Manitoba Soil Science Society

64th Annual Manitoba Soil Science Society Conference and Annual General Meeting

Soil Webs; Keeping connected by collaborating between disciplines

February 4-5, 2021

Online – ZOOM

2020 - 2021 MSSS EXECUTIVE

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CONFERENCE PROGRAM

Thursday, February 4, 2021

1:00 pm — Conference Commences
Opening Remarks –Megan Westphal, MSSS President

1:05pm — Keynote Presentation: **Classifying and mapping forest soils-based ecosites in west-central Manitoba**
Paul LeBlanc
LP Building Solutions, Swan Valley, MB

1:45pm — **Poster Session and Nutrition Break**

Simulation of water table depth using DRAINMOD under canola production in the Canadian Prairies

Numerical Modelling for soil moisture monitoring and forecasting

Evaluation of Raspberry Pi-based soil water content sensors for real-time data collection and transmission

Impact of water reservoir pressure on controlling evaporation rate from atmometers

Pesticides in water and bottom sediment samples at locations segmented to contrast agricultural and urban upland activities

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*****CCA CEUs for attending both SOIL RECLAMATION AND REMEDIATION and SOIL SUITABILITY AND MONITORING general sessions: 2.5 Soil & Water Management

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GENERAL SESSION: SOIL RECLAMATION AND REMEDIATION*
Chairperson: Clemence Muitire

2:00pm — **Organic amendment effects on productivity of wellsites reclaimed with suboptimal topsoil replacement depth**
Takudzwa Nawu[1], Francis Zvomuya[1], Inoka Amarakoon[1], Asfaw Bekele[2], and Michelle Young[2]*
[1] Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada.
[2]Imperial, 3535 Research Rd. NW, Calgary, Alberta, Canada.

2:12pm — **Early Implementation of Amendment Crops Reduces Long Term Yield Loss in a Pipeline Reclamation Setting**
Nicholas Birkhimer[1], Thomas Desutter[1] , Meridith Miller[2] , Jerry Bergman[2] , Caley Gasch[1], James Staricka[2]
[1] North Dakota State University, Department of Soil Science
[2] Williston Research Extension Center

2:24pm **Landscape Restoration of Topsoil on Eroded Hilltops: Ridiculous or Revolutionary?**

*Curtis Cavers[1], [2]*and David Lobb[2]*

[1]Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada.

[2]Agriculture and Agri-Food Canada, 370 River Road, Portage la Prairie, Manitoba, Canada

2:36pm **A Method for Remediating Brine-Impacted Soil Using Electrokinetics**

Dustin Anderson[1], Thomas DeSutter[1], Bernhardt Saini-Eidukat[2], Cody Anderson[1], and Chris Athmer[3]*

[1]Department of Soil Science, North Dakota State University, Fargo, North Dakota, USA.

[2]Department of Geosciences, North Dakota State University, Fargo, North Dakota, USA.

[3]Terran Corporation, Beavercreek, Ohio, USA.

2:48pm **Poster Session Nutrition Break**

Evaluation of natural fibres as substrate for growing vegetables in aeroponic systems for Northern areas

Comparison of Two Probe Types (Hydra-Probe and Sentek) for Monitoring Temperature and Moisture Contents in a Pesticide Rinsate Management System

An Examination of Pipeline Site-Preparation Methods for Improving Plant Establishment

Impact of Grazing on Soil N_2O Emissions from an Alpine Grassland in China

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GENERAL SESSION: SOIL SUITABILITY AND MONITORING*

Chairperson: Jess Nicksy

3:05pm **An Updated Assessment of Soil Salinity Status of the Lajas Valley Agricultural Reserve, Puerto Rico**

Beverly Álvarez-Torres[1], David Sotomayor-Ramírez1, José P. Castro Chacón[1], Gustavo A. Martínez[1], Luis R. Pérez-Alegría[2] and Tom DeSutter[3]*

[1]Department of Agro-Environmental Sciences, University of Puerto Rico, Mayagüez, PR

[2]Department of Agricultural Engineering and Biosystems, University of Puerto Rico, Mayagüez, PR

[3]Department of Soil Science, North Dakota State University, Fargo, ND

3:17pm **Assessment of a Two Timestamp vs. a Four Timestamp Chamber Sampling Method for Calculating Soil Greenhouse Gas Fluxes**

Autumn Wiebe[1], [2], Alexander Koiter[1] and Aaron Glenn[2]*

[1]Department of Geography & Environment, Brandon University, Brandon, Manitoba, Canada.

[2]Agriculture and Agri-Food Canada, Brandon Research and Development Centre, 2701 Grand Valley Rd, Brandon, Manitoba, Canada.

3:29pm **Changing Heat Units between Climate normal periods.**

Kody F. L. Oleson[1] & Dr. Timi Ojo[2]
[1]Department of Soil Science, University of Manitoba, Winnipeg Manitoba, Canada
[2]Province of Manitoba, Agriculture, Winnipeg, Manitoba, Canada

3:41pm **Pilot Project: Above Ground Burial of Pig Carcasses**

Van Doan[1], Clay Sawka[1], Petra Loro[1], Sean Steeves[2], Becky Raddatz[2]
[1]Manitoba Agriculture and Resource Development
[2]City of Winnipeg, Water and Waste

3:53pm Closing remarks End of Day 1 – Megan Westphal, MSSS President

Friday, February 5, 2021

1:00pm Opening Remarks Day 2 –Megan Westphal, MSSS President

PANEL DISCUSSION: COLLABORATIVE RESEARCH BETWEEN DISCIPLINES

Dr. Mario Tenuta, Department of Soil Science, University of Manitoba, Winnipeg, MB
Dr. Bobbi Helgason, University of Saskatchewan, Saskatoon, SK
Dr. Martin Entz, Department of Plant Science, University of Manitoba, Winnipeg, MB
Moderator: Megan Westphal

1:50pm **Poster Session and Nutrition Break**

General Approach to Improving Nitrogen Recommendations Using Canopy Sensing

Dynamics of the root associated bacterial microbiome in eight canola varieties under contrasting nitrogen fertilization

Soil nitrogen and phosphorus were greater in overlapping areas of fields in Alberta, Saskatchewan, Manitoba, and Ontario

Developing a Soil-Based Method to Screen Soybean (Glycine max) Seedlings for Early Season Vigor and Iron Deficiency Chlorosis (IDC)

2021 MSSS Soil Safari and Mounting the Trophies as Monoliths

GENERAL SESSION: SOIL NUTRIENT MANAGEMENT AND CYCLING

Chairperson: Nicholas Birkhimer
CCA CEUs: 1.0 Nutrient Management

2:05 pm **Microbial nitrogen cycling functional gene abundance in grazed forage pasture soils and links to N_2O emissions**

Tram Thai, Jiancan Liu, Jesse Reimer, Bobbi Helgason and Melissa Arcand*
Department of Soil Science, University of Manitoba Department of Soil Science, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.

