenhouse gases emissions from hog slurry applied to alfalfa and sainfoin on a silt loam soil in southern central Manitoba
29	Robert Gulden	Mycorrhizal fungi colonization and community dynamics in a long-term rotation as influenced by previous crop and weed management intensity
22	Xiaobin Guo	Effect of anaerobically digested dairy manures on nitrous oxide emissions, soil denitrification rates, and denitrifier abundance in short-term incubations
75	Krista Hanis	Seasonal carbon flux dynamics of a subarctic fen within the Hudson Bay Lowlands
68	B.L. Helgason	Response of soil microbial communities to ^{13}C labelled barley residue depends on management and is site-specific
20	Coby Hoogendoorn	Nitrous oxide emission factors for sheep urine deposited on winter-grazed forage brassica and ryegrass swards in New Zealand
11	Roland Kröbel	Using the Holos model to estimate the greenhouse gas emission inventory for cropland in the Black-Brook watershed, NB, during the years 1988 - 2011
30	M.A. Liebig	Quantifying greenhouse gas mitigation potential of cropland management practices: A review of the GRA Croplands Research Group Greenhouse Gas Network
31	Siobhan E. Maas	Agricultural greenhouse gas outreach for school children and the public
85	Guillermo Ramirez	Nitrous oxide fluxes in crop fields receiving various manure managements: A compilation of two studies in Indiana and Alberta
56	Jolene Rutter	Development of an automated system for greenhouse and nitrogen gas flux determinations from compost

34	Gurbir Singh Dhillon	Soil carbon sequestration and dynamics in the shelterbelts of Saskatchewan
59	A. Sissoko	Greenhouse gas emissions from dairy manure at various levels of storage tank emptying
13	David Snider	Combining micrometeorological measurements with molecular and stable isotope techniques to understand the mechanisms producing nitrous oxide emissions in dairy manure-fertilized soils
39	Muhammad F. Sulaiman	Net ecosystem exchange of dairy cropping systems
21	Amanda M. Taylor	Field-scale carbon dioxide and methane exchange over winter bale-grazing, backgrounding steers in Brandon, Manitoba
80	K.A. Thompson	Abundance of denitrifier communities in switchgrass and miscanthus biomass production systems
46	Andrew VanderZaag	Nitrous oxide emissions and nitrogen leaching in Dairy feed crops receiving manure, anaerobically digested manure, and urea
45	Andrew VanderZaag	Towards a methane emission inventory that responds to changes in manure management on Canadian farm
16	Tanja Voegel	Nitrifier and denitrifier abundances and activities in soils of woody perennial crops in a semi-arid inter-mountain basin environment
62	Joann K. Whalen	Elevated earthworm populations affected primary production and nitrous oxide fluxes from forage systems in a field enclosure study
47	Alex Woodley	Nitrogen carryover effects of various organic amendments on subsequent season cereal production within Southern Ontario, Canada

Poster Session 02 Wednesday July 24, 10:00 - 11:00 am

Presenting Author		Poster Title
17	Paul Bartlett	Canopy-snow interaction in CLASS: An investigation into canopy albedo, interception and unloading in relation to weather
12	Cory Fatteicher	The effect of wild oat stage on uptake and release of nutrients
64	Charles Geddes	The allelopathic potential of hairy vetch, fall rye, and winter wheat in a silty clay loam soil
67	John Heard	State and provincial soils: Pick yours out of this line-up!
49	Aruna Herath	Effects of liquid, solid and compost swine manure on soil phosphorus fractions in a clay loam soil under corn-soybean rotation
3	Nazrul Islam	Impact of inoculation with *glomus irregulare* on colonization and phosphorus uptake by pea (*Pisum sativum L.*) as affected by soil and climate
18	Lindsay Jmaiff	Method development for determining heavy metal concentrations and distribution in soil horizons located near Kamloops, BC

Panchali Katulanda	Assessing the impact of soil origin on microbial community structure of genetically different transplanted soils
Tom King	Effect of cattle manure application variability on soil nutrient movement in a Black Chernozem
Elizabeth MacCormick	Effect of salmon-based silage on soil nutrient dynamics: an incubation study
Mihiri C.W. Manimel Wadu	Probing inorganic P compounds in fertilized soils - A comparison of ^{31}P MAS NMR, P K- edge and P L-edge XANES
Mihiri C.W. Manimel Wadu	P solubility in ten Manitoba soils as influenced by sulphate salt addition – An exploratory study
Ahmad S. Mat Su	Rapid measurement of nitrate ion activity using a direct soil sensing approach
Sirajum Munira	Effect of phosphorous and cadmium levels on glyphosate sorption in soil under acidic and alkaline conditions
Oluwatoyin Obikoya	Continuous phosphorus fertilizer addition affects phosphorus forms of contrasting prairie soils
Lance Ouellette	Corn stover removal effects on soil aggregation and squash fruit yield in cover cropping systems
Kendra Purton	Characterization of soil organic matter along a climosequence in the grassland-forest transition in west-central Saskatchewan
Karin Rose	The effect of antibiotic presence and agitation on estrogen mineralization in liquid swine manure
Paul Sanborn	Organic Cryosols on forested upland slopes, northern Rocky Mountains, British Columbia
S. M. Sayem	Measurement of N release from solid beef and liquid swine manure in a growing season using anion exchange resin
Lakesh Sharma	Relationship of corn height, active optical sensor readings and corn yield under different soil surface textures in North Dakota
Ahmadreza Sheikhhosseini Esfahani	Sorption of nickel on palygorskite, sepiolite and calcite: Equilibrium and kinetic studies
Steve Sheppard	Vegetated buffer strips: 12 sites and 3 years and little evidence of phosphorus retention
Joanne Thiessen Martens	Profitable, sustainable and resilient cropping systems: A vision for the development of Canadian prairie agriculture
Laura L. Van Eerd	Long term effects of tillage system and crop rotation on soil physical and chemical properties in a Brookston clay loam at Ridgetown, ON
Brian Wallace	Spring wheat yields and $NO3^-$ leaching from green manure plowdown in Nova Scotia
Jen Webb	Information technology to assess and achieve compliance with Manitoba regulations

5	Xueming Yang	Potential of using mid-infrared spectroscopy in study of soil and solution samples in Canada

Poster Session 03 Wednesday July 24, 3:15 - 4:30 pm

Presenting Author		Poster Title
84	Mayowa. F. Adelekun	Temperature data logging system for soil temperature measurement
36	Mahtab Ahmad	Metal immobilization and soil quality improvement in military shooting range soil using soybean stover- and pine needle-derived biochars
53	Taiwo Akinseloyin	Cropping systems and swine manure types affect soil surface moisture and temperature
57	Carolyn Baldwin	Particle size and ^{137}Cs characteristics of wind eroded sediments in southern Alberta
76	Sukhwinder Bali	An evaluation of natric soil characterization data in North Dakota: A challenge for contemporary interpretation
26	Louise Barthod	Sediment colour analysis by UV-vis and NIR reflectance spectrometry, a new fingerprinting method to identify sediment sources
32	Eric Bremer	Evaluation of PRSTM probes for monitoring soil nutrients in potato production
83	Barbara J. Cade-Menun	The effect of in-field winter bale grazing on soil nutrients in pastures in Saskatchewan
81	Katelyn A. Congreves	Influence of used cooking oil on the fate of broccoli crop residue-derived ^{15}N
40	Ann-Marie Fortuna	Soil health, land management and remediation of sodicity
71	Keith D. Fuller	Nitrogen leaching losses in manure amended perennial hayfield and corn-soybean-wheat rotations in Atlantic Canada.
77	A.W. Gillespie	Biochemical characterization of three soil profiles across an eroded prairie catena
78	A.W. Gillespie	Detecting biochemical signals in permafrost soil organic matter
63	Qiang Huang	The variation of tillage speed and its effect on tillage erosion
35	Nicolas A Jelinski	Meteoric Beryllium-10 as an *in-situ* tracer of landscape change due to land-use: theoretical considerations and case-study
9	Francis Larney	Long-term recovery of soil organic matter and aggregates stability in an artificially eroded soil under various one time amendments
55	Cenwei Liu	Dynamics of sediment particle size in the Tobacco Creek Watershed
87	David Lobb	All fats are not equal: Considerations when using fatty acid biomarkers in compound-specific stable isotope soil and sediment tracing
88	David Lobb	Preliminary assessment of sediment sources in the Lower Little Bow River watershed using ^{137}Cs as a tracer

89	David Lobb	The effectiveness of small-scale headwater storage dams and reservoirs on stream water quality and quantity in the Canadian Prairies
86	David Lobb	Unravelling soil erosion processes within agricultural fields, the upland sources of sediments from agricultural watersheds
37	Ross McQueen	Increasing the accessibility of extension information on the Internet
91	Brittany McWhirter	Determination of the bedrock stratigraphy of the South Tobacco Creek area in the Pembina Hills portion of the Manitoba Escarpment using field investigation, LIDAR and photo imagery
50	Ramona Mohr	Estimation of in-season nitrogen mineralization in irrigated potato production systems in Manitoba using a nitrogen balance approach
90	Halya Petzold	Channel morphology of the Tobacco Creek watershed in southern Manitoba
7	Réjean Picard	Nutrient cycling in winter grazing cattle on pasture: Forage impact five years following bale grazing once
8	Réjean Picard	Nutrient cycling in winter grazing cattle on pasture: Soil impact, five years following bale grazing once
15	Jeff Schoenau	The effect of biochar on soil nitrogen availability and greenhouse gas production in two fertilized prairie soils
25	Yong Sik Ok	Effects of pyrolysis temperature and feedstock on metal availability and microbial community in biochar-amended soil
43	Mervin St. Luce	Particulate organic matter and soil mineral nitrogen concentrations are good predictors of the soil nitrogen supply to canola following legume and non-legume crops in western Canada
72	Ben W. Thomas	Nitrogen mineralization from a sandy loam and silty clay soil with a three-year history of manure and mineral fertilizer
82	Yanhua Wang	Emissions of greenhouse gases from constructed wetlands for nitrogen removal
6	Xueming Yang	Fall accumulation and spring release of soil mineral nitrogen following winter wheat and before corn planting on a Brookston clay loam in SW Ontario

ORAL SESSION ABSTRACTS

Listed in alphabetical order by first author.
* indicates presenting author.

Instructions for Speakers:

All speakers are required to preload their power point presentation 30 minutes prior to the start of their session (either in the morning, at lunch, or during a coffee break) to the presentation room computer. Personal laptops cannot be used in meeting rooms while giving your oral presentation. At the end of the meeting, all files will be destroyed.

The time allotted is 12 minutes for presentation and 3 minutes for discussion and changeover to the next speaker. For some invited presentations, the time allotted may be different. Please check with your session convener if your presentation is an invited presentation for a special session. Session chairs will hold you to the allotted time and will show a flash card 2 and 1 minute before your time ends.

Comparison of colorimetric and ICP methods of phosphorus determination in soil extracts

O.O. Adesanwo, D.V. Ige, L. Thibault, D.N. Flaten, and O.O. Akinremi

A possible change in the method of phosphorus (P) determination from the traditional colorimetry method to inductively coupled plasma (ICP) optical emission spectroscopy could have serious implications on agronomic and environmental P management. Thus, the objectives of this study were to compare P determination by colorimetric and ICP methods in four extractants namely Olsen, Mehlich-3, $CaCl_2$ and water extraction methods and to evaluate the possibility of developing conversion equations for P determination by the two methods in Manitoba soils. Sixty surface soil samples (30 manured and 30 non-manured) were collected from across Manitoba and extracted with Mehlich-3 reagent, Olsen solution, $CaCl_2$ solution and deionized water. Extractable P in the extract was determined by colorimetric (Col-P) and ICP (ICP-P) methods. Mean comparison showed that P determined by ICP in Mehlich-3, water and $CaCl_2$ solutions were significantly greater than those determined by colorimetric method ($P < 0.05$) in the study. The differences between P determinations by the 2 analytical methods in the extractants were probably due to the presence of organic P which was included in ICP determination but not in colorimetric determination. The influence of other factors such as the presence of colloidal particles on the P that was determined by the 2 methods could not be ruled out. However, Olsen P determined by colorimetric method was not significantly different from the values determined by ICP ($P > 0.05$) probably because the alkaline nature of this extractant enhanced the hydrolysis of organic P in the extract, thus including organic P in the colorimetric determination of P. There were significant correlations between the two methods of P determination in the various extracting solutions with correlation coefficients ranging between 0.94 and 1.00. The 2 methods of P determination were linearly related for all the extracting solutions.

Tracing C & N through soil food webs with stable isotopes

Sina Adl* and Felicity Crotty
Department of Soil Science, University of Saskatchewan

We developed protocols to trace C and N nutrients through the soil food web with intact soil cores and microcosms using ^{13}C and ^{15}N stable isotopes tracers. Intact soil cores showed labelled bacteria were consumed through the bacterivory pathway, but could be traced through successive trophic levels into above-ground insects and plants. A similar protocol with labelled protists demonstrated novel food web interactions, which included micro-invertebrate consumers. The data were compared to natural abundances of the isotopes in environmental samples from a pasture and adjacent forest field sites. A new protocol was developed to follow the fungivory pathway in laboratory microcosms, through nematodes and micro-arthropods. These results demonstrate that existing estimates of C and N turnover and transfer through the food web can be improved through these new protocols. We further modified the method for analysis of stable isotopes in the mass spectrometry step by altering the chemistry at combustion. We can now detect isotopes from as little as 10 µg instead of 1 mg in standard procedures. Thus a small number of individuals suffice, preserving the integrity of feeding guilds in samples processed, instead of bulking unrelated super-orders for sample analysis. The quantitative information vastly improves previous estimates of nutrient transfer rates in soil food webs. We synthesize the results of 4 publications and the implications of these results on our understanding of soil food webs.

Canola yield and nutrient uptake as affected by biochar addition to a brown chernozem

Hasan Ahmed*, and Jeff Schoenau
Department of Soil Science, University of Saskatchewan,
51 Campus drive, Saskatoon, SK S7N 5A8
* hasan.pervej@usask.ca

The response of canola (*Brassica napus*) to biochar amendments was tested to investigate the effects of biochar on soil nutrient availability and crop growth. A series of pot experiments and a field experiment was conducted with four different biochars added to a Brown Chernozem at two rates (1 and 2 t ha^{-1}) with or without N and P fertilizer. Parameters tested included germination, yield, soil organic carbon, above ground plant nitrogen and phosphorus uptake and % plant recovery of applied N and P. The gravimetric soil moisture content was also measured. The canola yields in the controlled environment and field were significantly increased in only a few cases with biochar amendment and only when in combination with fertilizers. Occasional negative effects were also observed depending on biochar source. Soil amended with biochar showed increased nutrient uptake and fertilizer recovery in some cases but the effects were small and not consistent. Soil moisture content and water use efficiency were not significantly affected by biochar amendment. Small increases in soil pH and organic carbon contents were observed. Lack of large effects of biochar on plant growth and nutrient uptake are likely due to inherent high ion retention capacity of the Chernozem and the low rates of biochar utilized.

Effect of shelterbelts for abating agricultural greenhouse gas emission across the Boreal Plains and Prairie eco-zones of Saskatchewan, Canada

Chukwudi Amadi*, Rich Farrell, and Ken Van Rees
Department of Soil Science, University of Saskatchewan, Saskatoon, SK
* cca423@mail.usask.ca

The Agriculture and Agri-Food Canada Prairie Shelterbelt Program has distributed over 600 million shelterbelt tree and shrub seedlings to thousands of landowners across the Prairies since 1903 to reduce wind speed and protect crops. Despite the resulting large-scale shelterbelt planting, very little is known about their capacity to mitigate agricultural greenhouse gases (GHGs). The objective of this study was to investigate the atmosphere–soil exchange of CO_2, CH_4 and N_2O at nine field shelterbelt sites compared to adjacent crop fields across the Boreal Plains and Prairie eco-zones of Saskatchewan. The study sites are located at the Conservation Learning Centre (CLC), Prince Albert, University of Saskatchewan Horticulture facility, Saskatoon; and Canada Saskatchewan Irrigation Diversification Centre (CSIDC), Outlook. Preliminary measurements of CO_2, CH_4 and N_2O were carried out along transects between September and November 2012 using a sealed chamber method. Results indicated that the shelterbelt plots were sinks of N_2O (-0.391 N_20-N ha^{-1} d^{-1}), while the adjacent crop fields were sources (0.254 N_20-N ha^{-1} d^{-1}). CO_2 emission was slightly higher in the crop field (6.20 CO_2-C ha^{-1} d^{-1}), than the adjacent shelterbelt plots (5.822 CO_2-C ha^{-1} d^{-1}). Both crop field and shelterbelt plots were slight sinks of CH_4 (-0.002 and -0.001 CO_2-C ha^{-1} d^{-1}, respectively). Further year-long monitoring is required to determine the impact of shelterbelt planting for C sequestration and abating agricultural GHG emissions across the Boreal Plains and Prairie Eco-zones.

Degradation kinetics of spiked vs. excreted chlortetracycline, sulfamethazine and tylosin during composting of beef cattle manure

I.D. Amarakoon[1], S. Sura[2], F. Zvomuya[1], T. McAllister[3], F. Larney[3], D. Degenhardt [4], A. Cessna[2], and S. Xu[3]
[1]Department of Soil Science, University of Manitoba, Winnipeg, MB R3T 2N2
[2]Environment Canada, 11 Innovation Boulevard, Saskatoon, SK S7N 3H5
[3]Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge, AB T1J 4B1
[4]Alberta Innovates - Technology Futures, 250 Karl Clark Rd., Edmonton, AB T6N 1E4

In studies on the fate of veterinary antimicrobials (VAs) in the environment, VAs are commonly spiked into manure as a surrogate for excretion by animals. However, whether spiked VAs accurately reflect the behavior of VAs administered and excreted by animals remains unexplored. This study compared the dissipation of chlortetracycline (CTC), sulfamethazine (SMZ) and tylosin (TYL) during laboratory composting of manure spiked with the VAs *vs.* manure containing VAs fed to and excreted by animals. Manure was collected from pens in which steers had been fed diets containing (kg^{-1} dry feed): (i) 44 mg CTC, (ii) a mixture containing 44 mg each of CTC and SMZ (CTCSMZ), (iii) 11 mg TYL, and (iv) no antimicrobial (control). Manure from the control was spiked with the three VAs to achieve concentrations similar to those excreted. Manure samples were taken at 2- to 3-d intervals. Temperature averaged 35°C on Day 0 and peaked at 44°C on Day 1 before declining to 22°C after 30 d. The presence or type of antimicrobial did not affect mean temperature. Percent degradation of the compounds was greater for excreted CTC (mean for both formulations of CTC = 94%) than spiked CTC (80%), but lower for excreted SMZ (69%) and TYL (50%) than their spiked surrogates (95% for SMZ, 92% for TYL). The first order degradation rate constants were 0.179 µg kg^{-1} day^{-1} for fortified TYL vs. 0.086 µg kg^{-1} day^{-1} for excreted TYL, 0.094 µg kg^{-1} day^{-1} for fortified CTC vs. 0.132 µg kg^{-1} day^{-1} for excreted CTC, and 0.083 µg kg^{-1} day^{-1} for fortified SMZ vs. 0.064 µg kg^{-1} day^{-1} for excreted SMZ. In conclusion, the dissipation dynamics of spiked VAs may not accurately represent the fate of these antimicrobials when they are consumed, passed through the digestive tract, and excreted by the animal.

Phosphorus release from flooded soils in relation to soil test P and degree of P saturation

Geethani Amarawansha[1], Darshani Kumaragamage[2], Don Flaten[1], Mario Tenuta[1], Wole Akinremi[1], and Francis Zvomuya[1]
[1]Department of Soil Science, University of Manitoba
[2]Department of Environmental Studies and Sciences, University of Winnipeg
[*] eragodag@cc.umanitoba.ca

Various environmental and soil factors determine P retention in soils and release to water (sorption and desorption). A laboratory study was conducted to examine the effect of flooding on release of resident and applied P to surface water and pore water using 12 soils from Manitoba. Solid dairy cattle manure amended (100 kg P ha^{-1}) or unamended surface soils were incubated for four weeks and flooded with RO water to a height of 5 cm to simulate flooding and develop anaerobic conditions. Soil pore and surface water samples were collected each week over eight weeks and analyzed for dissolved reactive P (DRP) and dissolved Fe, Mn, Ca, Mg, and S concentrations. Soil samples collected before and after the anaerobic incubation were also analyzed for Olsen, Mehlich-3 and water extractable P, Mehlich-3 extractable Fe, Mn, Ca, Mg, and Al, and P sorption index (P150). Soil redox condition was measured when water and soil was sampled. Concentrations of DRP in soil pore water increased in all soils with flooding. In ten of the twelve soils, concentrations of DRP in ponded surface waters increased 2-14 fold after 21 days of flooding compared to the first day after flooding. In the other two soils, DRP concentrations in the ponded water were stable or decreased slightly during the study period. Between 28 and 56 days after flooding, DRP concentrations in surface and pore water were stable in most soils with few exceptions. Initial soil test P and degree of P saturation were highly correlated with the pore and flood water DRP concentrations after the onset of anaerobic conditions. Despite increased P release into soil pore and surface water during the anaerobic conditions, P adsorption capacity as well as Olsen and Mehlich-3 extractable P of most unamended soils remained unchanged. In manured soils, P adsorption capacity increased in 6 of the 12 soils but remained relatively unchanged in the other soils. Results suggest that P release from soils to surface water and pore water under flooded conditions depends on initial soil test P and the degree of P saturation, and does not always result in a decrease in soil available P.

Potential for transfer of lead, arsenic and polycyclic aromatic hydrocarbons from urban soils to vegetables and humans

Chammi Attanayake[*], Ganga Hettiarachchi, Sabine Martin, and Gary Pierzynski
Department of Agronomy, Kansas State University

Urban agriculture is becoming a significant source of food production. Urban soils may have high concentrations of potentially toxic contaminants originated from past human activities. Lead (Pb), arsenic (As) and Polycyclic Aromatic Hydrocarbons (PAHs) are most commonly found contaminants in urban soils that have potential for causing health hazards to humans. We conducted field experiments at four urban gardens located in the United States to evaluate transfer of Pb, As and PAHs to plants and humans under different compost type treatments. The locations were: 1) Kansas city, MO; 2) Indianapolis, IN; 3) Philadelphia, PA; and 4) Pomona, CA. The site in Indianapolis was contaminated with Pb (449±18 mg/kg), As (48±2 mg/kg) and PAHs (benzo[a]pyrene: 1.4-9.9 mg/kg). All other three sites were contaminated with Pb. The total Pb concentrations in soils were 140±6, 215±11 and 1500±41 mg/kg in Pomona, Kansas city, and Philadelphia, respectively. We added locally available compost in all these sites, except in Indianapolis where we added four types of composts with different maturity and origin. A type of a fruiting vegetable, a leafy vegetable and a root crop were grown in the each test plot. Compost addition diluted the total concentrations of contaminants in all soils significantly (15-50%). In general, compost addition did not reduce the concentrations of contaminants in the vegetables, comparing to the control. Root crops accumulated Pb greater than the maximum concentrations limits (MCLs) given by WHO/FAO. Other vegetables contained lower concentrations of contaminants than the MCLs. Compost addition reduced bioaccessible Pb and As concentrations in the soils as determined by an *in-vitro* physiologically based extraction technique (PBET). X-ray Absorption Fine Structure Spectroscopy (EXAFS) studied showed that the majority of Pb in the urban soils were sorbed to organic or inorganic soil constituents.

Assessing the relationship between pH and phosphorus behaviour in central Ontario soils

S.R. Baker[1*], S.A. Watmough[2], and M.C. Eimers[3]
[1]Environmental and Life Sciences Graduate Program
[2]Environmental and Resource Science Program
[3]Department of Geography, Trent University, ON
[*] scottbaker@trentu.ca

Total phosphorus (P) concentrations declined between 1980 and 2000 in many lakes and streams in central Ontario; over the same time period forest soils in this region became more acidic (Emiers et. al. 2009; Watmough and Dillon 2004). This study investigated how soil acidity was related to P speciation and P sorption to evaluate the potential influence of long term changes in soil pH on P release to surface waters. Soils were collected from 18 soil pits in three forested sub-catchments with similar bedrock geology and a wide range of soil pH. Soils were analysed by horizon for pH, P speciation via a modified Hedley P fractionation, as well as other chemical parameters. Batch P sorption experiments at a [P] of 45.2 µM were preformed on selected B-horizon soils at a variety of pH values (3-6.5) in 0.01M $CaCl_2$. The majority of extractable P in these soils exists in the B-horizon. Oxalate extractable aluminium (Al_{ox}) was not related to pH but strongly related to the proportion of oxalate extractable P. A higher proportion of labile P species was observed in lower pH B-horizon soils, and less sorbed P was measured on B-horizon soils in acidified solutions. These results suggest there could be higher P export from acidified soils in these sub-catchments and thus do not explain the aforementioned TP decline observed in the respective lakes. Possible mechanisms explaining the observed relationships will be discussed.

References:

Eimers et. al. 2009. Canadian Journal of Fisheries and Aquatic Sciences. 66: 1682-1692

Watmough and Dillon. 2004. Biogeochemistry. 67: 369-398

Validating the Wind Erosion Risk Indicator Model Using ^{137}Cs

Carolyn Baldwin[1*], David A. Lobb[1], Brian G. McConkey[2], Sheng Li[3], and Phil N. Owens[4]
[1]Department of Soil Science, University of Manitoba, Winnipeg, MB R3T 2N2
[2]Semiarid Prairie Agricultural Research Centre, Agriculture and Agri-Food Canada, Swift Current, SK S9H 3X2
[3]Potato Research Centre, Agriculture and Agri-Food Canada, Fredericton, NB E3B 4Z7
[4]University of Northern British Columbia, Prince George, BC V2N 4Z9
[*] baldwin.cdg@gmail.com

Agri-environmental indicators are utilized to provide a glimpse into the overall environmental performance of the agriculture sector. Agriculture and Agri-Food Canada (AAFC) utilizes the Wind Erosion Risk Indicator model (WindERI), in combination with risk indicators for water and tillage erosion, to determine soil erosion risk on soils in the Prairie Provinces. Using the radionuclide ^{137}Cs as a tracer, rates of total soil erosion can be estimated, allowing the WindERI to be validated. Two pivot irrigated fields and two reference sites located in southern Alberta were examined. This semi-arid area is classified as high risk for wind erosion based on AAFC's current WindERI. Analysis indicates that full core 137 Cs inventory values from the cultivated portion of both fields were lower than the grassed corners in each field, and nearby reference sites were not significantly different from the cultivated portions. The 137 Cs profiles within cores from these field sites, their grassed corners and the reference sites do not show evidence of appreciable sedimentation. Surface sample ^{137}Cs activity levels show no evidence of appreciable sedimentation either. This study will provide solid validation for the WindERI and provide policy makers with a reinforced scientific tool to evaluate existing programs and policies. Thus, allowing Canada's agricultural sector to better achieve economic, environmental and social sustainability.

Value enhancement of municipal organics Compost through the addition of effective microorganisms

Basanti Bandekar* and G.W. Price
Dalhousie University, Truro, NS
* Basanti.Bandekar@dal.ca

In 2008, Nova Scotia produced 321,352 MT of waste which consisted of 58% non-residential and 42% residential waste (source separated organics, SSO), of which major portion is diverted to landfills. There are several methods to manage these SSO waste materials but composting is often considered as a viable method for managing source separated organics (SSO), as it helps to improve the quality and fertility of soils. Composting is a time consuming process, which may be significantly reduced by addition of 'effective microorganisms' (EM). This study is aimed at examining the effects of applying EM in SSO composts across Nova Scotia. The hypothesis of the current study is that application of EM to SSO can shorten composting process and produce more valuable and mature compost product. The experiment will be set up as a 3x4 factorial design with three levels of composting stages (initial, stabilization and combination of initial and stabilization stages) and four levels of inoculants (two commercial inoculants, an active compost and a control). The maturity of final composting product will be measured by respirometry (CO_2 evolution). The expected outcome will be that the application of EM may accelerate and reduce the time of composting.

Predicting the potholes: Digital soil mapping in the Prairie Pothole Region

Angela Bedard-Haughn[1*], Chuck Bulmer[2], Grace Frank[3], Eve Flager[4], and Scott Smith[3]
[1]Department of Soil Science, University of Saskatchewan, Saskatoon, SK
[2]Research and Knowledge Management Branch, British Columbia Ministry of Forests, Lands and Natural Resource Operations, Vernon, BC
[3]Pacific Agri-Food Research Centre, Agriculture and Agri-Food Canada, Summerland, BC
[4]Private Consultant, Courtenay, BC
* angela.bedard-haughn@usask.ca

Digital soil mapping (DSM) tools can be used to refine our existing soil surveys, disaggregating soil polygons into individual soil types reflective of their pedogenesis and, where applicable, the conceptual soil landscape model. For the hummocky terrain of the Prairie Pothole Region (PPR), the conceptual soil landscape model has been well defined, and the requisite landform elements can be readily delineated using digital elevation models. However, the question remains: can DSM be used to predict where specific soil types will occur within this landscape? In particular, given the diversity of soils associated with the potholes or depressions in the landscape, can DSM reliably predict which wetland soil type we might find? Two different DSM techniques will be considered: knowledge-driven (ArcSIE – Soil Inference Engine) and data-driven (random forests). Challenges and opportunities associated with DSM in the PPR will be discussed.

Tracking channel-floodplain sediment exchange with conservative and non-conservative geochemical tracers

Patrick Belmont[1*] and Justin Stout[1,2]
[1]Utah State University, Department of Watershed Sciences, Logan, Utah 84322, USA
[2]University of Melbourne, School of Land and Environment, Melbourne, Victoria 3010, Australia
* patrick.belmont@usu.edu

Fine sediment is routed through landscapes and channel networks in a highly unsteady and non-uniform manner, potentially experiencing deposition and re-suspension many times during transport from source to sink. Two key uncertainties in predicting sediment routing at the landscape scale are 1) determining the proportion of suspended sediment that is derived from terrestrial (soil) erosion versus channel (bank) erosion, and 2) constraining the proportion of sediment that is temporarily stored and re-suspended within the channel-floodplain complex. Sediment fingerprinting that utilizes a suite of conservative and non- conservative geochemical tracers associated with suspended sediment can provide insight regarding both of these uncertainties.

Here we present a model that tracks suspended sediment with associated conservative and non- conservative geochemical tracers. We first use the model to explore the downstream evolution of non- conservative tracers under equilibrium conditions to illustrate how the process of channel-floodplain storage and re-suspension can potentially bias interpretation of sediment fingerprinting results. We then apply the model to explain measurements of meteoric Beryllium-10, Lead-210, and Cesium-137 associated with suspended sediment in two very different rivers, one incising (Le Sueur River, south- central Minnesota, USA) and the other aggrading (Root River, southeastern Minnesota, USA) in response to base level fall and rise, respectively. The Le Sueur River exhibits a narrow range of tracer concentrations in source areas. Suspended sediment samples collected immediately above and below the 30 km-long incising reach show a systematic shift in sources in the downstream direction, indicated by changes in Beryllium-10 concentrations. The Root River indicates a more variable erosion history, with significant variability of Beryllium-10 concentrations in source areas and inverted Beryllium-10 depthprofiles. Both rivers show a systematic disparity in normalized concentrations of conservative versus non-conservative tracers, indicating that significant storage and re-suspension occurs in both systems as the sediment is routed through the channel-floodplain complex.

The organic carbon content and decomposition potential of tundra soil eroding into a thermokarst lake

Christina Z. Braul, Elyn Humphreys*, and Pascale Roy-Léveillée
Department of Geography & Environmental Studies, Carleton University, Ottawa, ON

Arctic thaw lakes are important sources of greenhouse gases to the atmosphere. Expansion of these lakes may be rapid and result in thawing of large amounts of permafrost soil containing substantial stores of organic carbon. This study examines the organic carbon and its potential decomposability within the top 2 m of sediment within Wolverine Lake and from an overhanging bank about to erode into this lake near Old Crow, YT. We show there are large amounts of organic matter in both the active layer and permafrost sediments/soils. Incubations under aerobic and saturated conditions at different temperatures suggest that the soil organic matter in the permafrost has similar or even greater potential decomposition than organic matter within the active layer. However, under saturated conditions, only the near-surface sediments in the lake produced considerable methane and showed a great sensitivity to temperature.

Eddy covariance measurements of methane fluxes over arable land in Southern Ontario

Shannon E. Brown* and Claudia Wagner- Riddle
School of Environmental Sciences, University of Guelph
* sbrown06@uoguelph.ca

Agricultural soils provide a sink for atmospheric methane. Although the sinks are relatively small (~ -1 to -5 ng m−2s−1), this can translate to a significant quantity of methane consumption over large areas. The degree of sink strength can vary over time and space with changing soil moisture and texture, as well as variations in agricultural practices. Chamber measurements currently provide the majority of information on methane flux values for Ontario soils. Improvements in high-frequency trace gas instrumentation allows for easier eddy covariance flux measurements for methane, thus providing the opportunity for flux measurements over a larger integrated area than chambers. A Picarro G2311-f gas analyzer was recently acquired to measure CH4 and CO2 fluxes for a corn field in Southern Ontario treated with manure. The analyzer employs cavity ring-down spectroscopy to mea- sure gas concentrations and integrates sonic anemometry for eddy covariance measurements. Since methane flux values are small for agricultural soils, noise tests assessed the detection limits of the Picarro system in order to differentiate between instrument noise and fluxes close to zero. A spectral response test characterized the analyzer's capacity to resolve flux values by using a random noise generator to simulate different sized eddies passing by an eddy covariance system. Results from these tests and the first field measurements obtained with this analyzer during the Spring of 2013 will be presented.

Managing losses of dissolved phosphorus by time and place of application

Tom Bruulsema*
Director, Northeast Region, North American Program, International Plant Nutrition Institute
* tom.bruulsema@ipni.net

The application of phosphorus under 4R Nutrient Stewardship requires attention to source, rate, time and place. Placement can be critical for accessibility of the applied nutrient to the crop and to loss processes including runoff and drainage. When left on the soil surface, time of application can have large impact on runoff losses. With the increase in use and number of forms of conservation tillage for production of corn, soybeans and wheat, fertilizer placement options and the stratification profiles for available phosphorus in soils have changed. This presentation will explore the potential use of decision support tools to guide application timing and placement to avoid excess losses of dissolved phosphorus through surface runoff. In addition, the adaptation of such tools in a 4R Nutrient Stewardship program in the Lake Erie watershed will be discussed.

Distinct soil nitrogen transformation patterns in adjacent forest and grassland ecosystems in Central Alberta, Canada

Scott X. Chang[1*], Man Lang[1,2], Yi Cheng[1,2], Bruno Mary[3], Jin-bo Zhang[4], and Zu-cong Cai[4]
[1]Department of Renewable Resources, University of Alberta, Edmonton, AB T6G 2E3
[2]State Key Laboratory of Soil and Sustainable Agriculture, Institute of Soil Science, Chinese Academy of Sciences, Nanjing 210008, China
[3]INRA, Unit Agro-Impact, Site de Laon, Pole du Griffon, 02000 Barenton-Bugny, France
[4]School of Geography Sciences, Nanjing Normal University, Nanjing 210023, China
[*] scott.chang@ualberta.ca

Land use change can alter rates of organic matter input and the quality of soil organic matter; as such distinct nitrogen (N) transformation patterns may be formed in different land use systems. The above prediction was tested by studying gross and net rates of N transformations in two adjacent land use systems (forest and grassland) in central Alberta. We found that gross N mineralization and immobilization rates were significantly higher in forest than in grassland soils, while the reverse was true for gross nitrification rates. When soils from the two land use systems were subjected to different soil moisture, temperature and acidity treatments, those soils responded to the treatments differently, again indicating that there were distinct N transformation patterns in the two land use systems. For example, increasing temperature in a laboratory incubation experiment significantly increased gross nitrification rates in the grassland soil and gross N immobilization rates in the forest soil, suggesting that grassland soils maybe more vulnerable to N loss through NO_3^- leaching or denitrification. Nitrous oxide emission rates corroborated the N transformation rate measurements. We conclude that the effect of land use change on N transformation in the landscape should be carefully considered with implications for the climate system and the broader environment.

Overwinter transformation and fate of fall-applied nitrogen in various Canadian ecozones

Martin H. Chantigny[1*], Frank J. Larney[2], Denis A. Angers[1], Shabtai Bittman[3], David Lapen[4], and Philippe Rochette[1]
[1]Agriculture & Agri-Food Canada, Québec, QC
[2]Agriculture & Agri-Food Canada, Lethbridge, AB
[3]Agriculture & Agri-Food Canada, Agassiz, BC
[4]Agriculture & Agri-Food Canada, Ottawa, ON
[*] martin.chantigny@agr.gc.ca

There is growing evidence that nutrient cycling is sustained in agricultural soils during the non-growing season. Our objective was to determine if and to what extent fall-applied nitrogen may undergo transformations and be lost during the non-growing season. The NH_4-N fraction of liquid dairy cattle manure, liquid swine manure, and ammonium sulfate was enriched with ^{15}N, and all N sources were applied to bare sandy loams in early November at sites located in four ecozones, Pacific Maritimes, Prairies, Mixed Wood Plain, Boreal Shield. The experiment was replicated on two years at each site (2009-10; 2010-11). Soils were sampled on the week of application, in November, and at intervals until next May. The recovery of applied ^{15}N in soil NH_4-N, NO_3-N and organic N pools was measured in the 0-30 cm depth. Soil temperature was also monitored at the 5, 20 and 50 cm depths. Although the transformation of applied ammonium was delayed in colder ecozones, the disappearance of $^{15}NH_4$-N was generally completed by April. Both nitrification and immobilization of fall-applied $^{15}NH_4$-N occurred throughout the non-growing season at all sites. As a result, residual ^{15}N was essentially recovered as NO_3-N and organic N in the following spring. In most cases, more than 50% of fall-applied ^{15}N was not recovered in the following spring. In general, more $^{15}NH_4$-N was immobilized with manures than ammonium sulfate, possibly because of the presence of fresh carbon in the manure. As a result, more ^{15}N was recovered in the spring with the manure, and this was particularly obvious at the warmer Mixed Wood Plain and Pacific Maritimes ecozones. We conclude that a significant portion of fall-applied NH_4-N may be lost during the non-growing season, even in ecozones with cold and long winter period.

Wood chip biochar effects on soil phosphorus dynamics in low phosphorous Chernozemic soils

Surani Chathurika[1], Darshani Kumaragamage[1*], Francis Zvomuya[2], and Don Flaten[2]
[1]Department of Environmental Studies and Sciences, University of Winnipeg, 515 Portage Avenue, Winnipeg, MB R3B 2E9
[2]Department of Soil Science, University of Manitoba, Winnipeg, MB R3T 2N2
[*] suranichathurika@yahoo.com

Low phosphorus (P) availability is a prime limiting factor for crop productivity in most soils. Efficient P management therefore, is essential to improve soil P availability. The objective of this laboratory incubation study was to evaluate the effect of soil amendment with wood chip biochar on soil P status of two low-P soils. The experiment was a factorial combination of two soils (a sandy soil- Gray Chernozem and a clay soil- Black chernozem) and six treatments (mineral fertilizer,30kg P ha^{-1};biocharapplied at 1% by weight, biochar applied at 2% by weight, combination of biochar at 1% with mineral fertilizer, combination of biochar at 2% with mineral fertilizer, and a control).All treatments were replicated three times and incubated at 20°C. Treated soils were moistened to field capacity and incubated for 10 weeks. Soil samples were obtained bi-weekly and analyzed for Olsen P. At the end of the incubation period, soil P fractions were quantified using a modified Hedley sequential extraction procedure. Olsen P concentration in soils increased with all amendments, but the increase was significant for both soils in treatments where biochar (both 1 and 2% rates) was combined with P fertilizer. The highest Olsen P concentration was observed when biochar was applied at a rate of 2% with P fertilizer, resulting in a two-fold increase in Olsen P relative to control. Both rates of biochar and the fertilizer treatment significantly increased water-extractable inorganic P (Pi) in the sandy soil but had no significant effect on this P fraction in the clay soil. No significant treatment effects were observed for $NaHCO_3$-extractable Pi, NaOH-extractable Pi, HCl-extractable Pi or residual P in both soils. Amendment of soils with biochar in combination with P fertilizer seems to be more effective in increasing P availability in low P soils; however, the extent of this effect is soil-dependent.

Earthworms reduce soil nitrous oxide emissions during drying and rewetting cycles

Chen Chen[1*], Joann K. Whalen[1], and Xiaobin Guo[2]
[1]Department of Natural Resource Sciences, McGill University, Ste-Anne-de-Bellevue, QC
[2]Greenhouse and Processing Crops Research Centre, Agriculture & Agri-Food Canada, Harrow, ON
[*] chen.chen6@mail.mcgill.ca

Nitrous oxide (N_2O) is a greenhouse gas that is released from both nitrification and denitrification processes. Soil moisture content is a key controller of the biochemical pathways leading to N_2O emission, causing a switch between nitrification and denitrification processes. Earthworms are reported to increase N_2O emissions from soil under aerobic and anaerobic conditions, but how earthworm-induced N_2O emissions are affected by soil drying and rewetting cycles is unknown. The objectives of this study were to (1) evaluate earthworm-induced N_2O emissions from soils kept at constant 33% water-filled pore space (WFPS), constant 97% WFPS and variable moisture content during three wetting-drying cycle (WD); and (2) determine the earthworm effects on soil denitrifiers responsible for N_2O fluxes. During 69 day mesocosm study, endogeic and anecic earthworms were kept in 10 cm diameter by 20 cm tall PVC tubes of each soil moisture condition. The N_2O fluxes were quantified every one to three days, and the soil denitrifier activities were measured when the experiment ended. Soil moisture controlled N_2O fluxes and the WD treatment had the highest cumulative N_2O emissions . Earthworms increased N_2O emissions by 50% in the 33% WFPS treatment but decreased N_2O emissions by 34% in the 97% WFPS treatment, probably due to more complete reduction of N_2O to N_2. Earthworms also reduced N_2O emissions significantly, by 82%, in the WD treatment. Potential denitrification increased significantly when earthworms were present. Abundance of *16S rRNA*, *nirS*, and *nosZ* genes was affected significantly by the earthworm × soil moisture interaction, with the highest *16S rRNA* and *nosZ* abundance in soil from the WD treatments. We conclude that the decrease in cumulative N_2O emissions from soil at 97% WFPS and the WD treatment by earthworms was due to their stimulation of N_2O consuming bacteria and a general alteration of the denitrifying bacterial community composition.

Detailed soil survey in the municipalities of Blanshard and Hamiota

Sheila Cook*
Soil Survey, Manitoba Agriculture, Food and Rural Initiatives
* Sheila.cook@gov.mb.ca

Detailed soil survey maps and reports for the Rural Municipalities (RMs) of Blanshard and Hamiota have been completed. These municipalities each cover six townships to the west of Minnedosa and northwest of the city of Brandon. They are situated in the Prairie Pothole Region of North America, the landscape characterized by a complex landscape with undulating to hummocky topography and many small wetlands. Soil parent materials deposited by receding glaciers are a mixture of shale, limestone and granitic rocks. Shallow soils developed on glacial till account for over 90% of the soils in the study area. This is a significant indication of how uniform the parent material and landscape in the area are.

The majority of the area (Blanshard - 79.6%, Hamiota – 79.9%) is Class 2 for agriculture capability and >2% is Class 6 or Class 7 making it unsuitable agricultural land. The most common soil series described in both the RMs of Blanshard and Hamiota is the Newdale soil series, covering 48.8% and 41.9% of the study areas respectively. The Newdale soil series was recently proclaimed as Manitoba's Provincial soil based on its agricultural productivity and relative abundance in agricultural regions of western Manitoba.

Other soil and/or landscape properties analyzed include soil texture, drainage, erosion, topography, stoniness and salinity. Interpretations of the soil for agriculture capability, irrigation suitability, and engineering and recreational uses have been made. The largest management concerns are operating equipment around wetlands and preventing erosion on undulating topography.

The effect of freeze-thaw cycles on Atterberg limits of clay soils

Daryl Dagesse*
Brock University, Geography Department
* ddagesse@brocku.ca

The role of the freeze-thaw process in altering the physical and mechanical properties of soils is not fully understood. Pore water migration and ice crystal growth associated with the freezing process can have a myriad of effects which are largely dependent on pre-freezing soil physical properties. Atterberg limits are often viewed as fundamentally unchangeable as they are based on interactions between the clay minerals within the soil. Several studies in the literature, however, suggest Atterberg limits can be altered by the effects of freezing and thawing. The purpose of this study was to test the hypothesis that soil consistency, as measured by Atterberg limits, can be altered by the effects of freezing and thawing. Experimental material was comprised of two soils exhibiting similar clay contents but widely different Atterberg constants. Water contents were equilibrated overnight to 10% and 25% gravimetric before freezing. Replicated samples were frozen at -15°C for 12 hr and thawed at +15°C for 12 hr for 1, 5 and 10 cycles. Initial liquid and plastic limits were determined before freeze thaw cycling and following the prescribed number of cycles. Liquid limits remained essentially unchanged for both the high and low plasticity soils at both water contents and regardless of the number of freeze-thaw cycles. The plastic limit measurements exhibited a similar pattern. There were differences in the plasticity index (the difference between the liquid and plastic limits) in the case of the higher plasticity soil, particularly when frozen at the higher water content although these differences were not statistically significant. No particular effect on the Atterberg constants as a result of freezing and thawing were therefore noted, suggesting the initial state of aggregation in the soil may best explain the findings of the previous studies.

