Manitoba Soil Science Society

65th Annual
MB Soil Science Society Conference and Annual General Meeting

Dealing with Drought

February 3-4, 2022

Online – ZOOM

Hosted by Planners Plus

2021 - 2022 MSSS EXECUTIVE

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CONFERENCE PROGRAM

Thursday, February 3, 2022

1:00 pm Conference Commences
Opening Remarks –Steven Crittenden, MSSS President

1:10pm Keynote Presentation: **Managing soils after droughts**
Linda Gorim
University of Alberta, Edmonton, AB

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

GENERAL SESSION: SOIL NUTRIENT MANAGEMENT AND CYCLING
Chairperson: Jarrett Lardy
CCA CEUs: TBD

2:05pm **Advanced 4R Nitrogen Management Options for Corn in Sandy Soils of MB, Canada.**
Kody Oleson , Mario Tenuta*
Department of Soil Science, University of MB, Winnipeg, MB, Canada.

2:17pm **Soil Nitrogen Supply Rate under an Intermediate Wheatgrass Perennial Forage Grain System**
Nikisha Muhandiram[1], Francis Zvomuya[1], Doug Cattani[2], Emma McGeough[3], Tim Crews[4]*
[1]Department of Soil Science, University of MB, Winnipeg, MB, Canada
[2]Department of Plant Science, University of MB, Winnipeg, MB, Canada
[3]Department of Animal Science, University of MB, Winnipeg, MB, Canada
[4]The Land Institute, Salina, Kansas, USA

2:29pm **How well does wastewater-derived struvite dissolve and diffuse in MB soils?**
Oban Srinathan[1], Joanne Thiessen Martens[2], Inoka Amarakoon[2], and Francis Zvomuya[2]*
[1]Shaftesbury High School, Winnipeg, MB, Canada.
[2]Department of Soil Science, University of MB, Winnipeg, MB, Canada.

2:41pm **Impact of Regenerative Agriculture Fertilization Practices on Soil Microbiota and Biomass Production**
H. Ripplinger[1], S. Kronberg[2], T. DeSutter[1], and S. Banerjee[3]*
[1] Department of Soil Science, North Dakota State University, Fargo, ND
[2] USDA-ARS Northern Great Plains Research Laboratory, Mandan, ND
[3] Department of Microbiological Sciences, North Dakota State University, Fargo, ND

2:53pm **Sci-Comm tools for Soil Science in a digital era**
Beverly Álvarez-Torres and Thomas M. DeSutter*
Department of Soil Science, North Dakota State University, Fargo, N

3:05pm **Poster Session and Nutrition Break**

GENERAL SESSION: SOIL REMEDIATION AND RECLAMATION

Chairperson: Claudia Quilesfogel-Esparza
CCA CEUs:

3:20pm **Peat and biochar effects on revegetation of oil wellsites reclaimed with suboptimal topsoil replacement depth in northeastern Alberta**
Takudzwa Nawu[1], Francis Zvomuya[1], Asfaw Bekele[2], Inoka Amarakoon[1], and Michelle Young*
[1]Department of Soil Science, University of MB, Winnipeg, MB, Canada.
[2]Imperial Oil Resources Limited, 9223 23rd Street S.E., Calgary, Alberta, Canada.

3:32pm **Temporal changes in soil physical properties following reclamation of natural gas pipeline right-of-ways on cropland**
Clemence Muitire, Theresa Adesanya, Francis Zvomuya, Inoka Amarakoon, and Afua Mante*
Department of Soil Science, University of MB, Winnipeg, MB, Canada

3:44pm **The Effects of Oil and Natural Gas (ONG) Reclamation Projects on Soil Properties: A Meta-Analysis**
Nicholas Birkhimer1, Dr. Thomas DeSutter[1], Kyle Jore[2]*
[1]North Dakota State University, Department of Soil Science
[2]University of Minnesota

3:56pm **An Examination of Pipeline Site-Preparation Methods for Improving Plant Establishment**
Jarrett Lardy[1], Tom DeSutter[1], Miranda Meehan[2], Kevin Horsager[1], Nathan Derby[1], Aaron Daigh[1], and James Staricka[3]*
[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
[3] Williston Research Extension Center, Williston, North Dakota, United States