2:17pm **Circular nutrient sources supply phosphorus and improve yields in organically managed systems**

Jessica Nicksy[1], Brian Amiro[1] and Martin Entz[2]*
[1]Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada.
[2]Department of Plant Science, University of Manitoba, Winnipeg, Manitoba, Canada

2:29pm **Crop-specific productivity and rhizosphere processes associated with use of struvite fertilizer**

Joanne Thiessen Martens[1], Kim Schneider[2], and Francis Zvomuya[1]*
[1]Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada
[2]Department of Plant Agriculture, University of Guelph, Guelph, Ontario, Canada

2:41pm **Soil Phosphorus and Runoff Water Quality in Manitoba**

Jian Liu[1,2], Jane A. Elliott[3], Henry F. Wilson[4], Helen M. Baulch[2], and David A. Lobb[1]

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

[2] Global Institute for Water Security, University of Saskatchewan, Saskatoon, SK S7N 3H5, Canada

[3] National Hydrology Research Centre, Environment and Climate Change Canada, Saskatoon, SK S7N 3H5, Canada

[4] Brandon Research and Development Centre, Agriculture and Agri-Food Canada, Science and Technology Branch, Brandon, MB R7A 5Y3, Canada

2:53pm **Save the lake! Cross-border collaboration on agricultural nutrient BMPs in a cold climate region**

M.D. Timmerman[1]

[1]Manitoba Agriculture and Resource Development, Box 1149, Carman, Manitoba, Canada.

3:05pm Closing Remarks of Conference and Presentation of Awards

3:15pm MSSS Business Meeting and Passing of the Shovel

4:15pm End of Day 2

POSTER PRESENTATION ABSTRACTS

Simulation of water table depth using DRAINMOD under canola production in the Canadian Prairies

Emeka Ndulue[1] and R. Sri Ranjan[1]
[1]Department of Biosystems Engineering, University of Manitoba, Winnipeg, Manitoba, Canada.

The Canadian Prairies is prone to hydro-climatic variability, including waterlogging at the start of the season and prolonged soil water deficit during the growing season. The complex interactions and variability in climate, soil, and management practices have made modelling an attractive tool for effective water management compared to traditional field experiments, which are expensive, time-consuming, and tedious. When calibrated and validated, models provide an understanding of the agro-hydrological process, which is the basis for sustainable water management and decision making. However, the performance of hydrologic models varies from one location to another. In areas with shallow water tables and poorly drained agricultural lands, subsurface drainage is one of the water management techniques used for providing a conducive growing environment. The objective of this study was to simulate water table dynamics using the DRAINMOD model. Field data, including soil properties, water table depth, meteorological data, and drainage design parameters were collected and used to run the DRAINMOD model during the 2019 and 2020 growing seasons at the PESAI site, Arborg. MB. Simulated water table depth was compared with observed water table depth during the study period. Results showed that the DRAINMOD model could reasonably simulate a water table with R^2, NSE, and MAE of 0.72, 0.67, and 67 mm. These results suggest that the DRAINMOD model could be used as a water management and decision-making tool.

Numerical modelling for soil moisture monitoring and forecasting

Keshav Parameshwaran Shankara Mahadevan[1]*, Paul Bullock[2], Hartmut M. Holländer[1], Steven Frey[3] and Timi Ojo[2],[4]

[1]*Civil Engineering Department, University of Manitoba, Winnipeg, Manitoba, Canada.*

[2]*Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada*

[3]*Aquanty Inc., Waterloo, Ontario, Canada*

[4]*Manitoba Agriculture and Resource Development, Winnipeg, Manitoba, Canada*

Soil moisture is highly variable in space and time. Climate change is expected to produce more extreme fluctuations in precipitation across the globe and cause more frequent extremes in soil moisture, including floods and drought which have major impacts on agriculture and infrastructure. Forecasting can help mitigate the impacts of soil moisture extremes by providing warning about upcoming extreme events and prompt mitigation measures. Accurate soil moisture forecasting will provide policy makers, farmers and other stakeholders more reliable information on crop yield potential and flood risk to improve decision making. Real-time soil moisture monitoring and forecasting can be accomplished by a numerical modelling approach that consolidates various sources of weather and hydrological data to predict future states of soil moisture. However, soil water movement is difficult to describe numerically for fine textured soils. Additionally, soil water behavior during freeze/thaw events are generally weakly described by numerical tools. This study addresses both problems and evaluates how soil moisture can be forecasted under the hydrologically challenging conditions of the Brunkild sub-catchment within the Red River basin. Soil moisture levels were continuously monitored from June to August 2020 using Sentek sensors which were installed at different depths (10 to 90 cm) and POGO sensors were used to manually measure surface moisture levels at monthly intervals from June to August 2020. Climate variables were obtained from the RISMA stations present inside the catchment. In addition to soil moisture data, surface water flow and groundwater data will also be used to aid with calibration and validation of a fully-integrated Hydrogeosphere (HGS) surface water – groundwater model of the catchment. Testing of various model inputs relating to climatology and soil parameterization will be conducted to improve the HGS model skill when simulating and predicting field-scale root zone soil moisture levels across the range of soil types present in the Brunkild sub-catchment.

Evaluation of Raspberry Pi-based soil water content sensors for real-time data collection and transmission

Prabakaran Santhanam[1] and R. Sri Ranjan[1] Ph.D., P. Eng.
[1]Dept. of Biosystems Engineering, University of Manitoba, Winnipeg, Canada.