System-specific greenhouse gas budgets for irrigated and dry land cropping systems in Saskatchewan

Cody David[1*], Richard Farrell[1], and Warren Helgason[2]
[1]Department of Soil Science, University of Saskatchewan
[2]Department of Chemical & Biological Engineering, University of Saskatchewan
[*] cody.david@usask.ca

Driven by increasing global food demands, the proportion of irrigated agriculture within the Canadian Prairies is likely to increase. However, the implications of this with respect to the agricultural greenhouse gas (GHG) balance are not well understood. This study investigates and compares the greenhouse gas intensity of a typical irrigated and dry land cropping system in Saskatchewan, a semi-arid region of the Canadian Prairies. Irrigated cropping systems contribute greater GHG emissions than their dry land counterpart due to larger nitrous oxide (N2O) production rates and energy used for irrigation water delivery. Yet, partial offsets may be achieved through increases in soil carbon storage from the greater productivity realized through irrigation. Chamber-based flux measurements have been employed to quantify soil GHG emissions and the factors driving these emissions have been investigated through in-situ soil temperature, matric potential, and moisture measurements. The emissions associated with pumping water and typical crop management activities are accounted for using the Intergovernmental Panel on Climate Change (IPCC) literature and methodology. Preliminary data from the first year of study will be presented and discussed. The information derived from this study will aid in the development of regional specific soil emission factors, improved management strategies, and will identify new approaches for mitigating emissions.

Life cycle assessment of greenhouse gas impacts of different overwintering strategies for beef production in Western Canada

Goretty Dias[1*], Kumudinie Kariyapperuma[1], Gudmundur Johannesson[2], Matthew Wiens[3], and Steve Young[1]
[1]School of Environment, Enterprise and Development, University of Waterloo, Waterloo, ON N2L 3G1
[2]School of Environmental Sciences, University of Guelph, Guelph, ON N1G 2W1
[3]Agri-Environment Knowledge Centre, Manitoba Agriculture, Food and Rural Initiatives, Winnipeg MB
[*] gdias@uwaterloo.ca

A screening life cycle assessment (LCA) was conducted to quantify and compare cradle-to-farm gate GHG emissions from Western Canada's beef production systems for a typical 5.5 month overwintering in-confinement period and a reduced 1-month in-confinement period.

The LCA was based on cow-calf operations in Manitoba and feedlot operations in Alberta. Baseline cow-calf production was assumed to consist of management of cows, heifers, calves, bulls, and pasture and hay production. Calves are weaned at 7 months, while cows and heifers graze on open pasture from May 15-Nov 30. Cows and heifers bale graze during December and are in-confinement from Jan 1-May 15, and are fed with hay and feed supplements. Weaned calves are transported in mid-October to Alberta, and fed with a high forage backgrounding diet for 110 days and a high grain finishing diet for 170 days. Finished animals are marketed at a final weight of 605 kg at 16 months. For comparison, overwintering of beef cows in-confinement was reduced to 1 month (Mar 1-Mar 30; during calving) and cows and heifers were bale grazed from Jan 1-Feb 28 and Apr 1-May 14. The functional unit was 1 finished beef cattle at 605 kg weight and 16 months age.

Preliminary LCA results showed that the highest GHG emissions occurred during the cow-calf production life cycle stage, with the highest emissions arising from enteric methane (CH_4) from beef cattle. Compared to the baseline 5.5 month overwintering in-confinement period, the shortened 1-month in-confinement period increased total GHG emissions, mainly due to increased enteric CH_4 emissions from beef cattle and increased GHG emissions from pasture management. This assessment will also consider other impacts (e.g. eutrophication, water quality), to identify environmental trade-offs of overwintering confinement options.

Changing soil salinity gradients: An integrated approach to remediating brine-contaminated soils

R. G. Eilers[1], T.B. Goh[2], and Jennifer I. Nielsen[3*]
[1]Adjunct Professor, Department of Soil Science, University of Manitoba
[2]Department of Soil Science, University of Manitoba
[3]Department of Soil Science, University of Manitoba, Good Lands Environmental Inc.
[*] jennifer@goodlandsenviro.com

Soil salinization has occurred as a result of contamination with brines from oil and gas production in the southern prairies of western Canada. The affected areas are typically localized but widespread and occur mainly on lease sites and adjacent lands which have become incapable of agricultural production. An integrated approach to reclaiming these lands for agriculture was implemented including the installation of tile drains, sumps, and monitoring wells to remove and monitor groundwater, followed by an application of amendments and seeding with salt-tolerant forage mixtures. In a detailed study of two such field sites, changes in vegetation cover, soil salinity, and groundwater depth and quality were examined. The initial site characterization in 2001 using an electromagnetic (EM31v) survey (map of deep salinity – 0 to 600 cm) was completed prior to the installation tile drains, sumps and observation wells and defined the severity and extent of the problem. On-going monitoring of groundwater quality and vegetative growth response has continued to present. From 2009 to 2011 a more extensive data collection was undertaken, including remapping of deep salinity with the EM31 for comparison to the base case, and an electromagnetic (EM38) survey to map severity and extent of soil salinity in the upper (0-60 cm) and lower (0-120 cm) root zone. Poor growth areas and landscape topography were mapped using global positioning system (GPS) technology. Long-term trends (2001 – 2011) in groundwater quality (reduction of salinity) of the pump out water from the tile system, decreasing extent of saline impacted lands and the near complete re-vegetation of the sites with salt tolerant grasses and alfalfa have been observed and documented. This integrated approach to land remediation has had a significant beneficial impact on changing the gradients of soil quality across the landscapes and returning land to productive agricultural resources.

Subsoiling an irrigated and dry land brown chernozem: Effects on soil density, moisture, yield and economic return

B. Ewen[*], J. Schoenau, and M. Grevers
Department of Soil Science, University of Saskatchewan, Saskatoon, SK S7N 5A8
[*] brett.ewen@usask.ca

There has been a renewed interest in subsoiling among agricultural producers in Saskatchewan to improve soil water management and crop yield. Subsoiling in this study was performed using a Paraplow (Howard Rotavator). The tillage effects of subsoiling on bulk density, moisture, and crop yield were evaluated as part of the study. Paraplowing reduced bulk density and its effects persisted over multiple field seasons. The changes in the soil physical properties affected crop production, with small (5-10%) but significant increase in grain yield in the dry land cropping system, but no measureable effect in irrigated systems. A multi-year benefit was required in order to recover costs of the subsoiling operation.

Engaging students on water and sanitation security in First Nations communities

Annemieke Farenhorst[1*], Helen Fallding[2], Karen Busby[2,3], Brenda Elias[4], Chris Metcalfe[5], Selvin Peter[6], and Ross McQueen[1]

[1]Department of Soil Science, Faculty of Agricultural and Food Sciences, University of Manitoba

[2] Centre for Human Rights Research, University of Manitoba

[3] Faculty of Law, University of Manitoba

[4] Department of Community Health Sciences, Faculty of Medicine, University of Manitoba

[5] Institute for Watershed Science, Trent University

[6] Faculty of Arts and Science, University College of the North

[*] Annemieke.Farenhorst@umanitoba.ca

Water security means that communities have access to sufficient clean water to support their health, livelihood and culture, while mitigating water-related risks to an acceptable level. Major drinking water and wastewater service gaps for First Nations reserves were identified in a recent national engineering assessment. About 113 First Nations communities in Canada are currently under a drinking water advisory. Such unsafe water supplies and poor sanitation adversely affect the health of First Nations residents. This presentation aims to engage students to enroll into a new academic program that focuses on First Nation community participation in Manitoba and Ontario and the urgent need to strengthen human and infrastructural capacities in water and sanitation security. Almost 75% of the 3,400 First Nations homes that have no running water are in Manitoba and Ontario. In addition, an estimated 40% of the inspected water systems and 25% of the inspected wastewater systems on First Nations reserves in these two provinces have major deficiencies that pose significant health or environmental risks. The new academic program brings together more than 20 researchers from the University of Manitoba, Trent University and University College of the North. Non-academic collaborators include First Nations organizations such as the Assembly of First Nations, a wide range of industries, including the leading supplier of engineering services to Canadian Aboriginal Peoples, and several not-for-profit organizations. The academic program will provide opportunities for sponsored research training of more than 50 undergraduate and graduate students and post-doctoral fellows over the next six years. Trainee research projects will focus on current and alternative systems and technologies for domestic water and wastewater treatment; pathogens and chemical contaminants in drinking and source water; risk assessment and protection planning for watersheds using spatial tools; and improving the scientific basis for water and wastewater regulations.

Spatial distribution of greenhouse gas fluxes in drip and microspray fertigated vineyards and orchards in the Okanagan Valley, British Columbia

Mesfin M. Fentabil[*] and Craig Nichol

Earth & Environmental Sciences and Physical Geography, University of British Columbia Okanagan,

3333 University Way, Kelowna, BC V1V 1V7

*selames@gmail.com, craig.nichol@ubc.ca

The spatial distribution of major agricultural greenhouse gases (GHG) (CO_2, N_2O and CH_4) in fertigated woody perennial agrisystems requires further study. These systems are common in semi-arid regions such as the Okanagan Valley. Fertigation through drip and microspray system conserves water and increases over all nitrogen use efficiency. localized higher moisture content areas created by dripper or sprayer patterns coincident with available nitrogen may generate GHG emission "hotspots". Field studies were undertaken in selected treatments within grape (*Vitis vinifera* L.; Merlot) planted in sandy loam and apple (*Malus domestica* Borkh; Braeburn) experimental trials planted in a loamy sand soil in Summerland, B.C. The grape plots receive 40Kg/ha/yr nitrogen from 1) compost 2) synthetic fertilizer (urea) 3) synthetic fertilizer plus high C mulch surface cover, and are either drip or microspray irrigated four times a day. The apple plots receive 40 Kg/ha/yr synthetic nitrogen (calcium nitrate) through drip irrigation system applied twice a day, or twice per day on every other day, each with and without high carbon mulch surface cover. Experiments deployed 12 mini-chambers within 0.45 m^2 in the immediate vicinity of a dripper in the grape plots while 9 mini-chambers were deployed within 0.34 m^2 in the vicinity of a dripper in the apple plots. Measurements were conducted prior to the start of irrigation, during fertigation, and during irrigation after fertigation. Early indications are that most of the GHG, expressed as CO2 equivalent, are in the form of carbon dioxide followed by nitrous oxide and negligible methane.

Understanding the spatial distribution of GHG emission in drip/micro-sprayer fertigated agrisystems is important to determine the appropriate monitoring strategy to capture representative GHG footprints in treatments-based comparison experiments and for better understanding of the underlying processes.

Video-conferencing to deliver a graduate course on agricultural sustainability

Don Flaten[1*], Henry Janzen[2], Kim Ominski[3], and Amanda Taylor[4]
[1]Department of Soil Science, University of Manitoba
[2]Agriculture and Agri-Food Canada (AAFC) Lethbridge Research Centre
[3]Department of Animal Science, University of Manitoba
[4]Department of Soil Science, University of Manitoba
[*] Don.Flaten@ad.UManitoba.ca

From January to April 2013, graduate students in Soil Science, Plant Science and Animal Science at the University of Manitoba worked under the guidance of Dr. Henry Janzen at the AAFC Lethbridge Research Centre to complete a graduate course on agricultural sustainability. Henry's interaction with the students was facilitated by the AAFC videoconferencing system and hosted at the AAFC Cereal Research Centre on the University of Manitoba campus by Professors Don Flaten and Kim Ominski. The format for the course consisted of weekly readings, along with a weekly assignment and a 3 hour tutorial session. Henry introduced each tutorial session and participated in the discussion, using the AAFC videoconferencing session. In addition, for their term project, students were divided into two multi-disciplinary teams to assess the sustainability of a commercial farm and to recommend management practices that would improve the overall sustainability of the farm. The farmer from Brandon was unable to come to Winnipeg during calving, so the students presented their assessments and recommendations to their farmer-client at the AAFC Brandon Research Centre, where Henry was able to participate in the presentations and discussion through the AAFC videoconferencing system. The pros and cons of this system for course delivery will be discussed from the point of view of Henry Janzen (the tutor and mentor), Don Flaten (a local facilitator), and Amanda Taylor (a PhD student).

Phosphorus uptake by ryegrass in response to rate and type of P amendment in soils under long-term organic, organic manure-amended, conventional and native prairie management

T. Fraser[1*], D. Lynch[2], J. Nimmo[2], M. Entz[3], and K. Dunfield[1]
[1]School of Environmental Science, University of Guelph, ON NIG 2W1
[2]Faculty of Agriculture, Dalhousie University, Truro, NS B2N 5E3
[3]Department of Plant Science, University of Manitoba, Winnipeg, MB R3T 2N2
[*] tandra@uoguelph.ca

Changes in land management practices may have significant implications for soil microbial communities important in organic P turnover. Soil bacteria can increase plant P availability by excreting phosphatase enzymes which catalyze the hydrolysis of ester-phosphate bonds. This study examined the effect of long-term management and P amendment on alkaline phosphatase activity (ALP), P availability and ryegrass P uptake in a greenhouse trial. Soil samples (0-15cm) were collected from the grain-forage rotation (flax-alfalfa-alfalfa-wheat) of the Glenlea Long-term Rotation near Winnipeg Manitoba to compare organic (ORG), organic with composted manure (ORG-M), conventional (CON) and restored prairie (PRA) management systems. For each soil, treatments of zero P, composted cattle manure (3, 20 and 40 mg P kg^{-1} soil) and soluble P as KH_2PO_4 (15, 40, 80 and 160 mg P kg^{-1} soil) were applied to pots with 1 kg of soil. Ten Italian ryegrass plants were grown for 106 days and analysed for total P uptake. Soils were sampled at 30 and 106 days and analysed for total and inorganic P, microbial biomass C and P, ALP and bacterial ALP gene abundance (total and active). There was a greater response of ryegrass biomass in ORG and ORG-M pots than CON and PRA to both manure and soluble P addition compared to the control. ALP was higher and showed less variation in response to P amendments in ORG and ORG-M (5.63 and 5.46 µmol PNP g^{-1} hr^{-1}) than CONV and PRA (4.68 and 4.67 µmol PNP g^{-1} hr^{-1}). The "priming" effect of high manure addition was less in ORG and ORG-M compared to CONV and PRA. The addition of soluble P only suppressed ALP at 80 and 160 mg P kg^{-1} soil in the ORG and ORG-M soils. The abundance of bacterial ALP genes (total and active) is currently being investigated to examine the relation to ALP, plant P availability and P uptake.

Growing season denitrification losses impacted by land management practices, soil properties and weather conditions in manure-amended perennial hayfield and corn-soybean-wheat rotations in Atlantic Canada

Keith D. Fuller[1*], David L. Burton[2], Craig F. Drury[3], Mark G. Grimmett[4], Bernie J. Zebarth[5], Jeffrey L. Franklin[1], Vernon Rodd[4], Jack Van Roestel[6], and Ed St. George[1]
[1]Agriculture and Agri-Food Canada, Atlantic Food and Horticulture RC., Kentville, NS
[2]Environmental Sciences, Faculty of Agriculture, Dalhousie University, Truro, NS
[3]Agriculture and Agri-Food Canada, Greenhouse and Processing Crops RC., Harrow, ON
[4]Agriculture and Agri-Food Canada, Crops and Livestock RC., Charlottetown, PE
[5]Agriculture and Agri-Food Canada, Potato Research Centre, Fredericton, NB
[6]Perennia, Kentville, NS
[*] keith.fuller@agr.gc.ca

Denitrification losses from agricultural fields reduce nitrogen (N) utilization efficiency and contribute to Canada's greenhouse gas emissions. Losses have the potential to be significantly higher when organic amendments such as liquid dairy manure (LDM) are substituted for fertilizer N. A six year study was undertaken to compare the effect of land management practices on growing season (GS) denitrification losses in a perennial hayfield (PH) and a corn-soybean-wheat (CSW) rotation with or without tillage (T v NT). Daily denitrification rates were measured using the acetylene blockage technique with soil cores taken at biweekly sampling intervals, while cumulative N losses were estimated using linear interpolation of daily rates. Spring-applied LDM was used as an N source for crop production at rates equivalent to 150 – 195 kg N ha^{-1} in corn or wheat years (2007, 2009, 2010, 2012). In soybean years (2008, 2011) no manure was applied at the site and the PH rotation received 55 kg N ha^{-1} in both years, while the soybeans received no N fertilizer in 2008 and 20 kg N ha^{-1} in 2011, all as ammonium nitrate. Substantial GS denitrification losses were measured over the six year period in PH and CSW rotations and they accounted for between 2 to 16 % of the N from the spring applied manure. There were no significant differences in losses between rotations in any given year and no differences in cumulative losses (~55 kg N ha^{-1} GS^{-1}) over the study period. Differences in denitrification losses between seasons were larger than differences between rotations within a season. Denitrification losses between the CSW-T and NT treatments were comparable, with cumulative GS losses ranging between 48 and 54 kg N ha^{-1}, equivalent to 4–5 % of applied manure N. When treatment and seasonal data were combined, universal relationships between soil nitrate levels, % water filled pore space and daily denitrification rate were apparent. Large differences (~27 kg N ha^{-1} GS^{-1}) in denitrification rates between growing seasons, point towards soil/environmental factors as being the major denitrification drivers in these rotations under Maritime conditions.

Linking soil profile greenhouse gas concentrations to surface emissions in a prairie pothole agricultural landscape

Xiaopeng Gao[1*], Nandakumar Rajendran[1], Mario Tenuta[1], Adedeji Dunmola[1], and David L. Burton[2]
[1]Department of Soil Science, University of Manitoba, Winnipeg, MB R3T 2N2
[2]Department of Environmental Sciences, Dalhousie University, Truro, NS B2N 5E3
[*] xiaopeng.gao@ad.umanitoba.ca

Agricultural landscapes of the Prairie Pothole Region (PPR) of North America feature complex topography and hydrology, posing a significant challenge for estimating emissions of greenhouse gases (GHG) to the atmosphere. This study was designed to examine the linkage of soil profile concentrations of GHG (N_2O, CH_4 and CO_2) and O_2, in relation to the GHG surface emissions from a PPR agricultural field near Brandon, Manitoba, which were segmented into the four landscape elements (cropped Upper, Middle, Lower and uncropped Riparian). Soil profile gas concentrations at 5, 15, 35 and 65 cm depths and surface emissions were measured through fall 2005 into 2006 growing season of flax, using diffusive equilibrium samplers and static-vented chambers, respectively. Soil gas contents over monitored depths, including both gaseous and aqueous contents, were estimated to provide a measure of profile storage of gases for examining the relationship to surface emissions. Spring thaw caused a substantial increase in concentrations and contents of N_2O at 15-35 cm at the Lower and Riparian elements, though surface emissions increased only at the former, suggesting that N_2O accumulated in soils during spring-thaw in cold climates and was completely consumed under prolonged anaerobic conditions of Riparian element. Application of N fertilizer increased soil accumulations and emissions of N_2O from all cropped elements. Riparian element had consistently highest CH_4 emissions, which predominately occurred shortly after spring-thaw and coincided with increased soil CH_4 and decreased soil O_2 concentrations. Soil concentration and content of CO_2, as well as surface emissions, followed the trend of soil temperature, with values consistently higher at the Riparian than cropped elements. The study showed that the high emissions of N_2O and CH_4 from the lower elevations (Lower and Riparian elements) during the significant periods (spring-thaw and post-fertilizer) were greatly associated with the increased accumulations of the gases, which can further be attributed to dramatic changes in soil local environmental conditions, i.e. moisture, temperature and aeration, during these periods.

Determinants of summer weather patterns on the Canadian Prairies: Implications for long-lead forecasting of grain yields

Ray Garnett[1*] and Madhav Khandekar[2]
[1]Agro-Climatic Consulting (ACC), Winnipeg, MB
[2]retired Environment Canada scientist, Expert Reviewer for IPCC
(Intergovernmental Panel on Climate Change) 2007
Climate Change Documents, Markham, ON
[*] ergarnett@shaw.ca

To assess the drivers of weather extremes over the Canadian Prairies, a data matrix was created to explore 170 potential monthly predictors of drought severity, summer precipitation and summer temperature. Applying composite, correlation and regression techniques a comprehensive data analysis produced a suite of composites and regression models for providing climatic outlooks a few weeks to a few months in advance of the critical May-July growing period. This was done for the Prairies as a whole and for four agricultural ecological zones. The research identified several useful (and disparate) factors like the MJO and PDO both linked to large-scale atmospheric- oceanic circulation patterns in the equatorial and central Pacific Ocean. This study also identified parameters such as the AP index, which links solar variability to Prairie climate and grain yields. An empirical approach, using accumulated monthly values of atmospheric-oceanic indices, provides useful guidance for the forecasting of grain yields with a lead-time of a few weeks to a few months.

Carbon balance of an organic cropland in southwestern Manitoba

Aaron Glenn[*] and Henry Wilson
Science and Technology Branch, Agriculture and Agri-Food Canada, Brandon, MB
[*] Aaron.Glenn@agr.gc.ca

While there has been a resurgence of micrometeorological flux measurements in agroecosystems to quantify net cropland-atmosphere exchange of carbon dioxide (CO_2) and other greenhouse gases (GHGs) from different management decisions, there has been a lack of such studies from organic crop rotations, despite suggested benefits of increased soil carbon and GHG reductions under such production strategies. A field study was initiated in late spring 2012 to examine water, nitrogen and carbon balance components of an organic cropland in southwestern Manitoba on a Newdale clay loam. The net ecosystem exchange of CO_2 (NEE) was measured using the eddy covariance technique over two adjacent fields where hemp and a barley-peas intercrop were grown. Results from the first year of the study indicate that both crops were small sinks for CO_2 of similar magnitudes (hemp NEE ≈ -300 kg C ha^{-1}; barley-peas NEE ≈ -500 kg C ha^{-1}), prior to accounting for beef manure compost application to the hemp field and harvest biomass removal. The hemp crop had a longer period of net CO_2 uptake over the growing season and a higher peak leaf area index (5.2 m^2 m^{-2}) than the barley-peas intercrop (4.6 m^2 m^{-2}), and greater cumulative gross primary production. However, total ecosystem respiration was also higher from the hemp field, offsetting these photosynthetic gains, and resulting in a similar NEE to the barley-peas intercrop. Other C balance components of the cropland such as soil organic matter, beef compost application, harvest biomass removal, as well as, aqueous fluxes of dissolved organic and inorganic C in runoff and leachate were also measured at the site and will be discussed in terms of significance to the agroecosystem.

A First Order Plus Logistic (FLOG) model for soil respiration and soil mineral nitrogen dynamics following incubation with organic residues

J. Daniel Gillis[1,*] and Gordon W. Price[2]
[1]Department of Bioresource Engineering, McGill University, Macdonald Campus,
21,111 Lakeshore Road, Sainte-Anne-de-Bellevue, QC H9X 3V9
[2]Department of Engineering, Dalhousie University, Agricultural Campus, 39 Cox Road,
Truro, NS B2N5E3
[*] joseph.gillis@mail.mcgill.ca

We have previously demonstrated that a first order exponential plus logistic (FLOG) model can describe CO_2 evolution from soils amended with organic residues. The FLOG model separates potentially mineralizable carbon into two pools that are separated in time. Based on recent developments in soil ecological theory, we hypothesized that the carbon pools represent a labile carbon pool (first order) and a slightly recalcitrant carbon pool (logistic) of polymerized substrates that are acted on by depolymerizing enzymes. Given that nitrogen mineralization is mediated by microorganisms that respire CO_2, and depolymerization of complex substrates has been recognized as a likely rate-limiting step in nitrogen mineralization, we extended the FLOG model to describe soil mineral nitrogen (SMN) dynamics following amendment with organic residues. In this approach, we use the time-separated (modeled, FLOG-C) CO_2 pools to describe SMN dynamics (FLOG-N) and assume that mineral nitrogen can be either mineralized or immobilized as a result of the microbial activity decomposing each pool of organic matter. FLOG-C parameters are fit using nonlinear regression, and FLOG-N parameters are fit using multiple linear regression of SMN vs. the predicted CO_2 evolution from both the exponential and logistic pools. The model was developed using data from an aerobic soil incubation with biosolids, and tested on C and N datasets extracted from literature sources for a variety of plant-based soil amendments. This approach successfully described complex SMN dynamics using the modeled first order and logistic carbon pools.

Fine-scale, *in-situ* phosphatase activities are not associated with specific fungal communities

Aaron Godin, and Melanie Jones*
Biology Department, University of British Columbia – Okanagan campus
* melanie.jones@ubc.ca

Phosphorus (P) plays an important role in driving primary production in terrestrial ecosystems; however, the majority of P in soil is covalently bound to complex organic compounds and is largely inaccessible to plants. Soil fungi facilitate the release of mineral P from organic forms through the release of extracellular phosphatase enzymes. Because of methodological challenges, we know little about the fungi responsible for phosphatase activity in soils. In the current study, we examined whether mm-scale microsites differing in phosphatase activities had different fungal communities and nutrient profiles. After localizing phosphatase activity using an *in situ* soil-imprinting technique, we collected small (0.05 g) soil samples from areas of high and low phosphatase activity at five root windows in a mixed Douglas-fir / paper birch stand. Pyrosequencing revealed a marginally higher ratio of ectomycorrhizal to saprotrophic fungal signatures in high phosphatase than low phosphatase microsites in two of the windows ($p<0.07$), but overall the fungal communities did not differ with phosphatase activity (Bray Curtis, $p=0.5$; Jaccard $p=0.5$). These results suggest that fungal community composition alone was not important in driving phosphatase activity. However, fungal communities differed among windows (Bray Curtis, $p<0.01$; Jaccard $p<0.01$), implying that fungal communities were functionally redundant with respect to phosphatase activity at this site. Total extractable P ($p=1.0$), inorganic phosphate ($p=0.9$), and soluble organic P ($p=0.2$) were not different between areas of high and low phosphatase activity across all windows, suggesting that P availability alone was not important in driving phosphatase activity. However, percent total carbon ($p=0.02$) and percent total nitrogen ($p=0.02$) were higher in microsites with high phosphatase activity. This implies that higher levels of carbon and nitrogen, especially relative to P, stimulated phosphatase activity.

Farming 4R climate: Utilizing 4R nutrient stewardship to reduce greenhouse gas emissions from the application of fertilizer and other crop nutrients

Clyde Graham[1], Kristian Stephens[1*], Cassandra Cotton[1], Amanda Giamberardino[1], Bruce Ringrose[2], Shahira Esmail[2], and Dan Heaney[3]
[1]Canadian Fertilizer Institute, 350 Sparks St., Suite 907, Ottawa, ON K1R 7S8
[2]Climate Check Corporation, 136 Clarence St. Ottawa, ON K1N 5P8
[3]RandomCross Consulting, 10615 43 Street NW, Edmonton, AB T6A 1V2
* kstephens@cfi.ca

An innovative approach to best management practices (BMPs) for fertilizers or other crop nutrient applications is the Right Source @Right Rate, Right Time, Right Place®, also known as 4R Nutrient Stewardship (4Rs). This concept helps farmers and the public understand how these BMPs for fertilizer contribute to sustainability goals for agriculture. The 4R concept involves crop producers and their advisers in selecting the right source-rate-time-place combination from practices validated by scientific research.

This four year project provides crop producers across Canada with science-based information and advice on how to use fertilizer BMPs under 4R Nutrient Stewardship to reduce emissions of greenhouse gas (GHG) when fertilizer or other crop nutrients are applied on fields. The project utilizes web-based extension and collaboration tools, as well as, traditional meetings and print communications to reach farmers in all major agricultural regions. This web-based collaboration approach facilitates the collection of technical data (yields, inputs, documentation of practices, etc.) from farmers, as well as, their perceptions concerning the challenges and opportunities encountered in adopting the 4Rs. This presentation will focus on the results obtained in the first year of the project and will discuss the next steps.

This project is being funded by Agriculture and Agri-Food Canada through the Agricultural Greenhouse Gas Program.

Seed-placed phosphorus and sulphur fertilizers: Effect on canola plant stand and yield

Laryssa Grenkow[1*], Donald Flaten[1], Cynthia Grant[2], and John Heard[3]
[1]Department of Soil Science, University of Manitoba, Winnipeg, MB R3T 2N2
[2] Brandon Research Centre, Agriculture and Agri-Food Canada, Brandon, MB R7A 5Y3
[3] Manitoba Agriculture, Food and Rural Initiatives, Carman, MB R0G 0J0
[*] umgrenkl@cc.umanitoba.ca

Hybrid canola has a high requirement for phosphorus (P) and sulphur (S). Conventional P and S fertilizers differ in their risk of ammonia and salt toxicity and can significantly reduce canola plant stands if applied in the seed-row above recommended safe rates. Enhanced efficiency fertilizers such as polymer coated monoammonium phosphate (cMAP), Vitasul, or Microessentials S15 (MES15) could be more seed-safe than conventional sources. Field studies were conducted to determine the effect of various sources and rates of seed-placed P and S fertilizers on plant stand and yield of canola. Soil properties may also affect the toxicity of the fertilizer. The risk of ammonia toxicity from ammonium sulphate (AS) may be especially severe on soils with a high calcium carbonate ($CaCO_3$) content, which can frequently occur on eroded knolls in Canadian Prairie landscapes. A growth room experiment was conducted to determine the effect of soils from different landscape positions on the toxicity of seed-placed AS and monoammonium phosphate (MAP) with canola. Under controlled environment conditions, canola emergence was reduced and delayed by conventional sources of seed-placed P and S fertilizers due to salt and ammonia toxicity. Ammonium sulphate, in particular, has a high salt index and risk of ammonia toxicity, especially on calcareous soils; therefore, AS has a greater potential to reduce plant stands than MAP. Under field conditions, the highly available sources of P and S may increase the risk and severity of seedling toxicity, but they also increase the frequency and size of yield response in situations where these nutrients are deficient. Enhanced efficiency fertilizers (cMAP, MES15 and Vitasul) were effective in decreasing seedling damage, but may not be as effective as conventional sources in providing sufficient available nutrients to reach yield potential.

Deciphering P sources in Lake Pepin

Ashley Grundtner and Satish Gupta*
Department of Soil, Water, & Climate, University of Minnesota, St. Paul, MN 55127
[*] sgupta@umn.edu

Lake Pepin is a natural impoundment on the Upper Mississippi River, 80 km south of the Twin Cities, Minnesota. Although a majority of the sediments in Lake Pepin are coming from river banks, there is a perception that a significant amount of particulate phosphorus is coming from agricultural lands. This research used P adsorption characteristics of bank materials along with river water quality to assess whether or not agricultural lands are a major source of particulate P in Lake Pepin. The P adsorption characteristics studied were the equilibrium phosphorus concentration (EPC_0), initial total phosphorus (TP) content, and the potential of bank materials to adsorb and desorb soluble P. Results showed that bank materials are inherently high in TP content (>400 mg/kg), have low EPC_0 (<0.1 mg/L) values, strong P binding ability, and high P adsorption and low P desorption potentials. Since agriculture was minimal prior to 1850, we were able to predict Lake Pepin particulate P just based on particle enrichment of bank materials. After 1850, we outlined scenarios using particle enrichment and historical river pollution as reasons for higher concentrations of particulate P in Lake Pepin. The historic river pollution included dumping of waste from Twin Cities of St. Paul and Minneapolis, waste from animal processing plant on the Mississippi River upstream of Lake Pepin, untreated and treated wastewater discharge to rivers in Lake Pepin watershed, and use of high P detergent from 1950s-1980s. We also adjusted the enrichment ratio to account for some settling of coarse silt due to locks and dams upstream of Lake Pepin. We conclude that a majority of particulate P in Lake Pepin is mainly from naturally occurring high P river bank materials as well as their scavenging of dissolved P from river waters as they tumble downstream and then settle in Lake Pepin.

Nitrous oxide and carbon dioxide emissions from aerobic and anaerobic incubations: Effect of core length

Xiaobin Guo*, Craig F. Drury, W. Daniel Reynolds, Xueming Yang, and Ruqin Fan
Greenhouse and Processing Crops Research Centre, Agriculture & Agri-Food Canada, Harrow, ON N0R 1G0
* xiaobin.guo@agr.gc.ca

An important and popular approach for elucidating soil respiration and denitrification processes includes laboratory incubation of uniformly repacked soil cores that are sealed at the base and maintained at constant temperature and gravimetric water content (θ_g). However, few studies have considered the impacts of core length on CO_2 and N_2O emissions. Hence, aerobic and anaerobic incubation studies were conducted using sieved and uniformly repacked Brookston clay loam soil at field capacity to evaluate the effect of core length (2.5, 5.0, 7.5, 10.0, and 15.0 cm) on CO_2 and N_2O emissions. The CO_2 and N_2O production rates were found to change with core length by factors of up to 1.7 and 22.8, respectively; and this was attributed to downward increasing θ_g (or decreasing volumetric air content) due to gravity redistribution of soil water, which in turn affected respiration and denitrification rates. Carbon dioxide emissions generally decreased with increasing core length for both aerobic and anaerobic incubations. Nitrous oxide emissions generally increased with increasing core length under aerobic conditions, but decreased with increasing core length under anaerobic conditions. The shortest core length (2.5 cm) appeared to create anomalies with the N_2O emission data. A boundary between aerobic and anaerobic respiration for Brookston soil apparently occurred at the 8-10 cm depth and consequently, the 10.0 cm and 15.0 cm core lengths likely created artifacts by depressing CO_2 emissions under aerobic conditions, and by stimulating both denitrification and N_2O reduction to N_2 under anaerobic conditions. Hence, core lengths of 5.0 to 7.5 cm likely provide the most realistic CO_2 and N_2O emission results for repacked soils at field capacity. It was concluded that unregulated core length can induce important artifacts into incubation estimates of CO_2 and N_2O emissions.

Mass balance of arsenic from poultry feed to poultry litter

Sanjay Gupta[1*], Martin Zuidhof[2], Gary Kachanosky[3], and Tariq Siddique[1]
[1]Department of Renewable Resources, University of Alberta, Edmonton, AB T6G 2E3
[2]Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB T6G 2P5
[3]Memorial University of Newfoundland and Labrador, St. John's, NL A1C 5S7
* sanjay1@ualberta.ca

Roxarsone (3-nitro-4-hydroxyphenylarsonic acid) is an organic compound which is added to poultry feed for growth promotion, enhanced feed utilization, improved pigmentation and disease prevention. This feed additive contains arsenic which is a known carcinogen. Poultry industry in Canada is under pressure to ban it because it has already been banned in the European Union, and its sale has recently been suspended in the United States as well. This ban will, however, affect the production, performance and bird welfare in Canada, and the poultry industry is also concerned about that loss. In this study, mass balance of arsenic from poultry feed to poultry litter was calculated to provide practical insights into arsenic retention in chicken tissues and excretion in the litter. High arsenic in chicken tissues is a direct human health issue, and disposal of arsenic-rich poultry litter on the cropland can again push it into our food chain via agricultural products.

Poultry litter was collected from a poultry feed study wherein broilers were reared on two types of feed (Rox - feed mixed with roxarsone @50g per ton, and Control - feed without roxarsone), and analyzed for total arsenic concentration on Inductively Coupled Plasma Mass Spectrometer (ICP-MS). Total quantity of arsenic taken in by the birds with feed and excreted out in poultry litter was calculated on pen basis. After accounting for all losses and additions, a final figure for arsenic recovery in poultry litter was derived. In poultry strains Cobb500 and Ross308, the maximum recovery was 72% and 92%, respectively. These numbers also indicate that 28% arsenic in Cobb500 and 8% in Ross308 was either retained in chicken body or lost into the environment. These results will help in accurate assessment of health risks and environmental impacts associated with arsenic in poultry litter, and facilitate designing of regulations for land application of arsenic-rich poultry litter in Canada.

Nitrogen dynamics in an organic rotational no-till system in southern Manitoba

C. Halde[1*], R. H. Gulden[1], A. M. Hammermeister[2], K. H. Ominski[3], M. Tenuta[4], and M. H. Entz[1]
[1]Department of Plant Science, University of Manitoba, Winnipeg, MB
[2]Department of Plant and Animal Sciences, Dalhousie University, Truro, NS
[3]Department of Animal Science, University of Manitoba, Winnipeg, MB
[4]Department of Soil Science, University of Manitoba, Winnipeg, MB
[*] carolinehalde@gmail.com

In Western Canada, there has been limited research conducted on reduced-tillage grain production systems managed organically or without herbicides. The overall goal of the study was to adapt an organic rotational no-till system to the growing conditions of Southern Manitoba. A 2-year field study was conducted twice in Carman, MB, on an Orthic Black Chernozem soil. In year 1 (Y1), ten different combinations of various green manures (GM) species were seeded in the spring and rolled using a roller-crimper in mid-summer, at the flowering stage. The GM species tested included barley, hairy vetch, pea, oilseed radish, and sunflower, in pure stand or in mixtures. These rolled mulches were then left on the soil surface over the fall and the winter. In year 2 (Y2), spring wheat was seeded directly into these mulches (no-till). Mulches with hairy vetch (*Vicia villosa*) showed the most promising results. GM treatments with hairy vetch had the highest mulch biomass in September Y1 (9.1-11.5 t ha^{-1}), and in the spring Y2 (6.0-7.6 t ha^{-1}). Organic spring wheat no-till planted into these mulches with vetch produced yields comparable to conventional rural municipality averages. In late-fall Y1, nitrogen content of mulches with vetch reached very high levels (308 kg N ha^{-1} on average), and high amount of nitrogen (93-164 kg N ha^{-1}) were released from these mulches over winter. Consequent, there was a significant increase in soil NO_3-N (0-90 cm) overwinter in treatments with vetch. During the duration of study, no net N immobilization of soil N by any green manure mulches was observed. Overall, the successful adaptation of the organic rotational no-till system to the growing conditions of Southern Manitoba reduced the need for tillage for a period of 1.5 to 2 years without affecting yields in organic spring wheat production.

Bacterial profiles of agricultural soil fertilized with solid pig and dairy manure, and synthetic N fertilizer

Ainsley Hamm[1], Mario Tenuta[2], Denis Krause[1,3], Kim Ominski[1], Ehsan Khafipour[1], and Don Flaten[2]
[1]Department of Animal Science,
[2]Department of Soil Science, University of Manitoba, Winnipeg, MB R3T 2N2
[3] Deceased
[*] umlittla@cc.umanitoba.ca

Within a single gram of soil, the bacterial community is immensely diverse containing roughly 10,000 different species. These bacteria support biochemical cycling, improve plant productivity, degrade pollutants, and contribute to climate regulation. Research has demonstrated that management practices impact the bacterial diversity of soil; however, very few studies have effectively characterized how bacterial communities respond to different nutrient sources. The objective of this study was to examine the impacts of manure and synthetic N additions on the diversity and composition of the bacterial communities within the soil. An annual cropping system was examined for short-term (within a growing season) and medium-term (three successive years) effects on bacterial diversity. Soil samples were collected from the National Centre for Livestock and the Environment Long-Term Crop and Manure Management Field Lab in fall 2007, prior to the start of the experiment, and post-planting, mid-season, and post-harvest in 2010. Treatments for this study included: solid pig manure, solid dairy manure, synthetic N fertilizer, and unamended control. Pyrosequencing, a high-throughput sequencing technique, was used to characterize the bacterial communities. A total of 218,895 sequences, from the V1-V3 region of the 16S rRNA gene were obtained. Thirteen phyla were identified and dominated by Actinobacteria (42.9%) and Proteobacteria (24.8%). In general, time of sampling within the growing season had more of an effect on bacterial communities than treatments. Pig manure was more diverse than both the control and synthetic fertilizer treatments and diary manure was intermediate to the pig manure, control and synthetic treatments. The post-harvest period was significantly more diverse than the post-planting period. Soil sulphate, nitrate and ammonium concentrations significantly explained 44% of the variation observed in bacterial communities across treatments and sample periods. The relationship between bacterial taxa and soil nutrients will be discussed.

Can inclusion of 4 years of perennial forage in an annual crop rotation within the Red River Valley of the Canadian Prairies increase soil carbon storage and reduce nitrous oxide emissions?

K.L. Hanis[1], M. Tenuta[1], B.D. Amiro[1], A.J. Glenn[2], S.E. Maas[3], and M. Gervais[1]
[1]Department of Soil Science, University of Manitoba, Winnipeg, MB
[2]Agriculture and Agri-Food Canada, Brandon, MB
[3]Bruce D. Campbell Farm and Food Discovery Centre, Faculty of Agricultural & Food Sciences, University of Manitoba, Glenlea, MB

The introduction of perennial forages into annual cropping systems may have the potential to increase soil carbon sequestration and decrease nitrous oxide (N_2O) emissions to the atmosphere. However, there are few quantitative measurements about this impact on the Canadian Prairies. A long-term field experiment to measure both carbon dioxide (CO_2) and N_2O fluxes was established at the Trace Gas Manitoba (TGAS-MAN) research site at Glenlea, Manitoba. The soil is clay with poor drainage in the Red River Valley. The field experiment consisted of four 4-hectare plots. All four plots were planted to corn in 2006 and faba bean in 2007. In 2008, grass-alfalfa forage was introduced to two plots (annual - perennial) and grown until 2011 whereas the other two plots (annual) were planted to annual crops: spring wheat, high erucic acid rapeseed, barley and spring wheat in 2008, 2009, 2010 and 2011, respectively. In 2012, all four plots were planted with corn, and in 2013 planted with soybeans. We continuously measured CO_2 and N_2O fluxes from each plot using the flux gradient method and a tunable diode laser analyzer. The results indicate that over seven crop years (2006-2012), the annual – perennial system increased carbon (C) uptake by 3.4 Mg C ha^{-1} and reduced N_2O emissions by 6 kg N ha^{-1} compared to the annual system. However, after harvest removals the annual – perennial system was a greater carbon source by 7.6 Mg C $ha^{-1}$and overall greenhouse gas source by 22 Mg CO_2equivalent ha^{-1} than the annual system. Termination of the perennial crop also affected the fluxes over the short-term, and we are currently following the long-term impacts.

Wetland and traditional phytoremediation approaches for the decommissioning of municipal lagoons

Adenike Hassan[1*], Francis Zvomuya[1], and Lisette Ross[2]
[1]Department of Soil Science, University of Manitoba, Winnipeg, MB R3T 2N2
[2]Ducks unlimited, A-1238 Chevrier Blvd, Winnipeg, MB R3T 1Y3
[*] hassana3@cc.umanitoba.ca

Land spreading is the currently approved method of disposal of municipal biosolids in many jurisdictions, including Manitoba. However, the technique is expensive and presents a risk of pathogen and contaminant transfer during transportation and spreading of the biosolids. This growth room study examined the effectiveness of alternative in-situ remediation approaches – a constructed wetland and a traditional phytoremediation system – for decommissioning municipal lagoons in southern Manitoba. In the phytoremediation experiment, switchgrass (*Panicum vigratum*) and cattail (*Typha latifolia*) seedlings were transplanted into pots containing 3.93 kg (dry wt.) of biosolids from a primary cell (PB), biosolids from a secondary cell (SB), or a 1:1 mixture of PB and soil (PBS). In the wetland microcosm experiment, cattail seedlings were transplanted into pots containing 4.54 kg (dry wt.) of either PB or PBS, above which a 10-cm deep water column was maintained. In both experiments, aboveground biomass was harvested either once at the end of the 90-d growth period or twice during this period. Initial results from these experiments indicate that biosolids can support a healthy plant population and produce high biomass yields without amendment with soil. Repeated harvesting increased biomass yield of switchgrass in the phytoremediation experiment but had no significant effect on cattail yield in this experiment relative to a single harvest during the 90-day growth cycle. By contrast, cattail biomass yield in the wetland system was greater for one than for two harvests. In both systems, repeated harvesting significantly improved nutrient uptake because of the greater biomass with repeated harvesting in the phytoremediation system and because of greater biomass-weighted nutrient concentration in the wetland system. While it is too early to determine long-term trends, these initial results suggest that the approaches tested may offer viable alternatives to currently permitted practices of land application and landfill disposal of biosolids.

What is the policy value of a 'virtual phosphorus footprint'?

Phil M. Haygarth*
Environment Centre, Lancaster University, UK
* p.haygarth@lancaster.ac.uk

Human-derived inputs of phosphorus (P)to water from sewage, industry and agriculture have contributed to the extent that currently P transfer from land to coastal waters is double that of pre-human fluxes. This elevated P flux influences the ecosystem services upon which we depend, through degradation of natural resources (soils, freshwater) and loss of biodiversity. Controlling the flux of P between pools (most critically between land and water) must be the foci of new policies for P management and that our (perhaps misguided) preoccupation with managing stores of P (i.e., the 'peak P' argument) means we have missed a trick in the sustainable use of this critical resource. The concept of a virtual P footprint will be examined in terms of its usefulness for helping us go forward in relation to: (1) the global P cycle and where in the earth system the major fluxes are located; (2) accumulation of P (including organic forms) in soil and opportunities for some biotechnological 'root' solutions; (3) opportunities for improved animal manure and human biosolid P management and recycling, and (4) the need for holistic & integrated systems thinking. Ultimately, both global and national policy perspectives will benefit here, but delivery of solutions will in the main depend on local responsibilities (institutionally and legally defined) and local action (funded from local or higher sources). It is important to acknowledge many contributors to this work, who will be named and acknowledged in the oral presentation.

Spatiotemporal modeling of soil redistribution induced by sheet erosion using the Universal Soil Loss Equation

Brandon Heung[1*], Laurens Bakker[2], Suzana Dragićević[3], and Margaret Schmidt[1]
[1]Soil Science Lab, Department of Geography, Simon Fraser University, Burnaby, BC
[2]IRMACS Centre, Simon Fraser University, Burnaby, BC
[3]Spatial Analysis and Modeling Lab, Department of Geography, Simon Fraser University, BC
* bha4@sfu.ca

Soil redistribution, a combination of erosion and deposition processes, is a crucial determinant of landscape evolution. Soil redistribution is a classical example of a feedback mechanism: the flows of matter evolve the landscape, which thereby alter their own course. In this study, a sheet erosion-induced soil redistribution model was developed in order to examine this feedback mechanism. The model is unique in that it is temporally dynamic and it employs a spatially distributed fluvial sediment flux (q_s), calculated using the Universal Soil Loss Equation (USLE).

The USLE was particularly suitable as it incorporates aspects of Jenny's five soil-environmental variables for the modelling of short to medium-term soil erosion. Furthermore, the USLE variables could easily be derived from geospatial data in order to calculate a spatially disaggregated value of q_s for each grid cell. The *R-factor* was derived from mean annual precipitation data; the *C-Factor* from satellite imagery; the *LS-factor* from a digital elevation model; and the *K-factor* from soil survey data. The amount of erodible soil was calculated for each grid cell using the USLE and was transported and deposited down slope to neighbouring cells. The model was tested on Bowen Island, British Columbia at a 25 m spatial resolution over a 100-year time span. Model simulations with and without a feedback loop diverged markedly where a small change in slope and flow pathways resulted in a disproportionately large change in soil redistribution.