4:08 pm **Can calcium acetate be used as an alternative to gypsum for improving hydraulic conductivity in oilfield brine (produced water) impacted soils?**
Annalie Peterson[1], Thomas DeSutter[1], Nathan Derby[1], Miranda Meehan[2], and Aaron Daigh[1]*
[1]School of Natural Resource Sciences, North Dakota State University, Fargo, North Dakota
[2]Department of Animals Sciences, North Dakota State University, Fargo, North Dakota

4:20pm Closing remarks End of Day 1 – Stephen Crittenden, MSSS President

February 4, 2022

1:00pm Opening Remarks Day 2 –Stephen Crittenden, MSSS President

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GENERAL SESSION: SOIL AND WATER MANAGEMENT

Chairperson: Clemence Muitire
CCA CEUs: TBD

1:10 pm **Landscape Restoration Impacts on Eroded, Droughty Soils and Crop Performance in 2021**
Curtis Cavers[1,2], David Lobb[1] and Stephen Crittenden[2]*
[1]Department of Soil Science, University of Mantioba, Winnipeg, MB, Canada
[2]Agriculture and Agri-Food Canada, Brandon Research and Development Centre, Brandon, MB, Canada

1:22pm **Modeling Resilience into Crop Nutrition Planning.**
Edgar Hammermeister[1] and Ken Greer[2]
[1]Western Ag Professional Agronomy, Saskatoon, Saskatchewan, Canada
[2]Western Ag Innovations, Saskatoon, Saskatchewan, Canada

1:34pm **Frequency of Extreme Precipitation and Associated Risk of Soil Nitrogen Losses with Fall Applications**
Trevor Fraser[1], Timi Ojo[1, 2], Paul Bullock[1], Ramona Mohr[3] and John Heard[2]
[1]Department of Soil Science, University of MB, Winnipeg, MB, Canada.
[2]MB Agriculture and Resource Development, Agriculture Branch
[3]Agriculture and Agri-Food Canada, Brandon, MB

1:46pm **Snowmelt runoff of phosphorous from manured agricultural lands**
Viranga Weerasinghe[1, 2], Darshani Kumaragamge[2] and Inoka Amarakoon[1]*
[1]Department of Soil Science, University of MB
[2]Department of Environmental Studies and Sciences, University of Winnipeg

1:58pm **Residual benefits of soil amendments in reducing phosphorus losses from soils under simulated snowmelt flooding**
Madelynn Perry, Darshani Kumaragamage and Doug Goltz*
University of Winnipeg, Department of Environmental Studies and Sciences

2:10pm **Beneficial Practices for Soil and Water Management in Undulating Soils in Southwestern MB: A Research and Demonstration Project**
David Whetter[1, 2] and Bruce Shewfelt[2]
[1]AgriEarth Consulting Ltd., Winnipeg, MB, Canada.
[2]PBS Water Engineering Ltd., Morden, MB, Canada

2:22pm **Poster Session and Nutrition Break**

GROUP A 3 MINUTE VIDEO PRESENTATIONS

Chairperson: TBD
CCA CEUs: TBD

2:37pm **Fall Nitrification Inhibition of Anhydrous Ammonia in MB**
Muhammad Junaid Afzal[1], John Heard[2,] and Mario Tenuta[1]*
[1]Department of Soil Science, University of MB, Winnipeg, MB, Canada
[2]MB Ministry of Agriculture and Resource Development, Carman, MB

2:40pm **Earthworm Species in Agriculture and Adjacent Land in Brandon, MB**
Dana Eliuk[1, 2], Stephen Crittenden[2], Greg King[1] and Lindsey Andronak[2]*
[1]Department of Science, University of Alberta, Camrose, Alberta
[2]Agriculture and Agri-Food Canada, Brandon Research and Development Center, Brandon, MB

2:43pm **The Impact of Manure and Perennials on Soil Health indicators in the Red River Valley**
Jacob Kolody[1], Yvonne Lawley[1] and Mario Tenuta[2]*
[1]Department of Plant Science, University of MB, Winnipeg, MB, Canada
[2]Department of Soil Science, University of MB, Winnipeg, MB, Canada

2:46pm **Quantifying the transport potential of antibiotics and their degradation products in spring-thaw snowmelt runoff from manure-amended cropland.**
Haven Soto[1], Inoka Amarakoon[2] and Nora Casson[3]*
[1]Master of Environment and Social Change Program, University of Winnipeg, Winnipeg, MB, Canada
[2]Department of Soil Science, University of MB, Winnipeg, MB, Canada
[3]Department of Geography, University of Winnipeg, Winnipeg, MB, Canada

2:49pm **Q&A Period for Group A Presenters**

GROUP B 3 MINUTE VIDEO PRESENTATIONS

Chairperson: TBD
CCA CEUs: TBD

2:54pm **Evaluation of Natural and Synthetic Substrate in Aeroponic Systems for Vegetable Production**
Farhatun Nabi and R. Sri Ranjan*
Department of Biosystems Engineering, University of MB, Winnipeg, MB, Canada.