Soil water content is one of the most important factors affecting crop development. Knowledge of soil water content (SWC) in agricultural fields help us manage water in a sustainable manner. There are several methods available to monitor SWC which includes labor intensive gravimetric method and different types of sensors. Although SWC sensors are helping the farmers to monitor SWC, they are very expensive and lack the spatial resolution, accuracy, and precision. For optimal design of irrigation systems, it is very important to know the plant root zone water uptake pattern using miniature soil water sensors installed within the rootzone. There is a need to test the accuracy, ease of use, and precision of different soil water sensors in Manitoba soils to enable remote monitoring. Raspberry Pi based data acquisition systems will be useful to collect, store, and transmit field data collected with different sensors. However, the commercial water content sensors lack the precision necessary for data collection in experimental plots. In this research, capacitance-based soil moisture sensors were connected to the Raspberry Pi to monitor soil water content in soil samples which were weighed periodically to obtain the gravimetric water content as the standard to compare. The data presented in this study will compare the accuracy and precision of the capacitance sensors. A data collection, storage, and transmission protocol will be presented.

Impact of water reservoir pressure on controlling evaporation rate from atmometers

Mujibur Rahman[1] and Ramanathan Sri Ranjan[1]
[1]University of Manitoba, Winnipeg, MB, Canada

For sustainable agricultural crop growth, efficient irrigation is a significant factor for a better yield in the field and economically feasible. In this context, the evaporation rate's precise measurement is critical for the atmometer to assess an accurate amount of water that needs to irrigate in the field. The primary objectives of this study were to measure the rate of evaporation from a water reservoir at different suction levels and the variation of evaporation in different pressure head. In this experiment, three similar systems were built with a ceramic plate with a water reservoir attached to an iron pipe and a plastic tube and a burette connected to the systems to measure the water loss through the ceramic plate. All the data from the different systems were recorded to compare the results among the systems in the same atmospheric condition. The applied suction on the water supplied side was noted as 0, 20, 40, 60, 80, and 90 cm, and the loss of water was measured in mm/day. In the beginning, when the suction was kept 0 cm, the evaporation of water was the highest, while in 90 cm suction, the evaporation was the lowest. Keywords: Atmometer, Evaporation rate, Suction, Irrigation

Pesticides in water and bottom sediment samples at locations segmented to contrast agricultural and urban upland activities

Marufa Fatema[1*], Annemieke Farenhorst[1], Claudia Sheedy[†]
[1]*Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada*
[†] *Deceased: July 12, 2020, Previous address: Agriculture and Agri-Food Canada, 5403 1st Ave. S., Lethbridge, AB, T1J 4B1, Canada*

River water-column (n=162) and bottom-sediment (n=54) samples were collected every two weeks from early May to late August, 2017 from various locations in the Red River and three of its tributaries (Assiniboine River, La Salle River and Seine River). Out of the about 170 compounds screened for, a total of 34 (water) and 32 (sediment) pesticides or their metabolites were detected. Across all rivers, the most frequently detected compound in water was thiamethoxam (a current-use neonicotinoid insecticide), with a detection frequency of 73% and a maximum concentration of 76 ng/L. Tebuconazole (a current-use triazole fungicide) was the most frequently detected compound in sediment (73%) with a maximum concentration of 9,850 ng/kg freeze-dried sediment. Despite being banned for decades, the legacy insecticide DDT was detected in 3% of the sediment samples collected in the Red River, with its metabolites DDE (60%) and DDD (40%) being more frequently detected, and in concentrations ranging from 1,490-2,660 ng/kg freeze-dried sediment. Current-use herbicide glyphosate was detected in about one-half (65%) of the sediment samples in the Red River with a maximum detection of 1,088,390 ng/kg (freeze-dried basis). There was no indication that agricultural versus urban upland activities had an impact on the types of compounds detected at locations. However, for some pesticides that were detected, their concentrations were larger during weeks that these pesticides were presumably applied on agricultural land. The detected pesticide concentrations in water never exceeded the Canadian Water Quality Guidelines for the Protection of Aquatic Life, although there were also pesticides detected that do not have these guidelines established.

Evaluation of natural fibres as substrate for growing vegetables in aeroponic systems for Northern areas

Farhatun Nabi and Ramanathan Sri Ranjan*
Department of Biosystems Engineering, University of Manitoba, Winnipeg, Manitoba, Canada.

The insecurity of food supply in Northern areas of Canada could be eliminated by sustainably operated aeroponic systems. As a growth medium, rock wool is used worldwide in greenhouse operations. Rockwool is a synthetic material which is not readily available in Northern areas. The elimination of this non-biodegradable, unsustainable and synthetic material with fibres from naturally growing cattail plants (*Typha latifolia*) would be a sustainable alternative. Cattail fibre possesses excellent strength, sorption property, and biodegradable property as well as an increased longstanding efficacy for this application. Moreover, cattail plants are known as a nutrient absorber in aquatic environments. Therefore, the cattail fibre block will provide the necessary nutrients to the plants. The preliminary assessment of plant growth (N=57) showed better performance in cattail fibre blocks compared to rock wool during germination and growth stages. Plant yield in cattail fibre block was higher. Also, the fibre blocks appear to be reusable for many cycles of growth. After a few cycles of use, the cattail fibres could be composted and used as media for germination.

Comparison of Two Probe Types (Hydra-Probe and Sentek) for Monitoring Temperature and Moisture Contents in a Pesticide Rinsate Management System

Sarah Johnson[1] and Annemieke Farenhorst[1]
[1]Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada

A biobed is a pesticide rinsate management system that protects surface and ground water from pesticide contamination. Biobeds operate by percolating collected pesticide rinsate from product handling areas through a media mixture of dried plant matter (e.g., straw, wood), humified organic matter (e.g., peat, compost) and soil. This biomatrix allows for the sorption of pesticide molecules, and their break down by microorganisms thriving in the media mixture. In 2019/20, a new double celled biobed was constructed at the Ian N. Morrison Research Farm. The biobed became operational in August 2020 and pesticide rinsate was applied during this month and into September 2020. A series of two different types of probes (Hydra-Probe versus Sentek) were installed in both biobed cells to monitor the temperature and moisture content of the biomatrix, with probes measuring both variables hourly. These measurements are important because both temperature and moisture content can influence pesticide sorption and degradation processes, as well as the growth of microorganisms. For the 36-day operational period between August and September, this study examined the impact of biobed cell, biomatrix depth and probe type on these temperature and moisture data.