Most studies in the field of digital soil mapping have focused on a temporally static representation of soil attributes and hence, time is not explicitly considered. The uniqueness of this model is in its treatment of time in addition to Jenny's remaining soil-environmental variables. The proposed model is only a first step towards the development of a fully dynamic digital soil-process model.

Relationship of crop yield and protein content to soil properties in an undulating landscape in south central Saskatchewan

Elliott Hildebrand*, Jeff J. Schoenau
Dept. of Soil Science, 51 Campus Drive, University of Saskatchewan, Saskatoon, SK S7N 5A8
* erh947@mail.usask.ca

A field season initiated in spring 2012, in south central Saskatchewan, was established to assess relationships between grain yield, grain protein and soil properties including elevation, electrical conductivity, organic carbon in an undulating landscape. Grain protein can reflect the balance of nitrogen relative to other yield limiting factors that affect plant growth. The objective of this study is to assess if protein content can aid in identifying management zones for variable rate N application. Wheat, canola and peas were seeded on field areas of 9.7, 12.9 and 10.5 ha respectively. Soil samples and harvest measurements were taken from two transects in each field. Wheat, canola and pea yields ranged from 882-2554, 1143-2342, and 839-3122 kg/ha respectively across the transects while protein content for wheat, canola and peas ranged from 10.5-14.4, 14.2-20.6 and 14.5-17.7 percent respectively. Protein in wheat was positively correlated with pH in the 30-60 cm depth and was negatively correlated with electrical conductivity in the 30-60 cm depth. Protein in canola was negatively correlated with elevation and positively correlated with pH, organic carbon and electrical conductivity in the 0-30 cm depth. Protein in peas was positively correlated with organic carbon in the 0-30 and 30-60 cm depth. Yield in wheat was positively correlated with organic carbon in the 30-60 cm depth, and negatively correlated with pH in the 0-30 cm depth. Canola yield was not significantly correlated with any measured soil properties. Pea yield was positively correlated with elevation, likely due to disease pressure in low lying areas, and was negatively correlated with electrical conductivity in both the 0-30 and 0-60 cm depths, reflecting the high sensitivity of pea yield to soil salinity. These relationships will be assessed and used to identify N management zones for seeding in spring 2013.

Nitrogen leaching from sheep grazed hill country in New Zealand

Coby Hoogendoorn*, Rogerio Cichota, Iris Vogeler, Brian Devantier, and Catherine Lloyd-West
Grassland Research Centre, AgResearch Limited, Private Bag 11008, Palmerston North, New Zealand
*coby.hoogendoorn@agresearch.co.nz

Pastoral farming in hill country is a major land use in New Zealand but there is large uncertainty on the impact of on-going intensification on nitrogen (N) cycling within this landscape. In grazed hill country, dung and urine distribution is non-random due to animal behaviour, resulting in the transfer of ingested nutrients, from moderate (MS, 13–25°) and high (HS, >25°) sloped areas to low slope/camping (LS, 0-12°) sites. The aim of this study was to measure the impact of slope class and grazing intensity on leaching of ammonium-N (NH4-N), nitrate-N (NO_3-N) and dissolved organic N (DON) in sheep-grazed hill country. Leaching was measured using lysimeters (15 cm ø x 30 cm depth) installed in 3 intensive (14 ewe-equivalents ha^{-1}) and 3 extensively (8 ewe-equivalents ha^{-1}) grazed paddocks (0.4 ha each). Each paddock had 8 lysimeters in both LS and MS areas. Leachate was collected monthly and amounts of NH_4-N, NO_3-N, and DON leached per lysimeter were calculated from their concentration in the leachate and volume leached. Topography had a highly significant effect on the amount of all forms of N leached, with LS leaching 7, 40 and 60 kg of NH_4-N, NO_3-N and DON ha^{-1} yr^{-1}, respectively, compared to 1, 1 and 10 kg of N ha^{-1} yr^{-1} on MS. After 2 years of differential treatment, grazing intensity had no significant impact on the amount of N leached from either LS or MS. Biophysical data collected from the site was utilised to parameterise the APSIM model used to simulate N leaching in this landscape. The model was capable of describing the observed variations in inorganic, but not organic, N leaching. Our results indicate that LS areas of grazed hill country are critical source areas of both inorganic and organic N loss from below the root zone of pastures.

Use of a GIS/stratigraphic model to predict zones of elevated cadmium and other metals in soils derived from Cretaceous Pierre Shale on the Pembina Escarpment, Cavalier County, North Dakota

D. G. Hopkins[1*], A. L. Steffen[2], B. Sani-Eidukat[2], and R. E. Utter[1]
[1]Department of Soil Science, North Dakota State University
[2]Department of Geosciences, North Dakota State University
[*] david.hopkins@ndsu.edu

Recent soil geochemical studies in North Dakota and the Prairie Provinces of Canada have revealed micronutrient distributions important to crop yield and quality. Cadmium (Cd) has also been measured due to its bioaccumulation in confectionary sunflower, edible flax, and durum wheat. Elevated Cd levels have been identified with Cretaceous shales on the Manitoba and Pembina Escarpments, and in shale-enriched northern North Dakota tills. On the Pembina Escarpment in North Dakota, topsoil Cd concentrations of enriched soils are 10 to 30 times higher than a Cd baseline concentration established for prairie topsoils. Here, we test the integrity of a GIS model using stratigraphic position of organic shales to identify if the presumed source sediments are correlated with zones of naturally occurring trace metals, specifically Cd. Well logs were used to project elevations of the highest priority shale facies to the surface of the eastward sloping Pembina Escarpment. Given dip uncertainty, target sampling zones were designed at 1, 5, and 10 m variance around the projection. We hypothesized that Cd and other metals would be elevated within such zones. Samples from 10 sites along a 1.5 km transect were collected to 2 m depth as well as topsoils and subsoils from 4 satellite samples 20 m distant. Samples were digested using EPA Method 3050B, and analyzed by ICP-OES. Aggregate mean topsoil values (satellite and cores, n=5) over the entire transect are elevated 17-fold relative to the Cd baseline. The highest Cd levels measured (10.3 and 9.6 mg/kg for topsoils and subsoils, respectively) were located within the 1 meter lateral zone of the projected shale outcropping. Arsenic, copper, nickel, and zinc correlate well with the model; all have their highest values within the 1 meter zone. The data corroborate the model and show that is possible to predict element variation within the landscape.

Continuous measurements of methane fluxes, environmental variables and manure properties from stored dairy manure over 16 months on a commercial farm

Gudmundur Johannesson[1]*, Claudia Wagner-Riddle[1], Andrew VanderZaag[2], Rob Gordon[1], and Chris Duke[3]
[1]School of Environmental Sciences, University of Guelph
[2]Agriculture and Agri-Food Canada
[3]Ontario Ministry of Agriculture and Food
* gjohanne@uoguelph.ca

Accurate on-farm measurements are needed for improved understanding of quantities, rates and mechanisms of methane fluxes from stored dairy manure. The relatively scarce data currently available from such studies provide basis for national GHG inventories and GHG emission models describing emissions released from farms.

Methane emissions from liquid dairy manure, in open storage (730 m^2 surface area), were measured at a commercial farm in southern Ontario using a micrometeorological mass balance method, from July 2010 to November 2011. The farm had an under-barn storage and an off-site storage so manure was added to the storage tank intermittently and manure was removed once, leaving 50% residual in the tank. Environmental variables in and around the manure storage tank were monitored, as well as changes in manure properties with time in storage. Manure was sampled incrementally by depth at one to three month intervals, and analysis results indicate non-linear degradation of organic matter with time, particularly total and volatile solids.

Average monthly fluxes were consistently lower from December 2010 to April 2011 ranging from 42.5 to 72.8 μg CH_4 m^{-2} s^{-1}, with highest peak emissions observed in September of both years. Fresh manure additions in late summer 2010 resulted in higher peak in 2010 (1584 μg CH_4 m^{-2} s^{-1} monthly average in September) compared to 914 μg CH_4 m^{-2} s^{-1} in September 2011.

Using stepwise regression of daily data, five measured environmental parameters explained 55% of the variability in methane fluxes; manure temperature near surface, at 0.5 m, and 2 m depths, air temperature, and solar radiation.

The study results validate the need for continuous, high-resolution measurements of methane emissions to capture variability and identifies useful environmental parameters to predict emissions.

Nitrate and phosphorus leaching on a loamy sand soil at two rates of liquid swine manure and fertilizer

Rezvan Karimi Dehkordi[1*], Wole Akinremi[1], and Katherine Buckley[2]
[1]Department of Soil Science, University of Manitoba, Winnipeg, MB
[2]Agriculture and Agri-Food Canada, Brandon, MB
[*] karimirezvan@yahoo.com

Excess nitrate (>10 mg l^{-1}) in drinking water regardless of the source (fertilizers or organic amendments), leads to degradation of water quality and serious problems for animals and humans. At very low concentration of phosphorus (0.035-0.1 mg l^{-1}) in water, eutrophication occurs. To monitor the effect of liquid hog manure and commercial fertilizer on NO_3^- and P movement from the root zone, a field experiment was conducted at Carberry on a Loamy sand soil. The field experiment was a randomized complete block design with 6 treatments and 4 replicates. Treatments included two rates of liquid hog manure (2500 and 5000 gallons per acre), two rates of fertilizers corresponding to the amount of available nitrogen in manure, compost when both compost and urea was applied based on the amount of available nitrogen of 2500 gallons per acre of liquid hog manure and control. Leachate was collected from lysimeters (one per 10 m by 10 m plot) at intervals dependent on observed precipitation during 2010 and 2011 growing seasons. The total volume of leachate from each lysimeter was recorded and the NO_3^- and P concentrations were measured. Soil samples were collected during spring, mid-season and harvest and analyzed for inorganic N and P concentrations. Results showed the amount of nitrogen that was lost in 2010 ranged from 21.4 to 133.5 kg ha^{-1} and was greater than that of 2011 which ranged from 18.76 to 82.4 kg ha^{-1}. The higher rate of fertilizer had greatest loss of nitrate-N in both years. This suggests that, from environmental or even agronomical point of view, the rate is not sustainable on this sandy soil. Phosphorus leaching was negligible and the maximum loss of phosphorus was from the higher rate of liquid hog manure (58 and 83 g P ha^{-1} in 2010 and 2011, respectively).

Manure-based struvite for reduced seedling toxicity and enhanced phosphorus use efficiency in canola production

Y. Katanda[1*], F. Zvomuya[1], D. Flaten[1], and N. Cicek[2]
[1]Dept. of Soil Science, University of Manitoba, Winnipeg, MB R3T 2N2
[2]Biosystems Engineering, University of Manitoba, Winnipeg, MB R3T 2N2
[*] katanday@cc.umanitoba.ca

Canola production in the Canadian prairies is highly limited by phosphorus (P) supply. Rates of commercial P fertilizers applied in the seedrow are limited by the risk of seedling toxicity, while P placed away from the seed-row may have limited availability due to poor mobility. This greenhouse experiment was set up to evaluate the effectiveness of manure-derived struvite at enhancing P use efficiency (PUE) and reducing seedling toxicity in canola grown on two contrasting low-P Chernozemic soils. Monoammonium phosphate (MAP) and polymer-coated monoammonium phosphate (PCMAP) were included for comparison, along with a non-fertilized control. Phosphorus fertilizers were applied at rates of 25 and 50 kg P_2O_5 ha^{-1}, either in the seed-row or in a side-band. All pots also received nutrient solutions and were watered with reverse-osmosis water to maintain moisture content near 70% water-filled pore space. Seedling counts (a surrogate for seedling-toxicity), which commenced when 50% of seeds in the control pots had emerged, showed no significant seedling damage due to P source or rate. Above-ground biomass yield, assessed when 50% of the plants had started flowering, was greater for fertilized than non-fertilized (control) plants. Canola biomass yield in the loamy sandy was significantly higher with MAP than struvite, regardless of P rate, and increased with P rate across all P sources and both placement methods. When applied in the seedrow, the 50 kg P_2O_5 ha^{-1} rate also resulted in higher canola biomass yield in the clay loam. Compared to side-banding, seedrow placement significantly increased canola biomass in the loamy sand. Results of biomass yield for the second and third cycles, as well as PUE assessments will also be presented.

Questogo: Bringing mobile technology into the outdoor classroom

Carolyn King[1*], Julia Dordel[2], Maja Krzic[1,2], Suzanne Simard[1], and Les Lavkulich[2]
[1]Faculty of Forestry, University of British Columbia, 2424 Main Mall, Vancouver, BC V6T 1 Z4
[2]Faculty of Land and Food Systems, University of British Columbia, 2357 Main Mall, Vancouver, BC V6T 1Z4
[*] carolynmkg@gmail.com

Technology has become ever present in our society, and this has necessitated a shift in the way that we view education and social interactions. In this study, we explored the viability of mobile technology and the emergence of game-style smartphone apps in a post-secondary educational setting. To address the issue that instructor to student ratios are getting lower, we incorporated online mobile technology into a lower level postsecondary course on Forest Ecology offered at the University of British Columbia (UBC), Vancouver that has traditionally been enhanced by one-on-one instruction in an outdoor field setting. In this study we employed the mobile phone application Questogo, developed by the 14Oranges company located in Richmond, BC. The study group consisted of 130 undergraduate students. The quest that students completed incorporated question and answer, instructional/directional, and Global Positioning System (GPS) tasks that tested students' knowledge of forest and disturbance ecology in a provincial park adjacent to the UBC campus. After completing the quest, students were asked to fill out an online survey. The results showed that this type of self-guided education was engaging to students, and was preferred when compared to more structured, traditional labs. The feedback also indicated that it is essential that the knowledge base of the quest participants be fully known to have questions tailored to the correct level of difficulty for the audience. The feedback generated by this pilot study showed that educational mobile phone applications such as Questogo have a great potential for postsecondary education in an outdoor setting.

Effect of variability in cattle manure application on soil nutrients and crop yield

Tom King[1*], Jeff Schoenau[1], Joy Agnew[2], and Hubert Landry[2]
[1]Department of Soil Science, University of Saskatchewan, 51 Campus Drive, Saskatoon, SK S7N 5A8 [2]Prairie Agriculture Machinery Institute, Humboldt, SK S0K 2A0
[*] tom.king@usask.ca

An assessment of the effects of non-uniform distribution of solid cattle manure (SCM) is necessary, as the impact of non-uniform distribution on crop yield and soil nutrients has not been well documented in Western Canada. Equipment used in Western Canada to apply SCM such as box spreaders can have coefficient of variation (C.V.) for uniformity of distribution that can range from 30 to 110 % (Landry et al. 2011). The objective of this study was to examine the effect of two year's application of SCM as affected by the uniformity of manure application on crop yield and soil nutrient distribution across the application area. The study was conducted on a loam textured Black Chernozem soil located in east-central Saskatchewan. Solid cattle manure was applied at rates of 20 t ha^{-1} and 60 t ha^{-1} using an applicator machine capable of varying the C.V. Three C.V. treatments were used: Low C.V.~10%, Mid C.V. ~ 50% and High C.V. ~ 110%. In the two years of the study, oat and barley yields were lower in the 60 t ha^{-1}, High C.V. treatment than in Mid and Low C.V. treatments, indicating a negative effect of uneven application of SCM on crop yield, especially at high rates. Soil nitrate concentrations across the application area were not closely related to manure distribution patterns but where SCM was non-uniformly distributed in bands, greater concentrations of soil extractable P were found at the soil surface in accumulation zones.

References:

Landry, H., T. King, J. J. Schoenau, C. Lague and J. Agnew. 2011. Development and Evaluation of Subsurface Application Technology For Solid Organic Fertilizers. Appl. Eng. Agric. 27: 533-549

Investigating the role of connectivity and scale in assessing the sources of sediment in an agricultural watershed in the Canadian prairies using sediment source fingerprinting

Alexander J. Koiter[1*], Philip N. Owens[2], Ellen L. Petticrew[3], David A. Lobb[4], Kevin D. Tiessen[5], and Sheng Li[6]
[1]Natural Resources and Environmental Studies Program, University of Northern British Columbia, Prince George, BC
[2]Environmental Science Program and Quesnel River Research Centre, University of Northern British Columbia
[3]Geography Program and Quesnel River Research Centre, University of Northern British Columbia
[4]Department of Soil Science, University of Manitoba
[5]International Development Research Centre
[6]Potato Research Centre, Agriculture and Agri-Food Canada
[*] koiter@unbc.ca

Sediment adversely impacts the quality of surface water and is a significant source of contaminants such as nutrients and pesticides. Correctly identifying the contributions of different sediment sources is an important part of designing and targeting conservation efforts. Effective watershed management strategies to address these issues increasingly rely on sediment fingerprinting to identify sediment sources. Watershed geomorphology, topography and hydrology are factors that strongly influence sediment dynamics, and as such, they need to be taken into consideration when selecting sampling locations and when interpreting the data. However, in sediment fingerprinting the importance of sampling location is often overlooked and sediment, typically collected at the watershed outlet, may not accurately represent processes affecting sediment dynamics elsewhere in the watershed. The present study is located in the predominately agricultural South Tobacco Creek watershed in south-central Manitoba. This watershed extends across the Manitoba Escarpment; its upper reaches lay in undulating glacial tills and its lower reaches lay in the lacustrine sediments of glacial Lake Agassiz. The objective of this study was to identify the sources of sediment within the watershed using sediment fingerprinting. Samples were collected over the course of three years at six locations along the main stem of the creek, ranging from 3rd order (48 ha) to 7th order (7441 ha) drainage basins. Our analysis concluded that there is a switch in the sediment sources between the headwaters and the outlet of the watershed. The suspended sediments in the upper reaches are dominated by topsoil sources while the suspended sediments moving through the lower reaches and being exported from the watershed had a higher proportion of sediment coming from streambank and shale bedrock sources. This research highlights the importance of the sampling location, scale and connectivity on the interpretation of results derived from the sediment fingerprinting technique.

Microbial and carbon dynamics in a buried A horizon from an eroded catena at St. Denis National Wildlife Area

H.J. Konschuh [1,2], A. Bedard-Haughn[2], A. J. VandenBygaart[3], and B.L. Helgason[1*]
[1]Agriculture and Agri-Food Canada (AAFC), Research Centre, Saskatoon, SK
[2] Dept. of Soil Science, University of Saskatchewan, Saskatoon, SK
[3]AAFC Experimental Farm, Ottawa, ON
[*] bobbi.helgason@agr.gc.ca

Quantifying carbon dynamics in agricultural landscapes is important for understand the net C input and storage in soil. Erosion in hummocky landscapes results in the transport of soil and concentration of C in depositional positions. However, we are still striving to quantify and understand the impact of these transport processes on net C storage within a given catena and more broadly on agricultural lands. The biological availability of C that is buried and stored in lower slope positions is unknown and the extent to which microorganisms are able to exist and function in this C-rich environment is unstudied. Using phospholipid fatty acid analysis (PLFA), we surveyed microbial communities to the depth of the A horizon in three different landscape positions (two erosional and one depositional) at St. Denis, SK. Substantial carbon and microbial biomass were present up to 80 cm depth in a depositional A horizon. Remarkably, community composition in the depositional soil profile was related to where in the landscape the soil originated, even after decades of sub-surface conditions. We then examined the susceptibility of this buried C to loss through mineralization by incubating freshly sampled soils under controlled conditions for 62 d. Despite the presence of significant C and microbial biomass, C mineralization in the buried A horizon soils was constrained, relative to surface soils. While there was some adaptation in microbial community structure during the incubation period, the community structure in soils from different depths remained dissimilar throughout the experiment. Our results indicate that even under surface-like conditions, the buried C was not readily accessible to the indigenous microbial community.

Location-based tool brings soil science out of the classroom through mobile technology

M. Krzic[1*], K. Watson[2], S. Dyanatkar[3], J. Wilson[1], C. Crowley[3], P. Sanborn[4], A. Bedard-Haughn[5], and N. Basiliko[6]

[1]The University of British Columbia, Faculty of Land and Food Systems, Vancouver, BC

[2]Thompson Rivers University, Kamloops, BC

[3]The University of British Columbia, Center for Teaching and Learning Technology, Vancouver, BC

[4] University of Northern British Columbia, Prince George, BC

[5]University of Saskatchewan, Saskatoon, SK

[6]Department of Geography, University of Toronto-Mississauga, Mississauga, ON

[*] maja.krzic@ubc.ca

As smartphone and tablet usage continues to rise in Canada and around the world, this opens opportunities to create mobile learning resources that enhance accessibility of educational content and engaged learning. Currently, the Virtual Soil Science Learning Resources (VSSLR) group (www.soilweb.ca) is developing an innovative on-line, location-based tool that uses mobile technology and global positioning system (GPS) coordinates to connect virtual content (e.g., text, graphics, videos) to specific geographical locations. The tool is based on two educational websites – "Canadian Soil Orders" (http://soilweb.landfood.ubc.ca/classification/) and "Land Use Impacts on Soil Quality" (http://soilweb.landfood.ubc.ca/luitool/). Using responsive design (formatted for both desktop and mobile devices), an interactive map of British Columbia is being created and populated with detailed content from the websites mentioned above. This tool adds innovation to the traditional soil science curriculum by engaging learners both inside and outside the classroom. It allows learners to undertake self-guided field trips and take advantage of experiential, hands-on learning at a real life field location combined with access to virtual content about that specific location. Learners stay connected to the physical world via their natural senses (e.g., touch, vision, smell) while at the same time having access to, and interacting with, digital information specific to their field location. The flexibility of the location-based tool (Google Fusion Table, which links site information to a dynamic database) will also allow, in the next phase of its development, a basis upon which end-users can expand through crowdsourcing activities. A number of target audiences including students, soil scientists and professionals, land managers and even avid gardeners can input information for more geographical sites that can expand this network across Canada, connecting people interested in soils. An interactive overview of the latest version of the tool will be given during the presentation.

Emissions of ammonia, methane and nitrous oxide from dairy production facilities in southern Idaho

April B. Leytem[*], Robert S. Dungan, and David L. Bjorneberg

USDA-ARS, Northwest Irrigation and Soils Research Laboratory, Kimberly, ID

[*] april.leytem@ars.usda.gov

Concentrated dairy operations emit trace gases such as ammonia (NH_3), methane (CH_4), and nitrous oxide (N_2O) to the atmosphere. The implementation of air quality regulations in livestock-producing states increases the need for accurate on-farm determination of emission rates. Our objective is to compare the emission rates of NH_3, CH_4, and N_2O from three commercial dairies in southern Idaho that vary in size, animal housing, and manure handling systems. The three dairies consisted of a small open lot dairy (700 cows), large open lot dairy (10,000 cows) and a large open-freestall dairy (10,000 cows) with an anaerobic digester. Both housing and manure management systems were monitored in order to determine "whole farm emissions" and determine the effects of manure handling practices on emissions from the different farm sectors. Gas concentrations and wind statistics were measured and used with an inverse dispersion model to calculate emission rates. Average emissions from the housing area per cow per day for the three farms ranged from 0.10 – 0.14 kg NH_3, 0.33-0.49 kg CH_4 and 0.01 - 0.02 kg N_2O. Average emissions from the wastewater ponds (g cow^{-1} d^{-1}) were 10 - 129 NH_3, 27 – 1,028 CH_4 and 3.7 – 4.9 N_2O. Data from this study can be used to develop trace gas emissions factors from dairies in southern Idaho and other production systems in similar climatic regions.

Greenhouse gas flux from western U.S. agroecosystems: Synthesis of mitigation opportunities

M.A. Liebig[*] and A.D. Halvorson[2]
[1]USDA-ARS, Mandan, ND 58554
[2]USDA-ARS, Ft. Collins, CO 80526
[*]mark.liebig@ars.usda.gov

Maintaining critical agroecosystem functions will require proactive management responses that concurrently mitigate greenhouse gas (GHG) emissions and adapt to impacts from climate change. In the western U.S., numerous strategies currently exist to mitigate GHG emissions from cropland and rangeland, though the quantification of their effectiveness has remained elusive due to the large diversity of climatic/edaphic conditions and management practices throughout the region. Given this need, we sought to summarize management effects on carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) flux using recently published data for western U.S. agroecosystems as a means to infer mitigation effectiveness while identifying critical research gaps. Conversion from conventional tillage (CT) to minimum-till (MT) or no-till (NT) resulted in net CO_2 uptake in most, but not all, cropping systems. Most rangelands were net CO_2 sinks, with assimilation rates ranging from 0.2-1.1 Mg C ha^{-1} yr^{-1}. Cropland management had a negligible effect on CH_4 flux, while rangelands were minor CH_4 sinks (with the notable exception of prairie wetland). Fertilizer rate and N source were found to have overarching effects on cropland N_2O emissions, with some practices decreasing emissions by as much as 50% compared to conventional fertilization practices. Nitrous oxide flux from rangelands were small (1.4-3.2 g N_2O-N ha^{-1} d^{-1}), and increased with N fertilization, invasion of non-native grasses, and woody plant encroachment, but not grazing intensity. While significant progress has been made in recent years to better understand GHG dynamics in western U.S. agroecosystems, numerous deficiencies persist that undermine the development of robust estimates of mitigation potential for most management practices. Such deficiencies stem from a lack of measurements across all major agroecosystem categories in the region, as well as limitations associated with a basic understanding of mechanistic processes related to GHG flux. Amidst this pressing opportunity, recommendations will be offered.

Evaluation of dynamic image analysis for characterizing clast particles derived from bedrock outcrops in the South Tobacco Creek Watershed

Cenwei Liu[1*], David A. Lobb[1], and Sheng Li[2]
[1]University of Manitoba, Winnipeg, MB
[2]Agriculture and Agri-Food Canada, Fredericton, NB
[*] LiuC179@gmail.com

The morphology of clast particles helps in understanding the origin of sediments, and the dynamics and delivery and any modifying processes that may have occurred during transport within a watershed. The objective of this study was to evaluate the use of ImageJ, an automated image analysis software based on the digital image analysis of rock photographs to determine particle shape. Samples of rock material were collected from bedrock outcrops and the associated stream channels and during summer low flow in the South Tobacco Creek Watershed. Particle morphology data were obtained with a high-resolution digital camera. The morphology of the particle population was characterized using round, circularity, and aspect ratio. Round was derived from the area-perimeter relationship and showed an increase trend from the source to further place. Visually, the increase in roundness represented the formation of large particles with more smooth edge and decreased perimeters. This study suggests that the changes in particle morphology may provide a distinct fingerprint for each rock from different location.

Conversion of conservation tillage to rotational tillage resulted in reduced loads of phosphorus during snowmelt runoff in the Canadian prairies

Kui Liu[1*], Jane A. Elliott[2], David A. Lobb[1], Don N. Flaten[1], and Jim Yarotski[3]
[1]Department of Soil Science, University of Manitoba, Winnipeg, MB R3T 2N2
[2]Environment Canada, National Hydrology Research Centre, Saskatoon, SK S7N 3H5
[3]Agri-Environment Services Branch, Agriculture and Agri-Food Canada, Regina, SK S4P 4L2
[*] kui.liu@ad.umanitoba.ca

Conversion to conservation tillage (ConsT) from conventional tillage (CT) has been reported to decrease N but increase P loss during snowmelt runoff. A field-scale study, 2004-2012, was conducted to determine if conversion of ConsT to rotational tillage (RT), whereby ConsT is interrupted by a single tillage pass every second year, can effectively reduce P loads. This experiment was built on a long-term paired ConsT vs CT fields established in 1993. The CT field has remained under conventional tillage practices since the establishment and was characterized by a fall tillage using a heavy-duty cultivator. The ConsT field characterized by no fall tillage started in 1997 and continued until 2007. The ConsT changed to RT since 2008 with heavy-duty cultivator passes in the late fall of 2007, 2009, and 2011. Runoff was monitored at the edge of two fields and water samples were taken for measuring nutrient content. Each fall, soil and crop residue samples were taken to determine soil nitrogen (N) and phosphorus (P) and N and P released from crop residue. Change of tillage significantly altered duration of runoff with the highest in ConsT and the lowest in CT. Compared with CT, the ConsT significantly decreased the concentration and loads of TDN and TN, but increased TDP and TP. Higher soil P, particularly in the 0-5 cm, more P released from crop residue, and longer duration of runoff are likely the reasons for the increased P loss in ConsT relative to CT. Tillage in RT resulted in mineralization of carbon accumulated during the ConsT phase and increased the concentration of dissolved organic carbon (DOC) by 25% and load by 44% compared with CT. The RT resulted in increases in load of DOC by 34%, TDN by 34%, and TN by 60% compared with ConsT; however, conversion of ConsT to RT decreased load of TDP by 56% and TP by 60% due mainly to a decrease in P released from crop residue, an increase release of carbon from surface soil, and reduced duration of runoff. On the Canadian Prairies, where P is a major environmental concern compared with N, adoption of RT was demonstrated to be an effective practice to reduce P loss compared with the ConsT.

Anion competition by sulphate affects P solubility and speciation in calcareous soils: A ^{31}P MAS NMR and S K - edge XANES investigation

Mihiri C.W. Manimel Wadu[1]*, Yongfeng Hu[2], Scott Kroeker[3], and Olalekan O. Akinremi[1]
[1]Department of Soil Science, University of Manitoba, Winnipeg, MB R3T 2N2
[2]Canadian Light Source Inc., 44 Innovation Boulevard, Saskatoon, SK S7N 2V3
[3]Department of Chemistry, University of Manitoba, Winnipeg, MB R3T 2N2
* ummanime@cc.umanitoba.ca

Precipitation reactions of P with Ca decrease the P fertilizer efficiency in calcareous soils. The objective of this study was to determine the effect of applying K_2SO_4, $(NH_4)_2SO_4$ and $MgSO_4$ salts with monopotasssium phosphate (MPP) on the solubility of P. The hypothesis is that the anion competition of sulphate with phosphate for Ca will increase phosphorus solubility. This objective was accomplished by conducting a laboratory incubation experiment using a model calcareous soil and a Dezwood Loam (DL) soil. Chemical analysis was conducted to determine P solubility in soils. Phosphorus - 31 magic-angle spinning nuclear magnetic resonance (^{31}P MAS NMR) and S – K edge X – ray absorption near edge spectroscopy (XANES) were used to identify P and S compounds formed in soils, respectively. Addition of sulphate salts increased the water-soluble P concentration compared to the treatment contained MPP (MPP only). The enhanced P solubility in both soils was in the order of K_2SO_4 > $(NH_4)_2SO_4$ > $MgSO_4$. The results of S – K edge XANES showed that $CaSO_4$•$2H_2O$ was formed in the DL soil. Dicalcium phosphate dihydrate (DCPD) was formed in the 0 – 3 mm depth of both soils with all the treatments as shown by MAS NMR. The soil treated with MPP only contained 100% DCPD while the relative percentage of DCPD decreased with the presence of sulphate salts due to the formation of a new P compound. Both chemical and XANES analyses confirmed the increased P solubility in calcareous upon addition of sulphate salts. The addition of sulphate not only lead to the formation of $CaSO_4$•$2H_2O$ but also altered the species of P compounds that were formed. Application of K_2SO_4, $(NH_4)_2SO_4$, and $MgSO_4$ together with P fertilizer is a promising agronomic strategy for enhancing P solubility in calcareous soils.

P solubility in ten Manitoba soils as influenced by sulphate salt addition – An exploratory study

Mihiri C.W. Manimel Wadu* and Olalekan O. Akinremi
Department of Soil Science, University of Manitoba, Winnipeg, MB R3T 2N2
* ummanime@cc.umanitoba.ca

Anion competition of sulphate with phosphate for Ca can limit P precipitation reactions in calcareous soils. The objective of this study was to determine the effect of applying K_2SO_4, $(NH_4)_2SO_4$, $MgSO_4$ and $(NH_4)_2CO_3$ salts with monopotasssium phosphate (MPP) and monoammonium phosphate (MAP) on the solubility of P in Red River, Osborne, Ladywood, Glenhope, Thalberg, Balmoral, St. Claude, Ramada, Eigenhof, and Scanterbury soils. The P:S ratio in treatments containing sulphate salts was 1:1 and a treatment with P:S of 1:2 was carried out using $(NH_4)_2SO_4$ only. Soil pH and P were determined after two weeks of incubation. Soil pH was significantly decreased by both P sources but addition of sulphate salts did not significantly affect pH in most of the soils. There was a significant treatment effect on water extractable P in all soils ($P < 0.0001$), a significant soil effect ($P < 0.0001$) and a significant soil by treatment interaction ($p < 0.0001$). Response of each soil to MPP and MAP was similar while greater P solubility and lower pH were obtained from MAP compared to MPP in all soils. Application of K_2SO_4, $(NH_4)_2SO_4$ and $MgSO_4$ enhanced P solubility by a factor that ranged from 6% to 44% in Osborne, Red River, Balmoral and St. Claude soils. Application of $(NH_4)_2CO_3$ significantly increased P solubility (11% - 14 %) in Glenhope, Ramada and Eignehof soils while the other salts decreased P solubility. Ladywood,Thalberg and Scanturbery soils showed a negative response to sulphate salts addition to both P sources. There was no significant effect of P:S ratio on the P solubility in all soils with both P sources. Soil properties such as acid extractable Ca:Mg, P sorption index and Ca^{2+} saturation on the exchange complex showed a significant correlation to the water extractable P. Application of sulphate salts with MAP can be a promising agronomic practice for soils like Osborne, Red River, Blamoral and St. Claude.

Variation in growth response of lentil to zinc fertilization and residual Zn availability to wheat in ten Saskatchewan soils

Muhammad A Maqsood[1*], Jeff Schoenau[1], Albert Vandenberg[2], Ron Urton[1], and Cory Fatteicher[1]
[1]Department of Soil Science, University of Saskatchewan, SK S7N 5A8
[2]Department of Plant Sciences, University of Saskatchewan, SK S7N 5A8
* mam757@mail.usask.ca

Application of zinc (Zn) fertilizer to grain crops can affect both marketable yield and Zn content of the grain. An experiment was conducted to evaluate the response of large green market class lentil to Zn fertilizer application and subsequent residual availability of applied Zn to wheat in ten Saskatchewan soils. Lentil was grown without Zn (control), and with 2.5 and 5 kg Zn ha^{-1} added as zinc sulfate to each soil prior to planting. Zinc fertilizer application significantly influenced grain yield of lentil classes and the effect was soil dependent. A significant increase in grain yield over the control was observed from application of Zn on some low organic matter, high pH Brown Chernozem soils whereas a decrease in grain yield over control was observed in other soils such as a Black Chernozem of high organic matter content and low (<7) pH. Lack of positive yield response to additions of Zn were related to measured high DTPA and PRS resin membrane extractable Zn. Application of Zn fertilizer generally increased the grain concentration of Zn. For example, an increase of ~20% in Zn concentration over control was observed when supplied with 5 kg Zn ha^{-1} on a loamy textured low organic matter Brown Chernozem soil. No significant grain yield response was observed in subsequently grown hard red spring wheat. However, a similar trend to lentil was observed in wheat grain Zn concentration, with a maximum increase of ~10% in the wheat grain grown on a Brown Chernozem where 5 kg Zn ha^{-1} was applied.

Estimating greenhouse gas emissions using experimental data

Ahmad S. Mat Su[1,3*], Viacheslav I. Adamchuk[1], Chandra A. Madramootoo[1], Joann K. Whalen[2], and Hsin-Hui Huang[1]
[1]Department of Bioresource Engineering, McGill University, 21111 Lakeshore Drive, Ste. Anne de Bellevue, Quebec H9X3V9
[2]Department of Natural Resource Sciences, McGill University, 21111 Lakeshore Drive, Ste. Anne de Bellevue, Quebec H9X3V9
[3]Department of Agriculture Technology, Faculty of Agriculture, University Putra Malaysia, 43400 Serdang, Selangor, Malaysia
[*] ahmad.matsu@mail.mcgill.ca

Large datasets are generated when greenhouse gas measurements are taken at multiple field sites over several growing seasons, necessitating robust algorithms for rapid and unbiased calculation of gas fluxes. A total of 7497 greenhouse gas (GHG) samples were taken from six sites across Eastern Canada to study the effect of water management and soil conditions on GHG fluxes throughout the growing season. The sites varied in terms of cropping systems, soil type and water management. A MatLab script was developed to: 1) remove outliers based on CO2, N2O and CH4 concentrations, 2) estimate GHG fluxes for 3 to 5 samples taken on each sampling date (from 7 to 20 sampling days per site), and 3) assess overall GHG emissions for the entire weekly sampling period and growing season. All gas samples were collected from the headspace of non-steady-state chambers placed in fixed locations across the experimental sites. In this work, the GHG flux was estimated as the median slope for all pairs of timed samples taken from the same chamber on a given sampling date (ten pairs for a sequence of five samples). The median slope approach, rather than the more traditional regression method, allowed data to be disregarded if it originated from an erroneous measurement. One dimensional time series interpolation and integration processes were used to aggregate flux calculations and to obtain estimates of the total annual emissions for each chamber. The data were used to compare the effects of different water management practices applied to diversified cropping systems.

Testing the ability of MODIS-NDVI models to forecast crop yields on the Canadian Prairies

M.S. Mkhabela[*], and P.R. Bullock
Department of Soil Science, University of Manitoba, Winnipeg, MB R3T 2N2
[*] Manasah.Mkhabela@ad.umanitoba.ca

Grain crop production plays a major role in the economy of the Canadian Prairie Provinces; therefore accurate and timely crop yield forecasts are important for grain marketing decisions. Models were developed in a previous study to forecast crop yields on the Canadian Prairies using MODIS-NDVI data. The previous study utilized crop and MODIS data from 2000 to 2006. The objective of the current study was to test the accuracy of these models for predicting crop yields observed in 2007 and 2008. Growing season (May to August) MODIS 10-day composite NDVI data were obtained from the Canada Centre for Remote Sensing (CCRS). Barley, canola, field peas and spring wheat yield data for each Census Agricultural Region (CAR) in western Canada were obtained from Statistics Canada.

Results showed that the models developed with data from 2000 to 2006 were able to forecast crop yields in 2007 and 2008 with reasonable accuracy. Depending on the agro-climatic zone, the difference in predicted and actual yield for each crop averaged over the two years ranged from 1%-7%, 3%-8%, 0%-3% and 0%-9% for barley, canola, field peas and spring wheat, respectively. Mean Absolute Error (MAE) ranged from 315-476, 257-338, 230-382 and 302-428 kg ha^{-1} for barley, canola, field peas and spring wheat, respectively. A further expansion is planned for this study to have it also encompass the 2009 to 2012 cropping seasons.

Influence of composted cattle and separated hog solids manure and soil fumigation on potato yield, quality and suppression of Early Dying disease in Manitoba

Oscar Molina[1*], Mario Tenuta[1], Jolene Rutter[1], Katherine Buckley[2], and Fouad Daayf[3]
[1]Soil Science Department, University of Manitoba, Winnipeg, MB
[2]Agriculture and Agri-Food Canada, Research Centre, Brandon, MB
[3]Plant Science Department, University of Manitoba, Winnipeg, MB
[*] molinao@cc.umanitoba.ca

Incorporation of organic amendments may improve plant health and crop productivity. Our past research in Manitoba showed composted cattle manure reduced Potato Early Dying (PED) and increased late tuber bulking and yield. The objective of this research was to evaluate the effect of different rates (20, 40 and 80 Mg ha^{-1}) of composted cattle manure (CCM) and separated hog slurry solids (CSHSS) on *V. dahliae* densities in soil, disease severity and incidence, soil nutrients, and yield. The effect of the composted materials was compared with rates (40 and 60 gal $acre^{-1}$) of the soil fumigant Vapam, high inorganic fertilizer and standard fertility treatment ((control). Two experiments planted to Russet Burbank and Standard Norland were conducted in 2012. Each experiment was replicated three times using commercial fields in Manitoba. Overall, compost, fumigant and high fertilizer treatments reduced PED severity and incidence in Russet Burbank and Norland. Nevertheless, PED incidence was significantly lower than the control only in fumigated (40 and 60 gal $acre^{-1}$) and CSHSS 80 Mg ha^{-1} treatments, in Russet Burbank and Norland (P <0.001), respectively. Compared to the control, Vapam 40 gal $acre^{-1}$ showed the highest increase in total yield with Russet Burbank and Norland by 15 and 10%, respectively. In conclusion, application of Vapam (40 gal $acre^{-1}$) increased potato yield, and reduced disease severity and incidence, possible due to the consistent reduction of inoculum of *V. dahliae*, in both experiments, while CSHSS 80 Mg ha^{-1} reduced Early Dying only with Norland.

Alternative statistical distributions and transformation of nitrous oxide soil flux data

Alan P. Moulin[1*], Aaron Glenn[1], Mario Tenuta[2,3], David A. Lobb[2], Adedeji S. Dunmola[4], and Priyantha Yapa[5]
[1]Agriculture and Agri-Food Canada, Brandon, MB R7A 5Y3
[2] Department of Soil Science, University of Manitoba, Winnipeg, MB R3T 2N2
[3] Canada Research Chair in Applied Soil Ecology, University of Manitoba, Winnipeg, MB R3T 2N2
[4] Shell Canada Limited, Calgary, AB
[5]Sabaragamuwa University of Sri Lanka, Belihuloya, Sri Lanka
[*] alan.moulin@agr.gc.ca

Probability distributions of N_2O fluxes are often non-normal due to large temporal and spatial variability of environmental factors. The most common approaches to statistical analyses of these fluxes in the scientific literature are to transform data with a log function, or conduct non-parametric tests. These data are transformed to ensure that analysis of variance and regression based on least squares, meet the assumption of normality for the distribution of data and equality of variances. Analysis of N_2O flux data for 128 sites within a 16 ha field, taken on 20 dates in 2005 and 2006 near Brandon, Manitoba, show that the Johnson Su and generalized log probability distributions provided the best fit for the majority of sample dates. Further analysis of N_2O data for 30-minute and daily fluxes of N_2O in Manitoba, show that continuous functions such as the Johnson Su and Sl, Generalized Log or normal quantile may be an alternative to the lognormal which was relatively less effective in transforming data, though each transformation should be evaluated on a case-by-case basis.

Land reclamation international graduate school (LRIGS)

Dr. M Anne Naeth
Land Reclamation International Graduate School
Department of Renewable Resources
Faculty of Agricultural, Life and Environmental Sciences
University of Alberta
* anne.naeth@ualberta.ca

The Land Reclamation International Graduate School (LRIGS) has a bold mandate to train graduate students and post doctoral fellows with the background and skills for working in interdisciplinary and collaborative environments with industry, government and community stakeholders to tackle serious land reclamation challenges. The services of land reclamationists are ever increasing in demand around the world as the daily growth in human population parallels a daily increase in land disturbances caused by anthropogenic activities. Reclaiming the world's disturbed lands is arguably one of the most pressing challenges of the 21st century to help secure the livelihood of current and future generations.

LRIGS is the first graduate school of its kind and offers a unique and innovative training program. In addition to biophysical sciences, students will study ecosystem service valuation, cost effectiveness analysis, land use planning and management, and land use policy and learn how to incorporate these economic and social concepts into the development of reclamation strategies. During their time at LRIGS, students will have access to, and interaction with, leading scientists and industry and regulatory personnel around the world. Their research will encompass implementation of reclamation strategies from micrometre to kilometre spatial scales and from short to long term temporal scales. Students will conduct field research at a landscape, operational scale, with field size equipment, and laboratory research and simulation modeling in modern, efficient facilities. Training will provide students with an understanding of current world practices and challenges and will facilitate rapid transfer and implementation of reclamation knowledge into regulatory regimes and into industrial regimes without the need for large scaling up stages.

Phosphorus loss in water observed during Alberta's BMP evaluation project

Barry Olson*, Janna Casson, Jollin Charest, Andrea Kalischuk, and Lynda Miedema
Water Quality Branch, Irrigation and Farm Water Division, Alberta Agriculture and Rural Development
* barry.olson@gov.ab.ca

A 6-yr (2006-2012) study was carried out to evaluate the environmental effectiveness of beneficial management practices (BMPs) in Alberta. Study sites included two agricultural watersheds: Indianfarm Creek (IFC) Watershed near Pincher Creek and Whelp Creek (WHC) Sub-watershed near Lacombe. In addition, two irrigated fields with a history of manure application were selected north of Lethbridge: Battersea Drain Field (BDF) and Lower Little Bow Field (LLB). Several BMP sites were selected in the IFC and WHC watersheds. At these BMP sites, and at the BDF and LLB sites, water quality was monitored for 2 to 4 yr. Then BMPs were implemented and water quality was monitored for another 2 to 4 yr. Water samples were analyzed for several parameters including total P (TP) and total dissolved P (TDP). Soil samples were analyzed for soil-test P (STP) in the top 15 cm. Biannual (spring and fall) average STP concentration ranged from 16 to 509 mg kg^{-1} among the BMP sites with cultivated fields. Fields with recent manure application had elevated STP concentrations compared to fields without manure application. The two manured, irrigated fields had the highest STP concentration in excess of 200 mg kg^{-1}, and 3 yr without manure application resulted in no decrease in STP concentration. Average TP concentration in water at the WHC outlet was nearly twice the concentration at the IFC outlet. At the outlet of the IFC Watershed, 64% of TP was in the particulate form; whereas, 87% of TP was in the form of TDP at the outlet of the WHC Watershed. The majority of TP in runoff water at all edge-of-field sites was in the form of TDP. The two irrigated sites with the highest STP concentrations had the highest TDP in runoff water.