2:57pm **Evaluation of Raspberry Pi-based soil water content sensors for real-time data collection to measure the root zone water uptake**
Prabakaran Santhan and Dr. R. Sri Ranja[1] Ph.D., P. Eng.*
Department of Biosystems Engineering, University of MB, Winnipeg, Canada.

3:00pm **Comparative Study of Reference Crop Evapotranspiration Estimation Using Temperature Based Models in Winkler, MB**
Thushyanthy Akileshan and Ramanathan Sri Ranjan*
Department of Biosystems Engineering, University of MB, Winnipeg, MB

3:03pm **Building and evaluating a plant-controlled atmometer**
Mujibur Rahman and Ramanathan Sri Ranjan*
Department of Biosystems Engineering, University of MB, Winnipeg, MB

3:06pm **Q&A Period for Group B Presenters**

3:11pm Closing Remarks of Conference

3:25pm MSSS Business Meeting and Passing of the Shovel

4:15pm End of Day 2

POSTER PRESENTATIONS

2021 MB Fall Soil Moisture

Timi Ojo [1, 2] and Hailey Wright [1]
[1]MB Agriculture and Resource Development, Agriculture Branch
[2]Department of Soil Science, University of MB, Winnipeg, MB, Canada.

Soil moisture considerations are important for many farm management decisions from seeding to post-harvest operations. Compared to thermo-gravimetric soil moisture method that is time-consuming, destructive and non-replicable, soil moisture sensors use a property of the soil, such as dielectric permittivity, to determine the soil water content. The permittivity of water is ~80, dry soil ~5, ice ~3 and air is 1. Therefore, an increase in soil moisture content increases the dielectric permittivity of the soil. Fall soil moisture status provides an indication of the amount of water that may be available to crops at the start of the next growing season. Given how dry 2021 growing season was, fall precipitation, especially, snow on unfrozen soil in mid-November, helped provide much needed soil moisture recharge. The poster highlights soil moisture monitoring in MB and showed some maps of the 2021 fall soil moisture status prior to soil freeze-up.

Efficacy of Urease Inhibitor with and without Nitrification Inhibitors in Reducing Ammonia Volatilization from Urea

Theresa Adesanya [1], Francis Zvomuya [1], and Ranil Waliwitiya[2]
[1] Department of Soil Science, University of MB, Winnipeg, MB, Canada
[2] Active AgriScience Inc., Saskatoon, SK, Canada

Urea is susceptible to losses that can reduce fertilizer efficiency and economic benefits. Urease and nitrification inhibitors can reduce nitrogen (N) losses due to volatilization, thereby improving fertilizer efficiency. The objective of this study was to evaluate the efficacy of new formulations of Active AgriScience urease inhibitor products with and without nitrification inhibitors relative to Agrotain. Ammonia volatilization was measured over 14 d following banded and broadcast application of inhibitor-treated and untreated urea. Residual soil N was measured at the end of the study. Results showed that all inhibitor treatments lowered ammonia volatilization. When compared with Agrotain, 18% ARM U, 30% ARM U and Active Stabilizer applied at the rate of 2.4 L per 1000 kg of urea (2.4 AS) produced similar results for cumulative ammonia volatilization and percentage reduction in volatilization. Incorporation of fertilizer (shallow banding) significantly reduced ammonia volatilization losses relative to broadcast application. Soil residual ammonium-N concentration was greater under banded urea than broadcast urea treatments. While residual nitrate-N concentrations were similar for all inhibitor treatments, nitrate-N concentrations were significantly higher for Agrotain, 30% ARM U, Active Stabilizer PLUS applied at the rate of 1.8 L per 1000 kg of urea (1.8 ASP), and Active Stabilizer applied at the rate of 1.8 L per 1000 kg of urea (1.8 AS) than the untreated urea treatment. Reduced N losses from inhibitor treatments could potentially translate to increased yields. The treatment of urea with urease inhibitors with and without nitrification inhibitors reduced ammonia volatilization, with some Active AgriScience products showing similar efficacy to Agrotain despite their lower concentration of the active ingredient, N-(n-Butyl) thiophosphoric triamide (NBPT).