An Examination of Pipeline Site-Preparation Methods for Improving Plant Establishment

Jarrett Lardy[1], Tom DeSutter[1], Miranda Meehan[2], Nathan Derby[1], Kevin Horsager[1], and Aaron Daigh[1]*

[1]Department of Soil Science, North Dakota State University, Fargo, North Dakota, United States

[2]Department of Animal Science, North Dakota State University, Fargo, North Dakota, United States

Energy development and installation, specifically natural gas pipelines, have expanded across western North Dakota within the Williston Basin (Bakken and Three Forks formations). Over the last decade, this expansion has challenged reclamation by limiting plant establishment post-installation. This limited plant establishment has led to increased soil erosion, soil compaction, loss of potential revenue for landowners, and provides an environment with the potential to allow invasive plants to encroach. Our study examines three frequently used reclamation treatments near Williston, ND, and their effects on water runoff, sediment loss, and plant establishment under rainfall simulation and natural conditions. The three treatments used in this study are a wood-fiber hydromulch, land imprinting, and wheat-straw crimping, as well as the combination of wood-fiber hydromulch and land imprinting, done on 2% and 5% slopes within the same catena. Establishment of treatments and the initial rainfall simulations were completed in September 2020, with more rainfall simulations planned for June 2021. The results from our study will be applicable to reclamation specialists establishing plants in pipeline right-of-ways, the reclaiming of well pads, and any other activity where soil becomes disturbed. The fall 2020 simulated rainfall study results will be summarized during this presentation.

Impact of Grazing on Soil N_2O Emissions from an Alpine Grassland in China

Xiaopeng Gao, Mingyuan Yin, and Mario Tenuta
Department of Soil Science, University of Manitoba, Winnipeg, MB, Canada, R3T 2N2

Soil N_2O emissions from grassland can be affected by grazing intensity, through changes in soil physico-chemical properties or abundance/activity of functional genes in nitrification/denitrification. Here we report results from an alpine grassland in China where we examined the effect of sheep grazing intensity on soil N_2O fluxes. We further linked the grazing effect on N_2O emissions with soil factors of moisture, temperature, nitrogen and carbon availability, as well with the abundance of nitrifiers and denitrifiers genes. Compared to the non-grazed control, light (1.0 sheep ha^{-1}) and intensive (3.0 sheep ha^{-1}) grazing treatments increased the 2-yr (2017-2018) total N_2O emissions by 27.5% and 68.1%, respectively. In addition, reducing grazing intensity from intensive to light resulted in more above-ground biomass and N uptake in both years. Daily N_2O flux rate correlated positively with soil water-filled pore space (WFPS), temperature, and dissolved organic carbon (DOC) but not with the abundances of nitrifiers (*AOB, AOA, Nitrobacter-like nxrA*), nitrate reducers (*narG*) and denitrifiers (*nirS, nirK, and nosZ*). These results suggest that soil environmental factors rather than the functional gene abundances were more important in determining the grazing enhancement of N_2O emissions from the alpine grassland. A proper grazing intensity is of particular importance not only for reducing GHG emissions but also for increasing/maintaining productivity of grassland for livestock.

General Approach to Improving Nitrogen Recommendations Using Canopy Sensing

Claudia Quilesfogel-Esparza[1], Mario Tenuta[1] and Paul Bullock[1]*
[1]Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada.

Corn is an important staple food for both human and animal nutrition. The biggest challenge in producing corn is the inimical environmental impact linked with large quantities of nitrogen (N) fertilizer being applied (Havlin et al.,2013; Schmidt et al., 2011). Over applying N fertilizer has been and continues to be done as a form of *insurance* (Scharf and Lory 2002).

Traditional nutrient testing methods do not account for field variability, which can significantly affect yield. N, a mobile nutrient can be corrected in-season if deficiencies are present (Holland & Schepers, 2010; Holzapfel, 2009). The human eye can only see the visible portions of the electromagnetic spectrum. However, optical sensors can quantify visible to near infra-red wavelengths and are well suited to access the nutritional status of a growing corn crop (Dias Paiao & Fernandez, 2020).

My research is being conducted in western Manitoba using trials on commercial fields, one year each from 2018 to 2021. The objective is to evaluate the reliability of crop sensors to predict N fertilizer rates for in-season corn. The N status of growing corn will be examined using a passive UAV and two active hand-held sensors. Based on the reflectance wavelength of growing corn, various vegetation indices will be evaluated for the ability to predict grain yield response to added N fertilizer. Ultimately, I would like to provide farmers with an option to use sensors to determine the most economical in-season fertilizer recommendations at early corn stages. It is hoped that utilizing sensor economic modeling data to make in-season fertilizer recommendation, N fertilizer rates applied to corn will not be excessive and thus limit the loss of the nutrient to the environment.

Dynamics of the root associated bacterial microbiome in eight canola varieties under contrasting nitrogen fertilization

Yunliang Li[1], Bobbi Helgason[1], Sally Vail[2], Melissa Arcand[1]*
[1]Department of Soil Science, University of Saskatchewan, Saskatoon, Saskatchewan, Canada
[2]Agriculture and Agri-Food Saskatoon Research and Development Centre, Saskatoon, Saskatchewan, Canada

Canola varieties show a wide range of yield potential which is highly related to nitrogen use efficiency (NUE). The root associated microbiome is considered as an essential factor in NUE but this relationship is not well explored in different canola varieties. We looked at the bacterial microbiome of eight canola lines grown at Melfort and Saskatoon, SK under high and low N fertilizer application in 2019 and 2020. These sites have inherently different soil and environmental characteristics including different soil N supply rates. We examined the bacterial rhizosphere and root-associated microbiome responses to high and low N fertilizer application at early vegetative and flowering stages using amplicon-based DNA sequencing. We found that roots of canola line 46A65 had lower relative abundance of Proteobacteria than other canola lines at both experimental sites, especially at low N. There were no differences in alpha diversity between lines however bacterial community structure was highly affected by geographic location, year, and differed in the root vs. rhizosphere. The top 10 bacterial amplicon sequence variants (ASVs) in the core microbiome belong to the *Streptomyceteaceae*, *Rhizobiaceae*, *Thermomonosporaceae*, *Caulobacteraceae*, *Pseudonocardiaceae*, and *Xanthomonadaceae* families. Interestingly, hierarchical clustering showed that all canola lines from the AAFC nested association mapping panel (NAM-0, 17, and 72) were clustered together, indicating that these lines from the AAFC NAM breeding panel had similar root microbiomes, compared to historical commercial varieties. Ultimately we will integrate this sequencing data with agronomic data to identify potential biomarkers of the rhizosphere and root associated microbiome that are related to high NUE and can be exploited to enhance canola production.