Assessing carbon dynamics using diffuse reflectance infrared Fourier transform (DRIFT) spectroscopy in cover crop systems

Lance Ouellette[1,2,*], R. Paul Voroney[1,3], and Laura L. Van Eerd[1,2]
[1]School of Environmental Sciences, University of Guelph
[2]Ridgetown Campus, Ridgetown, ON N0P 2C0
[3]Guelph, Ontario, Canada N1G 2W1
[*] louellet@uoguelph.ca

Autumn-planted cover crops are used to improve soil quality and crop productivity, however the assessment of soil quality for cover cropping systems has typically involved the use of destructive methods. This study was conducted to evaluate the effect of cover crop and corn stover residue decomposition on soil quality in a Brookston sandy loam. The field experiment consisted of a split-plot design with cover crops planted in autumn 2007-2010 as main plot factor, and the presence or removal of corn stover in autumn 2011 as split-plot factor. Cover crop treatments included a control with no cover, oat (*Avena sativa* L.), cereal rye (*Secale cereale* L.), oilseed radish (*Raphanus sativus* L. var. *oleoferus* Metzg. Stokes), and a mixture of oilseed radish and cereal rye planted at 81, 67, 16, and 9+34 kg ha^{-1}, respectively. In autumn 2012 after squash production, composite soil samples were extracted (0-15 cm) from subplots and mixed with dried, ground cover crop biomass based on mean above-ground biomass yields (3100 to 3600 kg ha^{-1}). Mixed soils were weighed (250 g), adjusted to 60% water holding capacity, placed in microcosms, incubated at 22±3˚C for 72 d, and sampled 13 times during the incubation period. Diffuse Reflectance Infrared Fourier Transform (DRIFT) technique was used to assess average spectral peak area for active and inactive soil carbon fractions. A decomposition curve was established for polysaccharide-C (950-1050 cm^{-1}) spectral region and was compared to C and N mineralization rates from destructive sampling methods (microbial biomass C and soil mineral nitrogen). Preliminary results of spectral datum indicated differences between corn stover treatments (removed vs retained) with polysaccharide-C bands peaking at 2 d and plateauing in 15 to 35 d. In this study, DRIFT spectroscopy represented a rapid and accurate non-destructive method to assess cover crop decomposition in a soil matrix.

Use of ^{137}Cs to determine role of riparian buffers in trapping sediment and phosphorus from agricultural fields

Philip N. Owens[1], David A. Lobb[2*], Katrina A. Caley[1], and Carolyn Baldwin[2]
[1]University of Northern British Columbia, Prince George, BC
[2]University of Manitoba, Winnipeg, MB
[*] David.Lobb@UManitoba.ca

Agricultural practices often result in increased soil erosion and runoff with farm fields and, consequently, increased sediment and nutrient losses from fields. The use of vegetative buffer strips (VBS) to minimize these losses from fields and protect watercourses is becoming a common practice. During the summer of 2011, soil core samples were collected from the VBS and upslope field from the two study sites located in Manitoba. Sampling locations centred along the main surface flow paths which originate in the fields and travel through the VBSs. ^{137}Cs measurements provided strong evidence that sediment is being trapped and stored at the current field-buffer boundaries where the highest ^{137}Cs inventories are found for both sites. Based on the ^{137}Cs pattern along the flow path at the one site, it appears that some sediment deposition is also taking place 2 m into the field, which might suggest that the main surface flow path is becoming increasingly more dispersive and sediment is falling out of suspension before it reaches the field-buffer boundary. Sediment deposition before the field-buffer boundary may also be due to slight topographical changes (i.e. decreased slope steepness) which would encourage infiltration of the runoff into the soil and decrease its transport capacity. Similar to ^{137}Cs, the highest inventories of phosphorus occur at the field-buffer boundary suggesting that the buffer is also trapping and storing P over the short- and medium-term. The presence of a topographical step at the field-buffer boundaries (caused by tillage) likely limited the movement of surface runoff beyond the boundary and into the VBS. Based on these preliminary findings, it is currently believed that topography has a strong influence on the transport and deposition of sediment and P in these two agricultural systems and their buffers.

Effect of nitrogen fertilizer practices on nitrous oxide emissions from irrigated potato in Manitoba

Sally Parsonage[1*], Mario Tenuta[1], Alison Nelson[2], Dale Tomasiewicz[3], and Ramona Mohr[4]
[1]Department of Soil Science, University of Manitoba, Winnipeg, MB
[2]CMCDC, Carberry, MB
[3]AAFC-CSIDC, Outlook, SK
[4]AAFC, Brandon, MB
[*] umpars22@cc.umanitoba.ca

This study determined the effects of N fertilizer practices on N_2O emissions from irrigated potato in Manitoba. Two studies were located near Carberry, MB in 2011 and 2012. The first, *N Strategy*, considered timing (single, split application, fertigation) and source (urea, polymer-coated slow release urea (ESN)). The second study, *N Placement*, considered rate (0, 100, 200 kg N ha^{-1}), placement (in-hill banding, broadcast), and source (urea, ESN). Nitrous oxide was measured using static-vented chambers. Nitrous oxide emissions occurred when soil moisture was sufficiently high, above 20% soil volumetric moisture. This occurred shortly after planting and fertilizer addition in both years. Split applications reduced emissions over single application; 560 g N_2O-N ha^{-1} compared to 1470 g N_2O-N ha^{-1} in 2011. Fertigation had emissions intermediate (950 g N_2O-N ha^{-1}) of split and single applications in 2011. Banding reduced emissions compared to broadcast treatments in 2011 and 2012 for the period of high moisture. Banded and broadcast treatments had elevated fluxes mid-season during periods of increased soil moisture in 2012. Over both years, broadcast emissions were 4320 g N_2O-N ha^{-1} while banded emissions were lower at 3473 g N_2O-N ha^{-1} averaged over sources and rates. Emissions were linked with rainfall events shortly after planting and fertilizer addition, but not with irrigation events. There was no consistent difference between ESN and urea in either year. Higher fertilizer rates induced higher emissions in both years - 4476 g N_2O-N ha^{-1} at 200 kg N ha^{-1}, vs. 3126 g N_2O-N ha^{-1} from 100 kg N ha^{-1} in *N Placement*. Banding appears to reduce emissions if soil moisture is high following planting.

Magnitude and significance of the N_2O priming effect associated with long-term applications of manure

Ryan Pearce[1*], Bobbi Helgason[2], Reynald Lemke[2], and Richard Farrell[1]
[1]Soil Science Department, University of Saskatchewan, Saskatoon, SK
[2]Agriculture and Agri-Food Canada, Saskatoon, SK
[*] rjp956@mail.usask.ca

Sustainable agriculture requires not only an understanding of the inputs and crop benefits of nutrient additions but also the secondary impacts and losses created from these nutrient inputs such as the efflux of nitrogen as greenhouse gas emissions from the soil. The use of fertilizer amendments to increase crop productivity can result in large nitrous oxide (N_2O) emission losses especially when nitrogen applications are above crop requirements. These fluxes of N_2O emissions are linked to microbial activity in the soil by means of nitrification and denitrification. Nitrification emissions are associated with dryer periods and aerated soils while denitrification emissions occur when the soils are more anaerobic. Therefore, denitrification becomes increasingly important during rainfall events and snowmelt in agricultural systems benefiting from fertilizer amendments. Microbial activity and composition may also be directly affected by fertilizer amendment applications. However, changes to the microbial communities contributing to the fluxes of N_2O as a result of a change over from long-term manure applications to a chemical fertilizer (urea) are not fully understood. The potential for microbial 'priming effects', or genetic and community changes as a result of long-term manure amendments leading to increased N_2O emissions needs further understanding to ensure sustainable agricultural practices.
At the Dixon research site west of Humboldt, Saskatchewan, this study is investigating potential 'priming effects' for N_2O emissions from agricultural soils with a 12-yr history of manure amendments and after a change in nitrogen source and availability. The results from two field seasons of gas emissions monitoring, and a single field season of microbial activity analyses using denitrification enzyme assays will be assessed to provide insight into potential 'priming effects' in this system. Preliminary 2012 results indicate that the historically applied long-term manure amendments show increased denitrification potential.

Soil science needs to get dirtier

Dan Pennock
Department of Soil Science, University of Saskatchewan
* Dan.pennock@usask.ca

Arguably our approach to teaching soil science is caught in a fundamental contradiction – the literature on soil science's future focuses on very real but very high-level concerns (e.g. food security, climate change mitigation and adaptation, biodiversity), yet students entering university consistently state they want a career-focused education leading to employment. More simply, students (and, I suspect, employers) are interested in soil science as an applied science ("getting their hands dirty"), yet the discipline of soil science (and many of its practitioners) remains focused on loftier goals. Soil science has no future if we do not attract bright, enthusiastic students into the soil science pipeline; to do this we need better alignment between the applied and basic aspects of our science. Achieving this alignment is made more challenging by the near-complete retreat of the federal government from many aspects of soil science, but several promising approaches currently exist and need to be fully supported by the soil science community.

What if Luvisols ain't?

Dan Pennock* and Kendra Purton
Department of Soil Science, University of Saskatchewan
* Dan.pennock@usask.ca

The process of clay translocation by lessivage (i.e., the physical transfer of clay from the eluvial Ae to the illuvial Bt) is integral to the concept of the Luvisolic order in Canada. Recent research has, however, challenged this singular focus on lessivage as the dominant cause for the occurrence of these texture-contrast soils. Data illustrating the conundrums faced by an eluvial/illuvial translocation pathway will be presented from a grassland-forest transition transect located NW of North Battleford Saskatchewan. Two main concerns with the lessivage hypothesis will be illustrated. First, the mass of clay in Bt horizons is often inconsistent with an eluvial origin for the clay in the Ae horizon. Second, Luvisolic soils are often found in close proximity (e.g. < 100m) to Chernozemic soils, and it is very difficult to postulate what shift in soil-forming conditions could lead to such a profound change in soil formation over this distance. One hypothesis is that the change occurs not because of a direct vegetation effect but because the root systems of the aspen (*Populus tremuloides*) dominated forest effectively exclude the major bioturbation agent of the grasslands, burrowing mammals, from mixing the surface horizons. The implications of alternative genetic pathways for the Canadian System of Soil Classification will also be (briefly) explored.

Understanding bio-physicochemical mechanisms of soil carbon protection using STXM-NEXAFS

Pavithra Pitumpe Arachchige*, Ganga Hettiarachchi, Chammi Attanayake, and Charles Rice
Department of Agronomy, Kansas State University
* pavithra@ksu.edu

Microaggregates are recognized as a repository of the most stable organic carbon (C) pool in soil. Biochemical recalcitrance, chemical stabilization and physical protection are the three main mechanisms which involve in organic carbon protection in soil. The objectives of the study were to image C and other relevant elemental distribution in intact soil microaggregates to study micro-scale associations and interactions of soil C, soil biota and soil minerals within soil aggregates; and the SOC chemistry and aggregate mineralogy.

Soils (mollisols) were collected from 0-5 cm depth from north agronomy farm, Manhattan, Kansas, which had been under no till continuous corn for 23 years with two fertilizer treatments (compost/urea) and a control. Free soil microaggregates (150-250 µm) were isolated under a light microscope and saturated with e-pure water for 18 hours using a humidifier followed by shock freezing in liquid nitrogen. 100 nm ultrathin sections were obtained by a cryo-ultramicrotome at -55^{o}C using a diamond knife and carefully transferred to C free copper grids and stored in helium atmosphere until further use.

NEXAFS-STXM analyses are being performed at the Advanced Light Source, Lawrence Berkeley National Laboratory (beamline 5.3.2) at K- and L- edges of C and other environmentally relevant elements. Results will be presented with the emphasis that how interactions between aggregate architecture, mineralogy and chemistry impact SOC protection in this studied soil.

Predicting macropore flow at the watershed scale with a re-conceptualized SWAT

David Poon[1*], Aubert Michaud[2], Joann Whalen[1], Simon-Claude Poirier[1], and Isabelle Beaudin[2]
[1]McGill University
[2]Institut de Recherche et de Développement en Agroenvironnement (IRDA)
[*] david.poon2@mail.mcgill.ca

Macropore flow transports significantly more phosphorus (P) to surface waters via tile drains than water percolating through the soil matrix. However, the Soil and Water Assessment Tool (SWAT) model describes macropore flow poorly for Quebec soils, and it does not partition percolation between macropore and matrix flows. The objective of this study was to determine the effects of a new macropore flow algorithm on SWAT's prediction of hydrological flows at an agricultural subwatershed (30 km^2) in southern Quebec. The algorithm was incorporated into a new SWAT called SWAT-QC2 (Quebec version 2). The algorithm improved the partitioning of flow between annual surface runoff and subsurface flow, such that SWAT-QC2 reasonably predicted the partitioning of subsurface flow between macropore and matrix portions, according to independent results from a chemical-based hydrograph separation of the streamflow in the subwatershed. The predicted amount of macropore flow into tile drains was greater under finer-textured soils than coarser-textured soils. SWAT-QC2 better predicted macropore flow during the growing season or the dormant season (for crops) but not during both seasons, after adjustment to the macropore connectivity parameter of the new algorithm. Changing the algorithm to account for dynamic macropore connectivity or effective macroporosity may improve the year-round predictions of macropore flow, but research is needed to determine experimentally how soil moisture and management practices affect macropore flow. By partitioning percolation into macropore and matrix portions, the macropore flow algorithm provides a framework for better descriptions of subsurface drainage and P transport through tile drains in SWAT.

Effects on soil chemical parameters and crop yields over five years of land applying an alkaline treated biosolid

G.W. Price[1*] and K. Liu[2]
[1]Faculty of Agriculture, Dalhousie University, Truro, NS B2N 5E3
[2]Department of Soil Science, University of Manitoba, Winnipeg, MB R3T 2N2
[*]gprice@dal.ca

A five year study was conducted to examine the effect of land applying an alkaline treated biosolid (ATB) at increasing rates on soil chemical parameters and crop yields. An ATB originating from the Halifax Regional Municipality was land applied annually at rates of 0, 7, 14, 28, and 42 Mg ha^{-1} on a gleyed and fragic humo-ferric Podzol from 2008 until 2012. The plots were setup in a randomized complete block design to account for variation in topography at the site. Soil mineral nitrogen concentrations, measured monthly during the growing season (April/May to November), responded as a function of ATB rate increases. Corn yields ranged from 1 to 3 Mg ha^{-1} greater in ATB amended plots relative to the unamended control. In addition, soil pH increased from 5.3 in the control soil to 6.5 at the highest rates of ATB application.

Multiple working hypotheses for the genesis of a Brunisolic Gray Luvisol Catena in Central Saskatchewan

Kendra Purton[*] and Dan Pennock
Department of Soil Science, University of Saskatchewan
Dan.pennock@usask.ca

Brunisolic Gray Luvisols are an example of texture-contrast soils (TCS) that are difficult to explain by a lessivage-dominated genetic pathway. Recent research has suggested many other potential causes for the formation of TCS soils: inheritance from parent material; deposition of surficial parent materials; bioturbation and winnowing of fines; clay neoformation; ferrolysis; and preferential biological weathering. These alternative working hypotheses are applied to a catena of Brunisolic Gray Luvisolic soils in the Mixed wood forest of Saskatchewan. The distinctive feature of the catena is the presence of a sand-filled crack to approximately 80 cm depth in one pit. The sediment in the crack has a consistent particle size range with the upper Ae-Bm horizons found in the other soils along the catena, suggesting a contemporaneous deposition of this sediment. The occurrence of the coarser surficial material is also consistent with new evidence from the glacial geomorphological community about the origin of hummocky surface forms.

A tale of two trees: Soil biogeochemistry in the boreal mixed wood

Sylvie A. Quideau[*], Emily Lloret, Mathew J.B. Swallow, and Charlotte E. Norris
Department of Renewable Resources, University of Alberta, Edmonton, AB
[*] sylvie.quideau@ualberta.ca

The western boreal mixed wood landscape consists of a mosaic of forest types ranging from aspen- to white spruce-dominated stands. Ongoing research is exploring how the interaction of stand type and disturbance influences soil biogeochemical processes in this boreal mixed wood setting. Work was conducted at EMEND (Ecosystem Management by Emulating Natural Disturbance), a large-scale experiment in northwestern Alberta. Forests in the area grow on fine-textured luvisolic soils. Early results indicated that organic matter quality differed between aspen and spruce forests floors. Further, we found distinct differences in microbial and microfaunal communities among stand types, which were linked to the presence of white spruce. Differences among stand types appeared resilient to both harvesting and silvicultural treatments. Resistance of the forest floor biological communities to changes was confirmed by manipulating litter inputs via a reciprocal transfer experiment. More recent work is investigating how differences in biological communities may translate to biogeochemical fluxes. The fate of ^{13}C labelled litter as well as ^{13}C-glucose was followed during controlled laboratory incubations using stable isotope probing of phospholipid fatty acids and ^{13}C-CO_2 measurements. Results suggest that aspen and spruce soils harbor functionally distinct microbial communities that diverge in their carbon utilization pathways, even for simple labile compounds. This could have significant implications for soil carbon storage in the boreal mixed wood when faced with a future of potential shifts in vegetative communities due to a changing climate.

Equity in education: A case study of underrepresentation at a Canadian university

Jenna O. Rapai[1*], Annemieke Farenhorst[2], Janice Dodd[3,4], Janice Ristock[4,5], and Christine Van Winkle[6]
[1]Individual Interdisciplinary Studies, Faculty of Graduate Studies
[2]Department of Soil Science, Faculty of Agricultural and Food Sciences
[3]Department of Physiology, Faculty of Medicine
[4]Women's and Gender Studies Program, Faculty of Arts
[5]Department of Anthropology, Faculty of Arts
[6]Faculty of Kinesiology and Recreation Management, University of Manitoba
[*] Jenna.Rapai@umanitoba.ca

Women now receive more than 57% of the total degrees awarded at the bachelor degree level in Canadian Universities. Meanwhile, the percentage of women in faculty positions remains less than 33% across all disciplines in these universities and a wide range of studies have raised concerns about the leaking pipeline and the glass ceiling that women are facing while progressing through their careers. In some fields such as physics, chemistry, engineering, and computer science, part of the science, technology, engineering, and math fields (STEM), the participation of women is generally below 15%, at both the student and faculty level. Gender inequity continues to generate important discussions within universities, as well as the industries relying on graduates of these academic institutions. In addition to gender disparities, other inequities are recognized and exist with respect to ethnicity, sexual orientation, age, and other demographic factors.

We conducted research to assess the experiences of University of Manitoba undergraduate students around issues of equity, and their attitudes towards policies and programs designed to address inequities in the academic community. A web-based survey research design was used and involved collecting data from a cross-section of the entire undergraduate student population of the University of Manitoba. A total of 383 responses were collected, resulting in a 5% confidence interval at a 95% confidence level for the survey. Results indicate that a substantial portion of the students reported witnessing or experiencing issues of inequity, regardless of gender or other demographic backgrounds. However, preliminary analysis has also revealed that opinions about the implementation of affirmative action type policies appear to be gendered, with women finding affirmative action to address any type of inequity more important than men, and the fear of some men, particularly those involved in STEM, that affirmative action will decrease opportunities for them in academia.

Effect of short-term forage legumes on phosphorus availability to a following wheat crop

Mikrigul Rehmut[1*], Jeff Schoenau[1], and Paul Jefferson[2]
[1]Department of Soil Science, University of Saskatchewan, 51 Campus Drive, Saskatoon, SK S7N 5A8
[2]Western Beef Development Center, Humboldt, SK S0K 2A0
[*] mir509@mail.usask.ca

Including forage legumes in short-term (2 years) rotation with annual crops could increase phosphorus (P) availability to following annual crops due to the deep roots and intensive root mycorrhizal infection of forage legumes. This hypothesis is tested in a study set up to evaluate the impact of forage legumes in short rotation on yield and soil nutrient availability at four sites in Saskatchewan. Two-years of two different forage legume (alfalfa and red-clover) were compared with an annual legume (pea) and non-legume (flax) for their effect on soil P fractions, total P uptake, biomass yield and grain yield of a wheat crop that followed in the rotation. The study was conducted at four sites in Saskatchewan: Saskatoon (Dark Brown), Swift Current (Brown), Lanigan (Thin Black), and Melfort (Thick Black), and the experimental design was a complete randomized block design. In Saskatoon, wheat biomass and grain yield were positively affected by alfalfa as the preceding crop in the previous two years. In contrast, at the drier Swift Current site, alfalfa in rotation showed a negative effect on wheat grain yield and biomass the following year, due to greater soil moisture depletion by this crop. No significant rotation effects were found on soil P fractions extracted from all sites. The amounts of both labile and stable P fractions were generally similar following two years of alfalfa, red clover, pea or flax. The results suggest that a two-year rotation of forage legumes may be too short to significantly affect soil P availability for the following crop. Wheat grain yield improvements by the forage legumes are mainly attributed to improved soil N nutrition.

A generalized analysis for the variable-head borehole permeameter test

Dan Reynolds[*], Craig Drury, Xueming Yang, and Jingyi Yang
Agriculture & Agri-Food Canada, Harrow, ON
[*] Dan.Reynolds@AGR.GC.CA

The variable-head borehole permeameter test appears to have been developed independently by Lefranc (1936), Kirkham (1946) and Hvorslev (1951), and it is used world-wide in geotechnical, hydrological and soils investigations for in-situ determination of field-saturated hydraulic conductivity (Kfs). Major difficulties with this test include: i) the antecedent or background pore water pressure head in the porous medium (h) must be "guestimated" or assumed, which can lead to serious errors in the Kfs determination; and ii) the test is invalid for unsaturated and/or elastic (deformable) porous media ($\Delta\theta > 0$). A "velocity graph" analysis has been developed (e.g. Chapuis 1999) that can estimate h and Kfs when $\Delta\theta = 0$, however, situations where $\Delta\theta > 0$ remain problematic. In this talk, a generalized analysis is presented which allows simultaneous and accurate determinations of Kfs, h and $\Delta\theta$, thereby making this legendary test valid and useful for saturated, unsaturated and elastic porous media.

References:

Chapuis, R.P. 1999. Borehole variable-head permeability tests in compacted clay liners and covers. Can. Geotech. J. 36: 39-51.

Hvorslev, M.J. 1951. Time lag and soil permeability in ground-water observations. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Miss., Bulletin No. 36.

Kirkham, D. 1946. Proposed method for field measurement of permeability of soil below the water table. Soil Sci. Soc. Am. Proc. 10:C: 58-68.

Lefranc, E. 1936. Procédé de mesure de la perméabilité des sols dans les nappes aquifèrs et application au calcul du débit des puits. Le Génie Civil 109(15): 306-308.

Total and bioavailable metals in compost, soil, and leachate from waste gypsum wallboard composting

Chris Richards* and G. W. Price
Dalhousie University, Truro, NS
* Chris.richards@dal.ca

A study was conducted to determine the potential impact of adding waste gypsum wallboard (WGW) on heavy metal fate and movement during composting. Treatments consisted of a control without WGW, addition of crushed papered WGW, and de-papered WGW in three blocks. Compost treatments were placed in concrete lysimeter cells over a 30 cm layer of soil. The cells were open to the environment and leachate was collected for analysis during the length of the study. Total and bioavailable heavy metals analysis of the compost treatments and soil were conducted throughout the study. No significant differences between the initial and final compost total heavy metal concentrations of the three treatments. Significant differences in bioavailable metals were observed in the compost treatments found over the study period. Both WGW treatments had elevated levels of bioavailable cadmium while the control treatment had higher concentrations of bioavailable zinc. Leachate water analysis resulted in elevated concentrations of soluble cadmium, nickel, and zinc from the WGW treatments compared to the control treatment. Leachate water from the control treatment had higher concentrations of copper than the WGW treatments.

The fate effect of ciprofloxacin presence on 17 β-estradiol or 17 α-ethinylestradiol in sewage sludge and stabilized biosolids

Karin Rose* and Annemieke Farenhorst
Department of Soil Science, University of Manitoba, Winnipeg, MB R3T 2N2
* umrose5@cc.umanitoba.ca

Antibiotics and steroidal estrogens are chemicals detected in sewage sludge from municipal sewage lagoons and biosolids from wastewater treatment plants. This study examined the effects of the presence or absence of the antibiotic ciprofloxacin on the degradation of 17 β-estradiol (E2) and 17 α-ethinylestradiol (EE2) steroidal estrogens in samples from seven sources: two primary sewage sludges, two secondary sewage sludges, two conditioned biosolids and a composted biosolid. Concentrations of various antibiotics and steroidal estrogens were quantified in all samples. Microcosm incubations under a constant 20˚C temperature were conducted to determine E2 and EE2 mineralization in samples amended with ciprofloxacin at a rate of 4 and 40 mg kg^{-1}, and compared to E2 and EE2 mineralization in controls (no amendments).. Parallel respiration studies under a constant 20˚C temperature were used to monitor the evolved CO_2 from sewage sludge and biosolid samples during incubation. Sorption coefficients (K_f) of the antibiotic and steroidal estrogens were also determined using batch equilibrium techniques. Preliminary results show that E2 is more readily mineralized than EE2 in all samples. Estrogen mineralization was more pronounced in sewage sludges and composted biosolids than conditioned biosolids, with the addition of the antibiotic having a lesser influence than media on E2 and EE2 mineralization. Respiration rate decreased in the order or: conditioned biosolids > composted biosolids > primary sewage sludges > secondary sewage sludges in the presence of both estrogens.

Bulking agent effects on greenhouse and nitrogen gas losses during composting of solids separated from hog slurry

Jolene Rutter[1*], Mario Tenuta[1], Matt Gervais[1], Gerry Dubé[2], and Christine Rawluk[3]
[1]Department of Soil Science, University of Manitoba
[2]Compo-Stages Manitoba Services Co-op Inc
[3]National Centre for Livestock and the Environment, University of Manitoba
[*] Jolene_rutter@hotmail.com

Intensive hog production facilities are considering solid-liquid separation to meet Manitoba manure management regulations. Separation techniques such as centrifugation concentrates the P-rich solid fraction (separated hog solids (SHS)) into a product that can be transported and applied to land that is further away. However, SHS are easily decomposed resulting in odours and NH_3 volatilization. Managing SHS by windrow composting has potential to reduce odours and stabilize nutrients. To compost SHS, a bulking agent provides carbon and increases pore size to prevent anaerobic conditions and methane (CH_4) emissions, while still allowing heat and moisture retention. This research compared wheat straw (ST) and wood shavings (WS) as bulking agents to reduce greenhouse gas and N losses during composting. Gas emissions were measured using an innovative combination of the LI-8100a automated chamber system (LICOR BioSciences) and Fourier Transform Infrared spectroscopy multi-gas analyzer (Gasmet DX4015). The compost windrows were initiated on October 17, 2012 and turned with a Backhus windrow turner once a week for the first 4 weeks. Both ST and WS amended treatments underwent rapid decomposition in the first 5 weeks, indicated by temperatures above 50°C and high CO_2 emissions. After this phase temperatures gradually declined until both ST and WS froze up in mid-January. Wet fall conditions resulted in WS emitting higher and more frequent CH_4 emissions, because WS provided less pore space than ST. After the 2nd and 4th turning, rain and snow incorporated into the windrows increased moisture to produce CH_4 emissions from ST. In the first 6 days of composting, NH_3 volatilized from ST; no NH_3 was measured from the WS. ST and WS windrows both emitted N_2O after the high temperature phase. N_2O emissions were also measured in the WS windrow during the high temperature phase, likely due to nitrates building up on the surface that underwent denitrification when the windrow was turned. Overall, WS was effective at eliminating NH_3 volatilization but did not provide adequate pore space to reduce greenhouse and nitrogen gas losses.

Soil nitrate and phosphate after fourteen years of liquid swine manure addition in North Eastern Saskatchewan

J.J. Schoenau[1], T. King[1], and S.S. Malhi[2]
[1] Department of Soil Science, University of Saskatchewan, Saskatoon, SK
[2] Agriculture and Agri-Food Canada, Melfort, SK

The amounts and distribution of nitrate and phosphate were examined in a Dark Gray Chernozem in Saskatchewan receiving applications of injected liquid swine manure (LSM) at 37,000 l ha^{-1} annually (1X, ~ 80 kg N ha, ~10 kg P ha), double (2X) every second year, and three times (3X) every third year, for the last fourteen years. For comparison, a urea treatment (80 kg N ha^{-1} annually) was included. Sub-plots were supplemental S fertilizer (elemental or K_2SO_4) applied at 40 kg S ha^{-1} every third year. After canola harvest, soil cores were taken to a 120 cm depth and analyzed for nitrate nitrogen. The 0-15cm and 15-30cm depths were analyzed for extractable available phosphorus using modified Kelowna extraction. Soil NO_3-N in the 0-15 cm depth did not exceed 40 kg NO_3-N ha^{-1} in any of the treatments. Soil NO_3-N was significantly higher (about 15 kg ha^{-1} higher) in the LSM treatments and urea treatments than the control. Residual NO_3-N contents were significantly higher in LSM and urea treatments that received supplemental S fertilizer, despite higher crop yield and N removal, suggesting that mineralization of nitrogen may have been enhanced by the sulfur fertilization in this sulfur deficient soil. No evidence of deep leaching of nitrate was apparent in the LSM treatments. Nitrate contents generally decreased with depth to levels around 1 – 2 kg NO_3-N ha^{-1} in the 60-90 cm and 90-120 cm depths. Soil test phosphorus levels were quite similar among manure treatments, ranging from around 20 kg P ha^{-1} in the urea treatments to about 30 kg P ha^{-1} in the LSM treatments. Low P content of the liquid swine manure used at this site over the years is resulting in little build-up of soil available P levels, with no evidence of P migration below 0-15 cm.

Role of organic ligands in lead phytoremediation

Muhammad Shahid[1,2,3*], Camille Dumat[1,2], and Eric Pinelli[1,2]
[1]Université de Toulouse, INP-ENSAT, Av. de l'Agrobiopôle,
31326 Castanet-Tolosan, France
[2]UMR 5245 CNRS-INP-UPS, EcoLab (Laboratoire d'écologie fonctionnelle),
31326 Castanet-Tolosan, France
[3]Department of Environmental and Energy Engineering, COMSATS Institute of Information Technology, Vehari, Pakistan

Metal speciation plays an important role in soil-plant transfer of metals. This study evaluate the effect of different organic ligands *viz* ethylenediaminetetraacetic acid (EDTA), citric acid and two types of humic substances (Suwannee River fulvic acid and Elliott Soil fulvic acid) on early steps of lead uptake and translocation to aerial parts. *Vicia faba* seedlings were exposed for 1, 12 and 24 hourd (h) in controlled hydroponic conditions to 5µM of Pb nitrate alone and chelated by organic ligands. Visual Minteq and WHAM VI metal speciation softwares were used to estimate the chelated and free Pb cations concentration in nutrient solution. The results showed that EDTA increased Pb uptake but reduced its translocation to aerial parts of *V. faba*. In contrast, citric acid does not have any effect on Pb uptake or translocation to shoot tissues. Fulvic acids application increased Pb uptake and translocation at low levels of application whereas decreased at high level. Based on these results it is suggested that metal speciation play an important role in phytoremediation studies.

Assessment of modified Swiss sandwich system of ground cover for supplying nitrogen to an organic apple orchard

Mehdi Sharifi[1*], Zahidul Alam[2], Julia Reekie[3], and Andrew Hammermeister[2]
[1]Department of Plant and Animal Sciences, Dalhousie Agricultural Campus, Truro, NS
[2] Environmental and Resource Studies Program, Trent University, Peterborough, ON
[3]Agriculture and Agri-Food Canada, Kentville, NS
[*] Mehdisharifi@TrentAgriculture.ca

Performance of modified Swiss sandwich system of ground cover was examined at a 7-yr-old Honey crisp apple orchard for tree performance, fruit yield and overall soil quality with particular emphasis on nitrogen (N) nutrition. Cover crop treatments consisted 1) Bare ground (BG), (control); 2) Red clover and oat mix (RCOM); 3) Pea, oat, hairy vetch mix (POVM); 4) Sweet clover and oat mix (SCOM); 5) Triple mix (TM: red clover, alsike clover and timothy grass); and 6) Alfalfa (AL). Due to an unusual prolonged dry period during mid-May to mid-June 2012, there were delayed and poor establishment of cover crops. Initial soil test results showed low soil mineral N status (0.012 and 0.269 mg L^{-1} for NH_4-N and NO_3-N, respectively). First year (2012) results revealed that cover crops treatments added 1.6 to 2.25 Mg ha^{-1} (cover crops average, ~2.0 Mg ha^{-1}) dry matter (DM) and 62-88 kg ha^{-1} N (cover crops average, ~75 kg ha^{-1}) to the soil without prominent differences between cover crop treatments. Average mid-season NH_4-N and NO_3-N concentrations increased to 3.70 mg kg^{-1} and 40.0 mg kg^{-1} respectively as result of soil mineralization; however, did not differ between cover crop treatments including control. End-of-season mineral N concentrations ranged between 0.41-1.18 mg kg^{-1} NH_4-N and 1.19-3.32 mg kg^{-1} NO_3-N. Leaf tissue nutrient concentrations (N - 2.52%, P – 0.19%, K – 1.09%, Ca – 0.96%, Mg – 0.26%, Fe – 77 ppm, Mn – 41 ppm, Cu – 15 ppm, Zn – 11 ppm, and B – 26 ppm) and fruit yield parameters also did not significantly differ between cover crop treatments including control. Leaf Zn content was at deficient level however, most other essential tissue nutrient concentrations were at the lower end of the sufficiency range. Increasing soil organic matter and N concentrations in a sustainable manner through cover crops, is a steady and continuous process. Taking this perspective (and poor establishment of cover crops), yearly average addition of ~2.0 Mg ha^{-1} DM and ~75 kg ha^{-1} N from the cover crops during the first year of this study were very promising towards a sustainable tree growth, fruit yield, and improved soil health and tree nutrition best suited for the grower's condition.

Effects of citrate and DFOB siderophore on nickel sorption by palygorskite, sepiolite and calcite minerals

Ahmadreza Sheikhhosseini*, Esfahani, Hossein Shariatmadari, and Mehran Shirvani
Department of Soil Science, Isfahan University of Technology, Isfahan, Iran
* sheikhosseini@yahoo.com

The presence of different ligands of various complexing abilities can change the sorption properties of heavy metals and hence, their fate in the environment. Citrate and siderophore are present in soils naturally. The effects of citrate and desferrioxamine B (DFOB) on the sorption of nickel to palygorskite, sepiolite and calcite minerals were assessed in a bath experiment. Different isotherm and kinetic models were used to assess the sorption of nickel to the minerals. Citrate had decreasing effects on the amount and rate of nickel sorption to palygorskite and sepiolite however, it did not have a significant effect on Ni sorption to calcite. The addition of DFOB siderophore strongly limited the sorption of Ni on the studied minerals except calcite which showed a drastic increase in Ni sorption. Sorption kinetics of Ni to all minerals in the presence of the studied ligands fit the power function model. The presence of DFOB decreased the rate of Ni sorption to palygorskite and sepiolite, but increased the rate of Ni sorption to calcite.

Model estimates of the variation in organic, inorganic and volatilized N in manure

Steve Sheppard[1*], and Shabtai Bittman[2]
[1]ECOMatters Inc., Pinawa, MB R0E 1L0
[2]Agriculture and Agri-Food Canada, PO Box 1000, Agassiz, BC V0M 1A0
* sheppards@ecomatters.com

Manure nitrogen (N) contains organic N, which includes undigested N from the feeds; ammoniacal and easily hydrolysable N, which includes urea and uric acid; and nitrate/nitrite species, which are the least abundant. The largest change in N concentration occurs because of volatilization of ammonia (NH_3) from the ammoniacal and easily hydrolysable fraction. Ammonia emission is highly dependent on manure management, and some strategies such as manure injection are designed to decrease NH_3 loss. This paper utilizes recent models of NH_3 emission from beef, dairy, swine and poultry production to estimate the net organic and ammoniacal N content of manure in 2780 landscape polygons across Canada. The overall average is that 27% of excreted N was emitted to the atmosphere, 38% was retained on soil as inorganic ammoniacal N and 36% was retained on soil as organic N, nearly equal thirds. However, there were distinct differences across Canada in the proportions of organic versus ammoniacal N. Broiler-rich polygons in British Columbia, feedlot-rich polygons in Alberta and grazing-rich polygons in the Prairies were most different.

Soil phosphorus dynamics under annual vs. single applications of alkaline treated biosolids

Weixi Shu[1*], Gordon Price[1], Mehdi Sharifi[2], and Barbara Cade-Menun[3]
[1]Department of Engineering, Dalhousie Agricultural Campus, PO Box 550, Truro, NS B2N 5E3
[2] Environmental and Resource Studies Program, Trent University, 1600 West Bank Drive, Peterborough, ON K9J 7B8
[3]Agriculture and Agri-Food Canada, PO Box 1030, Swift Current, SK S9H 3X2
* wx205944@dal.ca

The influence of annual alkaline-treated biosolids (ATB) land application on phosphorus (P) dynamics in soils needs to be better understood for more efficient P management. This study explores the relationship between P accumulation and potential risks of losses, as well as examining the changes in readily available P fractions in soils receiving ATB applications for up to four years. A split plot design study, divided into 48 plots with 4 blocks, where management practice (annual ATB applications vs. a one-time ATB application) was randomly assigned to each whole plot within each block and application rates (control, 2 Mg ha^{-1} lime, 7, 14, 28 and 42 Mg ATB ha^{-1}) represented subplots within each whole plot. For the annual ATB applications, no treatment effects on water extractable P (WEP) was observed. The ATB application rate of 28 Mg ATB ha^{-1} resulted in higher Mehlich-3 (M3) P than the other treatments ($p<0.05$) except for the 42 Mg ATB ha^{-1} rate. Year had no effect on M3-P concentrations, but in 2011 lower WEP was observed relative to the other years ($p<0.05$). For single biosolids application, similar responses for WEP and M3-P measures were observed relative to the annual ATB treatments. Total soil P and plant P uptake will be determined in the future for determine P accumulation and plant uptake P in soils.

Labile organic nitrogen transformations in clay and sandy-loam soils amended with ^{15}N-labelled faba bean and wheat residues

Mervin St. Luce[1, 2*], Joann K. Whalen[1], Noura Ziadi[2], Bernie J. Zebarth[3], and Martin H. Chantigny[2]
[1]Department of Natural Resource Sciences, Macdonald Campus, McGill University, 21, 111 Lakeshore Rd, Ste-Anne-de-Bellevue, QC H9X 3V9
[2]Soils and Crops Research and Development Centre, Agriculture and Agri-Food Canada, 2560 Hochelaga Blvd., Quebec City, QC G1V 2J3
[3]Potato Research Centre, Agriculture and Agri-Food Canada, 850 Lincoln Road, PO Box 20280, Fredericton, NB E3B 4Z7
[*] mervin.stluce@mail.mcgill.ca

Labile organic nitrogen (N) fractions are actively involved in short-term N mineralization, but the extent to which each fraction is involved in N cycling and contributes to N mineralization is not fully understood. The objective of this study was to examine the flow of ^{15}N-labelled faba bean (*Vicia faba* L.) and wheat (*Triticum aestivum* L.) residues through the soil microbial biomass N (MBN), water-extractable organic N (WEON), light fraction organic matter N (LFOMN), particulate organic matter N (POMN) and mineral N in sandy-loam and clay soils in a controlled laboratory incubation. After 3 d, most (17-30%) of the residue ^{15}N was incorporated in the POMN, with a greater proportion of the wheat than faba bean residue recovered as POMN. Mineralization was greater in the sandy-loam than the clay soil, with about 22 to 36% and 13 to 20% of the faba bean and wheat residue N, respectively, recovered in the mineral N pool after 112 d. The LFOM^{15}N concentration declined throughout the study, while POM^{15}N concentration increased or remained constant for 28 d in the sandy-loam and until 56 d in the clay soil, suggesting that some LFOMN was transformed to POMN. Subsequently, the POM^{15}N concentration declined and corresponded to mineral ^{15}N accumulation in the soils. Mineral ^{15}N concentration after 112 d was positively related to the initial POM^{15}N concentration ($r = 0.78$, $P < 0.001$) but not to the initial LFOM^{15}N concentration ($r = -0.48$, $P > 0.05$). This study suggests that N flows from crop residues through LFOMN, then POMN and is finally released as mineral N. The WEON and MBN appear to be transient pools with rapid turnover times. As POMN is directly correlated to mineral N accumulation, it could be used as an index of soil mineral N supply in agricultural soils.

.

Measuring carbon exchange over three cropping systems in Manitoba

Amanda M. Taylor[*], Brian D. Amiro, and Trevor J. Fraser
Department of Soil Science, University of Manitoba, Winnipeg, MB R3T 2N2
[*] Amanda_M_Taylor@umanitoba.ca

Agricultural management and choices of crop rotations affect carbon exchange between the agroecosystem and the atmosphere, potentially causing a field to gain or lose carbon. Carbon dioxide exchange was measured using eddy-covariance flux towers on three adjacent fields with different cropping systems near Woodlands, Manitoba. One field was converted from pasture in 2008 and had an oat-canola-oat rotation in 2009-2010-2011. A second was converted in 2009 and had a hay-oat-fallow rotation over this same period. The third field was perennial pasture for more than 20 years; hay was cut once per year and grazed for one month each fall. We evaluated the carbon budget for these three fields, as well as the dynamics of gross primary production and ecosystem respiration. Prior to any biomass removals or additions, the oat-canola-oat field lost 100 g C m^{-2}, the hay-oat-fallow field lost 500 g C m^{-2}, and the hay field gained 550 g C m^{-2}over the 30-month period (June 2009-Nov 2011). Tillage, herbicide application, and spring/fall fallow at the annual crop sites contributed to carbon losses, while a permanent vegetative cover at the hay site allowed it to accumulate carbon earlier in the year and later in the fall. Application of manure on the annual crop sites added carbon. With harvest exports and manure additions included, the annual crop sites were still carbon sources (240 and 415 g C m^{-2} respectively), and the hay site was a minor carbon sink of 120 g C m^{-2}.

The Watershed Observatory system: Status and prospects

Dr. Henry David (Hank) Venema*
International Institute for Sustainable Development
* hvenema@iisd.ca

In watersheds around the world, effective planning and implementation at the watershed scale is often inhibited by problems such as incomplete and inaccessible data, jurisdictional fragmentation, transboundary issues and poor communication between stakeholders. In such a disjointed environment, it is difficult to track when progress is being achieved. This presentation will explore a potential solution to this challenge, the development of a "watershed observatory" (watershed indicator system), that consolidates information on a watershed and serves as a common reference point for all stakeholders (e.g. agricultural groups, governments, conservation districts, non-governmental organizations). Measurements tracked could include environmental (e.g. water quality, land cover, distributed water storage), social (e.g. drinking water quality, health status, community social capital) and economic (e.g. income, losses from natural disasters, farm production), giving a rich picture of progress towards sustainability. The watershed indicator system would transpose into a rural context approaches from an urban-focused indicator system developed by the International Institute for Sustainable Development. Also explored in this presentation will be how such a system can be developed (i.e. process), how it could function and how data could be presented in a user-friendly manner. In addition to facilitating the use of data, an important benefit would be to give the diverse interests in a watershed some common understanding and, therefore, facilitate cooperation and progress.

Farm-scale assessment of greenhouse gas mitigation strategies in dairy livestock-cropping-systems

Claudia Wagner-Riddle[1*], Kari Dunfield[1], Craig Drury[2], Robert Gordon[1], John Lauzon[1], Bill Van Heyst[3], and Andrew VanderZaag[4]
[1]University of Guelph, School of Environmental Sciences, Guelph, ON
[2]Agriculture and Agri-Food Canada, Harrow, ON
[3]University of Guelph, School of Engineering, Guelph, ON
[4]Agriculture and Agri-Food Canada, Ottawa, ON
* cwagnerr@uoguelph.ca

As a part of the Government of Canada's Agricultural Greenhouse Gases Program (AGGP), we initiated a study on greenhouse gas (GHG) mitigation strategies in dairy-cropping systems in fall 2011. Several projects are underway to examine GHG emissions associated with barns, manure management, and cropping systems management. The project's objectives are to 1) test new technologies and beneficial management practices that could result in net GHG reduction in integrated animal production, manure management, and crop production systems; 2) contribute scientific data to address gaps in the National GHG Inventory; 3) enhance understanding of the fundamental processes of carbon and nitrogen cycling in agriculture, which will be used to develop and improve models of nutrient flows and GHG emissions in the livestock-cropping-system complex; 4) train highly qualified personnel and 5) facilitate communication and technology transfer between researchers, government, industry and producer groups interested in reducing GHG emissions from the dairy sector. We are taking an integrated approach so mitigation strategies will be evaluated collectively rather than in isolation. At each stage (livestock, manure, crops and soils), we are quantifying the pertinent GHG emissions (CH_4, N_2O, NH_3) or sequestration (CO_2) to understand additive impacts (positive or negative) and determine the overall effect on emissions from the whole-farm. Currently, GHG emissions are being measured at two commercial dairy barns. Emissions from stored manure are being studied at one of the commercial farms, and in replicated meso-scale studies, where we can establish cause and effect relationships between BMPs and net GHG emissions. Soil emissions are being quantified from agronomic studies as well as field scale plots, as affected by application timing (fall vs. spring) and method (injected, surface applied and incorporated) and manure treatment (raw vs. anaerobically digested). We will provide an overview of this project and highlight the first year results.

Over-winter dynamics and associated losses of N_2O to air and drainage water following spring and fall plow down of red clover in Truro, Nova Scotia

Brian Wallace[2,3*], David Burton[1], Derek Lynch[2], and Angela Bedard-Haughn[3]
[1]Environmental Science, Dalhousie University
[2]Plant & Animal Science, Dalhousie University
[3]Soil Science, University of Saskatchewan
[*] brian.wallace@dal.ca

Over-winter N_2O soil flux from agricultural fields are known to be higher than those that occur during the growing season in Eastern Canada. However, the dynamics and losses of N_2O that is associated with fall and spring plow down of green manures (red clover) are not well understood. In this experiment we evaluate N_2O from chamber based soil flux measurements, concentrations in the soil profile, and N_2O dissolved in tile drain water in Truro, Nova Scotia. Clover plow down treatments were in randomized blocks with 3 repetitions: 1) Early fall (September) plow down (SEP), 2) Late fall (November) plow down (NOV), 3) Hayed clover/ Late fall (November) plow down (Hay NOV), and 4) Spring (May) plow down (MAY). Cumulative soil N_2O emissions (Sep 2011-May 2012) were highest for MAY, but there was no difference among fall (SEP, NOV, Hay NOV) treatments. Nearly half of the 964 g of N_2O emitted from the MAY treatment in 2012 occurred during the spring thaw in the month of March before spring plowing. Cumulative losses of N_2O in drainage water for 2012 (Jan 17-Mar 20) was not different among treatments. Although final 2013 data is pending, the loss of N_2O in drainage water from Oct 16, 2012 to Jan 30, 2013 had a range of 24 to 61 g N_2O ha^{-1}, which represents a significant N_2O loss pathway in tile-drained systems. Concentrations of N_2O in the soil profile were different among treatments in 2012 and 2013, however the decrease in concentration with depth (15, 30, 50 cm) and a temporal increase in N_2O as water drainage slows during the winter is perhaps a more important result. The difference in soil structural properties and abiotic factors (i.e., porosity, temperature and water content) among clover plow down treatments is an important driver of over-winter N_2O losses and dynamics.