Soil nitrogen and phosphorus were greater in overlapping areas of fields in Alberta, Saskatchewan, Manitoba, and Ontario

S.J. Crittenden, J. Fitzmaurice, M. Lewis, K. Reid, and B. Irvine

A total of 344 soil cores were taken in annually cropped fields of Alberta, Saskatchewan, Manitoba, and Ontario from 2011 to 2013 in areas where the field shapes, or obstacles within fields, required the driving pattern of farm operations to overlap. Soil nitrate-N concentrations in overlapping areas were 60% greater, soil Olsen-P concentrations were 23% greater, and pH was 0.5 units greater at 0–15 cm depth compared with non-overlapping areas, suggesting smaller nutrient use efficiency and potential for greater nutrient loss. Key words: nitrogen, phosphorus, soil organic matter content, overlap, spatial distribution.

2021 MSSS Soil Safari and Mounting the Trophies as Monoliths

John Heard[1] and Megan Westphal[1],
[1]Manitoba Agriculture and Resource Development,
John.heard@gov.mb.ca

As a special feature to our “non traditional, drop in summer soil tour” the MSSS offered a special opportunity for participants to take monoliths of a Red River clay or an Almasippi loamy sand. Some 10+ monoliths were extracted that day and more in following days. A series of videos was produced to coach participants along in completing the monolith mounting. These videos were hosted on the MSSS homepage. A progress report on the monolith preparation by participants will be presented.

Developing a Soil-Based Method to Screen Soybean (*Glycine max*) Seedlings for Early Season Vigor and Iron Deficiency Chlorosis (IDC)

Kevin Baron , Richard Rutherford and Craig Riddell
N49 Genetics, Winnipeg, MB

For growers in the Red River Valley and Interlake regions of Manitoba yellowing of soybeans due to iron deficiency chlorosis (IDC) is a major stress factor that severely reduces yield potential when sensitive cultivars are grown upon calcareous, high pH soils. The current project was initiated with the objective to develop a rapid, cost-effective and soil-based method to screen soybean germplasm for iron deficiency chlorosis (IDC) in a growth room or greenhouse scenario. Over the 2019 and 2020 growing season fields in the Rural Municipalities of Woodlands and Rockwood displaying severe IDC symptoms were identified, geo-referenced, and soils collected for nutrient analysis and related chemical properties. In late 2020 these soils and professional grow mix were utilized as substrates to screen soybean seedling growth within Ray Leach "Cone-tainers"™. Several components of the single cell container method were further adapted based on salinity and IDC work by soybean researchers in Arkansas, Missouri and North Dakota. A unique component of our protocol development focused on the use of simple hand-held sensors and cameras to characterize leaf greenness, leaf temperature and biomass accumulation without destructive sampling of plants. These quantitative tools for evaluating soybean performance are being assessed as a supplement to the visual rating scale (1= tolerance, 5= susceptible) commonly used to rank soybean varieties for tolerance to IDC. In the short term the method will be scaled to provide commodity organizations, seed companies and researchers with a reliable means of assessing IDC resistance of newly released soybean cultivars against established checks. Long term the technique will be applied towards screening breeding populations and developing early maturing soybean germplasm with improved IDC and stress tolerance.

ORAL PRESENTATION ABSTRACTS

Classifying and mapping forest soils-based ecosites in west-central Manitoba

Paul LeBlanc[1]
[1]*Louisiana – Pacific Canada Limited, Swan River, MB, Canada*

Both Louisiana-Pacific Canada Ltd. and the Province of Manitoba have a goal of managing the forest guided by Ecosystem Based Management (EBM). There was a strong emphasis to include EBM and forest ecosystems in the 20-year Forest Management Plans. Ecosystems consist of the interacting elements of soils, canopy and understory vegetation. However, ecosystem classification and ecosystem mapping were large gaps in west-central Manitoba.

600,000 ha of ecosystems in the Duck and Porcupine Mountain Provincial Forests were mapped at a shared cost of $3.0 M. This multi-pronged effort began with top-down soils mapping (aerial photos and soils pits) at a scale of 1:60,000. These landscape-level soils polygons formed the basis for the rest of the ecosystem inventory. Forests and wetlands were nested inside the soil polygons an operational scale of 1:15,000.

Ecosystem soils and vegetation data were collected on 536 forested wetland and forested upland sites. Multivariate gradient analyses were used to determine relationships between environmental variables and vegetation. Detrended Correspondence Analysis (DCA) was used to identify that moisture gradient (soil moisture regime) and fertility gradient (nutrient regime, soil texture) had the greatest influence on ecosystems. 24 distinct and unique forested ecosites (soils and vegetation combinations) were classified and a field key was created. Ecosite factsheets summarized the average and range of soils and vegetation attributes for each of the 24 ecosites. Ecosystem mapping was proactively facilitated by photo-interpreting critical ecosystem attributes (i.e. soil moisture classes and soil texture classes) at the same time as the multi-canopy forest inventory. Ecosite assignments were made for all forested polygons in the FLI, by using the ecosite primary data and the ecosite key. Recently, agriculture soil mapping data was utilized to map the remaining ecosites outside the forests.

Ecosites were utilized as the strata or framework of the 20-Year Forest Management Plans (FMPs) in 2006 and 2019. The rich and robust ecological information from the ecosite classification and background data allowed us to generate incredibly useful products that enhanced the FMP's ability to strategically plan forest management activities using Ecosystem Based Management. These products included: spatial bird modeling of 17 indicator bird species, and one bird species at risk. Biodiversity metrics, identification of rare ecosites, forest succession, snags, downed woody debris, and shrub communities were quantified. Carbon yield curves were created for the soil and vegetation carbon combined. The ecosite information has also proved useful to an elk researcher, who found ecosite to be the strongest predictor variable of elk habitat. There is great potential for collaboration between forestry and agriculture, using soils as our common denominator.

Organic amendment effects on productivity of wellsites reclaimed with suboptimal topsoil replacement depth

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An inevitable consequence of oil and gas extraction are disturbed sites, such as wellsites and borrow sites, which will require reclamation to restore and sustain levels of productivity equivalent to those that existed before the disturbance. However, available salvaged topsoil at many sites is often insufficient to meet the 80% topsoil replacement depth (TRD) required for successful reclamation. This 5-yr study examined the effectiveness of peat and biochar to augment reclamation of wellsites using suboptimal (i.e., 50%) TRD relative to 50% TRD and 80%TRD without amendments. Amendments were applied once at total organic carbon rates equivalent to those in the non-amended 80%TRD treatment. Tree and shrub seedling mixes were transplanted in all plots at the beginning of the study. Soil properties and vegetation attributes were measured annually for 5 yr. Compared to non-amended plots, peat significantly increased total Kjeldahl nitrogen concentration while biochar produced significantly greater concentrations of potassium in plots receiving 50% TRD. Forb, tree, shrub, and non-native canopy covers did not vary significantly with treatment. However, graminoid and native plant cover, were significantly higher in 50%TRD+peat than in 50%TRD+biochar plots. Our results show that organic amendments can improve reclamation success at disturbed boreal sites where salvaged soil is insufficient to achieve the optimal 80% TRD.