Climate change or zombie apocalypse? Teaching environmental science at the tipping point

Fran Walley[*] and Tom Yates
Department of Soil Science, College of Agriculture and Bioresources, University of Saskatchewan
[*]fran.walley@usask.ca

Since the Rio Earth Summit in 1992, awareness of global climate change issues has grown both in the scientific community and in the general public. Students are inundated with bleak messages regarding future climate change and current environmental issues that are emerging as a consequence of human activity. Images of starving polar bears, eutrophied lakes, 'dead zones' on major water bodies, and floating islands of plastic are the new normal for environmental science students. Recently, Barnosky et al. (2012, Nature 486:52-58) warned that the global ecosystem may be approaching an irreversible planetary-scale critical transition as a result of human activities, and we need to address the root human causes that are forcing biological changes. Barnosky further argues that averting a planetary-scale critical transition demands world cooperation and research into strategies to stem the impact. The question is, how do we balance our current reality with hopeful futures, and ultimately convince our students—the scientists and practitioners of the future—that there is a future waiting for them beyond the grim predictions that are shaping their psyche?

BC regional soil description and interpretation short courses 2009 - 2013

Kent Watson[1*] and Shannon Berch[2]
[1]Department of Geology, Thompson Rivers University, Kamloops, BC V2C 0C8
[2]British Columbia Ministry of Environment, Ecosystems Protection & Sustainability Branch, North Road Lab, Victoria BC V8M 1B8
[*] kwatson@tru.ca

Provincial and Federal government cutbacks over the years and the non-replacement of pedologist faculty at BC universities has led to a decline in personnel capable of describing and classifying soils in the field. Soils courses are still being taught at a number of universities in BC but pedology is not covered at all institutions. Graduate students, in particular, require these skills in their research. In 2009 Shannon Berch took on the role of planning and coordinating the first short course on the description and interpretation of soils. Regional coordinators and pedologists from the BC Ministry of Forests, Agriculture Canada, and universities have been enlisted to locate field sites and, along with local volunteer soils experts, have assisted in running the course. This procedure has been used in all the courses delivered to date with the regional coordinators changing. Advertising and registration is coordinated through the Pacific Regional Society of Soil Science office. The 2009 four day course was a success but was refined, with participant feedback and evaluations, into the current three day version. Learning outcomes include soil texturing, digging soil pits, differentiating and describing horizons and relevant soil features, soil classification and providing landscape interpretations. Students work in groups, describe soils of different orders and present their findings to the other groups. This course has run four times: in the Okanagan and Kamloops regions (2009), southern Vancouver Island (2010), Chilcotin and Williams Lake area (2011) and around Dawson Creek (2012). The 2013 course is scheduled for the East Kootenays. Participants include university graduate and undergraduate students, soil consultants, engineers and other interested persons with basic knowledge of soils. Over the years many have returned for course repeats. Students from UBC, SFU and UNBC have the option of taking the course for credit. This presentation will cover the course format with the intent of developing interest in other provinces and regions of Canada.

Field handbook for the soils of western Canada – an update

Kent Watson[1*], Dan Pennock[2], and Paul Sanborn[3]
[1]Department of Geology, Thompson Rivers University, Kamloops, BC V2C 0C8
[2]Department of Soil Science University of Saskatchewan, Saskatoon, SK S7N 0E1
[3]Paul Sanborn Ecosystem Science & Management Program University of Northern BC, Prince George, BC V2N 4Z9
[*] kwatson@tru.ca

In 2008 the pedology subcommittee recognized that elements of the Canadian System of Soil Classification were in need of revision. It was proposed that in five years a CSSC 4th edition be published to update changes. In 2012, the pedology subcommittee decided that a field guide should be compiled first that would include proposed CSSC changes. These changes would be tested and the next step would be to write the CSSC 4th edition. Work has begun on the Field Handbook for the Soils of Western Canada. We believe there is a real need for such a handbook as many new field personnel do not have soils undergraduate degrees and have limited knowledge of soil genesis, morphology and classification. The handbook has two major goals. Firstly, it will provide enough detail on horizon description that a novice practitioner can accurately identify horizons, describe horizon morphology and use the profile description to classify the soil while in the field. The handbook will be self-contained and will provide all the information needed to complete the first goal. Secondly, it is designed to capture and transmit the decision-making processes that an experienced field pedologist follows when describing and classifying soils in the field. The manual will focus on western Canada but could be readily adapted for other regions should interest exist. This presentation is a progress update and will cover the rationale, objectives and the status of work completed to date.

Soil food web controls on nitrogen mineralization: Can these be integrated into measures of the soil nitrogen supply?

Joann K. Whalen[1*], Maria Kernecker[1], Ben W. Thomas[1], Vanita Sachdeva[1], and Christopher Ngosong[1,2]
[1]Department of Natural Resource Sciences, McGill University, Ste-Anne-de-Bellevue, QC
[2]International Institute of Tropical Agriculture, 1st, Main Road IRAD, Nkolbisson, PO Box 2008 (Messa), Yaoundé, Cameroon
[*] joann.whalen@mcgill.ca

Agricultural crop production depends upon judicious use of nitrogen (N) fertilizers to sustain yields. Considering that part of the soil N supplied to crops comes from biological N_2 fixation and mineralization of soil organic N, quantifying these contributions could reduce our reliance on exogenous N inputs. This presentation will describe how the microbially-mediated reactions of N mineralization and nitrification contribute to the soil N supply, and biotic controls on these reactions in the soil food web. Potential N mineralization by heterotrophic bacteria and fungi can exceed 10% of the total soil N per year, and ammonium released by mineralization is rapidly transformed to nitrate through the action of chemoautotrophic ammonia oxidizers (bacteria and archaea) followed by heterotrophic and chemoautotrophic nitrifiers (bacteria and fungi). Predation of these microorganisms, primarily by soil microfauna, accounts for additional release of ammonium, estimated at 32 to 38% of the annual N mineralization. Soil meso- and macro-fauna also contribute to N mineralization and nitrification by accelerating the decomposition of organic substrates and modifying the soil habitat in ways that favor microbial activity. Tillage, application of organic amendments and improving soil drainage in humid temperate regions should favor N mineralization and nitrification processes in soil food web, whereas agrochemical use is expected to have a negligible effect. The concept of the soil N supply expands previous notions of soil fertility because it acknowledges the potential of the soil food web to furnish part of the crop N requirements through N mineralization and nitrification processes. Soil test methods that explicitly consider the soil food web contribution to N mineralization needs to be included in the soil N supply concept, which requires the development of field-based measurements and models of the soil N supply.

Development of research and extension opportunities on soil health in North Dakota

Abbey F.Wick[1*], Francis X.M. Casey[2], and G.LaPlante[3]
[1]Department of Soil Science, North Dakota State University, Fargo, ND 58108
[2]School of Natural Resource Sciences, North Dakota State University, Fargo, ND 58108
[3]North Dakota Corn Growers and Utilization Council, Fargo, ND 58101
[*]abbey.wick@ndsu.edu

Two soil issues negatively influencing cropping systems in North Dakota are salinity and sodicity. Nearly 90% of farms state-wide exhibit some loss in productivity (via reduced germination, stunted plant growth) as a result of these adverse soil parameters. There are several strategies (including, but not limited to, tillage practices, cropping systems, and tiling) used to manage these issues; however, (1) demonstrations of these strategies are scattered across the state, (2) strategies are often not used in combination with each other, (3) longevity of sites using a particular management strategy is typically less than five years, (4) demonstrations are not replicated making it impossible to conduct research and (5) whole systems management approaches requested by producers are often neglected. A combination of these factors makes it increasingly difficult for producers to choose the right management application or combination of applications for their situation. To address these issues, the Soil Health and Agricultural Research and Extension (SHARE) farm was established on a quarter section of saline sodic land in Richland County, North Dakota. The goal of this long-term site (10-15yrs) is to address multiple practices for managing saline and sodic soil conditions from a whole systems perspective (soils, crops, pests, root disease, weeds, hydrology etc.). Having multiple approaches in a single location will increase awareness and provide necessary tools for producers and consultants in a timely and unbiased manner. To guide research and extension efforts conducted at this site, an advisory panel of area producers and consultants has been formed. This panel will allow for effective transfer of information among groups on a biweekly basis and connect these groups to the site. Development of the SHARE farm is unprecedented in North Dakota. Preliminary data and details pertaining to the process of forming partnerships and conducting research will be discussed.

Aggregate-scale Spatial Heterogeneity of arbuscular mycorrhizal fungi in response to commercial mycorrhizal inoculation

M.A.K. Wijesinghe[1*], P. Voroney[3], J.N. Klironomos[2], M.M. Hart[2], K.E. Dunfield[3]
[1]Department of Soil Science, College of Agriculture, University of Saskatchewan, SK
[2]I. K. Barber School of Arts and Sciences, University of British Columbia, BC
[3] School of Environmental Sciences, University of Guelph, ON
[*] maw397@mail.usask.ca

Mycorrhizae improve plant growth and ecosystem sustainability by forming a symbiotic association with higher plants including the economically important willows (*Salix* spp.). With the recognition of the importance of mycorrhizae in terrestrial ecosystems, inoculation of plants with mycorrhizae is becoming a common practice in agricultural and land reclamation industries. However, little information is available on important ecological parameters such as soil aggregation and spatial distribution of mycorrhizal communities associated with different aggregates size classes. The main objectives of this research were to explore how commercial mycorrhizal inoculation of willows impacts (1) percent water-stable soil aggregates (%WSA) and (2) indigenous arbuscular mycorrhizal fungi (AMF) community composition associated with different size soil aggregates. These objectives were examined under both greenhouse and field conditions.

Using molecular approaches, we observed the existence of spatial variability in indigenous AMF communities among different soil aggregate size classes. This spatial variability varied with type of soil and could be reduced by inoculating with a commercial AMF inoculant. In addition, %WSA, within the willow rhizosphere also varied by soil type and changed in association with commercial mycorrhizal inoculation.

Overall this research indicates that AMF and EMF inoculation has a potential to influence the composition of the AMF community in the systems tested.

Soil development and management in the south-western Manitoba

Ronggui Wu[*], Sheila Cook, Yi Zhang, and Lynn Manaigre
Manitoba Agriculture, Food and Rural Initiatives
[*] ronggui.wu@gov.mb.ca

This presentation describes soil development from continental glaciations in the south-western Manitoba. The glacial materials consist primarily of granites, limestone, shales and sandstones. The fine sandy and silty shales are limited to the Turtle Mountain region. In addition to commonly seen sedimentary and igneous materials, the debris from metamorphic rocks are also observed in the glacial moraine. The last glacial ice generally advanced towards southwest, so thick stratified glacial sediment widespread in the southwest. The glaciated terrain in the south western Manitoba is characterized by a fresh eroded rock surface that has not been chemically weathered.

A case study of the Rural Municipalities of Roblin (RBL) and Killarney-Toutle Mountain (KTM) area clearly shows the sediments brought by the glaciation. Water from the melting ice and surface runoff from the east side of the Turtle Mountain flowed northeasterly toward the Pembina River. Sediments were deposited as a thin veneer over till, resulting in large areas of lacustrine deposits over glacial till. This also modified the glacial till landscape from the common rolling and/or hummocky to a gently undulating landform. Soils developed from fluvial relevant materials are found in the areas close to the Pelican Lake and strips along the Pembina River.

Soils in the rural municipalities of RBL and KTM are dominated by two Black Chernozemic soil associations, Waskada and Ryerson. The Waskada soil is developed on thin, strongly calcareous, loamy lacustrine sediments overlying strongly calcareous, loamy glacial till, whereas Ryerson soil is derived from moderately to strongly calcareous, loamy moraine till. The undulating landscape is dominant in the study region, followed by Hummocky and nearly level. Soil landscape has influential impacts on soil development, soil physical/chemical properties and soil management practices. Managing soils properly offers both economic and environmental benefits to producers.

Nitrogen budget and nitrogen fertilizer use efficiency in China

Xiaoyuan Yan*, and Chaopu Ti
Institute of Soil Science, Chinese Academy of Sciences, East Beijing Road 71#, Nanjing, China
* yanxy@issas.ac.cn

We evaluated nitrogen (N) Input into and output from terrestrial ecosystems in mainland China using temporally and spatially-based land use maps and statistical data for years 1980-2010. The results showed that chemical fertilizer dominated the N input. Biological N fixation was the second most important N input untill1990,after which atmospheric deposition became the second most important source. More than half of the total N input was denitrified or stored in the system. Ammonia volatilization accounted for 18.9-22.9% of the total N input, and N export to water bodies accounted for 17.9–20.7%. About 5.1–7.7% of the N input was emitted to the atmosphere through biomass burning. Per unit area total N input, N export to water bodies, denitrification and storage could be very well explained by human population density. Nitrogen input and major outputs were also positively related to per capita gross domestic product (GDP) and the percentage of total land area used as cropland.

For the crop production system, while the fertilizer N use efficiency in annual term is indeed low (<30% in recent years), the residual effect of fertilizer N has been increasing continuously, to the point that 40-68% of applied fertilizer is taken up sooner or later. The residual effect is evidenced by a buildup of soil N and a large difference between nitrogen use efficiencies of long- and short-term experiments.

Effects of grassland set-asides on selected soil properties in the western Fraser Valley of British Columbia

Dru Yates[1*], Maja Krzic[1], David Bradbeer[2], and Sean Smukler[1]
[1]Faculty of Land and Food Systems, University of British Columbia, Vancouver, BC
[2]Delta Farmland & Wildlife Trust, Delta, BC
* dru.e.yates@gmail.com

Grassland set-asides (GLSAs) have been used to encourage environmental stewardship on agricultural land. They have been part of the Common Agricultural Policy of the European Union and in the Conservation Reserve Program of the United States. A similar program – the Grassland Set-aside Stewardship Program – has been run in Delta, British Columbia (BC) since 1994.Through this program, farmers plant a mixture of grasses and legumes in place of harvestable crops for a minimum of one full year with a goal to improve soil quality and create bird habitat. The farmers are financially compensated for establishing these short-term grasslands. The objective of this study is to determine the effects of GLSAs on selected soil properties on agricultural fields in Delta. In April – May 2012, four GLSA field sites, ranging in age from two, three, four, and six years, were sampled. Four adjacent fields cultivated with potatoes in 2011 were also sampled for comparison to the GLSAs. Samples were taken for the following soil properties: bulk density, mechanical resistance, aeration porosity, moisture content, total C and N, and aggregate stability. Aboveground biomass was also measured on the GLSAs. It is anticipated that soils under GLSAs will show reduced compaction, increased soil nutrients, and improved structure as the GLSAs increase in age, as well as compared to the cultivated potato fields. The intent of this study is to provide information on how to further develop the GLSA Program in Delta, BC as a means for improving soil quality.

Group project in RRM: More than one with the course

Tom Yates*
Department of Soil Science, College of Agriculture and Bioresources, University of Saskatchewan
* tom.yates@usask.ca

Not long ago in a B.Sc. program not too far away (University of Saskatchewan) is offered RRM 421 Group Project in Renewable Resource Management. Renewable Resource Management is an applied science program that prepares students for careers in sustainable land management with a focus on field skills, data management, environmental modeling and project management. Group Project in Renewable Resources Management, despite its tragically bland name, delivers learning outcomes that include the application of RRM skills to real-world situations by defining, planning, and executing a project for a non-university organization. In turn students are exposed to the grim reality of working with and depending on others, vague and sometimes unrealistic expectations, deadlines, subject areas not always in their comfort zone, and to their own limitations. This is experiential learning in the raw. This course does not garner much appreciation during its delivery, but student emerge from the learning cycle with a sense of accomplishment and pride that they carry into the job market as well as the soft skills that employers desire. It is only then that these young apprentices begin to understand the power of the course. Referring to course structure, learning outcomes, student evaluations and interviews of former course participants the challenges and rewards of delivering and taking RRM 421 will be discussed.

Effects of long-term and recently imposed tillage on the concentration and composition of amino sugars in a clay loam soil

Bin Zhang[1,2,3], Craig F. Drury[1*], Xueming Yang[1], W. Daniel Reynolds[1], and Xudong Zhang[2]
[1]Greenhouse and Processing Crops Research Centre, Agriculture & Agri-Food Canada, Harrow, ON N0R 1G0
[2]State Key Laboratory of Forest and Soil Ecology, Institute of Applied Ecology, Chinese Academy of Sciences, Shenyang, P.R. China 110164
[3]Graduate University of Chinese Academy of Sciences, Beijing, P.R. China 100049
[*] craig.drury@agr.gc.ca

Tillage disturbance influences soil microorganisms and consequently the production and decomposition of microbial residues such as amino sugars. However, our understanding is still limited with respect to the changes in amino sugars which occur in soil after tillage operations. In this study, changes in amino sugars in a clay loam soil were tracked in long-term (29 years) no tillage (NT), long-term conventional moldboard plow tillage (MP), and long-term bluegrass (*Poa pratensis* L.) sod (BG) as well as when long-term (13 years) NT was converted to MP, long-term MP was converted to NT, and long-term bluegrass BG was converted to MP. Soil samples were collected at depths of 0–5, 5–10, and 10–20 cm after 1, 6, 11, and 16 years following tillage conversion. The amino sugar concentrations were much higher under long-term BG than under both long-term NT and MP treatments. In the 0-5 cm depth, long-term NT significantly increased total amino sugars and fungal-derived glucosamine by 18 and 25%, respectively, compared to long-term MP. Concentrations of total amino sugars in the 0–5 cm depth were reduced significantly within the first year after converting long-term NT and BG to MP, due primarily to decreases in the glucosamine concentrations. On the other hand, soil amino sugar levels accumulated gradually after converting long-term MP to NT. The results confirmed our hypothesis that loss of soil amino sugars is rapid and substantial when MP tillage is initiated after NT and BG, while their recovery is gradual when NT tillage is initiated after MP.

Effects of biochar and biochar feedstock on soil microbial biomass, soil carbon and nitrogen mineralization and greenhouse gas emissions from soil

H. Zhang[1*], P. R. Voroney[1], and G. W. Price[2]
[1]School of Environmental Sciences, University of Guelph, Guelph, ON N1G 2W1
[2]Department of Engineering, Dalhousie University, Truro, NS B2N 5E3
[*] hongjie@uoguelph.ca

Biochar has the potential to store carbon (C), mitigate greenhouse gas (GHG) emissions from soil, and affect soil microbial biomass (SMB) involved in carbon (C) and nitrogen (N) dynamics. Laboratory incubation studies were conducted to compare the effects of amendments with biochar and biochar feedstocks on SMB, C and net N mineralization, as well as GHG (CO_2, N_2O and CH_4) emissions from soil. Biochar feedstocks were coffee grounds, wood pellets, and horse manure and bedding compost. The biochar was prepared from these feedstocks by gasification at 700ºC. Biochar and raw feedstocks amendments were incorporated into a silt loam soil at a rate of 0.75% by weight at 22 % gravimetric water content and incubated for 175 days. GHG emissions were sampled 17 times and measured by gas chromatography (GC), while net N mineralization (ammonium and nitrate-N) and MB-C and MB-N were measured weekly for up to 70 days by colorimetric and fumigation extraction methods. The data has shown that amendments with biochar feedstocks significantly increased CO_2 emission rate and SMB in contrast to treatments with biochars which were not different from the unamended soil. Mineralized C from biochar feedstocks was 13, 37 and 51 % of initially added C for horse manure and bedding compost, coffee grounds and wood pellets, respectively. By contrast, biochar treatments mineralized only around 0.5 % of initially added C, suggesting biochar did not significantly increase microbial activity. Moreover, mineral N immobilization was evident in the biochar feedstocks amendments whereas biochar treatments did not have a significant effect on net N mineralization and nitrification rates. Finally, biochar had no effect on N_2O and CH_4 emissions from soil. In conclusion, high temperature biochar as a soil amendment, appears to be rather inert, showing no effect on either soil microbial biomass and inorganic N dynamics or GHG emissions.

Understanding natural nitrogen enrichment in subtropical acid forest soils and effects of land use by examining nitrogen transformation dynamics

Jinbo Zhang[1], Zucong Cai[1*], Tongbin Zhu[1], Wenyan Yang[1], Christoph Müller[2]
[1]School of Geography Sciences, Nanjing Normal University, Nanjing 210023, China
[2]Department of Plant Ecology, Justus-Liebig University Giessen, Heinrich-Buff-Ring 26, 35392 Giessen, Germany
[*] zccai@njnu.edu.cn

Many subtropical and tropical forest ecosystems are naturally nitrogen (N) enriched, while most temperate forest ecosystems are N-limited. The mechanisms underlying naturally occurring N enrichment are not well understood. We quantified gross N transformation rates in various subtropical and tropical acid forest soils vs. temperate forest soils, and agricultural vs. non-agricultural soils in the subtropical zone. Humid subtropical and tropical acid forest soils had significantly higher gross rates of N mineralization and significantly higher turnover rates, but much stronger capacities for retaining inorganic N than temperate forest soils, which is characterized by significantly lower rates of NH_4^+ oxidation and NH_3 volatilization due to low pH, and significantly higher rates of NO_3^- immobilization into organic N, which is effective for reducing leaching, runoff, and denitrification, previously shown to be weak in these soils.

The results showed that gross autotrophic nitrification rates in the woodland soils (average 0.19 mg N kg^{-1} d^{-1}) were significantly lower than that in the agricultural soils (average 1.81 mg N kg^{-1} d^{-1}) ($p<0.01$). However, the NO_3^- immobilization rates in the agricultural soils (average 0.10 mg N kg^{-1} d^{-1}) were significantly lower than that in the woodland soils (average 0.47 mg N kg^{-1} d^{-1}) ($p<0.01$). On average, 98% of total NO_3^- produced could be immobilized into organic N in the woodland soils, but only 10% in the agricultural soils. These differences in gross N transformations resulted in the inorganic N being dominated by NH_4^+ in the woodland soils, but NO_3^- dominance in the agricultural soils. Therefore, agricultural use destroys the ability of humid subtropical soils to retain inorganic N and increases the risk of NO_3^- leaching and runoff.

Soil survey information vital for increasing productivity and sustainability in the RMs of Ritchot and Springfield, Manitoba

Yi Zhang[*]
Manitoba Agriculture, Food, and Rural Initiatives, 36 Armitage Street, Minnedosa, MB R0J 1E0
[*] yi.zhang@gov.mb.ca

Soil survey data is the key to understanding and managing the soil resource. Manitoba's soil survey program undertakes a systematic collection of samples and data from the survey areas and performs detailed field investigation and laboratory analysis. Detailed soil survey at a 1:20,000 scale was completed in the RMs of Ritchot and Springfield, Manitoba. The survey report and soil maps provide valuable soil data, supporting effective and science-based decision-making for a wide range of applications.

Soil materials in two RMs' areas were deposited during the glacial Lake Agassiz and consist mainly of deep, clayey lacustrine sediments with some areas of clay soils underlain by silty sediments. These materials form the very fertile and productive soils in southern Manitoba. Approximately 80 soils were classified in two RMs. The flat topography in the areas results in the majority of soils being classified as imperfectly to poorly drained. Major problem limiting agricultural use is the inadequate drainage. The very slow surface drainage is facilitated by a network of artificial drains to enhance runoff and reduce surface ponding. Also, soil compaction, unfavorable workability, and potential degradation due to erosion are some basic restrictions.

Agriculture capability is a 7 class rating system of mineral soils based on the severity of limitations for dry land farming. The soils in Ritchot are rated at 64% in Class 2 and 29% in Class 3, and those in Springfield at 33% and 37%, respectively, for agricultural capability with moderate to moderately severe limitations like inadequate drainage. Management considerations are primarily related to heavy clay textures and wetness. Effective farming relies on systematic soil information to use and protect soil resources in a sustainable manner. Numerous soil survey data of two RMs play a key role in evaluating the kind and intensity of land management for agricultural and environmental planning.

POSTER ABSTRACTS

Listed in alphabetical order by first author.
* indicates presenting author.

Temperature data logging system for soil temperature measurement

Mayowa. F. Adelekun* and Durodoluwa. J. Oyedele
Department of Soil Science and Land Resources Management, ObafemiAwolowo University, Ile-Ife, Osun State, Nigeria
*mayowaadelekun@gmail.com

This study was conducted to design a soil temperature data logger capable of measuring and logging at different depths in real time. It is with a view to producing an inexpensive tool required for monitoring soil temperature.
The circuit was designed with Proteus ISIS while the print circuit board was laid out with Proteus ARES® from Labcenter Electronics. The firmware programme that controlled the device was written with C programming language then compiled to executable hex code using MikroelektronikaMikroC® PRO for PIC. The software that interfaced the design with computer was designed with Microsoft® Visual Studio (2010) using Visual Basic .Net. The PIC18F4550 Microchip® microcontroller unit served as the heart of the data-logging system while temperature sensor LM35 was embedded into the temperature sensing probe. The date and time were monitored with DS1307 RTC (Real Time Clock) timer, 24LC512 a 512kbit EEPROM was used as the storage unit and LCD LM016L was used as the display unit. At the end of the construction, calibration was carried out and the readings from the device were validated with sample readings from two different sites and were correlated with readings from standard analog thermometer and a commercial digital thermometer.
The results showed positive correlations between the designed temperature data logger, the standard analog thermometer and also the automated data-logging system. The paired t-test analysis also showed that there was no significant difference ($P > 0.05$) between the readings from the designed temperature data-logging system, standard analog thermometer and the automated temperature data logging system. A sinusoidal temperature pattern was observed for diurnal temperature, with the wave amplitude decreasing with depth of the soil. The variation in the temperature of the soil was more pronounced on the top soils because they were in closer contact with the source of heat which is principally solar radiation.

Effects of pyrolysis temperature and feedstock on metal availability and microbial community in biochar-amended soil

Mahtab Ahmad[1], Sang Soo Lee[1], Byung Yong Kim[2], Yong Sik Ok[1*]
[1] Korea Biochar Research Center & Department of Biological Environment, Kangwon National University, Chuncheon 200-701, Republic of Korea
[2] Microbial Genetics Division, National Institute of Agricultural Biotechnology, Rural Development Administration, Suwon 441-707, Republic of Korea
* soilok@kangwon.ac.kr

Biochar (BC) is a carbon-rich-solid-material obtained from biomass pyrolysis under a limited oxygen condition. Application of BC into soils has been known to enhance soil physicochemical and biological properties. Four BCs originating from soybean stover at 300 and 700°C (S-BC300 and S-BC700, respectively) and pine needles at these temperatures (P-BC300 and P-BC700, respectively) were applied at a rate of 10% of soils contaminated with Pb and As, and then incubated for 90 days. The pyrosequencing of barcoded 16S rRNA gene amplicons was used to assess the bacterial communities in soils treated with BCs. The BCs at 700°C possessed remarkably higher surface area, resident matter or fixed C content, and pH values than the BCs at 300°C. A great loss of mobile matter in BCs at 700°C contributed to the development of BC micropores, thereby increasing surface area. Both BCs originating from soybean stover showed higher O contents or molar O/C ratios, indicating lower maturity or stability, compared to BCs originating from pine needles. Bioavailability and leachability of Pb and As were tested by exchangeable metal fractions and toxicity characteristics leaching procedure (TCLP). Both the exchangeable- and TCLP-Pb contents decreased while those of As contents increased in soils treated with BCs compared to control soil. The S-BC700 indicating soybean stover feedstock pyrolyzed at high temperature showed the strongest influence on decreasing Pb bioavailability and leachability compared to other BCs, and its maximum reduction of Pb mobility reached to 95%. It could be related to O contents because cationic heavy metals such as Pb easily form complexes with O-containing functional groups (-COOH). Additionally, bacterial richness and diversity in soils treated with BCs were similar to or higher than control soil or feedstock treated soils.

Metal immobilization and soil quality improvement in military shooting range soil using soybean stover- and pine needle-derived biochars

Mahtab Ahmad[1], Sang Soo Lee[1], Jung Eun Lim[1], Yohey Hashimoto[2], Yong Sik Ok[1,*]

[1]Korea Biochar Research Center & Department of Biological Environment, Kangwon National University, Chuncheon 200-701, Republic of Korea

[2]Department of Bioapplications and Systems Engineering, Tokyo University of Agriculture and Technology, Tokyo 184-8588, Japan

* soilok@kangwon.ac.kr

Recent research interest in biochar (BC) has opened up multi-disciplinary functions in science and engineering. The remediation of metal contaminated soil could be a promising exploitation of BC. Mechanistic understandings are needed for the appropriate selection of BC to immobilize metals in soils. In this study, BCs produced from soybean stover and pine needles pyrolyzed at 300 and 700°C were applied to metal contaminated shooting range soil. The characteristics of BCs were greatly influenced by pyrolysis temperature and to a lesser extent by feedstock type. The BC significantly decreased bioavailability and leachability of Pb (up to 88 and 65%, respectively) and Cu (up to 89 and 83%, respectively) compared to the control. Contrarily, up to 89% of Sb leached out compared to the control after BCs application. Precipitation, sorption, and ion-exchange were the possible mechanisms controlling the metal (im)mobilization by BCs. The soybean stover-derived BCs were more effective in immobilizing Pb and Cu than the pine needle-derived BCs, due to the relatively high content of O-containing functional groups. Sequential chemical extractions and thermodynamic modeling indicated that BCs resulted in the geochemical transformation of the metal species. Extensive spectroscopic investigations, using scanning electron microscopic elemental dot mapping and extended X-ray absorption fine structure spectroscopic (EXAFS) measurements indicated that Pb was immobilized in BCs amended soil by the formation of stable chloropyromorphite. BCs were also effective in improving soil quality by increasing the soil organic C and microbial activity. Additionally, the non-labile C fraction in the soils amended with BCs produced at 700°C was increased, signifying the potential of these BCs towards C sequestration in soil. Results suggested that the feedstock type may affect the BC efficacy in (im)mobilizing metals in soils. Special care should be taken when applying BC as an amendment for anionic metal/metalloid contaminated soils.

Cropping systems and swine manure types affect soil surface moisture and temperature

Taiwo Akinseloyin[1*], Wole Akinremi[1] and Paligwende Nikiema[2]

[1] Department of Soil Science, University of Manitoba, Winnipeg, MB, Canada R3T 2N2

[2] Manitoba Conservation and Water Stewardship, Winnipeg, MB, Canada R3T 3W3

* akinselt@cc.umanitoba.ca

Soil water and temperature are two key limiting factors in agronomic processes. Although the principal aim of adding manure either solid or liquid to soil is to augment soil nutrients, manure addition to the soil also affect the temperature and water retention most especially near the surface. The objective of this study was to evaluate the impact of liquid and solid hog manure on surface soil temperature and water. The study was conducted at the University of Manitoba research station at Carman. The experiment is a full factorial split-plot design with annual and perennial system of cropping as the main plot and hog manure treatments as the sub-plot. Five treatments were contained in the subplot: liquid swine manure N-based, liquid swine manure P-based, a solid swine manure N-based; a solid swine manure P-based and a control. Three of these were sampled: the solid and liquid swine manure N-based and the control. A Campbell temperature probe was used to measure soil surface temperature and soil sample was taken within the 0-10cm depth for gravimetric water content. Observed temperature and moisture values were subjected to analysis of variance. The results showed that the manure has no significant effect on surface temperature while there was a significant effect of cropping system on soil temperature. Plots that were treated with the solid swine manure had significantly greater soil water content than the liquid manure treated plots. These preliminary results show that manures do not only provide nutrients but can also influence the physical environment of the crop.

The impact of a shelterbelt on soil properties and greenhouse gas emission in an adjacent crop field

Chukwudi Amadi*, Rich Farrell, Ken Van Rees
Department of Soil Science, University of Saskatchewan, Saskatoon, SK
* cca423@mail.usask.ca

Field shelterbelts play an important environmental role on the agricultural landscape in the Prairies and their influence into the crop field has not been studied with respect to greenhouse gases (GHGs). The objective of this study was to examine the spatial influence of shelterbelts on the adjacent crop field on soil properties and GHG emissions. The study was carried out in a 31-year-old field shelterbelt on a coarse black/gray Chernozem located at the Conservation Learning Center (CLC) research farm, Prince Albert, Saskatchewan. The effect of the shelterbelt on soil organic carbon content (SOC), mineral N, and fluxes of CO_2, CH_4 and N_2O were investigated. Parallel transects were established in the centre of the shelterbelt strip (S), in the shelterbelt edge (Es), field edge (Ef) and in the field at distances of 10 m (F10) and 50 m (F50) away from the shelterbelt strip. Preliminary results indicated that N_2O emissions increased with increasing distance from the shelterbelt with minimum and maximum values (-0.17 N_20-N ha^{-1} d^{-1} and 1.66 N_20-N ha^{-1} $d^{-}1$) occurring at the shelterbelt edge and field centre, respectively. Highest peaks of CO_2 emissions (10.77 CO_2-C ha^{-1} d^{-1} and 7.59 CO_2-C ha^{-1} d^{-1}) occurred at the shelterbelt strip and field centre, respectively. All sample points were slight sinks of CH_4 and no visible patterns were found along the transect. Patterns of SOC and mineral N were similar to CO_2 and N_2O patterns, respectively. Further year-long research is required to establish the effect of shelterbelts on GHG emissions at different locations away from the shelterbelt strip.

Soil carbon pools in different size and density fractions in three agroforestry and adjacent agricultural ecosystems in central Alberta

Mark Baah-Acheamfour[1], Scott X. Chang[1,*], Edward W. Bork[2], Cameron N. Carlyle[2]
[1] Department of Renewable Resources, University of Alberta, Edmonton T6G 2E3, Canada
[2] Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton T6G 2E3, Canada
*****scott.chang@ualberta.ca

Agroforestry has significant potential for increasing storage of carbon (C) in biomass and soil to mitigate greenhouse gas (GHG) emissions. Soil C sequestration will be affected by physical protection of soil organic C (SOC) by fine soil particles. This study investigated the distribution of SOC in particle-size and density classes under different land use systems. Soil samples (0-10 cm) were collected from three agroforestry systems (shelterbelt, natural hedgerow, and grazed aspen woodland) and adjacent agricultural fields (either annual cropland or pasture, used as reference). The bulk soil was separated into three particle-size or three density fractionations and the C content in each fraction determined. Results showed that average SOC content was greater in the agroforestry than in their respective agricultural fields. Soil organic C increment in agroforestry can be attributed in part to: (i) greater deposition of litter from the tree components, (ii) retention of more SOC in silt- and clay-sized fractions, and (iii) accumulation of more SOC in coarse-sized fraction. In general, our results demonstrate the potential of agroforestry as a C sequestration strategy. It is also suggested that future research should focus on soil C in deeper soil layers in order to make broader conclusions.

Particle size and ^{137}Cs characteristics of wind eroded sediments in Southern Alberta

Carolyn Baldwin[1*], David A. Lobb[1], Phil N. Owens[2], Murray E. Lewis[3] & Sheng Li[4]
[1] Department of Soil Science, University of Manitoba, Winnipeg, MB, R3T 2N2
[2] University of Northern British Columbia, Prince George, BC, V2N 4Z9
[3] Saskatoon Research Centre, Agriculture and Agri-Food Canada, Saskatoon, SK, S7N 0X2
[4] Potato Research Centre, Agriculture and Agri-Food Canada, Fredericton, NB, E3B 4Z7
* baldwin.cdg@gmail.com

Long thought to be an area at high risk for wind erosion, the semi-arid, extensively tilled southern Prairies have been a focus for soil conservation research in Canada. From 2006 to 2011, Agriculture and Agri-Food Canada (AAFC) conducted a study in a southern portion of Alberta where wind erosion loss rates had been estimated at greater than 33 t ha^{-1} yr^{-1}. Wind eroded sediments were collected at four heights, 0.1, 0.2, 0.5 and 1.0m, with Big Spring Number Eight (BSNE) sediment samplers that faced into the prevailing wind. Soil samples (0 - 2.5cm) were also collected. The collected sediment samples from six selected sites were prepared and analyzed for ^{137}Cs concentration using gamma spectrometry and particle size using laser diffraction. Soil samples underwent textual analysis by the hydrometer method at an outside laboratory. The three components of wind erosion sediment transport, creep, saltation and suspension, are associated with both different particle sizes and observed heights. Laser diffraction of the wind eroded sediments showed no difference in mean particle size between sampling sites or between BSNE collection heights; although preferential transport of smaller particles to greater heights is present in shifts to the particle size distribution curves. A slight elevation in mean ^{137}Cs concentration was found in the eroded sediments collected in the BSNE samplers from the sampling site with the finest soil texture. An increase in mean 137Cs concentration with BSNE collection height was also observed. The fallout radionuclide ^{137}Cs is adsorbed by the exchange sites associated with organic matter and clays; thereby confirming the preferential transport occurring among the three components
of sediment transport analogous with wind erosion.

An evaluation of natric soil characterization data in North Dakota: A challenge for contemporary interpretation

Sukhwinder Bali*, Thomas DeSutter and David Hopkins
Department of Soil Science, North Dakota State University
* sukhwinder.bali@my.ndsu.edu

There are about 4.7 million acres of sodic soils in North Dakota, distributed across a variety of parent materials and subject to differing degrees of ground water influence and quality. A dataset of 110 pedons sampled for progressive soil surveys, irrigation development, and thesis investigations from 1949 to 2009 were compiled for this study. Characterization data were collected from the USDA/NRCS Kellogg Soil Survey Laboratory and from North Dakota State University Agricultural Experiment Station. The major USDA taxonomic subgroups are Leptic, Glossic and Typic Natustolls and Natrudolls, with fewer Natraquolls. The equivalent Subgroups in the Canadian System of Soil Classification are Solonetz, Solod, and Gleyed Solonetzic Black. The objective of this research was to review the physical, chemical and taxonomic properties of these sodic soils, create flowcharts describing data completeness, and to determine data gaps and discrepancies. Of the 110 pedons, there are 37 Glossic, 27 Leptic and 46 Typic Subgroups. However, only 15 Glossic, 12 Leptic and 12 Typic pedons have complete data with respect to sodic soil properties. In addition, there are 17 Glossic, 20 Typic and 1 Leptic Subgroups that fail to meet sodic criteria according to USDA Soil Taxonomy. Although much work has been done to characterize sodic soils in North Dakota, many of the characterization pedons do not have chemical data that either identifies these soils as being sodic (SAR, EC, pH) or chemical analyses were never determined. The ability to make comparisons even within respective soil series is challenged by a lack of complete data. Improved characterization and understanding of the genetic controls on sodic soils (i.e., physiography, parent material, ground water) will enable more targeted land management which will allow for improved vegetative production and potential remediation.

Canopy-snow interaction in CLASS: an investigation into canopy albedo, interception and unloading in relation to weather

Paul Bartlett* and Diana L. Verseghy
Climate Processes Section, Environment Canada
* Paul.Bartlett@ec.gc.ca

The winter albedo of forests is often poorly represented in climate models, owing to inadequate representation of solar radiation trapping, interception and unloading of snow. The Canadian Land Surface Scheme (CLASS V3.6) incorporates representation of these processes, but, simulated winter albedo peaks are smaller than observed; CLASS is not sensitive enough to snowfall and unloads intercepted snow too slowly. The fractional coverage of canopy snow f_{snow} is represented as the ratio of intercepted snow mass to the interception capacity (I/I^*) and unloading has an e-folding time of 10 days.

We estimated I/I^* and f_{snow} on a 10-point scale using photographs of boreal black spruce and jack pine canopies in Saskatchewan. We modelled the e-folding time of snow unloading using variables likely to promote unloading. The resulting algorithms were tested in CLASS. We calculated the effective depth of newly-intercepted snow in each time-step and determined the optimal value for f_{snow} to reach unity. f_{snow} decreases during unloading following the ratio of I to the most recent peak. The albedo assigned to a snow-covered canopy was increased using recent values from the literature.

We tested these changes at the above boreal forests as well as an alpine forest near Alptal, Switzerland, and a maritime forest near Hitsujigaoka, Japan. The seasonal trend in modelled albedo was improved at all of the forests. There was variation in the effect of weather variables on the improvement of the unloading model, wind being more important at the alpine forest, for example, but combinations of radiation, temperature and wind showed the widest applicability. The previous low bias and RMSE were reduced and the index of agreement increased at all of the sites. The systematic proportion of the error was markedly reduced suggesting that the current model structure for canopy radiation and interception is performing as well as can be expected.

Soil respiration in a deciduous mixed wood forest near Borden, Ontario

Paul Bartlett[1*], Ralf Staebler[2], Norma Froelich[3], M. Altaf Arain[4], Kuo-Hsien Chang[5], Shannon Brown[6], Eduardo Santos[7], Jon Warland[6]
[1] Climate Processes Section, Environment Canada
[2] Air Quality Processes Research Section, Environment Canada
[3] Climate Chemistry Research Section, Environment Canada
[4] School of Geography & Earth Science, McMaster University
[5] Department of Geography, University of Toronto
[6] School of Environmental Sciences, University of Guelph
[7] Department of Agricultural Engineering, Federal University of Viçosa
* Paul.Bartlett@ec.gc.ca

In recent years, Canadian forest carbon stocks have been examined in order to determine whether forests represent a long-term source or sink of atmospheric carbon. This determination requires an understanding of the processes that affect the rate of carbon turn-over in forests, so that possible responses to changes in climate can be estimated. By examining the release of CO_2 from the soil (soil respiration), and its response to environmental variables, we can better understand the controlling factors, and can improve parameterizations representing the decomposition of organic matter in the soil for use in climate models.

Soil respiration is examined over six growing seasons in a deciduous mixed wood forest at Borden, Ontario (44°19'N, 79°56'W). An automated single-chamber system (LI-COR Inc., model LI-8100) was employed in a primarily deciduous area, with occasional manual spatial measurements in deciduous and coniferous areas of the forest. Patterns of soil respiration are presented with respect to soil temperature and soil moisture on daily and half-hourly time-scales at various depths, and are compared with relationships employed in the Carbon and Nitrogen version of the Canadian Land Surface Scheme and the Canadian Terrestrial Ecosystem Model. Relationships with temperature are in the range of those reported for other temperate and boreal forest sites; Q_{10} ranges from 1.3 – 4.5, the latter under non-moisture stressed conditions at 20 cm depth. Variability is strongly controlled by wetting and drying cycles, suggesting that changes in precipitation and evapotranspiration will be especially important in determining the sensitivity of soil carbon storage to changes in climate. Drying cycles are associated with reductions in observed CO_2 fluxes from the soil. The relationship between respiration and soil moisture is more stable when respiration values are normalized with respect to temperature and a significant moisture control is evident as soil moisture decreases below 10% by volume.

Evaluation of PRS™ probes for monitoring soil nutrients in potato production

Eric Bremer[1*], Donald A. Horneck[2], Mario Tenuta[3] and Oscar Molina Tirado[3]
[1] Western Ag Innovations, Saskatoon, SK
[2] HAREC, Oregon State University, Hermiston, OR
[3] Department of Soil Science, University of Manitoba, Winnipeg, MB
* ericbremer@westernag.ca

Soil nutrients are intensively monitored in potato crops due to their high value and nutrient requirements and to frequent production on soils with low nutrient-holding capacity. The potential use of Plant Root Simulator (PRS™) probes (ion exchange membranes in a plastic support) to monitor soil nutrients was evaluated in field trials conducted in Oregon and Manitoba in 2012. A one-week burial period provided a more reliable indication of fertility treatment effects than a one-day burial period. Soil supply rates of N, P and K were significantly affected by fertility treatment, date of burial and their interaction, depending on nutrient type and experiment. A close relationship to petiole measurements was observed in some cases, but not others, which could be attributed to the differences in type of measurement. Potential exists for use of PRS probes for in-season monitoring nutrients for potatoes.

The effect of in-field winter bale grazing on soil nutrients in pastures in Saskatchewan

Barbara J. Cade-Menun[1*], Brian G. McConkey[1], Alan D. Iwaasa[1], and H.A. (Bart) Lardner[2]
[1]Agriculture and Agri-Food Canada, Semiarid Prairie Agricultural Research Centre, Swift Current, SK
[2]Western Beef Development Centre, Humboldt, SK
[*] barbara.cade-menun@agr.gc.ca

Winter cattle bale-grazing on annual cropland or on pastures has become common practice on the Canadian Prairies, replacing winter corral feeding. In addition to saving producers the cost of spreading manure, it is assumed that the direct deposit of urine and feces will enhance pasture fertility. However, this practice also increases the risk of nutrient runoff during snowmelt. A four-year study was conducted in Swift Current Saskatchewan to determine the effects of in-field winter bale grazing on soil fertility and on snowmelt runoff, using Russian wild rye (RWR) and crested wheat grass (CWG). These were bale-grazed in alternate years, each for two years total, and were compared to controls with no bale-grazing or with fall-spread manure. This presentation will report on the soil nutrients. Soil samples (0-10 and 10-20 cm) were collected in fall 2008 – 2012, and were analyzed for plant-available nutrients (NH_4-N, NO_3-N, PO_4-P in bicarbonate extracts), total soil P, C, N; soil organic P; Mehlich P and $CaCl_2$-P. Bale-grazing increased soil NH_4-N in 2009 but not 2011 for RWR and did not increase it at all for CWG. Bale-grazing increased soil NO_3-N in 2011 but not 2009 for RWR, and in 2010 for CWG. However, concentrations of both these nutrients dropped to pre-experiment levels in years without bale-grazing. Fall-spreading manure increased NH_4-N and NO_3-N only in 2011. It is interesting to note that the controls, without bale-grazing or manure application, also showed significant increases in soil N in that year. There were no significant changes in soil PO_4-P from any treatment. In contrast, high concentrations of nutrients were lost each spring in snowmelt runoff. These results suggest that the enhancement of soil fertility from in-field winter bale-grazing will be limited if nutrients are lost from pastures in runoff.