Early Implementation of Amendment Crops Reduces Long Term Yield Loss in a Pipeline Reclamation Setting

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Breakthroughs in horizontal drilling and fracking technology has led to a drastic increase in oil and natural gas (ONG) extraction from the Bakken and Three Forks Regions. The pipeline network of the region has expanded to meet ONG transportation needs, resulting in soil disturbance on the construction right of way (ROI). Soil mixing over the pipeline trench dilutes fertile topsoil and heavy machinery traffic may lead to soil compaction, both of which result in reduced soil function. Improper reclamation can result in these disturbances persisting for years. A need exists for reclamation strategies that can be readily implemented by producers without disturbing their farming operation. This study assesses the effects of diverse cropping sequences on long-term yield in a pipeline reclamation setting. Research began at the Williston Research Extension Center (WREC) in 2015 after a 91cm diameter water pipeline was installed under 0.4 km of agricultural land. Treatments were tested on three disturbance areas: the pipeline trench, the adjacent roadway, and undisturbed cropland west of the construction site which acted as the study control. Five four-year cropping sequences aimed at restoring plant productivity and alleviating soil compaction were tested. Crops that were implemented to achieve these objectives were peas, safflower, and a cover crop mix. Cropping sequence treatments consisted of the following: mono-cropping Durum wheat, a pea-barley-safflower-durum rotation, a durum-pea-barley-safflower rotation, a durum-cover crop rotation, and a cover crop-durum rotation. Durum wheat and safflower were planted across all plots in years five and six to assess the effects of each treatment. Plots were harvested annually and yields were normalized amongst the same crop and compared between disturbance areas. Our results indicate that treatments planted to peas or cover crops in year one did not show significant differences in yield between the disturbed and undisturbed areas by year six.

Landscape Restoration of Topsoil on Eroded Hilltops: Ridiculous or Revolutionary?

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The issue of soil erosion is a long-standing problem threatening soil sustainability and productivity all over the world. Intuitively, we know that erosion of topsoil by water, wind and tillage eventually reduces crop productivity to the point where soils become unproductive and are subsequently abandoned.

The challenge is that soil erosion does not occur uniformly throughout the landscape, and productivity losses are often imperceptible until a critical point is reached. The adoption of conservation tillage, where tillage is minimized and soil cover is enhanced, is effective at preventing further losses of topsoil, but on its own does not restore productivity quickly enough to make a positive impact on productivity in the eroded areas.

An examination of literature considers the advantages and disadvantages of several practices to rebuild topsoil (increase SOM) in order to restore productivity as quickly as possible that provides direct benefits to the producer. Based on this analysis, coupled with background characterizations of three sites in south-central Manitoba, experiments are being designed to track performance over time of the productivity of eroded hilltops that have received 10-20 cm of topsoil from adjacent lower slopes.

A Method for Remediating Brine-Impacted Soil Using Electrokinetics

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Electrokinetic remediation (EK) uses low-level direct current (DC), passed between rows of charged electrodes, to mobilize organic and inorganic pollutants for recovery. Controlling the acid/base fronts for complete pollutant recovery remains an obstacle for wide application of this emerging remediation technology. We hypothesize that understanding the geochemical processes influencing these fronts are key to effective application of this technology when remediating clayey soils impacted with produced waters (brine; NaCl dominated). At an existing produced brine-spill site in northwestern North Dakota, three treatment cells composed of 27 recovery wells (17 positively charged anodes and 10 negatively charged cathodes) were installed within the spill area. After 16 months of treatment groundwater samples near the anode and cathode had pH values ranging from 0.9 to 1.4 and 11.4 to 12, respectively. Additionally, Na concentrations at the anode and cathode were about 2,000 and 71,000 mg/L, respectively, and Cl concentrations were about 36,000 and 700 mg/L, respectively. We concluded that EK is an effective technology for migrating charged ions and suggest future work should focus on the influence of geochemical processes at play in extreme pH conditions proximal the recovery wells.

An Updated Assessment of Soil Salinity Status of the Lajas Valley Agricultural Reserve, Puerto Rico

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The soils of the Lajas Valley Agricultural Reserve, located in the southwest of Puerto Rico, present saline and/or sodic conditions in 14% of the surface up to a depth of 120 cm, a condition that increases in magnitude at greater depths (Bonnet and Brenes, 1958). After more than 60 years, the salinity and sodicity of the valley soils continue to be a concern among farmers in the area due to the lack of recent research to determine the status of this resource. The study hypothesis was to demonstrate changes in the magnitude and spatial distribution of the salinity and sodicity of the soils at the regional level. A protocol was developed to evaluate the magnitude and spatial distribution of the salinity and sodicity of soils at the field and regional scale in the Lajas Valley using edaphological parameters, measurements of apparent electrical conductivity (ECa), laboratory analysis of saturated pastes and soil / water solutions at 1:5 (m/v) proportions and satellite images. The results demonstrated that field-scale ECa-ECe and ECa-SARe measurements can be extrapolated to a regional scale by analyzing satellite images obtained from Sentinel 2A, Landsat L8 and environmental variables. The Radial Basis Functions (RBF) Neuronal Network algorithm was used to extrapolate the salinity and sodicity maps to a regional scale. On a local scale, most of the soils classified as normal and saline-sodium, while on a regional scale normal and saline soils predominated. When comparing the salinity maps generated in 1958 and 2020 on a regional scale, a reduction was observed in saline-sodic and sodic soils and an increase in saline soils.