Nitrous oxide emissions as affected by timing and method of dairy manure application in corn

Sebastian Cambareri [1,2*], Claudia Wagner Riddle[1], Susantha Jayasundara[1], John Lauzon [1], Craig Drury[3]
[1] School of Environmental Sciences, University of Guelph, Ontario, Canada
[2] Instituto Nacional de Tecnologia Agropecuaria (INTA), Argentina
[3] Agriculture and Agri-Food Canada, Harrow, Ontario, N0R 1G0
* scambare@uoguelph.ca

Nitrous oxide is mainly emitted from agricultural soils, due to the nitrification-denitrification processes. These processes are affected by agricultural practices that increase soil C, moisture and soil N transformations (e.g. manure application). The main goal of this research is to study N_2O emission dynamics from soil in corn when dairy manure is applied at various times (spring vs. fall) and using different application methods (broadcast, broadcast and incorporated or injected). The field experiment was started at the Elora Research Station (43.85º N,-80.42º W) in November 2011 and is on-going. The experimental design consisted of a factorial randomized complete block design with 4 replications. Manure was applied either on November 24, 2011 or April 25, 2012. Nitrous oxide flux was measured using non-steady state chambers placed near the centre of each plot. Gas samples were taken every 0, 12, 24 and 36 min with syringes and collected in sealed vials. A significant effect of manure application method was observed during 30 days after fall application and a higher average N_2O emission was reached with the injection method (19.5 ± 8.2 g N_2O ha^{-1} d^{-1}). Spring-applied manure was found to produce a higher average N_2O emission than fall-applied manure (124.3 ± 34.2 vs 8.6 ± 2.2 g N_2O ha^{-1} d^{-1}, respectively) during 30 days after spring application . During this period, the N_2O emissions produced by the injection method reached an overall average of 144.1 ± 49.6 g N_2O ha^{-1} d^{-1}, significantly higher than the other methods. Our results suggest that nitrous oxide emission increases with the use of injection method and they are higher when manure is spring-applied.

Influence of used cooking oil on the fate of broccoli crop residue-derived ^{15}N.

Katelyn A. Congreves* and Laura L. Van Eerd
School of Environmental Sciences, University of Guelph
Ridgetown Campus, Ridgetown, Ontario, Canada N0P 2C0
* kcongrev@uoguelph.ca

Cole crops can pose a high risk of N losses after harvest because 202-247 kg N ha^{-1}, which rapidly mineralize, remains in the field as crop residues. Previous field and laboratory studies showed lower soil mineral N with organic carbon amendment of used cooking oil (OCA-oil) after broccoli harvest. However, the quantity of N-derived from broccoli crop residue must be separated from indigenous soil N or N fertilizer to accurately assess N dynamics. Thus, a ^{15}N tracer study was conducted to assess the fate of broccoli crop residue-N (CR-^{15}N) after harvest and into the subsequent year, with and without OCA-oil. In spring 2011, 342 kg N ha^{-1} of 5% atom excess enriched ^{15}N urea was incorporated in 1.35m^2 micro-plots prior to broccoli transplanting in a randomized complete block with four replications in two systems. At broccoli harvest, treatments of ^{15}N crop residue incorporated with or without OCA-oil at 5 Mg ha^{-1} were established. Spring wheat was grown in 2012. Plant (broccoli, spring wheat) and soil (0-30, 30-60 cm) samples were collected for N and ^{15}N analysis. Two weeks after broccoli harvest in autumn, OCA-oil reduced soil mineral CR-^{15}N by 19 kg ha^{-1} and increased microbial biomass CR-^{15}N by 21 kg ha^{-1} compared to the control ($P<0.05$), indicating immobilization of CR-^{15}N and a reduced potential for N losses. Although, no differences were observed between the control and OCA-oil for total soil CR-^{15}N in autumn or spring after broccoli harvest, by spring wheat harvest OCA-oil had greater total and mineral soil CR-^{15}N compared to the control by 43.5 ($P<0.1$) and 0.75 ($P<0.05$) kg ha^{-1}, respectively. Thus, OCA-oil appeared to reduce soil CR-^{15}N losses over a year, without impacting spring wheat yield or plant N content. Therefore, growers should apply OCA-oil after cole crop harvest to minimize the risk of N losses.

Rapid measurement of nitrate ion activity using a direct soil sensing approach

Nandkishor M. Dhawale[1], Viacheslav I. Adamchuk[1], Shiv O. Prasher[1], Joanne K. Whalen[2], Luan Pan[1] and Ahmad S. Mat Su*[1]
[1] Department of Bioresource Engineering, McGill University, Saint-Anne-de-Bellevue, Québec, H9X 3V9, Canada
[2] Department of Natural Resource Sciences, McGill University, Saint-Anne-de-Bellevue, Québec, H9X 3V9, Canada
*ahmad.matsu@mail.mcgill.ca

Nitrogen is an important soil nutrient for growing agricultural crops. It is of significant interest as a result of environmental and economic concerns. The mobile nature of the soil mineral nitrogen makes it difficult to assess the amount that is actually stored in the soil profile at any specific point in time. Conventional soil sampling and laboratory analysis of nitrate and ammonium ion concentrations are laborious and expensive. Therefore, it becomes economically prohibitive to map the spatial variability of the soil mineral nitrogen. As an alternative, a direct soil measurement approach allows for on-the-spot determination of nitrate ion activity using combination polyvinyl chloride (PVC) ion-selective electrodes. To test this method, a field under canola production in Quebec was divided into sixteen plots and treated with different levels of granular urea-nitrogen fertilizer (0, 75, 100 and 150 kg N /ha). Two months after planting, three random in-situ measurements were taken 2-3 cm below the soil surface. The electrode voltage output was recorded and processed using a specially designed data acquisition system. The electrode was calibrated using standard solutions with known nitrate concentrations. A simple linear regression method was applied to determine the relationship between the per plot averages of the electrode outputs and the nitrate concentrations measured using corresponding composite (five cores) 15-cm deep soil samples; these were analyzed in the laboratory using a KCl extraction procedure and a cadmium reduction colorimetric technique. Based on the analysis, in-situ and ex-situ measurements were correlated with a coefficient of determination $R^2=0.87$. The standard error of nitrate content prediction was 0.21 mg/kg, which meant the ratio of prediction over deviation equalled 2.72. These results suggest there is potential for automated residual nitrogen testing to support the site specific management of the soil nitrogen supply.

The effect of wild oat stage on uptake and release of nutrients

Cory Fatteicher[1]*, Amarsanaa Bayar[2] , Jeff Schoenau[1], Rick Holm [3]and Ken Sapsford[3]
[1] Department of Soil Science, University of Saskatchewan, 51 Campus drive, Saskatoon, SK, Canada
[2] Mongolia State University of Agriculture, MSUA, Han-Uul District, Ulaanbaatar, Mongolia
[3] Department of Plant Sciences, University of Saskatchewan, 51 Campus Drive, Saskatoon, SK, Canada
* cory.fatteicher@usask.ca

Herbicides can be used to control wild oats in wheat crops at different growth stages. This results in death of wild oats and the addition of dead wild oat residue to the surface of soil at different growth stages of both the wild oat and the wheat crop. The effect of the age of the weed at the time of control on competition specifically for soil nutrients has received little attention. The growth stage of the wild oat when herbicide is applied will determine the extent to which nutrient, that would otherwise have been available for crop use, has instead been utilized by the wild oat plant. It is postulated that the growth stage of control, by affecting residue nutrient forms, concentrations, and composition (C:N; C:P ratios) following plant death, will affect the rate at which nitrogen and phosphorus in the residue may be released back into plant available forms for the crop to use. A controlled environment experiment was conducted to determine the extent to which nitrogen and phosphorus in dead wild oat residue is conserved and recycled for crop uptake. The highest proportion of nutrient in the wild oat residue was recovered by wheat from the youngest wild oat residue (1 week old), with apparent recoveries of 6% of residue N and 85% of residue P in the above ground wheat biomass. Recoveries of residue nutrient decreased to less than 1% with old wild oat residue. The release of nutrient from residue, particularly older residue from a delayed kill, is likely to result in little benefit to the crop as only a small proportion would be released and it would come too late for yield recovery. Early wild oat control will promote more rapid recycling of N and P contained in the residue back into available forms for crop use.

Soil phosphorus turnover in long-term organic and conventional management systems

T Fraser[1*], D Lynch[2], M Entz[3], K Dunfield[1]
[1] School of Environmental Science, University of Guelph, ON, NIG 2W1
[2] Faculty of Agriculture, Dalhousie University, Truro, NS, B2N 5E3
[3] Department of Plant Science, University of Manitoba, Winnipeg, MB, R3T 2N2
*tandra@uoguelph.ca

Low plant available phosphorus (P) levels have been reported in organically managed soils across Canada. Manure can be a valuable source of P but large distances may prohibit regular application in the Great Plains region. Replacement of P in long-term organic systems is challenging since limited options are available under organic certification, making the turnover of organic P (Po) in these soils important. Soil samples were taken from the wheat phase of the Glenlea Long-term Rotation near Winnipeg, Canada, established in 1992. Soil P pools and turnover of organic P (Po) were measured in the wheat phase of a forage-grain rotation (flax-alfalfa-alfalfa-wheat) managed as organic no input, manure-amended organic (fall applied, 2002 and 2011 only), conventional, and restored native prairie systems. In spring 2011, Hedley P fractionation revealed significantly lower concentrations of both soil labile and moderately labile P fractions in the organically-managed treatments compared to the prairie and conventional systems, although plant P concentrations showed no difference (after one-time manure application). Alkaline phosphatase (ALP) activity in July was highest in the no input organic and organic manure-amended treatments, with correspondingly low levels of plant available P. Samples collected in July 2012 from the same plots now in flax, following the second fall manure application, indicated organic manure-amended ALP activity to be similar to the conventional and native prairie systems. The influence of long-term organic systems and periodic manure application on the abundance and diversity of total bacteria harbouring an ALP gene was not well correlated to ALP activity. Quantification of active and total ALP genes by co-extraction of RNA and DNA may provide a better indication of ALP excreted by soil bacteria.

Use of dairy manure solids as mulch for establishment of red raspberry: influences on soil nematode communities and N and P availability

Tom Forge[1]*, Tom Walters[2], Mike Particka[2] and Carol Koch[1]

[1] Agriculture and Agri-Food Canada, Pacific Agri-Food Research Centre, Summerland, British Columbia V0H 1Z0

[2] Washington State University, Mount Vernon Research Centre , 16650 State Route 536, Mount Vernon, WA 98273

*Tom.Forge@agr.gc.ca

Small-fruit production in the Pacific Northwest and British Columbia is often located near intensive poultry or dairy operations. The effects of mulches of dairy manure solids (DMS) and composted dairy manure solids (CDMS) on soil N and P dynamics, nematode community structure, root growth and root pathogens were studied over three years in a new field of 'Meeker' red raspberry planted on Skagit silt loam at the Washington State University Research and Extension Centre, Mt. Vernon, Washington. Five fertilizer/mulch treatments were applied to 16 m long row plots: (1) 34 kg N ha^{-1} applied as granular fertilizer in April; (2) 34 kg N ha^{-1} applied in May; (3) split application of 34 kg N ha^{-1} April + 34 kg N ha^{-1} May; (4) 34 kg N ha^{-1} fertilizer + DMS; and (5) 34 kg N ha^{-1} fertilizer + CDMS. Cumulative applications of DMS and CDMS were 28 and 49 Mg dry material ha^{-1} concentrated on the 1 m wide raspberry row, respectively. Adsorption of NO_3-N and P onto anion-exchange resins, and October soil NO_3-N concentrations, were lower in mulched soil than in non-mulched soil, but leaf N concentrations were greater in mulch treatments. Fine root biomass and the abundances of bacterivorous, fungivorous and omnivorous-predacious nematodes were greater in mulched soil than in non-mulched soil. Nematode indices of soil food web enrichment and structure were lower and greater, respectively, in mulched soil than in non-mulched soil. Mulches had no effects on root-lesion nematode (*Pratylenchus penetrans*) nematodes infecting roots. Our results suggest that mulches of composted or non-composted DMS can enhance root growth, overall soil biological activity and nutrient acquisition while also reducing soil mineral N pools and the risk of nitrate leaching from the root zone of raspberry.

Soil health, land management and remediation of sodicity

Ann-Marie Fortuna, Heather Matthees-Dose*, Sukhwinder Bali, Larry J. Cihacek, Thomas M. DeSutter and Joel Bell

Soil Science, North Dakota State University, Fargo, ND

* heather.dose@gmail.com

North Dakota experiences extreme hydrologic shifts that increase salt affected areas. Current grain prices have increased acreage planted to high yield row crops on marginal soils affected by salinity or sodicity (Gleyed Calcareous Black, Gleyed Solonetzic Black). Until recently much of the marginal ground in ND was in the conservation reserve program (CRP); a USDA program intended to protect marginal land from continued degradation. Management of CRP ground can be minimal leading to lowered productivity relative to tile drained, cropping systems. Baseline soil samples were taken to a 30-cm depth prior to tilling and planting of CRP ground within a field divided into 45, 24 x 24 m blocks. Soil health parameters included biological (enzyme activities: ß-glucosidase, dehydrogenase, urease, ammonia oxidase, nitrate reductase, phosphatase, arylsulfatase) and chemical (pH, electrical conductivity) measurements. Enzyme assays were sensitive indicators of edaphic properties, reflecting biological activity and cycling of plant available nutrients. Spearman correlation analyses verified associations between enzyme activities, electrical conductivity (0.5 to 1 ds m^{-1}), pH (~8.5) and soil organic matter. Electrical conductivities in the very slightly saline range were negatively correlated with enzyme assays. High soil pH ~ 8.5 reduced ammonia oxidase, phosphatase and arysulfatase activities that are optimum at a pH range of 6 to 7. Soil organic matter (SOM) containing carbon (C), nitrogen (N), phosphorus (P), and sulfur (S) was positively correlated with urease, ammonia oxidase, phosphatase and arysulfatase. Decomposition of SOM releases plant available forms of C, N and S that are transformed by enzyme reactions. Leaching of salts is expected to increase microbial activity and has the potential to increase yields and the quantity of residues returned to soil, over time potentially leading to increases in soil organic matter. A shift in land use to tile-drained row crop systems on former CRP acreage may improve soil health.

Nitrogen leaching losses in manure amended perennial hayfield and corn-soybean-wheat rotations in Atlantic Canada

Keith D. Fuller[1*], Craig F. Drury[2], Mark G. Grimmett[3], David L. Burton[4], Jeffrey L. Franklin[5], Bernie J. Zebarth[5], Robert J. Gordon[6], Vernon Rodd[3], Jack Van Roestel[7], and Ed St. George[1]

[1]Agriculture and Agri-Food Canada, Atlantic Food and Horticulture RC., Kentville, NS

[2]Agriculture and Agri-Food Canada, Greenhouse and Processing Crops RC., Harrow, ON

[3]Agriculture and Agri-Food Canada, Crops and Livestock RC., Charlottetown, PE

[4]Environmental Sciences, Faculty of Agriculture, Dalhousie University, Truro, NS

[5]Agriculture and Agri-Food Canada, Potato Research Centre, Fredericton, NB

[6]Ontario Agricultural College, University of Guelph, Guelph, ON

[7]Perennia, Kentville, NS

[*] keith.fuller@agr.gc.ca

Poor nitrogen (N) utilization efficiency in cropping systems is a leading cause of nitrate N (NO_3-N) contamination of surface and ground waters in Atlantic Canada. The effect of tillage practices in perennial hayfield (PH) and corn-soybean-spring wheat (CSW) rotations on growing season (GS) and non-growing season (NGS) tile drainage volumes, mean flow-weighted nitrate concentrations (FWNC's) and nitrate loads, was investigated over a six year period. Spring applied liquid dairy manure (LDM) was used as the principle N source. Treatments included (i) PH rotation established and re-established with tillage (T) practices; (ii) CSW-T rotation; (iii) CSW-NT (no-till). Non-GS drainage volumes were significantly higher when compared with GS, averaging 425 and 225 mm over the study period, respectively. Non-GS FWNC's were generally 1.5 to 3.0 mg NO_3-N L^{-1} lower when compared with their GS counterparts. When rotations were compared, FWNC's under PH were significantly lower (factor of ~ 2.5) compared with CSW. No consistent differences or trends between GS and NGS NO_3–N concentrations of the two levels of tillage in the CSW rotation were observed. Nitrogen loading losses ranged between 2.1 and 58.5 kg N ha^{-1} and 4.9 and 63.0 kg N ha^{-1} for GS and NGS, respectively. Non-GS loads were approximately 3 times higher than their GS counterparts. The lower N utilization efficiency of the CSW rotation was reflected in the three times higher loading losses when compared with PH. An exception was the re-establishment year for the latter, when this trend was reversed. Growing season and NGS tile loads of CSW-T and CSW-NT were similar, although NT loads may have been offset by greater NH_3 volatilization losses in the period following spring manure applications. Differences in the amount of N removed by corn, soybean and spring wheat in the CSW rotation were observed, but these were not significant in determining the magnitude of NO_3-N loads in a particular season. Similarly, the correlation between liquid dairy manure rate and NO_3-N drainage losses in the period subsequent to application was poor. These observations demonstrate that N loading losses to tile drainage under Maritime conditions do not reflect the biological response time of the manure-soil system to agricultural practices.

Greenhouse gases emissions from hog slurry applied to alfalfa and sainfoin on a silt loam soil in Southern Central Manitoba

Xiaopeng Gao[1], Mario Tenuta[1], Katherine E. Buckley[2], Kim Ominski[3]

[1] Dept. of Soil Science, University of Manitoba, Winnipeg, MB, R3T 2N2

[2] Agriculture and Agri-Food Canada, Brandon Research Centre, MB, R7A 5Y3

[3] Dept. of Animal Science, University of Manitoba, Winnipeg, MB, R3T 2N2

xiaopeng.gao@ad.umanitoba.ca

Information regarding the greenhouse gas (GHG) emissions resulting from the application of hog slurry to forage in Western Canada is limited. This study examined the effects of 1) presence or absence of hog slurry, 2) forage species (sainfoin vs. alfalfa), and 3) soil water content as affected by position elevation on GHG emissions (nitrous oxide - N_2O, methane - CH_4) from a sandy loam soil in Brandon, Manitoba over two growing seasons. Hog slurry was surface injected at a rate of 35000 L ha^{-1} and 38000 L ha^{-1}, providing 62-15-50 and 205-45-86, actual N-P-K kg ha^{-1}, in 2006 and 2007, respectively. Emissions were measured on and between surface bands of the slurry applied to soil. Soil concentrations of NH_4^+-N and NO_3^--N, moisture, and temperature were also monitored. In 2007, slurry application increased N_2O emissions, mainly from on-band positions. The coherence of rapidly increasing N_2O emissions following slurry application with decreasing soil NH_4^+ and increasing NO_3^- concentration, in combination with the fact that emissions continued even when soil NH_4^+ concentrations were undetectable, suggest a combined nitrification/denitrification as the sources of N_2O. Emissions of CH_4 were generally slightly negative and unaffected by presence of slurry or forage species. In addition, forage species did not impact emissions. An increasing gradient in soil water content due to elevation position did not affect emissions of CH_4 but did increase those of N_2O.

The allelopathic potential of hairy vetch, fall rye, and winter wheat in a silty clay loam soil

Charles Geddes, Andrea Cavalieri and Robert H Gulden
Department of Plant Science, University of Manitoba
* umgeddec@cc.umanitoba.ca

Allelopathy is the chemical effect of one plant on another through the release of chemicals into the environment. Aqueous extracts of hairy vetch (*Vicia villosa*), fall rye (*Secale cereale*), and winter wheat (*Triticum aestivum*) were prepared using aboveground biomass to determine their allelopathic potential. Previous research indicated that aboveground biomass demonstrates greater allelopathic potential than belowground biomass. Vegetative and reproductive shoot biomass was extracted to evaluate the difference in allelochemical concentration between these developmental stages. Canola (*Brassica napus*), kochia (*Kochia scoparia*), lamb's quarters (*Chenopodium album*), wheat (*Triticum aestivum*) and wild oat (*Avena fatua*) were used as model weed species to evaluate the allelopathic potential of the extracts on filter paper and in silty clay loam soil. Allelopathic potential was measured by determining the % germination and radicle elongation when imbibed with each extract relative to control treatments. Allelopathic effects varied widely among model weed species. In the presence of soil, extract efficacy was decreased throughout. Vegetative tissue extracts suppressed weed seed germination and radicle elongation more than reproductive tissue extracts. Wild oat germination and radicle elongation, as well as lamb's quarters radicle elongation were stimulated by certain extracts in soil. The vegetative fall rye aboveground biomass extract displayed the greatest suppressive effect. Results indicate that the allelopathic effects were complex and dependent on extracted species, stage, medium, and model weed species in question. Further research on the allelopathic stimulation of radicle elongation of wild oat and lamb's quarters warrants investigation.

Biochemical characterization of three soil profiles across an eroded prairie catena

A.W. Gillespie[1], H.J. Konschuh[2,3], A. Bedard-Haughn[3], A. J. VandenBygaart[1], B.L. Helgason[2], T.Z. Regier[4], D. Chevrier[4], J.J. Dynes[4] and E.G. Gregorich[1]
[1] Agriculture and Agri-Food Canada (AAFC), Research Centre, Saskatoon, SK
[2] AAFC Experimental Farm, Ottawa, ON
[3] Dept. of Soil Science, University of Saskatchewan, Saskatoon, SK
[4] Canadian Light Source Inc., Saskatoon, SK.

Tillage processes in hummocky terrain displaces soil from high to low landscape positions, resulting in the burial of the original, carbon-rich, A horizon. This represents a pool of C which has not been characterized or included in biogeochemical models. We used C and N K-edge XANES to characterize the organic matter in soil cores obtained from erosional and depositional profiles along a catena sequence. In this poster, we discuss the relationships between buried and modern A horizon biochemistry, and relate these findings to microbial characterization of these soils.

Detecting biochemical signals in permafrost soil organic matter

Gillespie, A.W.[1], Diochon, A.[2], Ellert, B.H.[3], Regier, T.Z.[4], Chevrier, D.[4], Dynes, J.J.[4], Tarnocai, C.[1], Gregorich, E.G.[1]
Agriculture and Agri-Food Canada, Science and Technology Branch, [1] Ottawa, Ontario, Canada, K1A 0C6, [2] Lethbridge, Alberta, Canada, T1J 4B1
[3] Department of Geology, Lakehead University, 955 Oliver Road, Thunder Bay, Ontario Canada, P7B 5E1
[4] Canadian Light Source Inc, 44 Innovation Boulevard, Saskatoon, Saskatchewan, Canada, S7N 2V3

Insight into organic matter chemistry in northern soils is critical to understanding how biogeochemical cycles may be affected in a changing environment. The objective of this study was to systematically evaluate the organic chemistry of cryoturbated Subarctic earth hummocks, which are the most common patterned ground feature in the Western Arctic. Synchrotron-based X-ray absorption near-edge structure (XANES) spectroscopy at the C and N *K*-edges was used to characterize the chemical composition of soil organic matter (SOM). X-ray evidence showed the accumulation of ketone microbial byproducts in buried horizons, at the expense of carbohydrate, phenolic and carboxylic compounds. In contrast permafrost SOM does not show ketone signals, and instead show strong phenolic content. X-ray analysis showed that organic horizons also showed primarily protein-N content, whereas permanently frozen soils showed little protein, instead containing a significant pool of N-bonded aromatic compounds.

Mycorrhizal fungi colonization and community dynamics in a long-term rotation as influenced by previous crop and weed management intensity

Robert H Gulden[1]*, Susan Mitchel[2], Tim Daniell[2]
[1] Plant Science, University of Manitoba
[2] James Hutton Institute, Dundee, Scotland

Arbuscular mycorrhizal (AM) fungi are an important component of the soil-plant continuum and are influenced by many factors. The effects of previous crop (flax or canola) and in-crop weed management intensity (low, medium, or high) on mycorrhizal colonization and community structure were investigated in a durum trap crop that was grown in soil from a 10 year-old rotation study. The rotation study consists of a four year annual rotation (canola-wheat-flax-oats) with three different in-crop herbicide use intensities (2 of 4 –low, 3 of 4 – medium, or 4 of 4 years - high) that have established three different weed population densities over time. In addition to mycorrhizal colonization and community structure using T-RFLP analysis, above and below-ground durum biomass and root length were determined at four developmental stages of the durum trap crop (3-leaf, 5-leaf, flowering and physiological maturity). Few differences were found in the proportion of root colonization by AM fungi, although at the reproductive developmental stages of durum, roots were longer when grown in soil with reduced in-crop weed management and this influenced total colonized root length. The structure of the community of AM fungi was affected by weed management intensity and previous crop; the latter changed over time. During the early vegetative stage, the structure of the AM fungal community was similar after both flax or canola and then diverged during the later vegetative and early reproductive stages before converging again at physiological maturity. A number of the observed differences in AM fungal community structure were related to differences in community richness. This study reiterated that AM fungal communities are complex and indicated that subtle changes in weed management contribute significantly to root growth and the dynamics of AM fungi.

Effect of anaerobically digested dairy manures on nitrous oxide emissions, soil denitrification rates, and denitrifier abundance in short-term incubations

Xiaobin Guo[1*], Craig F. Drury[1], Chen Chen[2], Anna Crolla[3], Joann K. Whalen[2], Andy VanderZaag[4] Xueming Yang[1], and Claudia Wagner-Riddle[5]
1 Greenhouse and Processing Crops Research Centre, Agriculture & Agri-Food Canada, Harrow, Ontario, Canada N0R 1G0
2 Department of Natural Resource Sciences, Macdonald Campus, McGill University, 21,111 Lakeshore Road, Ste-Anne-de-Bellevue, Quebec, Canada H9X 3V9
3 Alfred College, University of Guelph, Alfred, ON
4 McGill University, Ste. Anne de Bellevue, PQ
5 University of Guelph, Guelph, ON
* xiaobin.guo@agr.gc.ca

The influence of anaerobically digested manures on soil denitrification rates, nitrous oxide emissions and the abundance of soil denitrifiers was investigated in short-term laboratory incubations. Soils were amended with raw and anaerobically digested (AD) manure slurries from four different dairy farms in Ontario. Results showed that cumulative CO_2 emission during 5 days incubation after manure application were significant greater from raw manure than in AD manure. AD manures from Kirchmeier and Terryland farms significantly reduced cumulative N_2O emission compared with the corresponding raw manure treatments. Soil basal and potential denitrification rates after 5 days incubation were also measured using the acetylene inhibition technique. The basal denitrification rates in the raw manure treatments (4.57-5.28 mg N_2O-N kg^{-1} d^{-1}) were significantly greater than AD treatments (2.63-3.93 mg N_2O-N kg^{-1} d^{-1}). Although the potential denitrification rates were 10.0 - 13.5 times greater than the corresponding basal denitrification rates, trends were similar to those observed for the basal denitrification rates. Quantitative polymerase chain reaction (qPCR) was used to measure the total denitrifying bacteria abundance (16S rRNA gene) and two denitrifier genes (*nos*Z and *nir*S) were quantified. Although there was no significant difference in 16S rRNA between the raw and AD manure treatments, the abundance of *nos*Z gene was significant greater in the AD treatments than in the raw manure treatments. The *nos*Z gene was found to be negatively correlated (r = - 0.30 to -0.44) with denitrification rates. The abundance of *nir*S gene was greater in the raw manure treatments than the AD manure treatments. Hence, the application of anaerobically digested manures can reduce soil denitrification rates as well as change the abundance of denitrifier in soil which may benefit the reduce of N_2O emission.

The effect of biochar on soil nitrogen availability and greenhouse gas production in two fertilized prairie soils

Ryan Hangs, Hasan Ahmed, and Jeff Schoenau*
Department of Soil Science, U of S
* jeff.schoenau@usask.ca

The utility of biochar to improve numerous soil physical, chemical, and biological properties has concentrated on old and highly weathered tropical soils with poor fertility, while the influence of biochar application on relatively young and fertile soils is largely unknown. The objective of this study was to determine the effect of a biochar soil amendment, produced by slow pyrolysis using shrub willow (*Salix* spp) biomass feedstock on carbon dioxide (CO_2) respiration, nitrous oxide (N_2O) production, and methane (CH_4) oxidation from two marginal Saskatchewan soils having contrasting organic matter content, with and without fertilizer N addition, over a six-week incubation period. Biochar decreased soil N availability in the lower organic matter (Brown) soil, regardless of fertilizer N addition, whereas soil N availability increased initially in the higher organic matter (Black) soil when both biochar and fertilizer were applied. There were no significant differences ($P > 0.05$) in measured CO_2 fluxes among the soils and treatments. Biochar reduced N_2O emissions from both soils when fertilized, along with the unfertilized Black soil. Both soils became stronger sinks for atmospheric CH_4 following the biochar amendment. The decreased N_2O emissions following biochar addition may be a consequence of ammonium adsorption and reduced nitrification. The capacity of biochar to make both soils stronger CH_4 sinks could result in part from the production of a more favourable environment for methanotrophic bacteria activity. The lack of differences in CO_2 fluxes, with or without fertilizer N, suggests that the biochar effect on N_2O and CH_4 fluxes may be largely the result of its influence on soil enzyme activity. Further research is required comparing biochars with different physical and chemical properties (e.g., C:N, surface area, cation-exchange capacity, etc.), along with studies verifying the operative processes.

Seasonal carbon flux dynamics of a subarctic fen within the Hudson Bay Lowlands

Krista Hanis[1]*, Mario Tenuta[1], Brian Amiro[1], and Tim Papakyriakou[2]
[1] Department of Soil Science, University of Manitoba, Winnipeg, MB
[2] Department of Environment and Geography, University of Manitoba, Winnipeg, MB
* kristahanis@umanitoba.ca

The Hudson Bay Lowlands (HBL) is the second largest contiguous peat accumulation and third largest wetland in the world. These peatlands store vast amounts of carbon, much of which is trapped within the permafrost. Ecosystem-scale CH_4 flux (F_{CH4}) and net ecosystem exchange of carbon (NEE) over a subarctic fen at Churchill, Manitoba, Canada was measured to understand the magnitude of emissions during spring and fall shoulder seasons, and the growing season in relation to physical and biological conditions. F_{CH4} and NEE were measured using the eddy covariance method from late-June to mid-October of 2008, early-May to mid-September of 2009, late-June to mid-November of 2010, and late-June to mid-November of 2011. Emission episodes of CH_4 were generally not observed during spring thaw. Soil temperatures to depths of 50 cm and air temperature were highly correlated with F_{CH4}, with near surface soil temperature at 5 cm most correlated across spring, fall, and the whole season. Growing season F_{CH4} also depended upon water table with F_{CH4} highest when water was 2–13 cm below and least when it was at or above the mean peat surface. Cumulative measured annual F_{CH4} (shoulder plus growing seasons) ranged from 3.0 to 9.6 g CH_4 m^{-2} yr^{-1} among the four study years, with a mean of 6.5 to 7.1 g CH_4 m^{-2} yr^{-1} depending upon gap-filling method. Methane emissions, in terms of cumulative C and CO_2 eq., will be compared to NEE over the study years to determine the net C and GHG budgets.

State and provincial soils: Pick yours out of this line-up!

John Heard
Manitoba Agriculture, Food and Rural Initiatives, Carman, Manitoba R0G 0J0

Designation of a state or provincial soil elevates soil to the same level of distinction as official provincial flowers and birds. In 2010 the Newdale Clay Loam was proclaimed Manitoba's official soil. Over the past 3 years the author has captured some 23 state and provincial soils in the field and on film. In this poster the soil horizon is displayed by name, depositional factor, natural vegetation and climate, but not by location. Using the visual profile and attached developmental factors, the viewer is challenged to match the soil with its home province/state.

A binder of factsheets featuring the US state soils and Manitoba's Newdale will be available for viewing.

Response of soil microbial communities to ^{13}C labelled barley residue depends on management and is site-specific

B.L. Helgason[1*], E. Gregorich[2], H. Janzen[3], B. Ellert[3] and R. Dick[4]
[1] Agriculture and Agri-Food Canada (AAFC), Research Centre, Saskatoon,SK
[2] AAFC Central Experimental Farm, Ottawa, ON
[3] AAFC Lethbridge Research Centre, Lethbridge, AB
[4] Ohio State University, Columbus, OH
*bobbi.helgason@agr.gc.ca

Microbial decomposition of crop residues controls the quantity and quality of C that remains in the soil. Understanding how microbial communities respond to different residue management strategies may facilitate the development of strategies for adaptation to climate change and enhancing soil C storage. We have conducted multi-year, in-situ field incubations of ^{13}C-labelled barley residues under different residue management and climatic conditions and used stable isotope probing of phospholipid fatty acids (PLFA) to measure the response of the soil microbial community. Microbial community composition and dynamics were affected by residue placement (surface vs. mixed), depth of incorporation and climate. Response of the whole microbial biomass (^{12}C + ^{13}C) was also different among residue treatments and were generally faster and more pronounced under humid vs. semi-arid conditions. Microbial retention of the ^{13}C label was greater (>50%) and more consistent over time when residues were mixed into the soil compared to when they were left on the surface. Within the labelled biomass, there was a gradual shift toward a community structure reflective of where residues were placed two years earlier, indicating that residue placement has a lasting influence on the movement of C through the microbial biomass. Site-specific influences on decomposition appear to be very important for microbial processing and retention of C and may explain why some residue management practices favor C accumulation at some locations, but not others.

Effects of liquid, solid and compost swine manure on soil phosphorus fractions in a clay loam soil under corn-soybean rotation

Aruna Herath[1], T.Q. Zhang[2], C.S. Tan[2], C. Hamel[3], T. Welacky[2], Gary Parkin[1], Michael Goss[1] and Ivan' O Halloran[1]
[1] School of Environmental Science, University of Guelph, Guelph, Ontario, Canada
[2] Agriculture & Agri-Food Canada, Greenhouse & Processing Crops Research Centre, Harrow, ON, N0R 1G0, Canada
[3] Semarid Prairie Agricultural Research Center, Airport Road, Box 1030, Swift Current, SKS9H 3X2, Canada

Understanding phosphorus (P) dynamics in soils applied with different forms of manure is essential to minimizing negative impacts on water quality, while improving crop P use efficiency. We conducted a study to evaluate the effects of various forms of swine manure (liquid - LM, solid - SM, and compost - MC) on soil P fractions compared with triple super phosphate (TSP) in the year of application and in the following year under a corn-soybean rotation in a clay loam soil. Various materials were applied at the same rate of P, 100 kg P ha^{-1}, only to the corn phase. Soils were sampled post-harvest and analyzed for P fractions using the modified Hedley's procedure. In the corn phase, added P from all sources increased most labile (water extractable), labile (bicarbonate extractable) and moderately labile (NaOH extractable) inorganic P (Pi), and the effects were similar to TSP on a given P fraction. Although soil total Pi and total P increased with addition of P in all sources, total organic P remained unchanged. In the following year, MC and SM treatments had residual effects on most labile P, with all P sources having residual effects on labile-Pi and MC, SM and TSP on moderately labile Pi. In both years, none of the treatments influenced moderately stable P (HCl extractable) and stable-P fractions. Regardless of P sources, residual P in soils was mainly in labile and moderately forms, indicating its availability to the following crops and loss potentials from soil to water.

Nitrous oxide emission factors for sheep urine deposited on winter-grazed forage brassica and ryegrass swards in New Zealand

Coby Hoogendoorn*, Jiafa Luo, Xuezhao Sun, Brian Devantier, Catherine Lloyd-West and David Pacheco
Grassland Research Centre, AgResearch Limited, Private Bag 11008, Palmerston North, New Zealand
* coby.hoogendoorn@agresearch.co.nz

New Zealand has a temperate, maritime climate conducive to pastoral agriculture. Autumn-planted forage brassica crops produce large amounts of high quality feed for winter grazing, when pasture growth rates are low. Grazing of these crops often occurs when soil moisture levels are above field capacity. Grazing also results in deposition of large numbers of urine patches which contain high loads of nitrogen (N), and urine deposition onto trampled and moist soils creates ideal conditions for nitrous oxide (N_2O) production. This study compared N_2O emission factors (EF_3; percentage of deposited animal excreta-N emitted as N_2O) for urine from sheep fed either a brassica (*Brassica napus* subsp. *Oleifera* L.) (BU), or a ryegrass (*Lolium perenne* L.) (RU) diet, and applied to soils growing either the brassica (BF) or ryegrass (RF) forage. Before urine application the soils were trampled to mimic grazing. Sheep urine was applied at a common rate of 4 L m^{-2} and static chambers were used to measure N_2O emissions twice weekly or weekly for 18 weeks. The urine N concentration of BU was half that of RU, resulting in the N loads of applied urine being 152 and 302 kg N ha^{-1}, respectively. Soil moisture levels were above field capacity for the first 6 weeks following urine application and rapid conversion of urine N to soil ammonium-N (2-3 days) and then nitrate-N (14-21 days) occurred. Across forage types, the EF_3 for BU (2.62%) was not significantly different from RU (1.72%) (*Pr*. = 0.30). The highest EF_3 was from the BU-BF treatment (3.53%), followed by RU-BF (2.03%), BU-RF (1.72%) and RU-RF (1.49%), although, due to high within-treatment variability, these differences were not significant (*Pr*. = 0.42). Results from this study will assist in assessing the impact of winter forage brassica crops on annual farm-scale N_2O emissions.

The variation of tillage speed and its effect on tillage erosion

Qiang Huang[1*], David Lobb[1], Brian McConkey[2], Ty Faechner[3], Sheng Li[4]
[1] Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2
[2] Semiarid Prairie Agricultural research Centre, Swift Current, Saskatchewan, S9H 3X2, CANADA
[3] The Agricultural Research and Extension Council of Alberta (ARECA), Sherwood Park Alberta, Canada T8A 4E3
[4] Potato Research Centre, P.O. Box 20280, 850 Lincoln Road, Fredericton, New Brunswick, Canada E3B 4Z7)
* Qiangh@ad.umanitoba.ca

During tillage operations, tillage speed may change greatly due to variations of landscape conditions and the manner of tillage operations. Consequently, the variation of tillage speed will affect how much and how far soil is moved, and, therefore, tillage erosion. However, the variation of tillage speed and its effect on tillage erosion has rarely been explored at a field scale before. During tillage operations at 3 farms in western Canada, data sets including the tractor's moving speed, direction, operation width, and elevation were collected. The data were recorded every 2 to 4 metres along the path of operation by a tractor mounted GPS. The collected data were then processed to map speed and speed difference distribution, calculate and map slope gradient along tillage paths, and to map comparisons. The result showed that relatively greater variation of tillage speed was observed both within wetlands and at outside field boundaries. The lag in tillage speed as a function of landscape position was observed only in hilly areas. The tillage erosion was estimated using the DirTillEM model and its pattern agreed with those of the slope and tillage speed.

Impact of inoculation with *Glomus irregulare* on colonization and phosphorus uptake by pea (*Pisum sativum* L.) as affected by soil and climate

Nazrul Islam*, Jim Germida and Fran Walley
Department of Soil Science, University of Saskatchewan, Saskatoon, Canada
* mdi985@mail.usask.ca

Commercially available arbuscular mycorrhizal fungal (AMF) inoculants have been introduced in western Canada and may have a good fit in pulse production systems for enhancing phosphorus availability. It is not known, however, if introduced AMF species will persist in soils, or if the introduced species will impact existing indigenous AMF communities. A three year field incubation study was established in May 2011 to examine the colonization success of an applied AMF inoculant in field pea, and to monitor the persistence of the applied AMF species. Soil cores were extracted using aluminum cores measuring (37cm x 20 cm) from four sites in the Brown (Swift Current - AAFC), Dark Brown (Scott - AAFC and Outlook - SIDC), and Black (Melfort - AAFC) soil zones. To evaluate the impact of soils and climates, field soil cores from each of the four sites were transported and installed at each of the four sites such that each site had soil cores from the other three sites. Inoculant was applied in half (16) of the cores, with the remaining cores serving as the control containing only indigenous AMF. This study will also test the persistence of non-native AMF strain under different agro-ecological zones of Saskatchewan. At the end of first cropping season (2011), field pea shoot and grain yield and phosphorus uptake was determined, and a bioassay was conducted to assess the persistence of the introduced AMF. The individual and interaction effects of local climates and soils significantly influenced both P accumulation and levels of AMF infective propagules (as determined using a most probable number (MPN) technique). Application of AMF resulted in variable plant growth responses but consistently enhanced the levels of infective propagules post-harvest. Shoot and grain P uptake varied between the different soils and sites. The diversity and structure of the indigenous AMF community as affected by various soil and climatic conditions are currently being assessed.

Meteoric Beryllium-10 as an *in-situ* tracer of landscape change due to land-use: theoretical considerations and case-study.

Nicolas A Jelinski[1*], Jane K Willenbring[2], Kyungsoo Yoo[1], David A Lobb[3], Tom E Schumacher[4], Sharon K Papiernik[5]
[1] Soil, Water and Climate, University of Minnesota-Twin Cities, Minneapolis, MN, United States
[2] Earth and Environmental Sciences, University of Pennsylvania, Philadelphia, PA, United States
[3] Soil Science, University of Manitoba, Winnipeg, MB, Canada
[4] Plant Science, South Dakota State University, Brookings, SD, United States
[5] USDA-ARS, Brookings, SD, United States

Soil sustainability in agricultural landscapes is highly dependent upon the pattern and intensity of wind, water, and tillage erosion, and is closely related to carbon cycling, nutrient status, and crop productivity. Radioisotope tracers such as 137Cs, 210Pb, and 7Be have long been used to study soil erosion due to land-use on timescales from days to decades. Estimating erosion and deposition rates from measured radionuclide activities requires the use of conversion models which, for isotopes with half-lives of decades or less have been well characterized and have a strong theoretical foundation. In contrast, meteoric Beryllium-10 (a cosmogenic radioisotope of Beryllium with a half-life of approximately 1.5 million years) has been under-utilized in anthropogenic landscapes as an *in-situ* tracer of erosion and soil truncation despite its ability to provide a window into erosion and landscape change on timescales of centuries. The reasons for its underutilization have been the relatively high expense of measuring Beryllium-10 on a large scale and the lack of a theoretical foundation for building conversion models for Beryllium-10, which must take into account both long-term geomorphic change in natural systems as well as land-use change due to anthropogenic activities. Here, we build a theoretical foundation for the application of meteoric Beryllium-10 in studies of long-term landscape change and develop conversion models, which due to longer timeframes require a different approach than models for shorter-lived isotopes. We then apply these conversion models to a well-characterized study site near Cyrus, in western Minnesota, USA. The results of this theoretical foundation can be used to better understand and utilize meteoric Beryllium-10 as an important tool in anthropogenic systems which, when used in conjunction with shorter-lived isotopes, models, and geospatial data can provide novel insights into the evolution and long-term sustainability of agricultural landscapes.

Method development for determining heavy metal concentrations and distribution in soil horizons located near Kamloops, BC

Lindsay Jmaiff[1], Kent Watson[2] and Sharon Brewer[1]
[1] Chemistry, Thompson Rivers University, Kamloops, BC, Canada
[2]Department of Geology, Thompson Rivers University, Kamloops, BC, Canada
* lindsay_jmaiff@hotmail.com

Currently there is no baseline data available for heavy metal concentration in soils around Kamloops. With increased industrial activity occurring close to Kamloops there is concern that heavy metals may increase in soils. The goal of this project was to develop a method to determine the concentration of the heavy metals: zinc, molybdenum, copper, cadmium, iron and lead from a Kamloops soil. Six soil samples, starting at 0 cm, were taken in 5 cm deep increments from an Eluviated Black Cherneozm. The samples were oven dried and screened using a 2-mm sieve. Approximately 1.0 g of each sample was digested in concentrated nitric acid, followed by 30% hydrogen peroxide. The solution was refluxed for one hour, centrifuged, filtered via gravity filtration and made up to a volume of 25 mL. The instrumental parameters for the Flame Atomic Absorption Spectrophotometer (FAAS) were optimized for the best detection for the each metal in question. Within the 30 cm sampled, molybdenum was detectable but not quantifiable and lead was not detected. Copper was found in concentrations ranging from approximately 105 to 135 ppm. The concentration of copper increased with depth. Iron was found in the highest concentrations of all the analytes. Iron values ranged from 19 to 25 parts per thousand, mg/g. Zinc was found in varying concentrations throughout the first 30 cm of the soil pit, ranging throughout 90 to 190 ppm. There was no obvious trend observed in the values. Cadmium was found at trace levels ranging from approximately 2.5 – 3.5 ppm. For all analytes, the sample from the 10-15 cm strata had the lowest concentration followed by a noticeable increase in the 15-20cm strata confirming the identity of the Ae horizon. RSD values ranged between 6 and 13% for Cu, Fe and Cd whereas RSD values for Zn were between 18-30%.

Assessing the impact of soil origin on microbial community structure of genetically different transplanted soils.

Panchali Katulanda*[1,2], Fran Walley[2], Bobbi Helgason[1]
[1] Agriculture and Agri-Food Canada, Research Centre, Saskatoon, SK
[2] Department of Soil Science, University of Saskatchewan, 51 Campus Drive, Saskatoon, SK
* pmk173@mail.usask.ca

Other than soil origin, intensive agricultural management practices, climate and topography are factors which have significant impacts on soil microbial abundance and diversity. The current research focuses on the influence of soil origin on microbial community composition of genetically different soils that have been transplanted to one location and managed under common conditions continuously for >21 years at Lethbridge, AB. The experimental design is a split plot design where transplanted soil type and rate of N fertilizer (0 and 60 kg N ha^{-1}) were used as the main and the subplot factors, respectively. Soil samples (0 -10 cm depth) were obtained in fall 2012 and microbial abundance and community compositions were analyzed by phospholipid fatty acids analysis (PLFA). Soils with highest inherent fertility and a history of manure application at recommended rate (30 tons ha^{-1} y^{-1}) had the highest microbial abundance. Low inherent fertility and excessively manured (90tons ha^{-1} y^{-1}) soils had significantly lower bacterial, fungal and AMF abundance. Similarly, different chemical compositions (available NO_3^-, SO_4^{2-}, PO_4^{3-} and K^+) were also observed among transplanted soils after 21 years. PLFA profiling of transplanted soils indicated that initial soil conditions have dominant long-term impact on abundance and community composition of soil microbes even after decades under identical conditions.