Assessment of a Two Timestamp vs. a Four Timestamp Chamber Sampling Method for Calculating Soil Greenhouse Gas Fluxes

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Quantifying soil greenhouse gas (GHG) fluxes is important because of climate, soil health, nitrogen use efficacy and influences of cropping inputs (e.g., fertilizer). To measure GHG fluxes from agricultural soils, the chamber method is often used, where three or more concentration points are commonly taken from each chamber over time. For this study, a comparison of a common four timestamp method (4TS) with a less frequently used two timestamp method (2TS) was conducted in order to assess the use of the 2TS method. Some benefits of using a 2TS method are less chamber headspace measurements needed to estimate fluxes allowing for a greater number of chambers to be deployed resulting in improved spatial and/or temporal coverage of the GHG fluxes in a field with little impact on the cost of analysis or time spent sampling. Paired chambers of both methods were monitored in four experimental treatments from a study investigating soil and vegetation management for a dual-purpose perennial grain crop. This approach allowed for a direct comparison of the two chamber measurement methods and the assessment of the impact of the different experimental treatments on soil GHG emissions, along with providing a better way to capture and quantify the spatial variability of GHGs. An implication of this study is to analyze the benefits and drawbacks of each of the sampling methods with hopes of contributing to a standard operating procedure on when it is appropriate to use each of these different methods. This could allow both researchers and farmers to save money as the researchers could reduce their cost of analysis per chamber while providing information to farmers for better nitrogen fertilizer management.

Changing Heat Units between Climate normal periods.

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Land-Use Land-Cover (LULC) and anthropogenic climate change have influenced temperature and moisture patterns in different ways across the prairies. Conversion of grassland and forest landscapes to agroecosystem can create a cooling effect during certain months of the year through increased evapotranspiration rates. Management practices such as summer fallow have also influenced temperature changes over time. As a derivative of daily maximum and minimum temperature, measures of monthly and seasonal Corn Heat Units (CHU) are used to evaluate physiological maturity of corn through the growing season and can be used to evaluate change over time. With continued warming trends in the 21st century and the earlier onset of spring observed in other research, we hypothesize the rate of seasonal CHU change has increased over time. We also expect different months of the growing season to show different rates of change in each period. Using data from 12 locations across the Canadian prairies, the parameter estimates of seasonal and monthly CHU were compared between climate-normal periods of 1930–1959, 1960–1989, 1990–2019. Results showed negative trends from 1930–1959 across the prairies, slightly positive trends from 1960–1989, and more positive trends from 1990–2020. Certain months showed greater rates of change for each climate-normal period. These results align with the history of LULC and climate change in the Canadian prairies, showing the difficulty in evaluating long term trends when LULC and climate change have an opposite effect on temperature changes over time.

Pilot Project:
Above Ground Burial of Pig Carcasses

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Mass livestock mortalities due to catastrophic events require a disposal method that can be deployed quickly and simply without negatively impacting the environment. Above Ground Burial (AGB) is a promising technique that combines the principles of burial with composting. It has been successfully field tested in the United States. The objective of this study is to evaluate the potential of AGB as a simple, operationally viable and environmentally sustainable practice for the management of pig mortalities in Manitoba. Manitoba Agriculture and Resource Development and the City of Winnipeg are piloting a two-year demonstration project at the Brady Road Resource Management Facility to explore AGB for future use on-farm and at landfills.

After designating the pilot area, baseline soil samples were taken and analysed for organic carbon, macronutrients, trace elements, pH and electrical conductivity. In August 2020, shallow trenches approximately 18-20 inches deep were excavated. A layer of straw or woodchips was applied to each trench, followed by carcasses. The trenches were capped with the excavated soil. Carcass treatments included: whole feeder pigs with straw, whole feeder pigs with woodchips, whole pigs of various sizes with straw, whole pigs of various sizes with woodchips, and ground pigs with woodchips. Trail cameras were installed to monitor for scavengers. Each trench has been monitored for temperature since construction. In November, the trenches were opened to visually assess decomposition.

Preliminary observations three months after construction indicate: no noticeable odour, no signs of scavenging, temperatures within the trenches ~10°C above ambient and significant decomposition with only hide and bones visible. Decomposition will be visually assessed again and when the carcasses are determined to be fully decomposed, soil samples will be taken and compared to the baseline samples and the land will be returned to its original use.

Microbial nitrogen cycling functional gene abundance in grazed forage pasture soils and links to N_2O emissions

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Introduction of legumes such as cicer milkvetch (*Astragalus cicer L.)* and sainfoin (*Onobrychis viciifolia*) in forage pasture is a common practice to improve yields and reduce bloat. How this affects N functional genes, particularly those involved in N_2O emissions, is poorly understood. A field trial was conducted at Termuende Research Farm at Lanigan, SK in a grass-legume stand dominated by brome grass (*Bromus madritensis*) and alfalfa (*Medicago sativa L.).* In 2015, cicer milkvetch and sainfoin were sod-seeded on the existing pasture and were compared to the original pasture composition (control). Static chambers were used to monitor N_2O fluxes, PRSTM probes monitored soil nutrient fluxes, and soils (0-10 cm) were sampled for microbial analysis in 2017-18. Quantitative real-time polymerase chain reaction (qPCR) was conducted to quantify the abundance of N cycling functional genes (amoA, nirS/nirK and nosZ). Despite no difference in N_2O emissions among legume species, bacterial amoA gene abundance was higher in non-bloat grass pasture soils. Gene abundance was not correlated with N_2O, but soil pH as well as bacterial amoA and nirS gene abundance were positively associated with Cicer milkvetch indicating that they might be potential predictors for N cycling in soil under this pasture.

Circular nutrient sources supply phosphorus and improve yields in organically managed systems

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Phosphorus (P) nutrition is vital for crop growth and yield, but the global P cycle is broken. P enters the food system as fertilizer mined from rapidly depleting phosphate rock reserves, and leaves the food system via food and human wastes entering landfill or waterways. Excess P from urban wastes contributes to eutrophication of freshwater bodies. Meanwhile, P deficiency can limit yields, particularly on organic farms which often have negative P balances due to limited nutrient import options. Improved recycling of P from urban areas onto farmland is essential for food system sustainability.

Urban recycled (circular) P fertilizers are understudied compared to manure and conventional P fertilizers. This research evaluates three circular nutrient sources for their capacity to supply P and improve yields on a P-depleted soil of the Canadian Prairies. Frass is the excreta of black soldier fly (*Hermetia illucens*) larvae fed a diet of urban pre-consumer food waste. Digestate is the product of anaerobic digestion of urban food processing waste. Struvite is a phosphate mineral precipitated from municipal wastewater streams. Frass, digestate, and struvite are compared with monoammonium phosphate (MAP), a soluble conventional P fertilizer; compost, a common organic amendment; and an unfertilized control. In a wheat (*Triticum aestivum*) experiment replicated in two years, frass, MAP, compost, and digestate supplied more P and improved yields compared to the control. In an alfalfa (*Medicago sativa*) based forage experiment monitored over two growing seasons, all nutrient sources improved phosphorus uptake and yield compared to the control in the second growing season. In a pot experiment using Italian ryegrass (*Lolium multiflorum*), where adequate nitrogen (N) was supplied to remove any N effect of the amendments, all nutrient sources improved P uptake and yields compared to the control.

Crop-specific productivity and rhizosphere processes associated with use of struvite fertilizer

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Struvite (magnesium ammonium phosphate hexahydrate, $NH_4MgPO_4 \cdot 6H_2O$) is a sparingly soluble, phosphorus (P)-rich mineral that can be recovered from wastewater streams and is gaining attention as a slow-release fertilizer. Crop productivity response to struvite is often greater than expected based on the low solubility of struvite in water, indicating that processes occurring in the soil increase the bioavailability of nutrients in struvite. Differences among crop species in response to struvite application suggest that specific plant P-acquisition mechanisms, such as rhizosphere acidification or organic anion exudation, may play a role in P mobilization from struvite. Such mechanisms may be especially important in alkaline soils, where struvite solubility is particularly low. Our objectives were (1) to assess the productivity response of three green manure crop species to application of struvite, relative to monoammonium phosphate (MAP), in alkaline soils and (2) to investigate the role of crop rhizosphere processes in P acquisition from struvite and MAP in these soils. Plot-scale field experiments were conducted in 2020 at two sites in Manitoba with alkaline soil pH, but contrasting soil texture and soil test P concentrations. Field pea (*Pisum sativum* L.), faba bean (*Vicia faba* L.), and buckwheat (*Fagopyrum esculentum* Moench) were fertilized at seeding with 30 kg P ha^{-1} as either struvite or MAP or left unfertilized. On two sampling dates (5 and 8 wk after seeding), we assessed aboveground crop biomass and collected rhizosphere soil extract to determine rhizosphere pH and organic anion content. Results on the effects of crop species and fertilizer treatment on crop biomass and rhizosphere pH will be included in this presentation.

Soil Phosphorus and Runoff Water Quality in Manitoba

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In Manitoba, challenges exist in improving agricultural water quality without impacting crop yield. Although soils are a major agricultural source of phosphorus (P) export to surface waters, the impact of soil P on runoff P has not been fully quantified. Recently, we explored the relationship between soil P and runoff P in 24 monitoring fields across Manitoba, and assessed the impacts of fertilizer P inputs on soil P fertility, P runoff and crop yield using a case study in the South Tobacco Creek watershed. Across all fields, flow-weighted mean concentrations of total dissolved P in both snowmelt runoff and rainfall runoff were significantly correlated with soil Olsen P concentrations in the 0-5 cm depth (R^2 = 0.69 and = 0.58, respectively). In the case study, we found that soil P budget significantly affected soil Olsen P concentrations. The study demonstrated that dissolved P concentrations in runoff could be significantly decreased by depleting soil test P through a combined approach of reducing fertilizer P inputs with harvest removal. Implementing the approach over 3 to 5 years decreased mean annual flow-weighted total dissolved P concentrations in snowmelt runoff from 0.60 to 0.30 mg L^{-1} in the field with high initial soil P and from 1.17 to 0.42 mg L^{-1} in the field with very high initial soil P. Declines in the P concentration in rainfall runoff were greater. Critically, yields of wheat (*Triticum spp*.) and canola (*Brassica napus* L.) were not affected by soil P depletion. Our studies highlight a management opportunity that can maintain crop productivity while improving water security in Manitoba watersheds containing high concentrations of soil P. However, questions remain regarding what the optimum soil test P values would be for both water and food security.

Save the lake! Cross-border collaboration on agricultural nutrient BMPs in a cold climate region

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Encouraging farmers to adopt agricultural beneficial management practices (BMPs) is critical to reducing nutrient loading to and improving water quality in the Red River and, ultimately, Lake Winnipeg. Recent research, however, suggests that the efficacies of many BMPs in cold climates, such as that of the Red River Basin (RRB), differ from warmer regions where much of the body of knowledge has accumulated. The scientific community must strive to get its story straight prior to seeking further practice change in the agriculture industry.

The Red River Basin / Cold Climate Agricultural Nutrients BMP Workshop was held in April of 2019. This event served as a first step towards achieving consensus on the science and a common message to producers regarding agricultural solutions to water quality problems. The challenge is unique for a region with a peculiar combination of characteristics. Outcomes of the Workshop, with emphasis on soil science, will be shared along with implications for policy, research and extension.

CONFERENCE EVALUATION

To assist with planning of upcoming MSSS events, we would appreciate your feedback and comments. Please rank each of the following on a scale of 1 (poor) to 5 (excellent).

Conference and Annual General Meeting	**Poor ----------Excellent**				
Timing (early February)	1	2	3	4	5
Notification (adequate notice; notice by email)	1	2	3	4	5
Program booklet	1	2	3	4	5
Poster Session	1	2	3	4	5
Business meeting (timing, format)	1	2	3	4	5
The following sessions:					
Keynote Presentation: Classifying and mapping forest soils-based ecosites in west-central Manitoba	1	2	3	4	5
PANEL DISCUSSION: Collaborative Research Between Disciplines	1	2	3	4	5
SOIL RECLAMATION AND REMEDIATION	1	2	3	4	5
SOIL AND WATER MANAGEMENT	1	2	3	4	5
SOIL NUTRIENT MANAGEMENT AND CYCLING	1	2	3	4	5

Should a special session, followed by panel discussion, be included next year? Y N
If yes - proposed topics for special session of the 2022 conference: _____
What is your preference for poster sessions? ___ during breaks ____dedicated session

Summer Tour

The MSSS typically holds a summer tour/workshop in late August. For 2021, please indicate:

Topics/regions of interest: _____
Preferred dates (if not late August): _____
1-day vs. 2-day tour: _____
Winnipeg, Brandon or Portage la Prairie starting point: _____

General Questions

Please indicate if you would like to participate in an MSSS Organizing Committee for one of the following events: __ 2021 Summer Field Tour __ 2022 Conference & AGM

Name: _____ Email address: _____
Affiliation: __Student __Faculty __ Government __Industry __Other:_____

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