Effect of cattle manure application variability on soil nutrient movement in a Black Chernozem

Tom King*, Jeff Schoenau, Alemayehu Adane, Sarah Anderson, Chen Chen, Cody David, Jorge Elvia, Elliott Hildebrand, Meghan Johnson, Sarah Kuzmicz, Minghui Li, Eduardo Mitter, Katie Slater and Wondowosen Tina
Department of Soil Science, University of Saskatchewan, 51 Campus Drive, Saskatoon, SK, CANADA, S7N 5A8
* tom.king@usask.ca

Non-uniform application of solid cattle manure (SCM) at high coefficient of variation (C.V.) can create problems with uneven crop growth and nitrate-nitrogen (NO_3) and phosphate (PO_4) overloading in zones where manure is piled, leading to potential nutrient leaching and/or runoff. The objective of this experiment, which was a class project in SLSC 803.3, was to assess the runoff of N and P from soil slabs removed from uniformly and non-uniformly SCM applied treatment plots. Spring snowmelt conditions were simulated *ex-situ* on soil slabs that had 60 t ha^{-1} of SCM applied at low (~10%), medium (~50 %) and high (~110 %) C.V. for two consecutive years. Runoff and/or leachate water was collected from thawing soil slabs and analyzed for soluble nitrate-nitrogen (NO_3-N) and orthophosphate (PO_4-P). Nitrate-nitrogen runoff and/or leaching export from thawing soil slabs was minimized (< 0.20 kg NO_3-N ha^{-1}) and significantly lower ($P \leq 0.10$) in low and high C.V. uniform application treatment plots compared to > 0.30 kg NO_3-N ha^{-1} in the mid C.V. treatment. Mid and high C.V. treatment plots had significantly higher PO_4-P export (> 0.10 kg PO_4-P ha^{-1}) in runoff/leachate water compared to the control. Slow mineralization and immobilization in accumulation zones of SCM could explain the low amount of NO_3-N found in the runoff/leachate. Although the same rate of manure was applied in the three C.V. treatments, the greater export of PO_4-P could be due to saturation of soil fixation sites where manure phosphate is accumulated.

Using the Holos model to estimate the greenhouse gas emission inventory for cropland in the Black-Brook watershed, NB, during the years 1988 - 2011

Roland Kröbel*, Henry Janzen, Shannan Little, Sheng Li
Science and Technology Branch, Agriculture and Agri-Food Canada
* roland.kroebel@agr.gc.ca

Regional estimates of greenhouse gas (GHG) emissions are usually conducted on an administrative scale (e.g., provincial or by ecoregion). This is due to the fact that most regional datasets are based on national and provincial statistics which are collected regularly and that international commitments require recording the results of such an analysis in this scale. However, water quality concerns have shifted the focus of attention onto more localized approaches that use watershed boundaries as spatial limit of assessment in order to focus the analysis on ecosystem processes and services without intertwining multiple systems. We propose to use a farm-level model (Holos) to calculate the GHG emission inventory from croplands of the Black-Brook watershed in New Brunswick over 23 years (1988 – 2011) and to investigate how the distribution of planted crop types influenced overall emissions. In order to do so, accumulated survey data are combined into a single virtual watershed farm where all recorded crops are simulated simultaneously. Livestock will be included depending on data availability. Due to the small size of the watershed, climate data can be represented by a single annual input, assuming that precipitation was uniform in the watershed on an annual basis. Ecodistrict data from the SLC (Soil-landscapes of Canada) database will be used to represent the watershed's soil properties. This project will not only demonstrate how a farm-level model can be used to conduct a regional analysis, but will also help determining which input data will have to be provided as default by the model when analysing watersheds on the basis of remote sensing derived land use maps.

Sediment colour analysis by UV-vis and NIR reflectance spectrometry, a new fingerprinting method to identify sediment sources

Zuzell Leal Cuba, Louise R. M. Barthod*, David A. Lobb
University of Manitoba, Watershed Systems Research Program, Ellis Building, 13 Freedman Crescent, Winnipeg, Manitoba R3T 2N2, Canada
* david.lobb@ad.umanitoba.ca

In the context of beneficial management practices development as a mean to minimize adverse impacts of agriculture on water quality, there is an increasing interest in identifying sediment sources. The sediment fingerprinting approach allows the determination of sediment sources and apportionment of their contribution within a watershed, using several sediment fingerprints or signatures of the potential sources.

Sediment colour has recently been used successfully as a fingerprint property to determine sediment sources within small watersheds and in systems with distinct geological differences. This technique is currently integrated in a composite fingerprinting approach to identify sources of sediments and associated phosphorus in four Canadian agricultural watersheds, South Tobacco Creek Watershed in Manitoba, Black Brook Watershed in New Brunswick, Bras d'Henri Watershed in Quebec and Lower Little Bow River in Alberta.

To characterize source material and downstream sediment colour, samples spectra are collected over the 0.4-2.5 μm range using a spectroradiometer ASD FieldspecPro. Colour coefficients are then computed from spectral reflectance measurements. The linearly additive behaviour of these colour coefficients will be tested, as an important requirement for its use in mixing models. Chromatic coordinates and brightness will be used to discriminate potential sediments sources within the watersheds and a numerical mixing model will be applied to apportion their contribution. This colour-based fingerprinting technique will be compared to other fingerprinting techniques (i.e., radioisotopes, compound specific stables isotopes, and shape and size of sediment particles) in order to better understand the sources of sediments within agricultural watersheds.

Long-term recovery of soil organic matter and aggregates stability in an artificially eroded soil under various one time amendments

Lingling Li[1], Henry Janzen[2], Francis J. Larney[2]*, Denis A. Angers
[1] Gansu Provincial Key Laboratory of Arid Land Crop Sciences/Faculty of Agronomy, Gansu Agricultural University, Lanzhou 730070, P.R. China
[2] Agriculture and Agri-Food Canada, Lethbridge, AB, Canada, T1J 4B1
[3] Agriculture and Agri-Food Canada, Québec, QC, Canada, G1V 2J3
*Francis.Larney@agr.gc.ca

An experiment was initiated in 1990 in Lethbridge, Alberta to assess simulated erosion and one-time amendments effects on soil quality and productivity. In this paper, desurfacing depths of 0, 10 and 20 cm, amendments of check (no amendment), fertilizer and manure were selected to evaluate long-term recovery of soil organic matter after 22 yr. Soil samples from 1990, 2004 and 2012 were analysed for soil organic matter fractions and samples from 2012 for aggregate stability. Results (0-7.5 cm depth) showed that after various depth of artificial erosion, labile fractions (light, mineralizable) can be recovered in 14 yr (or maybe even earlier), but soil organic carbon and total N were not recovered in 22 yr. However, recovery of labile fractions is sufficient to support crop yield recovery. Carbon fractions (organic, light, mineralizable) were significantly linearly related to each other, as were the three N fractions (total, light, mineralizable). In 2012, the manure-amended plots (averaged across all three depths of soil removal) showed SOC levels ~15% higher than check plots as a result of a one-time manure application (75 Mg ha-1 wet wt.) 22 yr earlier. Percentage of aggregates>1 mm can be used as an index of soil quality related to labile SOM. Our findings shown that labile SOM fractions are useful indicators of soil recovery from erosion.

Quantifying greenhouse gas mitigation potential of cropland management practices: a review of the GRA Croplands Research Group Greenhouse Gas Network

Liebig, M.A.[1*], A.J. Franzluebbers[2], G. Richard [3], P. Cellier[4], C.W. Rice[5], and S.R Shafer[6]
[1] USDA-ARS, Mandan, ND USA
[2] USDA-ARS, Raleigh, NC USA
[3] INRA – Environment and Agronomy Division, Orléans, France
[4] INRA, UMR EGC, Grignon, France
[5] Kansas State University, Manhattan, KS USA
[6] USDA-ARS, Beltsville, MD USA
* mark.liebig@ars.usda.gov

Multi-national greenhouse gas (GHG) flux networks play a central role facilitating model development and verification while concurrently identifying critical research needs. In 2012, a network was established within Component 1 of the Global Research Alliance (GRA) Croplands Research Group. The network, referred to as MAGGNET (Managing Agricultural Greenhouse Gases Network), sought to establish a coordinated, multi-national approach for inventory and analysis of GHG mitigation research specific to croplands. Initial MAGGNET activities focused on collection and organization of metadata from experimental sites where soil C dynamics and/or GHG flux had been part of the data collection protocol. Ten GRA countries (Argentina, Denmark, France, Indonesia, Italy, Japan, Korea, Spain, Uruguay, and USA), encompassing 123 unique experimental sites, contributed information in response to the initial metadata call. Follow-on activities have expanded collected metadata using published experimental site information, thereby establishing a foundation for inclusion of key response metrics (e.g., GHG flux, soil C stock changes, crop yields). MAGGNET aims to leverage data collected at cropland experimental sites throughout the world in order to strengthen estimates of GHG mitigation effectiveness from targeted management practices while identifying opportunities for additional field research. Moreover, network activities will be coordinated with ongoing C and N modeling efforts within the GRA Croplands Research Group (Component 3) and C/N Crosscutting Research Group, potentially improving national inventories of GHG emissions. Collectively, MAGGNET should serve to strengthen collaborations among scientists and contribute to the overall goal of the GRA Croplands Research Group, which seeks to reduce GHG intensity and improve overall production efficiency of cropland systems throughout the world.

Dynamics of sediment particle morphology in Tobacco Creek Watershed

Cenwei Liu*, David Lobb, Sheng Li
Department of soil science, University of Manitoba
* Liuc179@gmail.com

The sediment particle size and shape reflects the origin of sediment source and the dynamics of sediment during transport, deposition and remobilization within a watershed. The objective of this study was using a rapid and cost-effective fingerprinting technique based on physical characteristics, combining statistical verification procedures for composite signatures, to quantify visually observed changes in the morphology of sediment particles during base flow conditions and to assess the sediment source type in the Tobacco Creek Watershed in southern Manitoba. The suspended sediment was collected by sediment traps during summer low flow and winter high flow. The source materials were collected on cultivated field, riparian area and stream banks. Particle size was obtained with Malvern Mastersizer 2000S laser diffraction. Comparison of the results for the different component of sediment delivery showed the statistically significant particle size selectivity between sediments collected in summer and winter season.

Preliminary assessment of sediment sources in the Lower Little Bow River watershed using ^{137}Cs as a tracer

David A. Lobb[1*], Jim Miller[2], Phil N. Owens[3]
[1]University of Manitoba, Winnipeg, MB
[2] Agriculture and Agri-Food Canada, Lethbridge, AB
[3] University of Northern British Columbia, Prince George, BC
* David.Lobb@UManitoba.ca

The Lower Little Bow River watershed was one of the study sites in Agriculture and Agri-food Canada's Watershed Evaluation of BMPs (WEBs) program. The 55,664-hectare Lower Little Bow River Watershed is located within the Oldman River Basin in southwest Alberta. The Lower Little Bow River WEBs project focuses on a micro-watershed (2,565 hectares) north of Lethbridge. Land use in the Lower Little Bow River Watershed includes a wide range of agricultural activities and intensities such as cow-calf operations on native range, dry land farming, intensive irrigated row crop farming, and intensive livestock operations. Soil and sediment samples were collected throughout the Lower Little Bow River watershed from 2010 to 2012 to assess the sources of sediments moving through the river. Samples were analyzed for ^{137}Cs using gamma spectroscopy. A preliminary assessment of sediment sources was carried out using ^{137}Cs alone. This data suggests that a majority of the sediment moving through the study watershed is coming from stream bank erosion rather than fields. This preliminary work is being followed up with further soil and sediment sampling and with analysis of the geochemical and physical properties of the sediment to allow accurate sediment source identification using fingerprinting techniques.

Unravelling soil erosion processes within agricultural fields, the upland sources of sediments from agricultural watersheds

David A. Lobb*
University of Manitoba, Winnipeg, MB
* David.Lobb@UManitoba.ca

The sediment delivered from a watershed can vary greatly temporally and spatially. Cultivated fields are a major source of sediment within agricultural watersheds. Even within a single cultivated field the distribution and timing of erosion processes can vary greatly. Wind, water and tillage erosion operate within cultivated fields, and they operate together in a complex manner to transport eroded soil from its source within a field to the waterway which carries it out of a watershed. This complex pathway is presented in an effort to provide a better understanding of the spatial and temporal variability of sediment delivery at the field scale and the watershed scale.

Agricultural greenhouse gas outreach for school children and the public

Maas, Siobhan E.*, Amiro, Brian D., and Robbins, Guy
Bruce D. Campbell Farm and Food Discovery Centre, Faculty of Agricultural & Food Science, University of Manitoba
* siobhan.maas@umanitoba.ca

The Bruce D. Campbell Farm and Food Discovery Centre opened in 2011 to provide educational outreach to school children and the public regarding agriculture and food production. The Centre is located just south of Winnipeg, Manitoba at the University of Manitoba's Glenlea Research Station, with relatively easy access for a large urban population. One of the current goals is to increase scientific awareness of agricultural greenhouse gases, focusing on methane, nitrous oxide and carbon dioxide, which could be emitted or consumed by agricultural practices. A significant challenge is to develop learning tools that teach important concepts that can be grasped by middle-years elementary school children. One of our initial strategies has been to develop inter-personal games that develop the ideas of carbon cycling through ecosystems and energy capture by atmospheric molecules. These are active games that involve grade-school students moving a simulated carbon molecule, or have students behave as greenhouse gases capturing their classmates. For children and youth of all ages, we also involve them in artistic drawings of their impressions of agriculture and emissions. Older students have been challenged to describe the difference between amorphous sand and a carbon-rich potting soil, and to reason out the processes contributing to these differences. We are currently building a tool box to provide a large range of activities that can be implemented at the Discovery Centre, at public events (such as fairs) and links to internet tools for student learning. In these activities, we not only focus on potential emission processes, but stress that agriculture has the potential to sequester soil carbon as an environmental benefit.

Effect of salmon-based silage on soil nutrient dynamics: an incubation study

E. MacCormick[1*], G. W. Price[1], A. Kwabiah[2], R. P. Voroney[3]
[1]Dalhousie Faculty of Agriculture, Engineering Department
[2]Agriculture and Agri-Food Canada, St. John's NL
[3]University of Guelph School of Environmental Sciences

The Newfoundland and Labrador (NL) aquaculture industry generates over 12,000 metric tonnes of finfish each year. The salmon industry estimates that approximately 10% of salmon stock grown in pens will die before reaching production, creating a growing amount of salmon waste that cannot be used for human consumption. Because salmon mortalities contain essential plant nutrients, they are a potentially valuable resource as an agricultural soil amendment. It is hypothesized that liquid-based salmon silage will provide N-P-K fertility that is effective in terms of nutrient supply to both the crop and soil. An incubation study using salmon silage material was conducted to determine the amount of plant available nitrogen, as well as monitor microbial activity through carbon mineralization measurements. Three silage rates were used (80kgN/ha, 115kgN/ha, and 180kgN/ha), as well as a soil + lime control. Amended soils were incubated for 75 days to determine the effect of silage material on soil mineral nitrogen. Parameters tested were pH, mineral nitrogen, and total carbon and nitrogen. Early indicators suggest that adding salmon silage as a soil amendment may be of value for management of agricultural soil fertility.

P solubility in ten Manitoba soils as influenced by sulphate salt addition – An exploratory study

Mihiri C.W. Manimel Wadu and Olalekan O. Akinremi
Department of Soil Science, University of Manitoba,
Winnipeg, Manitoba, Canada R3T 2N2
* ummanime@cc.umanitoba.ca

Anion competition of sulphate with phosphate for Ca can limit P precipitation reactions in calcareous soils. The objective of this study was to determine the effect of applying K_2SO_4, $(NH_4)_2SO_4$, $MgSO_4$ and $(NH_4)_2CO_3$ salts with monopotasssium phosphate (MPP) and monoammonium phosphate (MAP) on the solubility of P in Red River, Osborne, Ladywood, Glenhope, Thalberg, Balmoral, St. Claude, Ramada, Eigenhof, and Scanterbury soils. The P:S ratio in treatments containing sulphate salts was 1:1 and a treatment with P:S of 1:2 was carried out using $(NH_4)_2SO_4$ only. Soil pH and P were determined after two weeks of incubation. Soil pH was significantly decreased by both P sources but addition of sulphate salts did not significantly affect pH in most of the soils. There was a significant treatment effect on water extractable P in all soils ($P < 0.0001$), a significant soil effect ($P < 0.0001$) and a significant soil by treatment interaction ($p < 0.0001$). Response of each soil to MPP and MAP was similar while greater P solubility and lower pH were obtained from MAP compared to MPP in all soils. Application of K_2SO_4, $(NH_4)_2SO_4$ and $MgSO_4$ enhanced P solubility by a factor that ranged from 6% to 44% in Osborne, Red River, Balmoral and St. Claude soils. Application of $(NH_4)_2CO_3$ significantly increased P solubility (11% - 14 %) in Glenhope, Ramada and Eignehof soils while the other salts decreased P solubility. Ladywood,Thalberg and Scanturbery soils showed a negative response to sulphate salts addition to both P sources. There was no significant effect of P:S ratio on the P solubility in all soils with both P sources. Soil properties such as acid extractable Ca:Mg, P sorption index and Ca^{2+} saturation on the exchange complex showed a significant correlation to the water extractable P. Application of sulphate salts with MAP can be a promising agronomic practice for soils like Osborne, Red River, Blamoral and St. Claude.

Probing inorganic P compounds in fertilized soils - A comparison of ^{31}P MAS NMR, P K- edge and P L-edge XANES

Mihiri C.W. Manimel Wadu[1*], Yongfeng Hu[2], Scott Kroeker[3] and Olalekan O. Akinremi[1]
[1] Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2
[2] Canadian Light Source Inc., 44 Innovation Boulevard, Saskatoon, SK, S7N 2V3, Canada
[3] Department of Chemistry, University of Manitoba, Winnipeg, Manitoba, Canada R3T 2N2
* ummanime@cc.umanitoba.ca

Direct characterization of P compounds is hindered by the extreme complexity of soil and this affects the potential to identify various P compounds in fertilized soils. The objective of this experiment was to compare Phosphorus - 31 magic-angle spinning nuclear magnetic resonance (^{31}P MAS NMR) with P K - edge and P L - edge X -ray absorption near edge spectroscopy (XANES), for their ability to identify the species of P compounds formed in fertilized calcareous soils. All the spectroscopic analyses were conducted on samples from a model soil which was made of resin and sand and Dezwood Loam (DL) soil. The range of total P concentration in the soil samples was 4.2 – 5.2 g kg^{-1}. The results of MAS NMR confirmed the formation of dicalcium phosphate dihydrate (DCPD) in all the soil samples that were treated with pottasium phosphate. Another P environment was formed in some of the soil samples which could not be identified using MAS NMR. The relative intensities of the DCPD and the unidentified P compound varied among different samples. The P K – edge XANES spectra showed strong similarity across the samples from both soils. The Linear combination fitting results (LCF) did not confirm the formation of DCPD in all soil samples. The P L – edge XANES spectra of model soil samples lacked characteristic features of DCPD and the DL soil spectra exhibited a very high signal-to-noise ratio. The low P concentration and effect of soil heterogeneity affected the P $L_{2,3}$ - edge analysis of our samples. The low sensitivity of P K - edge analysis was due to a lack of uniqueness of the spectral features of Ca - and Mg – P and lack of appropriate P standards to be used in LCF. Therefore we recommend solid state ^{31}P MAS NMR as a preliminary method for inorganic P speciation in soil samples with low paramagnetic ion concentration.

Increasing the accessibility of extension information on the Internet

Ross McQueen[1*], Annemieke Farenhorst[1], Todd Giffin[2], Tom Gonsalves[3], and Jeanette Gauthier[3]
[1] Department of Soil Science, Faculty of Agricultural and Food Sciences, University of Manitoba
[2] Vegetable Growers Association of Manitoba
[3] Manitoba Agriculture and Food Initiatives
* ross.mcqueen@ad.umanitoba.ca

Since the advent of the Internet, the agricultural community has seen the benefits of using web pages to communicate extension information to producers. As part of this movement, the Vegetable Growers Association of Manitoba (VGAM), Manitoba Agricultural and Food Initiatives (MAFRI), and the University of Manitoba have combined their strengths to develop a website that enables producers to have access to up to date information about pest management. The fact that growers are now relying on smart phones for most of their Internet access was taken into account. Typical agricultural extension websites, with their many links, work well on large screens, but are difficult to use on smart phones. In our consultations with producers, they indicated that ease of use on small screens would be the most important factor in their decision whether or not to use this information tool. Thus, we developed the user interface of the website using the jQuery Mobile Framework. This framework allows the development of a user interface specifically designed for mobile devices, yet the interface works well on desktop computers. Another important advantage of using the jQuery Mobile Framework is that it works well with the screen readers used by the visually impaired, and hence helps organizations to move closer to becoming compliant with Web Content Accessibility Guidelines. The website is based on digitizing information obtained from the Guide to Vegetable Crop Protection to provide producers with information about safe use of pesticides as well as detailed information about each pesticide product registered for use on vegetable crops grown in Manitoba.

The authors wish to extend a thank-you to Dr. Philip Northover and Brent Elliot (former MAFRI employees) who were instrumental in the initial stages of this project.

Determination of the bedrock stratigraphy of the South Tobacco Creek area in the Pembina Hills portion of the Manitoba Escarpment using field investigation, LIDAR and photo imagery

Brittany McWhirter, David Lobb, Jim Bamburak, Michelle Nicolas, Genevieve Ali, Li Sheng Li
Red River College

South Tobacco Creek cuts through the Manitoba Escarpment exposing bedrock of the Cretaceous Period present in Southwestern Manitoba. During the summer of 2012, all Cretaceous bedrock outcrops were mapped using photos, GPS coordinates and tracking. This was done to create a visual stratigraphic picture of the Cretaceous formations present in this region. This information is now being combined with LIDAR (Light Detection and Ranging Data) to create a 3D model of the creek. Analyzing the LIDAR data using ArcGIS 10.1 we will be able to create an elevation model of the watershed. This will assist us in indicating where slumping of bedrock has occurred. This information combined with the ground truthing data has the potential to indicate the nature of minerals and geochemical composition within the bedrock units, which may assist us in ultimately determining the age of suspended sediments moving downstream. A stratigraphic model of the watershed may be interpreted for the surrounding region and facilitate the detection of possible alluvial mineralization patterns downstream from South Tobacco Creek and other portions of the Escarpment.

Estimation of in-season nitrogen mineralization in irrigated potato production systems in Manitoba using a nitrogen balance approach

Ramona Mohr[1*], Dale Tomasiewicz[2], Alison Nelson[3], Cynthia Grant[1] and Bernie Zebarth[4]
[1] Agriculture and Agri-Food Canada, Brandon, Manitoba
[2] Canada-Saskatchewan Irrigation Diversification Centre, Outlook, Saskatchewan
[3] Canada-Manitoba Crop Diversification Centre, Carberry, Manitoba
[4] Agriculture and Agri-Food Canada, Fredericton, New Brunswick
* Ramona.Mohr@agr.gc.ca

In-season mineralization of soil nitrogen has the potential to contribute significantly to the plant-available N supply in irrigated potato (*Solanum tuberosum* L.) production systems. Field experiments were conducted at various locations within Manitoba's potato-growing region from 2006 through 2012 to estimate in-season N mineralization in irrigated potato (cv. 'Russet Burbank') receiving no N fertilizer. While experimental treatments varied among site-years, all were arranged in a randomized complete block design with four replicates, and all included one 0N treatment in which net N mineralization was determined using a N balance approach. Estimated in-season mineralization ranged among site-years from approximately 10 to 160 kg N ha^{-1}, with lower net mineralization associated with higher growing season precipitation in some cases. In the majority of site-years (12 of 17), the range in net mineralization was relatively narrow, averaging 85 to 120 kg N ha^{-1}, although sites varied in terms of geographic location, soil type, soil texture, and soil organic matter concentration. In general, N mineralization appeared to increase with increasing total N concentration in the surface 0-15 cm of soil. Results of this study suggest that, under Manitoba conditions, mineralization of soil N during the growing season often contributes significantly to the plant-available N supply in irrigated potato systems.

Effect of phosphorous and cadmium levels on glyphosate sorption in soil under acidic and alkaline conditions

Sirajum Munira* and Annemieke Farenhorst
Department of Soil Science, Faculty of Agriculture and Food Sciences, University of Manitoba, Canada
* muniras@cc.umanitoba.ca

Glyphosate is the most widely used herbicide in the world with a projected annual use of 1.35 billion kg by 2017. In Manitoba, glyphosate applications now account for more than half of the total mass of agricultural herbicides used. Previous studies have demonstrated that increased phosphorus (P) or cadmium (Cd) concentrations in soil influences glyphosate retention. Increased P levels decreased glyphosate sorption because the herbicide and nutrient compete for sorption sites in soil. In contrast, increased Cd levels increased glyphosate sorption following Cd^{2+} exchange with H^{+} ion at the soil surface and possibly bridging between Cd^{2+} and glyphosate molecules. AMPA (aminomethylphosphonic acid) is the major metabolite of glyphosate which is more persistent in soil. The sorption of AMPA in soil has been rarely studied. The objective of this study is to quantify under acidic and alkaline conditions the interactive effects of P and Cd concentrations in soil on glyphosate and AMPA sorption. Soil collected from experimental plots that had received long-term field applications of P and Cd as chemical fertilizers provide for 10 treatments: 20 kg/ha P with Cd added at low, medium or high rates, 40 kg/ha P with Cd added at low, medium or high rates, 80 kg/ha P with Cd added at low, medium or high rates, and a control (no P and Cd added). Batch-equilibrium sorption studies are used to determine glyphosate and AMPA sorption in soil under a range of pH controlled conditions, and with and without additions of P and Cd in the laboratory. This poster presentation will show preliminary results of these studies, and discuss the broader implications of why this research is of agronomic and environmental importance.

Continuous phosphorus fertilizer addition affects phosphorus forms of contrasting prairie soils.

Oluwatoyin Obikoya[1], Cynthia Grant[2], Don Flaten[1] and Wole Akinremi[1]
[1] Department of Soil Science, University of Manitoba, Winnipeg, MB, Canada R3T 2N2
[2] Agriculture and Agri-Food Canada, Brandon Research Center, P.O. Box 1000A, RR#3, Brandon, Manitoba, Canada R7A 5Y3

Information on the changes in labile and non-labile phosphorus (P) forms following addition of inorganic P fertilizer over time will aid in recommendation of valuable P management strategies. Our objective was to investigate the (i) effect of continuous P application in excess of crop removal on the labile and non-labile P fractions of the soils and (ii) effect of P depletion years on P fractions. Phosphorus was added at rates of 0 (control) and 80 Kg P ha^{-1} (treated) at 5 different sites under durum wheat-flax cropping sequence for 8 years and P depletion for 3 years. Five P fractions were determined in these soils using a modified Hedley's P fractionation procedure. Results were analyzed statistically using PROC MIXED procedure. Results showed that with P addition across all sites, H_2O-P and $NaHCO_3$-P increased significantly constituting about 13-23% of total P in 2003 and increasing to 25-40% of total P in 2009. Cropping these soils for 3 years without application of P resulted in slight decline of the labile P to 18-34% of total P indicating P depletion. In contrast, the recalcitrant P (NaOH-P, HCl-P and Residual-P) showed a decrease from about 82% of total P in 2003 to about 50% in 2009, thereafter it slightly increase to 73% in 2012. This shows that most of the added P ended up in the labile fraction which was the fraction that was also depleted during the depletion phase.

Corn stover removal effects on soil aggregation and squash fruit yield in cover cropping systems

Lance Ouellette[1,2*], Richard J. Heck[1,3], and Laura L. Van Eerd[1,2]
[1] School of Environmental Sciences, University of Guelph
[2] Ridgetown Campus, Ridgetown, Ontario, Canada N0P 2C0
[3] Guelph, Ontario, Canada N1G 2W1
* louellet@uoguelph.ca

Although corn stover is increasingly used as a biofuel, the impact of its removal on agronomic production and soil quality is largely unknown. Cover crops may potentially mitigate untoward effects of crop residue removal. The one year impact of corn stover removal on soil aggregate stability and squash yield was assessed in autumn cover cropping systems. The field experiment consisted of a split-plot design with cover crops (a control with no cover, oat (*Avena sativa* L.), cereal rye (*Secale cereale* L.), oilseed radish (*Raphanus sativus* L. var. *oleoferus* Metzg. Stokes), and a mixture of oilseed radish and cereal rye) planted at 81, 67, 16, and 9+34 kg ha^{-1}, respectively, in autumn 2007-2010 as the main plot factor. The retention or removal of corn stover at harvest in autumn 2011 was the split-plot factor, where corn stalks were chopped and either retained on the soil surface or physically removed by hand. A plot composites consisting of three core samples (7.5 cm diameter) at 0-15 cm depth were taken 1 day prior and 30 d later to tillage. Acorn squash (*Cucurbita pepo* var. *pepo*) was planted after tillage (May 2012). Wet sieving measurements showed a mean 4.4±1.95% increase in water stable aggregates in stover-retained compared to stover-removed subplots (P=0.0325). Soil aggregation also increased by a mean 5.1±1.93% between monthly sampling times (P=0.0123), however cover crops did not influence soil aggregation (P=0.8591) and there was no stover-by-cover crop interaction (P=0.6419). Stover removal and cover crops did not affect squash fruit yield (P=0.4753) and there was no stover-by-cover crop interaction (P≥0.2103). Although corn stover removal influenced soil quality, there was no impact on subsequent crop yield. Future research will investigate C and N dynamics in these cover crop-corn stover removal systems.

Channel morphology of the Tobacco Creek watershed in southern Manitoba

Halya Petzold[1*], Brittany McWhirter[1], David A. Lobb[1], Geneviève Ali[1], Phil N. Owens[2], Juliette Brancourt[1], Cenwei Liu[1]
[1] Department of Soil Science, University of Manitoba
[2] Environmental Science, University of Northern British Columbia
* halyapetzold@gmail.com

Southern Manitoba's Tobacco Creek watershed and its sub-basins have been the subject of research for decades. However, to date the hydrology of the watershed has been examined only on a cursory level. This project begins a more detailed investigation of Tobacco Creek's channel form characteristics, specifically at locations currently used as sampling points for sediment fingerprinting under the Watershed Evaluation of Beneficial Management Practices (WEBs) study. In the summer of 2012 topographic survey of channel cross sections was undertaken throughout the drainage basin for computation and comparison of geomorphic variables including channel area, widths and depths. Sinuosity of select reaches was determined using GPS and air photos. In total, channel characteristics were examined at thirteen locations between the headwaters of South Tobacco Creek above the Manitoba Escarpment, and the mouth of Tobacco Creek near Rosenort. The impact of the Escarpment on stream morphology is seen in the difference between channel characteristics measured above versus below the escarpment.

Nutrient cycling in winter grazing cattle on pasture; Forage impact, five years following bale grazing once

Rejean Picard
Manitoba Agriculture, Food and Rural Initiatives
rejean.picard@gov.mb.ca

Perennial pastures are typically low in fertility which limits forage growth. On the other hand manure from livestock over wintering in confinement is nutrient rich and expensive to apply to fields. Bale grazing forage to cattle directly on fields/pastures during the winter time offers the opportunity to add much needed fertility to perennial pastures while reducing manure disposal costs related to over wintering cattle in confinement. Manure and feed residue remaining after bale grazing contain valuable nutrients that become available over time for established forage plants. This improves productivity and quality of the forage stand.

This project started before bale grazing was applied in 2007. This project was designed to measure and to monitor ten differently and independently managed bale grazing sites. Impact on forage is significant and is also being monitored.

Each cooperator bale grazed their herd in the fall 2007 to early winter 2008. Bale grazed sites varied in size from 3 to 14 acres. Each site belongs to a different owner and is managed independently from the others.

Forage samples were hand clipped in the bale grazed area and compared to samples collected in-between or away from the bale grazed zones to compare feed quality.

Nutrient cycling in winter grazing cattle on pasture; Soil impact, five years following bale grazing once

Rejean Picard
Manitoba Agriculture, Food and Rural Initiatives
rejean.picard@gov.mb.ca

Perennial pastures are typically low in fertility which limit forage growth. On the other hand manure from livestock over wintering in confinement is nutrient rich and expensive to apply to fields. Bale grazing forage to cattle directly on fields/pastures reduces feeding time and reduces costs normally associated with feeding livestock in confinement during the winter months. Manure and feed residue remaining after bale grazing contain valuable nutrients that become available over time for established forage plants.

This project was designed to measure and to monitor the soil nutrient levels of ten differently and independently managed bale grazing sites.

The ten established perennial pasture sites involved in this project were initially soil sampled to a depth of 48 inches in the fall of 2007 to determine the nutrient level of each pasture before bale grazing. Each cooperator bale grazed their herd in the fall 2007 to early winter 2008. Soil samples have been collected every fall since 2008 to measure the nutrient level in the bale grazed zones (green spots only). Depending on the site, eight to ten core samples are collected to form a composite sample of the bale grazed areas for each sampling depth. Bale grazed sites varied in size from 3 to 14 acres. Each site belongs to a different owner and is managed independently from the others.

Characterization of soil organic matter along a climosequence in the grassland-forest transition in West-Central Saskatchewan

Kendra Purton*, Fran Walley, Dan Pennock
Department of Soil Science, University of Saskatchewan
*Kendra.purton@usask.ca

The role of soils as either a carbon source or sink as our climate changes is still uncertain due, in part, to our incomplete knowledge of the factors affecting the persistence of soil organic matter. As such, there is currently a significant need to describe differences in the molecular nature of soil organic matter that result from changes in environmental conditions. This study aims to assess differences in the molecular nature of soil organic matter resulting from climate-induced vegetation changes by assessing soil organic nitrogen and soil organic carbon speciation using C and N K-edge x-ray absorption near edge structure (XANES) to examine soils selected from a pedologically defensible transect that exhibits a ~1ºC range in mean annual temperature and traverses the grassland-forest boundary in Saskatchewan. Preliminary results from the climosequence soils suggest that effects of climate-induced vegetation changes on the molecular nature of soil organic matter appear to be remarkably subtle and may provide further evidence for an overwhelming effect of a common decomposition sequence on soil organic matter quality despite large variation in vegetative communities.

Nitrous oxide fluxes in crop fields receiving various manure managements: a compilation of two studies in Indiana and Alberta

Guillermo Hernandez Ramirez[1*], Len Kryzanowski [2], Sylvie M. Brouder[3], Robert F. Grant[1], Trevor Wallace[2], Douglas R. Smith[4], George E. Van Scoyoc[3], Craig Sprout[2], Germar Lohstraeter[2] and Leigh-Anne Powers[2]
[1] Department of Renewable Resources, University of Alberta, Edmonton, AB
[2] Alberta Agriculture and Rural Development, Edmonton, AB
[3] Agronomy Department, Purdue University, West Lafayette, IN
[4] Soil Erosion Lab, USDA-ARS, West Lafayette, IN
* ghernand@ualberta.ca

Nitrous oxide (N_2O) losses can determine the outcome of greenhouse gas balance in agricultural lands. Both edaphic-climatic conditions and nitrogen input management typically drive the magnitude of these N_2O emissions. Moreover, liquid animal manure additions can further stimulate soil N_2O emissions in part due to the supply of readily available organic carbon. These effects can be amplified in fields where manure is repeatedly applied. Nonetheless, knowledge about manure management effects on soil N_2O fluxes remains incomplete, and available data is fragmented. This compilation of two N_2O studies examines the effects of various liquid manure management practices including assessment of time of injection (fall versus spring) in continuous maize fields (West Lafayette, Indiana) as well as application rate and placement method (injection vs. surface banding) in barley fields (Edmonton, Alberta). Static chambers were used at both experimental sites, and automatic chambers were also deployed in the Alberta study. Relative to manure or urea-ammonium nitrate injected in the spring, fall manure reduced area-based annual N_2O emissions by 45% in continuous maize. Also, yield-based annual N_2O flux revealed that spring and fall manure emitted 1.08 vs. 0.45 kg N_2O-N per Mg grain, respectively ($P < 0.001$). As expected, cumulative N_2O losses increased with spring-applied manure-N input in barley fields; background-corrected emission factors were 2.2 ± 0.5 and 3.0 ± 1.6 % (kg N_2O-N kg^{-1} manure-N) for the manure rates of 132 and 265 kg N ha^{-1}, respectively. With respect to manure placement choice, injection in the soil tended to increase N_2O losses 2 kg N yr^{-1} more than surface banding levels. Collectively, these results suggest the need for further research on manure management to identify effective means for N_2O mitigation and to simultaneously assess directional trade offs between N_2O emissions and other potential environmental impacts of land manure application.

All fats are not equal: Considerations when using fatty acid biomarkers in compound-specific stable isotope soil and sediment tracing

Dominic Reiffarth[1], Ellen Petticrew[1], Philip N. Owens[1], David A. Lobb[2*]
[1] University of Northern British Columbia, Prince George, BC
[2] University of Manitoba, Winnipeg, MB
* David Lobb, David.Lobb@UManitoba.ca

The development of cost-effective, convenient and reliable methods for tracing sediment movement will help establish water security. The use of compound-specific stable isotopes (CSSIs) has seen limited, small-scale applications, often in watersheds exhibiting exotic and highly diverse vegetation types. The CSSI tracing technique relies on the detection and transport of naturally occurring organics of plant origin (biomarkers); the biomarkers of interest are produced by flora, deposited on the soil and potentially mobilized along with soil particles. In part, the uniqueness of a biomarker is dependent on its biological pathway. As a plant fixes CO_2–its primary source of carbon for building larger organic molecules–discrimination against the heavier ^{13}C isotope leads to an enrichment of ^{12}C. The more complex the biological pathway the biomarker has been subjected to, the more discrimination and unique isotopic signature the biomarker exhibits. Successfully implementing CSSI tracing requires recognizing: (i) factors contributing to the natural variability of the isotopic signature (ii) the suitability of a biomarker and (iii) factors affecting sensitivity during analysis. Considering the relatively low input of suitable organic biomarkers into the soil and degree of signal dispersion, care must be taken to isolate and correctly identify biomarkers, particularly where vegetation types show low variability and where long-range transport occurs. Research is currently being conducted in the Horsefly River (British Columbia) and South Tobacco Creek (Manitoba) watersheds; the research seeks to address some of these concerns, particularly in a temperate climate where exotic vegetation types are not common and variability is expected to be low.

The effect of antibiotic presence and agitation on estrogen mineralization in liquid swine manure

Karin Rose* and Annemieke Farenhorst
Department of Soil Science, University of Manitoba, Winnipeg, Manitoba R3T 2N2, Canada
* umrose5@cc.umanitoba.ca

Antibiotics and natural steroid estrogens are chemicals detected in livestock manure storage facilities and in manure amended agricultural soils. This study examined the effects of the presence of absence of penicillin or tetracycline on the degradation of estrone (E1) and 17 β-estradiol (E2) steroidal estrogens in five media: manure alone, soil amended with a low rate of manure (LM), soil amended with a high rate of manure (HM) and soil alone. Laboratory microcosm studies were conducted under a constant 20˚C temperature to determine E1 and E2 mineralization in each medium (quadruplicated) with three levels of penicillin or tetracycline: 0, 40 and 200 mg kg medium^{-1}. Half-life of E1 or E2 in manure alone and HM were significantly ($P < 0.05$) greater than in soil regardless of antibiotic treatment. Within soil and LM, E1 half-life was significantly greater when treated with a high rate of penicillin addition than with tetracycline additions. In contrast, E1 half-life in manure alone was significantly greater when treated with tetracycline than with penicillin. Maximum estrogen mineralization (MAX) decreased in the order of: manure alone > soil = LM > HM. The presence of antibiotics had no significant effect on MAX in soil, LM or HM. However, MAX significantly decreased within manure in the order of: penicillin addition = no antibiotic addition > low rate of tetracycline addition > high rate of tetracycline addition. Agitation frequency in manure was observed to significantly increase MAX, as the manure samples that were agitated every 3-4 d had significantly higher MAX than those that were never agitated.

Development of an automated system for greenhouse and nitrogen gas flux determinations from compost

Jolene Rutter*, Mario Tenuta, Matt Gervais
Department of Soil Science, University of Manitoba
* Jolene_rutter@hotmail.com

Greenhouse (CO_2, CH_4, N2O) and nitrogen (NH_3, NO, NO_2) gas fluxes during composting of animal wastes can be considerable. However, determinations of all these gases simultaneously have not been possible using static vented chambers during windrow composting. Thus we developed an automated system for greenhouse and nitrogen gas flux determinations. A LI-8100a automated chamber system (LICOR BioSciences) and Fourier Transform Infrared spectroscopy (FTIR) multi-gas analyzer (Gasmet DX4015) was used in series to measure gas concentrations. This system is a closed loop system that measured the accumulation of gases inside a chamber headspace over a period of time. The chambers were setup on the top of the compost windrow; our setup was capable of using eight chambers. A chamber was closed and gas re-circulated for 3 minutes. The FTIR measured gas concentrations every 10 seconds. Linear regression analysis, the ideal gas law, gas volume of the system, and the area of the chamber were used to calculate flux in g-nitrogen or carbon m^{-2} s^{-1}. Every 30 minutes a flux determination was calculated from one of the eight chambers. Combining these instruments was a highly innovative approach because it allowed for nearly continuous unattended data collection of multiple gases; this provided the capability to capture the dynamic process of composting and determine the intrinsic links between carbon and nitrogen gases. However, the system had some problems. The high porosity of compost meant fluxes were underestimated when winds were high. The ability to collect gas emission data at such a high frequency identifies when gases emissions are underestimated and can be correlated with wind speed and direction. Also, due to the nature of ammonia, internal surfaces of the system were prone to sorption reactions. This caused a lag in accumulation of ammonia upon closing of chambers. Three different patterns for accumulation of ammonia were observed and the time interval used to determine ammonia flux was appropriately altered. Overall, the system was effective at determining fluxes of multiple gases emissions at a high frequency.

Organic Cryosols on forested upland slopes, northern Rocky Mountains, British Columbia

Paul T. Sanborn*[1], Chuck Bulmer[2], Marten Geertsema[3], Scott Smith[4], Andreas Hasler[3]
[1] Ecosystem Science & Management Program, University of Northern British Columbia, Prince George, BC V2N 4Z9
[2] Ministry of Forests, Lands, and Natural Resource Operations, Vernon, BC V1B 2C7
[3] Ministry of Forests, Lands, and Natural Resource Operations, Prince George, BC V2L 3H9
[4] Agriculture and Agri-Food Canada, P.O. Box 5000, Summerland, BC V0H 1Z0
* sanborn@unbc.ca

Recent mapping of permafrost distribution in NW Canada (Lewkowicz *et al.* 2012) has not considered soil landscape patterns. This preliminary study examines the topographic patterns of soil characteristics and temperature regimes in the discontinuous permafrost zone of the northern Rocky Mountains (~58–59°N) in British Columbia.

Organic Cryosols have formed on forested north-facing aspects in both steep (~40–60%) colluvium and more gently sloping (<10%) fluvial fans. Substantial organic C stocks occur as 40–80 cm+ thick forest floors and mineral horizons with ~5–15% organic C within and below the active layer. Incorporation of organic matter below the active layer likely occurs episodically via slope instability and fan aggradation after forest fires (*cf.* Smith *et al.* 2009). These strong topographic relationships, and a distinctive vegetation association consisting of open black spruce (*Picea mariana*) stands with a prominent shrub (*Salix* sp., *Alnus* sp.) understory, should assist identification and mapping of these Cryosols.

Soil and air temperature measurements at two field sites (Tetsa: 58°40'N, 124°27'W, 1000m asl; Poplar: 58°51'N, 125°18'W, 800m asl) indicate the presence of warm permafrost on north-facing slopes. While mean annual air temperatures are generally below 0°C at all locations, ground temperatures are 1.5–2°C colder on north- vs. south-facing slopes. Temperatures at 0.5–1 m depth on north-facing slopes remained at 0°C throughout the 4 year record. This isothermal temperature regime is typical of ice-rich soils and organic layers in permafrost at its climatic limit.

The morphology and upland feathermoss origin of these thick forest floors (predominantly F horizons), resemble those of folic materials, which were not distinguished within the Organic Cryosols by the Soil Classification Working Group (1998). We propose that a Folic Organic subgroup be established to recognize Cryosols with characteristics that would otherwise fit the Folisol great group in the absence of permafrost.

References:

Lewkowicz, A. G., Bonnaventure, P. P., Smith, S. I. and Kuntz, Z. 2012. Spatial and thermal characteristics of mountain permafrost, northwest Canada. Geogr. Ann. A. 94: 195-213.

Soil Classification Working Group. 1998. The Canadian system of soil classification. 3rd ed. Agriculture and Agri-Food Canada, Ottawa, ON. 187 pp.

Smith, C. A. S., Sanborn, P. T., Bond, J. D. and Frank, G. 2009. Genesis of Turbic Cryosols on north-facing slopes in a dissected, unglaciated landscape, west-central Yukon Territory. Can. J. Soil Sci. 89: 611-622.

Measurement of N release from solid beef and liquid swine manure in a growing season using anion exchange resin

S. M. Sayem*, O. O. Akinremi, D. N. Flaten
Department of Soil Science, University of Manitoba, Winnipeg, Manitoba
* sayemhstu@hotmail.com

Estimation of available nitrogen (N) released from manure is essential to maximize N use efficiency. Mineralization process determines the release of N from manure and the process is influenced by soil moisture and soil temperature. The objective of the study was to determine the effects of manures, soil moisture, soil temperature and soil type on the release of manure N in a growing season. Polyvinyl chloride cylinders were installed under randomized complete block design in clay and loamy-sand soil in Manitoba. Solid beef manures (SBM), liquid swine manure (LSM) and N fertilizer were incorporated into soil inside the cylinder at a rate of 100 kg ha^{-1} of available N. The amended available N in resin and soil compared to an unamended soil were measured at 0, 1, 2, 4, 6, 8, 10, 14 and 18 week. The volumetric soil moisture ranged from 13 to 51 % and soil temperature ranged from 2.5 to 27.4 º C in the clay soil while in sandy-loam soil moisture ranged from 14 to 36 % and soil temperature from 4.8 to 27.6 ºC. The recovery of N from clay soil decreased steadily possibly because of denitrification caused by very wet and water logged soil condition in 2010. Maximum net available N of 39 and 68 kg ha^{-1} were measured within 6-10 week from SBM amendments under loamy sand in the growing season of 2010 and 2011, respectively. Maximum net mineralized N was 27 and 48 kg ha^{-1} from SBM amendments in 2010 and 2011, respectively. Differences between the two growing seasons were due to variation in soil moisture and temperature. Maximum fertilizer equivalence of SBM amendments was 60 % in 2010 and 85% in 2011. With LSM the fertilizer equivalent was 60 % at the end of the growing season in both years. Increased available N or fertilizer equivalence from SBM amendments indicates mineralization and decreased from LSM amendment indicates the loss of N through ammonia volatilization, denitrification and immobilization.

Nitrous oxide emissions and nitrogen leaching in dairy feed crops receiving manure, anaerobically digested manure, and urea.

Emily Schwager[1], Andrew VanderZaag[2]*, Anna Crolla[3], Chris Kinsley[3], Claudia Wagner-Riddle[4], and Ed Gregorich[2]
[1] University of Guelph, School of Environmental Sciences, Guelph, ON
[2] Agriculture and Agri-Food Canada, Science and Technology Branch, Ottawa, ON
[3] Campus d'Alfred, University of Guelph, Alfred, ON
[4] University of Guelph, School of Environmental Sciences, Guelph, ON
* andy.vanderzaag@agr.gc.ca

This research is part of a large AGGP project to quantify greenhouse gas emissions and identify mitigation opportunities in the dairy sector, including the management of feed, manure, and cropping systems. This project focuses on cropping systems management for growing corn silage, an important crop in Ontario dairy rations. Specifically, the project is evaluating the effect of manure N-source (untreated and digested) and timing on N_2O emissions and N-leaching. The research site in Alfred, ON, was selected because it is in an intensive dairy production region and provides the unique opportunity to simultaneously measure gaseous fluxes and leaching losses on contrasting soil types. Furthermore, there are several dairy farms in the area with commercially operating anaerobic digesters generating heat and electricity. The anaerobic digestion process changes manure characteristics, increasing the ammonium-N content, decreasing organic-N, and decreasing the C:N ratio. The study began in the fall of 2011. Each field site has two randomized complete blocks with the following treatments: fall and spring digestate, fall and spring raw manure, spring inorganic fertilizer and a zero-N control. The zero-N treatment provides data on background N_2O emissions. Measurements of N_2O emissions using static chambers have been ongoing since late 2011, continuing through the winter, when high fluxes were observed. N-leaching is quantified with isolated tile-drainage system for each plot in the clay field, where flow is measured with calibrated tipping buckets and concentrations of nitrate and ammonium are measured. In the sandy loam soil, zero-tension lysimeters are used to measure leaching. This poster will describe the research site and methodology, and show preliminary results.

Relationship of corn height, active optical sensor readings and corn yield under different soil surface textures in North Dakota

Lakesh Sharma* and Dave Franzen
North Dakota State University, Fargo
* lakesh.sharma@ndsu.edu

One of the ways to theoretically improve N fertilizer efficiency in corn is to apply at least some of the N in a side-dress application. The objective of this study was to determine the value of using active-optical sensors to determine need and rate of a side-dress N application. Thirty sites in southeastern North Dakota were used to conduct N rate trials on corn (Zea mays, L) in 2011 and 2012. The experimental design was a randomized complete block with four replications and six treatments; check (no added N), 45 kg N ha^{-1}, 90 kg N ha^{-1}, 135 kg N ha^{-1}, 179 kg N ha^{-1} and 224 kg N ha^{-1}, applied as ammonium nitrate by hand preplant within a week of planting. Locations were categorized into high clay or medium textured soils as well as no-till and conventional tillage. Two active-optical ground based sensors, the Greenseeker (TM) and Holland Crop Circle-470 (TM), were used to gather imagery from each plot at both the 6 and 12 leaf stage. The middle row of each plot was hand harvested and the yield compared with sensor measurements to build an algorithm of in-season estimate of yield (INSEY). On the same dates as imagery collection corn height was measured using a tape measure. The determination coefficient (R2) value was used to evaluate the relationship of crop yield and sensor reading, and plant height. Linear, quadratic, and exponential models were used to evaluate the relationship. Multiplying the INSEY with corn height generally resulted in a stronger relationship with yield and a better estimate than INSEY alone.

Sorption of nickel on palygorskite, sepiolite and calcite: equilibrium and kinetic studies

Ahmadreza Sheikhhosseini Esfahani*, Hossein Shariatmadari, and Mehran Shirvani
Department of Soil Science, Isfahan University of Technology, Isfahan, Iran
* sheikhosseini@yahoo.com

Studying the behavior of heavy metals in the environment is of interest because of the hazardous impacts they may have on living organisms. Time and concentration dependency of nickel (Ni) sorption on three minerals occurring in calcareous soils, namely palygorskite, sepiolite and calcite, were tested in a laboratory batch experiment. Nickel sorption data on the minerals were best fitted to Langmuir model (R^2>0.95). Maximum sorption capacity (q_m) and sorption affinity (K_L) were found to be 2.41 mg/g and 0.155 L/kg for palygorskite, 4.57 mg/g and 52.05 L/kg for sepiolite and 1.84 mg/g and 0.002 L/mg for calcite, respectively. Pseudo-first and pseudo-second order kinetic models best described sorption of Ni on palygorskite and calcite with R^2>0.77 and R^2>0.89, respectively. In the case of sepiolite, sorption data were fitted with parabolic diffusion and power function models (R^2>0.95). Overally, sepiolite showed a far higher capacity and rate of Ni removal from liquid phase over the other examined minerals.

Vegetated buffer strips: 12 sites and 3 years and little evidence of phosphorus retention

Steve Sheppard[1]*, David Lobb[2], Don Flaten[2], Phil Owens[3] and Armand Bélanger[4]
[1] ECOMatters Inc., Pinawa, Manitoba, Canada, R0E 1L0;
[2] Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, R3T 2N2
[3] University of Northern British Columbia, Prince George, B.C., V2N 4Z9
[4] East Interlake Conservation District, Gimli, Manitoba R0C 1B0
* sheppards@ecomatters.com

A vegetated buffer strips (VBS) is a strip of permanent vegetation between a field and a waterway that is envisioned to entrain sediment, nutrients and/or contaminants that are flowing with runoff off the field. Although proven effective in some regions and commonly considered beneficial, their effectiveness in Manitoba remains in question because of high proportions of dissolved phosphorus (P), the runoff is often in discrete channels, and VBS are often snow filled and flooded. Four mini-catchments were sampled in each of the 4 watersheds over 3 years. In each sampling position, runoff samples were collected at the field-edge and at 5 m into the VBS, with multiple species of P and nitrogen (N) measured. Detailed soil samples were also collected in one catchment from each watershed for P and ^{137}Cs measurement. Vegetation harvest was a management treatment applied. The runoff concentrations of N and P sampled in the weirs were seldom decreased as the runoff flow passed from the field-edge weir to the weir 5 m into the VBS. In effect, the VBS was nearly as often a source of nutrient than it was a sink for nutrient. There was no effect of the removal of vegetation on the effectiveness of the VBS. Based on the soil analyses, 5 of the 12 weir-pair locations appeared to have retained P in the VBS, but the amount retained may not be enough to be relevant. The overall conclusion is that VBS can retain N and P, but the amount retained may not be sufficient to be relevant, and the VBS have the potential to become a source of N and P to the runoff flow.

Soil carbon sequestration and dynamics in the shelterbelts of Saskatchewan

Gurbir Singh Dhillon* and Ken Van Rees
Department of Soil Science, University of Saskatchewan, Saskatoon, SK
* gud510@mail.usask.ca

Sequestration of carbon in soils through the implementation of agroforestry practices is identified as one of the major strategies in the reduction of greenhouse gases by the Intergovernmental Panel on Climate Change (IPCC). This study determines the potential of shelterbelts, as an agroforestry management practice, for below-ground sequestration of soil organic carbon (SOC) at the farm landscape scale as well as at the provincial scale. To achieve this objective, the amount and quality of SOC sequestered under the hardwood and conifer shelterbelts species grown across the soil zones of Saskatchewan will be determined. The amount of carbon sequestered under the shelterbelts is determined by comparing the SOC under the shelterbelts to the adjoining fields in order to determine the increase in SOC pools due to the shelterbelts. The quality of SOC is determined by separating the soil organic matter into different fractions of varying stability. Since the stability of SOC is determined primarily by organo-mineral interactions, density fractionation technique will be applied, which separates soil organic matter according to its degree of interaction with minerals into the light and heavy fractions. The light fraction, representing the labile fraction, consists of plant-derived debris and the heavy fraction, representing the recalcitrant fraction, consists of mineral-associated organic matter. Organic matter with higher proportion of the heavy fraction is expected to have higher stability and mean residence time in the soil. This poster will present preliminary results of the impact of shelterbelts on the amount of SOC sequestered as well as the relative amounts of light and heavy fractions of organic matter under the shelterbelts compared to agricultural fields.

Greenhouse gas emissions from dairy manure at various levels of storage tank emptying

A. Sissoko, C. Wagner-Riddle, R. Gordon, and J. Wood

Animal manure contains large amounts of organic matter and other nutrients. It also significantly contributes to greenhouse gas (GHG) emissions, such as methane (CH_4), nitrous Oxide (N_2O) as well as ammonia (NH_3) emissions. Reducing the depth of aged manure remaining in the manure storage tank (i.e. inoculum) after spreading is considered as a possible GHG mitigation strategy. In this study, this strategy was evaluated in a pilot-scale manure storage facility that included six storage tanks each 1.8 m (depth) × 6.6 m^2 (surface area) in Truro, Nova Scotia. The aim of the study was to determine the effect of different levels of inoculum (i.e. aged dairy slurry manure) mixed with freshly excreted manure on GHG and NH_3 emissions from these storages. Different percentages (%) of inoculum (0, 5, 10, 15, 20 and 25 %) from 6 month old manure was loaded in six different tanks and monitored continuously for 164 d. Gas fluxes were measured continuously using steady-state chambers; CH_4 and N_2O concentrations were measured using trace gas analyzer (TGA), and NH_3 concentration using an acid trap technique. During the storage period (May-November), preliminary results showed the accumulated losses for CH_4 according to different % of aged manure respectively 2.28, 3.5, 3.8, 4.8, 4.8 and 3.6 kg m^{-2}. The accumulated losses for N_2O were 20.9, 27.1, 27.6, 8.0, 24.2, 13.9 g m^{-2}. For NH_3, it was 372.0, 351.3, 504.0, 586.6, 418.7 and 358.2 g m^{-2}. Fewer emissions observed with the highest % of inoculum were due probably to the presence of dry surface cover crust. Therefore, emptying or leaving minimal amounts of aged manure in the storage can reduce emissions of CH_4.

Combining micrometeorological measurements with molecular and stable isotope techniques to understand the mechanisms producing nitrous oxide emissions in dairy manure-fertilized soils

David Snider,* Karen Thompson, Claudia Wagner-Riddle, and Kari Dunfield
School of Environmental Sciences, University of Guelph, Guelph, ON N1G 2W1, Canada
* dasnider@uoguelph.ca

We characterized a high N_2O flux event after a heavy spring rainfall in a dairy manure-fertilized agricultural soil with the intent of identifying the dominant production pathway. A flux-gradient micrometeorological approach was used to record half-hourly N_2O fluxes from two 4-ha corn fields fertilized with liquid dairy manure in the fall or spring (150 kg N/ha). Changes in the activity and abundance of soil denitrifiers and nitrifiers before, during, and after the rainfall were determined using molecular methods. Stable isotopes at natural abundance ($\delta^{15}N$-N_2O and $\delta^{18}O$-N_2O) were measured to track the processes generating high N_2O emissions.

Large N_2O emissions occurred for several days following a 44-mm rainfall in June 2012 (337 g N_2O-N/ha was emitted to the atmosphere over a 2 week period). For comparison, this was 43% of the cumulative N_2O-N lost during the entire month of March 2012 (790 g N/ha) when large snowmelt N_2O fluxes occurred. The flux-weighted isotope ratio of the N_2O emissions from the spring-fertilized field was -31‰ ($\delta^{15}N$-N_2O rel. AIR) and +25‰ ($\delta^{18}O$-N_2O rel. VSMOW), and -25‰ and +27‰ ($\delta^{15}N$-N_2O and $\delta^{18}O$-N_2O, respectively) from the fall-fertilized field. These values are consistent with our expectations of a denitrification source in a well-drained soil. Subsurface N_2O concentrations were temporally and spatially variable, ranging from ambient levels (prior to the rain) to almost 100 ppm v/v (4 days after onset of rain). Isotope ratios of N_2O at depth were high prior to the rain event (enriched in ^{15}N and ^{18}O), but quickly declined to values indicative of newly-produced N_2O by denitrification. Quantitative PCR (qPCR) was used to enumerate the total bacterial communities (16S), and communities of denitrifiers by targeting nitrite reductase (*nirS*) and nitrous oxide reductase (*nosZ*) genes, and these results will be presented.

Particulate organic matter and soil mineral nitrogen concentrations are good predictors of the soil nitrogen supply to canola following legume and non-legume crops in western Canada

Mervin St. Luce[1, 2,*], Noura Ziadi[2], Bernie J. Zebarth[3], Joann K. Whalen[1], Cynthia A. Grant[4], Edward G. Gregorich[5], John T. O'Donovan[6]
[1] Department of Natural Resource Sciences, Macdonald Campus, McGill University, 21, 111, Lakeshore Road, Ste-Anne-de-Bellevue, QC, Canada, H9X 3V9
[2] Soils and Crops Research and Development Centre, Agriculture and Agri-Food Canada, 2560 Hochelaga Blvd., Quebec City, QC, Canada, G1V 2J3
[3] Potato Research Centre, Agriculture and Agri-Food Canada, 850 Lincoln Road, PO Box 20280, Fredericton, NB, Canada, E3B 4Z7
[4] Brandon Research Centre, Agriculture and Agri-Food Canada, PO Box 1000A, R.R. #3, Brandon, MB, R7A 5Y3
[5] Eastern Cereal and Oilseed Research Centre, Agriculture and Agri-Food Canada, 960 Carling Ave, Ottawa, ON, K1A 0C6
[6] Lacombe Research Centre, Agriculture and Agri-Food Canada, 6000 C and E Trail, Lacombe, AB, T4L 1W1
*mervin.stluce@mail.mcgill.ca

Accurate estimation of potential nitrogen (N) availability from preceding crops is essential to improve N fertilizer management in agricultural soils. Labile organic N fractions such as microbial biomass N (MBN), water-extractable organic N (WEON), particulate and light fraction organic matter N (POMN, LFOMN) are sensitive to management-induced changes and have the potential to predict N availability. This study assessed the impact of preceding legume [field pea (*Pisum sativum* L.), faba bean (*Vicia faba* L.), faba bean green manure] and non-legume crops [canola (*Brassica napus* L.) and wheat (*Triticum aestivum* L.)] on labile organic N fractions, mineral N (NH_4-N + NO_3-N), potentially mineralizable N (N_0) and soil N supply [canola grain yield and N uptake]. Our objective was to determine whether these soil parameters could be used as indicators of soil N supply across no-till sites in western Canada. Labile organic N fractions and N_0 were similar regardless of preceding crop. Soil N supply was greatest following faba bean green manure at four of five sites. POMN was the best single predictor of soil N supply (R^2 = 0.56 and R^2 = 0.69 for yield and N uptake, respectively) across sites. Soil N supply was primarily related to the combined effects of POMN, mineral N and sand content, which explained 68 and 71% of the variation in grain yield and N uptake, respectively. This study demonstrated that POMN and mineral N are good predictors of soil N supply to canola in western Canada. Future soil N test methods for canola N fertilizer recommendations should take into account these parameters and soil texture.

Net ecosystem exchange of dairy cropping systems

Muhammad F. Sulaiman*, Claudia Wagner-Riddle and Shannon Brown
School of Environmental Sciences, University of Guelph, Guelph, ON, N1G 2L1, Canada
* mbinsula@uoguelph.ca

A better understanding of net ecosystem exchange (NEE) in annual and perennial cropping systems used in dairy production is needed for greenhouse gas emission model developments and life cycle analysis. A three-year study was initiated in Fall 2011 to determine the net CO_2 fluxes from corn and hay production, the two main feed crops used in dairy production. Four 2-ha plots were continuously monitored using the flux-gradient method deployed with a tunable diode laser trace gas analyzer and sonic anemometers. All plots received dairy manure as fertilizer applied according to common practice. Two plots consisted of 5-year old hayfields and two were planted in corn in May 2012. Average CO_2 fluxes during the non-growing season 0.43 and 0.34 μmol CO_2 m^{-2} s^{-1} for hay and corn respectively. During the growing season (i.e. May to September), average day-time fluxes were -8.03 and -10.92 μmol CO_2 m^{-2} s^{-1} for the hay and corn respectively while average night-time fluxes were 5.18 and 3.10 μmol CO_2 m^{-2} s^{-1} for hay and corn respectively. These data and preliminary estimates of annual NEE values will be discussed.

Field-scale carbon dioxide and methane exchange over winter bale-grazing, backgrounding steers in Brandon, Manitoba

Amanda M. Taylor *, Brian D. Amiro, Matt Gervais, and Mario Tenuta
Department of Soil Science, University of Manitoba, Winnipeg, MB R3T 2N2
* Amanda_M_Taylor@umanitoba.ca

Beef cattle emit enteric methane but the perennial grasslands that support them have the potential to sequester carbon. Knowing the net balance of methane and carbon dioxide exchange is important to estimate the net emission of greenhouse gases to the atmosphere. There have been no previous measurements of field-scale, total greenhouse gases, from over winter and pasture fields of beef operations. We measured through the winter and spring of 2013 carbon dioxide and methane fluxes using eddy-covariance flux towers over a winter bale-grazing site in Brandon, Manitoba. Instrumentation included fast-response closed-path analysers for methane and carbon dioxide located at a central tower. With flux footprints of several hundred metres, cattle were in one sector of the footprint and emissions determined for the full farm depended on wind direction and atmospheric conditions. Measurements were complicated by the relative difficulty of determining the location of the 100 steers at any given time; thus, automated cameras were used to track their location. Freezing temperatures regulated the carbon flux, and showed small respiration losses through the winter. Wind direction dictated flux origin, and provided a landscape unoccupied by the cattle for comparison. Cattle increased methane fluxes when winds were from the directions they occupied. The study continues following the same cattle through summer pasture and fall swath-grazing. Improved spatial sampling is being undertaken with a second mobile tower. We plan to complete one full annual cycle of cattle movements on the farm, integrating the effects of the animals on the landscape emissions of greenhouse gases.

Profitable, sustainable and resilient cropping systems: A vision for the development of Canadian prairie agriculture

Joanne Thiessen Martens[1]*, Mark Wonneck[2]
[1] Department of Plant Science, University of Manitoba, Winnipeg MB
[2] Science and Technology Branch, Agriculture and Agri-Food Canada, Calgary, AB
* j_thiessen_martens@umanitoba.ca

In the face of global and regional drivers affecting the context in which Canadian agricultural systems function, it is important to consider how the Canadian agriculture sector should evolve and develop in order to thrive economically while protecting our natural resource base and building resilience. Diversified farming systems, which rely on the use of diversity to maintain biological functions and ecosystem services that support agricultural production, have been proposed as an alternative to the prevailing system of annual monoculture, a model which has caused unintended negative consequences such as environmental contamination, soil degradation and biodiversity loss. Diversification practices range from relatively simple and well-understood techniques such as crop rotation and choice of crop genetics to complex or novel systems such as integrated crop-livestock systems, agroforestry, perennial grains and farmscaping. The potential value of such practices to the sustainable development of Canadian prairie cropping systems depends on their ability to enhance profitability, environmental sustainability and resilience, along with their technical feasibility and adoptability. Based on a review of the literature, organic systems, perennial forages in rotation, perennial grains, integrated crop-livestock systems and farmscaping appear to have high potential for positive impacts on environmental sustainability, profitability and resilience. However, adoptability of many of these systems is limited by lack of knowledge on specific, locally adapted management practices and economic factors. A shift to integrated, ecologically-based agricultural systems as a framework in which to place all other farming practices would allow for synergies to develop among various farm practices, enhancing the benefits to Canadian prairie agricultural systems. Transitioning to such systems calls for a realignment of priorities to include environmental sustainability and resilience and would require support for farmers in the form of incentive programs, educational programs and demonstration projects, and interdisciplinary research programs focusing on local adaptation of ecological farming systems.

Nitrogen mineralization from a sandy loam and silty clay soil with a three-year history of manure and mineral fertilizer

Ben W. Thomas[1*], Mehdi Sharifi[2], Joann K. Whalen[1], Martin Chantigny[3], Bernie Zebarth[4], and David Burton[5]
[1]Department of Natural Resource Sciences, McGill University, Montreal, QC
[2]Canada Research Chair in Sustainable Agriculture, Environmental and Resource Studies Program, Trent University, Peterborough, ON
[3] Agriculture and Agri-Food Canada, Soils and Crops Research and Development Centre, Québec, QC
[4]Agriculture and Agri-Food Canada, Potato Research Centre, Fredericton, NB
[5]Department of Environmental Sciences, Faculty of Agriculture, Dalhousie University
[*] ben.thomas@mail.mcgill.ca

The Saint Lawrence River region of Quebec has the largest area of high intensity manure nitrogen (N) production in Canada ($\geq$ 40 kg N ha^{-1} y^{-1}). To minimize the loss of manure N to the environment, the proportion of N mineralized during a growing season should be quantifiable. The objective was to determine how a three-year history of manure and mineral fertilizer impacted the soil N supply in light- and heavy textured soil. Spring wheat (*Triticum aestivum* L., cv. AC Barrie) was used as a test plant. Planted pots were arranged in a completely randomized design, with three replications of each treatment (soil x fertility treatment) in a controlled environment chamber. Soils (silty clay and sandy loam) were taken from fields that received repeated applications (3 years) of mineral fertilizer, liquid dairy cattle manure (LCM), liquid swine manure (LSM) and solid poultry manure (PM), all applied at 90 kg N ha^{-1} y^{-1}, or that received zero N (control). In both soil textures, no significant differences ($P > 0.05$) were caused by fertility treatment for dry matter yield, total plant N uptake, soil N accumulation, microbial biomass C and N, soil N supply, apparent N mineralization, and apparent N mineralization rate. Apparent N mineralization was, on average, 170% higher in the silty clay soil (8.0 mg kg^{-1} soil) than the sandy loam soil (4.7 mg kg^{-1} soil). Dissolved organic carbon (DOC) and dissolved organic N (DON) were significantly ($P < 0.05$) affected by fertility treatment in the silty clay soil, but not the sandy loam soil. The mean values for DOC were 27 and 49.5 mg C kg^{-1} soil and for DON were 17.9 and 13.7 mg N kg^{-1} soil for the silty clay and sandy loam soil, respectively. In the silty clay soil, LCM increased DOC 198% compared with the mean DOC of LSM and PM treatments (42.9 vs. 21.7 mg kg^{-1} soil), and LCM and LSM increased DON by 145% and 136%, respectively, compared with PM (22.0 and 20.6 vs. 15.2 mg kg^{-1} soil, respectively). Preliminary results suggests that soil texture plays an important role in organic N dynamics.

Abundance of denitrifier communities in switchgrass and miscanthus biomass production systems

Thompson, K. A.[1]*, Deen, W.[2], Dunfield, K.E[1]
[1] School of Environmental Sciences, The University of Guelph, Guelph, Ontario
[2] Department of Plant Agriculture, The University of Guelph, Guelph, Ontario
* karen.ashley.thompson@gmail.com

Recently, interest in plant based biomass energy has increased as a way to decrease dependence on fossil fuels. Switchgrass and miscanthus are proposed as more sustainable alternatives for biomass production compared to annual crops. However, the effects of these perennial grasses (PGs) on soil quality indicators such as microbial abundance are unknown. Our objective was to assess changes in microbial abundance, specifically denitrifying community abundance, as influenced by biomass production strategies that include PGs. Field trials were established in 2008 in a randomized complete design (n=3), comparing crop species (miscanthus, switchgrass, corn and soybean), fertilization rates (0 and 160 kg N ha^{-1}) and biomass harvest dates (fall and spring) in Ontario, Canada. Soil was collected (0-15cm depth) from Elora (Guelph silt loam) and Ridgetown (Brookston clay loam) from 2010-2012. Quantitative PCR was used to enumerate the total bacterial communities (*16S*), and communities of denitrifiers by targeting nitrite reductase (*nirS*) and nitrous oxide reductase (*nosZ*) genes. Average abundances (gene copy number/g dry soil) ranged between $4.22x10^5$-$1.53x10^{10}$ for *16S*, $7.35x10^4$-$3.27x10^7$ for *nirS*, and $1.61x10^4$-$7.36x10^9$ for *nosZ*. Bacterial *16S* abundance was influenced by sampling date, with higher abundance in the fall vs. spring, and by fertilization rate in PG plots. Denitrifier abundance was affected by harvest timing and crop type. Spring harvested plots at Elora had higher *nirS* abundance than fall harvested plots and *nirS* abundance was higher in soils under PGs than annual rotations. Miscanthus had the highest *nosZ* abundance, indicating increased potential for complete dentrification in these plots. Overall, these results suggest that biomass production management influences soil microbial community structure, and this influence is dependent on field site. It is important to consider the potential for greenhouse gas emissions and the potential for carbon sequestration when assessing the environmental sustainability of biomass production systems.

The effectiveness of small-scale headwater storage dams and reservoirs on stream water quality and quantity in the Canadian Prairies

Kevin H.D. Tiessen[1], Jane A. Elliott[2], Mike Stainton[3], Jim Yarotski[4], David A. Lobb[5]*, Don N. Flaten[5]
[1] International Development Research Canada, Ottawa, ON
[2] Environment Canada, Saskatoon, SK
[3] Fisheries and Oceans Canada, Winnipeg, MB
[4] Agriculture and Agri-Food Canada, Regina, SK
[5] University of Manitoba, Winnipeg, MB
* David.Lobb@UManitoba.ca

For years, flooding and soil erosion impacted the South Tobacco Creek watershed in southcentral Manitoba. In response, local landowners constructed a network of small dams and reservoirs in the headwaters of this watershed for erosion and flood control. Between 1999 and 2007, two of the small dams/reservoirs (Steppler multi-purpose dam and Madill dry dam) were intensively monitored for their hydrological impacts and effectiveness in reducing flood peaks and downstream sediment and nutrient loading during spring snowmelt and summer rainfall periods. While there was considerable inter-year variation in their effectiveness, our results show that these small-scale headwater storage dams and reservoirs are effective in reducing peak flows from agricultural land in this region. The two dams/reservoirs monitored also reduced annual concentrations of sediment and total nitrogen (TN) to downstream receiving waters. However, annual concentrations of total phosphorus (TP) were only significantly reduced at the Madill dry dam, and the average concentrations of N and P within outflow water samples still exceeded current guidelines for freshwater in the Canadian Prairies. Nonetheless, both dams/reservoirs significantly reduced annual loads of sediment, TN and TP. Both reservoirs also reduced annual loads of dissolved N and P to downstream water bodies, and were generally effective in removing dissolved N and P during both snowmelt and rainfall-generated runoff—but, the percent retention of dissolved nutrients was consistently higher during the summer than the spring. While the reservoirs removed particulates during snowmelt-generated runoff, they were often sources (rather than sinks) of suspended nutrients during rainfall-generated events. However, since dissolved nutrients were the dominant form of both N and P (> 70 % in both snowmelt and rainfall-induced runoff events), the two dams/reservoirs were successful in reducing overall nutrient loads to downstream water bodies, annually and seasonally.

Towards a methane emission inventory that responds to changes in manure management on Canadian farms

Andrew VanderZaag[1]*, Doug MacDonald[2], Leigh Evans[1], Ray Desjardins[1], Xavier Vergé[3], and Tom Flesch[4]
[1] Agriculture and Agri-Food Canada, Science and Technology Branch, Ottawa, ON
[2] Environment Canada, Gatineau, QC
[3] Agro-ecosystem consultant, Ottawa, ON
[4] University of Alberta, Edmonton, AB
* andy.vanderzaag@agr.gc.ca

Methane emissions from manure management represent an important greenhouse gas mitigation opportunity, yet emission quantification at the inventory level does not contain adequate detail to capture changes in agricultural practices. We present a framework for improving the emission quantification approach. Two of the key aspects are: i) obtaining farm-scale emission measurements on manure management systems, and ii) validating a model with these measurement data. Methane emissions are greatest from liquid manure, but vary by an order of magnitude depending on how the liquid manure is managed. The default intergovernmental panel on climate change (IPCC) guidance, however, does not have the required elements to capture changes in emissions associated with manure management changes, only changes in the storage systems themselves. We propose a methodological approach that aligns with the IPCC framework but makes it more responsive to farm management. The ultimate aim of this work is to create a matrix of methane conversion factors (MCF) that account for key factors known to affect methane emissions: temperature, retention time and inoculum. This MCF matrix would be populated using a combination of mechanistic modelling and on-farm emission measurements. Implementation of this approach can be accomplished through the analysis of existing farm surveys but will rely on the continued collection of this activity data in the future. For model development and validation, emission measurement campaigns will be needed on representative farms over at least one full year, or manure management cycle. As an example of the data needed, results from recent micrometeorological measurements will be presented. With these improvements, the manure management emission inventory will become more responsive to changing practices on Canadian livestock farms.

Long term effects of tillage system and crop rotation on soil physical and chemical properties in a Brookston clay loam at Ridgetown, ON.

Laura L. Van Eerd[1,] *, Katelyn A. Congreves[1], Jillian Smith[2], Deanna D. Németh[3], David C. Hooker[4].
[1] School of Environmental Sciences, University of Guelph, Ridgetown Campus, Ridgetown, Ontario, Canada N0P 2C0
[2] Agriculture and Agri-Food Canada, Guelph, Ontario, Canada N1G 4S9
[3] Ontario Ministry of Agriculture and Food, Ministry of Rural Affairs, Vineland, Ontario, Canada L0R 2E0
[4] Department of Plant Agriculture, University of Guelph, Ridgetown Campus, Ridgetown, Ontario, Canada N0P 2C0
* lvaneerd@uoguelph.ca

Long-term studies allow for quantification of the effects of crop production practices such as tillage and crop rotation on soil quality and soil C and N stores. At Ridgetown, ON, two long term studies were established: 1) in 1991, a RCBD tillage trial with six replicates in a soybean-corn (S-C) rotation compared treatments of no-till (NT), fall moldboard plow with spring cultivation (conventional tillage, CT) and fall chisel plow with spring cultivation (chisel-T), and 2) in 1995, split-plot tillage-rotation trial with four replicates compared NT to CT within continuous corn (cC), continuous soybean (cS), S-C, soybean-winter wheat (S-W), and soybean-wheat-corn (S-W-C) rotations. Soil samples were collected in 5, 10, and 20 cm increments to 120 cm depth from both trials in 2006 for soil organic C (SOC) and total C and N quantification. In 2009, 0-15 cm depth was sampled for the Cornell Soil Health Assessment (CSHA) in tillage-rotation trial only. After 15 years, SOC, total N and C content and concentration were higher with NT compared to CT and chisel-T. After 11 years, rotation and tillage had no impact on total N and C within the 0-120 cm soil profile. However, compared to CT, the NT system had higher SOC within cC, cS, and S-W-C rotations but there was no difference between tillage systems within S-C and S-W rotations. For CSHA, there was no tillage by rotation interaction for all 14 parameters except for permanent wilting point. The CSHA overall soil quality score was higher with S-W rotation than S-C, but the other crop rotations were not different. Other than soil hardness score, all parameters and the CSHA overall soil quality score were higher in NT than CT. Thus, to improve soil quality and C sequestration, growers on clay loam soil in southwestern Ontario are recommended to adopt NT production.

Nitrifier and denitrifier abundances and activities in soils of woody perennial crops in a semi-arid inter-mountain basin environment

Tanja Voegel* and Louise Nelson
Department of Biology, University of British Columbia Okanagan
* Tanja.Voegel@ubc.ca

Nitrification and denitrification are the main microbial processes responsible for the loss of applied fertilizer nitrogen from agricultural fields. In addition, both metabolic pathways can produce nitrous oxide, a potent greenhouse gas. Little long term data about agricultural management practices influencing the abundance and activity of nitrifying and denitrifying bacteria are available. Here, soils of woody perennial crops (apple and grape) in the semi-arid inter-mountain basin environment of the Okanagan Valley were analyzed for changes in nitrification (*amoA*) and denitrification (*nirS*, *nosZ*) gene abundances and activities in response to different agricultural management practices. Treatments applied included two irrigation sources and frequencies, different amounts of fertilizer applied either inorganically or as compost, and bark mulch applications. DNA and RNA were isolated from soil samples collected at a snow melt event in February 2013 and analyzed in quantitative real time PCR experiments using primers for *amoA*, *nirS* and *nosZ* genes. To date, results show that *amoA* gene abundances ranged from 2.14×10^6 to 7.73×10^6 and from 1.86×10^6 to 5.26×10^6 copies per grams of dry soil in the apple and grape plots, respectively. For *nosZ*, gene abundances ranged from 1.72×10^6 to 3.09×10^6 and from 1.60×10^6 to 3.56×10^6 copies per grams of dry soil in the apple and grape plots, respectively. No significant differences between treatments were observed and were expected, as treatments were not applied during the winter period. Results for quantification of *nirS*, activity levels for all 3 genes and an additional sampling time point in spring, when treatments are applied, will be presented.

Spring wheat yields and NO_3^- leaching from green manure plow down in Nova Scotia

Brian Wallace[1,3]*, Derek Lynch[1], David Burton[2], Angela Bedard-Haughn[3]
[1] Plant & Animal Science, Dalhousie University, [2] Environmental Science, Dalhousie University, [3] Soil Science, University of Saskatchewan.
* brian.wallace@dal.ca

Organic small grain production requires a soil fertility plan that efficiently uses green manures (GMr) while minimizing N losses. Red clover is a common GMr for Eastern Canada in rotation with spring wheat, yet NO_3^- losses from tile drainage are rarely reported. The synchrony of the soil N supply with plant uptake while minimizing overwinter N leaching could be improved by altering the plow down date from early fall to late fall, or by removing biomass as hay and subsequently applying manure in the spring. Four production systems were studied in a 3-year red clover – spring wheat rotation in Truro, NS in randomized blocks with 3 repetitions. Flow and NO_3^- from tile drains were measured with tipping buckets and automatic water samplers from Sept to May (2011-2013). Water was analyzed for NO_3^- colorimetrically in the laboratory. Treatments were: 1) Early Fall clover plow down + spring fertilizer (Early Fall + N_{70}), 2) Late Fall clover plow down (Late Fall), 3) Hayed clover/ Late Fall plow down + spring manure (Hayed Late Fall + Manure), and 4) Spring clover plow down (Spring). Wheat grain yields were not different among treatments in 2011 or 2012, yet overall yields were 2.7 times greater in 2012 (2.7 t ha^{-1}) as compared to 2011 ($p < 0.0001$). Flow weighted NO_3^- concentrations (Oct-Nov) in 2011 were highest for Early Fall + N_{70} (14.3 mg l^{-1}) and lowest for Spring (9.1 mg l^{-1}), while the two Late Fall treatments were intermediate (9.8-10.8 mg l^{-1}). Results for NO_3^- losses in 2012 are pending. Spring plow down may reduce N losses, but wet soil conditions may delay field operations and limit the growing season. Late Fall plow down is a management option that both limits N losses while maintaining yields.

Emissions of greenhouse gases from constructed wetlands for nitrogen removal

Yanhua Wang*, Hao Yang
School of Geography Science, Nanjing Normal University, Nanjing, 210023, PR China
* wangyanhua@njnu.edu.cn

Loss of nitrogen from the soil-plant system has raised environmental concern. To estimate the nitrogen removal in the subsurface flow constructed wetlands and the tendency of N_2O formed through autotrophic nitrification, fluorescence *in situ* hybridization (FISH) were used. Linear regression of N_2O in different systems was handled vs. derived principle components. $NB_{2B}O$ emission data showed large temporal and spatial variation ranging from -3.2 to 61.2 mg N_2O m^{-2} h^{-1}. The highest $NB_{2B}O$ emission occurred in the cell planted with *P. australis* and *Z. latifolia* in the growth seasons. Whereas, the lower emission rate were obtained in the cell planted with *P. australis* and *T. latifolia*. These revealed that *Z. latifolia* stimulated the N_2O emission. The *P. australis* cell contributed to keeping high T-N removal performance and lower N_2O emission. The distribution of ammonia-oxidizing bacteria also supported this result. Statistical analysis showed several environmental parameters affecting the strength of T-N removal, such as water temperature, N_2O, TOC, plant species and plant cover. Roles of plants as ecosystem engineers are summarized with rhizosphere oxygen release and organic matter transportation to affect nitrogen transformation.

Information technology to assess and achieve compliance with Manitoba regulations

Jen Webb[1]* and Gerry Lux[2]
[1] Environmental Programs and Strategies, Manitoba Conservation and Water Stewardship
[2] GeoManitoba, Manitoba Conservation and Water Stewardship
* Jen.Webb@gov.mb.ca

Under The Environment Act, the Livestock Manure and Mortalities Management Regulation prescribes acceptable methods of storage and application of manure in Manitoba. Soil nitrate-nitrogen must not exceed regulated limits. To achieve compliance, manure application must consider the most limiting agricultural capability rating.

Since 1999, the Manitoba Land Initiative has warehoused electronic shape files of natural features in Manitoba which are accessible and free to all. Select files have recently been converted to improve accessibility to clients who work with free Google Earth software. The files include soil Agricultural Capability, drainage order maps and the quarter section grid. Corresponding instructions have also been developed.

Old manure storage facilities were not required to be constructed under the authority of a permit prior to 1994. As a result, number of facilities and environmental performance was difficult to estimate. Therefore, in 2004, the regulation was amended to require registration of those facilities.

A pilot project commenced in winter 2013 as a means to determine compliance with the requirement for registration. Ortho photography was used to identify possible manure storage facilities. This was compared with databases of permitted and registered facilities. Where gaps were identified, non-compliance was suspected and site visits confirmed livestock operations were present.

Spatial Imagery technology is a good tool for assessment of liquid/water features on the landscape and could be used to determine features on the landscape for the purpose of planning, assessing compliance, mapping and development. Integrating other known features such as drainage and soil maps further enhances the assessment of risk and compliance.

Elevated earthworm populations affected primary production and nitrous oxide fluxes from forage systems in a field enclosure study

Joann K. Whalen[1]*, Chen Chen[1], Shamim Gul[1, 2], Roberto Prieto[1] and Hicham Benslim[1]
[1] Department of Natural Resource Sciences, McGill University, Ste-Anne-de-Bellevue, Quebec, Canada.
[2] Department of Botany, University of Balochistan , Saryab Road, Quetta , Balochistan , Pakistan
* joann.whalen@mcgill.ca

Earthworms are important and dominant soil fauna in perennial forage systems that alter soil conditions and stimulate microbially-mediated processes such as nitrification and denitrification, which produce gaseous nitrous oxide (N_2O) emissions. A field enclosure study was conducted to determine how increasing the population of two earthworm species would affect the flux N_2O from two forage stands: red clover (*Trifolium pratense*) and couch grass (*Elytrigia repens*). The forages were not fertilized, although the red clover was inoculated and active nodules were present, so it was not nitrogen-limited. Earthworms were added to 1 m^2 enclosures at rates of 250, 500 and 1000 individuals m^{-2} and represented two functional groups: anecics (*Lumbricus terrestris* L) and endogeics (*Aporrectodea turgida* (Eisen)). Above-ground biomass was evaluated periodically during the experiment. Root and shoot biomass were taken when the enclosures were destructively sampled in June-July 2011. The N_2O flux was measured during sampling campaigns during fall 2009, spring and fall 2010 and spring 2011 using the closed chamber method. Primary production was affected by earthworm populations, particularly the root: shoot ratio in the clover enclosures. The number of earthworms added and the functional group had a significant ($P<0.05$) effect on N_2O fluxes from the clover enclosures, but not the grass enclosures. The average N_2O flux during the sampling period increased linearly ($R^2 = 0.96$) with the number of added earthworms, indicating that earthworms stimulated N_2O emission from the clover hayfields. These findings demonstrate that increasing earthworm populations in perennial forage stands dominated by clover is expected to significantly affect N_2O emissions at the field scale. Earthworm-microbial interactions make an important contribution to N_2O emission, which should be considered when developing predictive models of greenhouse gas emissions from agricultural soils.

Nitrogen carryover effects of various organic amendments on subsequent season cereal production within Southern Ontario, Canada.

Alex Woodley[1]*, Paul Voroney[1], John Lauzon[1] and Bill Deen[2]
[1] School of Environmental Science, University of Guelph, Guelph, ON
[2] Department of Plant Agriculture, University of Guelph, Guelph, ON
* woodleya@uoguelph.ca

Limited research exists to guide organic cereal producers, who use amendments as their primary Nitrogen (N) source, on the residual effects of these products on the following season's crop. If significant influences are detected on dry matter yield (DMY) and grain N content (GNC) in the following season this has implications on the producer's choice of source and the most economical rate of amendment (MERA) to apply. The analysis of residual nitrogen contribution was built upon field experiments completed in 2011 that examined several cereal crops (winter wheat, barley, winter spelt, and corn) on 4 organic farms in southern Ontario. Organic amendments including composted turkey litter, composted dairy manure, fresh broiler litter and an industrial bacterial by-product were applied, in a randomized complete block design, at rates ranging from 0% to 150% of the N requirement for the crop. At 3 sites red clover which had been under-seeded and soil incorporated, was evaluated for its potential in-season N contribution to the crop. At maturity, the crops were harvested for measurements of DMY and GNC. Greater DMY and GNC increases were observed for fresh manures over the composted equivalents and no apparent influence was detected from in-season red clover. In the 2012 growing season, crops were planted based on the rotation used by each producer, which included corn, barley, and oats. No additional amendments were added in this season. Spring, mid-summer and post-harvest soil Inorganic N was measured at each site. Crops were harvested and analyzed for DMY and GNC. Based on these field experiments, a modified MERA equation was generated based on the residual effects from amendments, cover crop interactions and grain N content. These modified recommendations are more representative of organic systems which use N sources that can persist in the soils for more than one season.

Fall accumulation and spring release of soil mineral nitrogen following winter wheat and before corn planting on a Brookston clay loam in SW Ontario

Xueming Yang*, Craig, F. Drury, W. Daniel Reynolds, Jingyi Yang
Greenhouse & Processing Crops Research Centre, Agriculture & Agri-Food Canada, Harrow, Ontario N0R 1G0
* xueming.yang@agr.gc.ca

Annual cropping systems in SW Ontario are "N leaky" because there are long fallow periods between crop maturity in September and the growth of the next crop in May, and this is particularly serious in systems which winter wheat is involved. We evaluated the effects of 4 cover crops [oats, yellow mustard, oilseed radish, nitro radish (2012 only)] on N accumulation and release in a randomized complete block design (four replicates of each treatment) after winter wheat harvest in fall. Cover crops were sowed into wheat stubble at late September (the same time as winter wheat planting) in 2009, 2010, and 2011 and cover crops were seeded shortly after winter wheat harvest in August 20, 2012. Cover crop biomass and N contents in biomass was measured after the first killing frost. Planting crops in August as compared to a month later increased biomass and N accumulation by 38 and 24 times for oats, 6.6 and 4.0 time for oilseed radish, and 6.2 and 7.3 times for yellow mustard, respectively. In 2012 fall, new cover crop nitro radish accumulated 10210 kg ha^{-1} biomass and 218 kg N ha^{-1}, which was the highest compared with other cover crops. Clearly, planting cover crop in August greatly increased cover crop N uptake which substantially reduced N leaching potential in fall and winter period. Soils were sampled weekly (0-15 and 15-30 cm) from mid-April to mid-May in 2013 from the cover crop plots. The samples are analyzed for soluble N (NO_3^--N and NH_4^+-N) to examine the synchronization of N release from mineralization in early spring. The beneficial effects of early cover crop sowing on biomass accumulation and N uptake are only based on one year data, accordingly, the effects of the early cover crop sowing need multiple years of data for proper site assessment.

Potential of using mid-infrared spectroscopy in study of soil and solution samples in Canada

Xueming Yang*, Craig F. Drury, Jingyi Yang
Greenhouse & Processing Crops Research Centre, Agriculture & Agri-Food Canada, Harrow, Ontario N0R 1G0
* xueming.yang@agr.gc.ca

The infrared spectroscopy instruments are now fast, small, and even portable for use in field trials. With progress in chemometrics and biostatistics for agricultural applications, infrared spectroscopy is widely being used in both research and industry as a simple and reliable technique for quantitative and qualitative determination and dynamic measurement of various kinds of samples. This poster summaries some of our novel trials in regards to the use of mid-infrared (MIR) spectroscopy in study of soil and solution samples, including: (1) predictions of soil organic carbon (SOC) and total nitrogen (TN) concentrations of the Brookston clay loam soils under different management practices, (2) estimations of SOC and TN concentrations in particulate organic matter and particle size fractions of Brookston clay loam soils under different management practices, and (3) quantification of SOC and TN concentrations and the texture of numerous agricultural soils under different crops and management practices across SW Ontario using MIR spectra collected from bulk soil and partial least square regression (PLSr) method; (4) predictions of fourteen crop nutrients plus pH and electrical conductivity in hydroponic solutions for greenhouse production systems using MIR spectra collected from solution samples and PLSr model; (5) assessment of the amino sugar concentrations (glucoasamine, galactosamine, and muramic acid) using the MIR spectra collected from soil hydrolysates and PLSr approach; and (6) evaluation of the changes of functional groups of SOC in the external layer and core fractions of dry-sieved soil aggregates using MIR spectra collected from soil and solution samples prior- and post-incubation in combination with PLSr method. Although the accuracy of estimation varied with the studies, we found, taking into account the time and expense saved, infrared spectroscopy technique is most recommendable as a fast, inexpensive, and not-hazardous method in study of soil and solution samples.

NOTES