Field evaluation of a regenerative versus traditional pasture fertilization approach

John Heard
MB Agriculture and Resource Development

The MBFI research and demonstration farm evaluated a novel, regenerative soil testing and fertilization approach compared to conventional soil sampling and MB Agriculture recommendations. The costs of the regenerative approach were extremely high, and attempted to balance base cation saturation ratios among other things. The season was dry and yield low. Yields, forage quality and fertilization practices and costs will be presented.

Band placement of fertilizers can confound traditional soil sampling procedures

John Heard
MB Agriculture and Resource Development

Three examples of fertilizer band placement in MB were soil sampled and shown to have great variability within a small area. Such variability may produce inappropriate fertilizer recommendation. Results are discussed along with possible solutions from other research.

Field evaluation of biological nitrogen fixing (BNF) products for non-legumes

John Heard
MB Agriculture and Resource Development

There have been recent developments of biological nitrogen fixation products for non-legume crops, based on a similar premise as in sugar cane. Two such products marketed as Envita and Utrisha were evaluated in small plot trials on wheat, canola, soybeans and grain corn. Utrisha was also evaluated in 3 on-farm-tests on field corn. Yield and other nitrogen parameters were measured in all crops, and there were no measurable effects from the products. Perhaps the dry conditions in 2021 interfered with N fixation, or the applied N was sufficient for the lower yields produced.

ORAL PRESENTATIONS

Advanced 4R Nitrogen Management Options for Corn in Sandy Soils of MB, Canada.

Kody Oleson[1], Mario Tenuta [1]*
Department of Soil Science, University of MB, Winnipeg, MB, Canada[1]

To ensure food security and a more sustainable future, Nitrogen (N) management options that reduce environmental losses and improve N use efficiency must be investigated. In recent decades, the pillars of 4R nutrient stewardship - Right Source, Right Rate, Right Time, Right Place, have guided the development of best management practices in various soil-climatic conditions. However, 4R research investigating measures of sustainability for multiple practices simultaneously remains in short supply. The objectives of this research were to compare growing season N_2O emissions and N use efficiency measures between 1) At-planting sources of N (Urea, ESN/Urea, SuperU); 2) In-season sources of N applied as surface dribble (UAN, Agrotain, AgrotainPlus); 3) In-season placement depths of UAN (Surface dribble, Shallow, Deep) applied to corn in sandy soils of MB, Canada. At three different sites with similar soil and management characteristics, treatments were replicated four times in a randomized complete block design. Triplicate gas samples were collected from static-vented chambers at four twenty-minute time intervals from plots given the recommended rate of N (112 kg N ha^{-1}), throughout the growing seasons of 2018–2020. PROC GLIMMIX was used in SAS to perform analyses of variance for each set of practices. Block and site-year were treated as random variables. Across three site-years, ESN/Urea showed the lowest mean area-scaled emissions among at-planting sources, however treatments did not show significant differences; area-scaled emissions of AgrotainPlus were significantly lower than UAN Surface; UAN Deep had the lowest emissions among in-season placements, however did not show significant differences. Persistent dry conditions and timely precipitation after fertilization lowered the potential for enhanced efficiency fertilizers and deep placement to reduce N losses. Future research aims to quantify NO_3^- leaching and NH_3 volatilization losses resulting from similar N management options in this region.

Soil Nitrogen Supply Rate under an Intermediate Wheatgrass Perennial Forage Grain System

Nikisha Muhandiram[1], Francis Zvomuya[1], Doug Cattani[2], Emma McGeough[3], Tim Crews[4]*
[1]Department of Soil Science, University of MB, Winnipeg, MB, Canada
[2]Department of Plant Science, University of MB, Winnipeg, MB, Canada
[3]Department of Animal Science, University of MB, Winnipeg, MB, Canada
[4]The Land Institute, Salina, Kansas, USA

Intermediate Wheatgrass (IWG, Thinopyrum intermedium (Host) Barkworth & D. R. Dewey) is a perennial, dual-purpose forage which can potentially be used for late fall/winter grazing of beef cattle. This experiment assessed nitrogen supply rate under four different IWG-based perennial forage treatments: IWG with no fertilizer post-establishment, IWG with synthetic fertilizer post establishment, IWG in a mixed stand with a legume (Alsike clover, Trifolium hybridum L.), and a single-purpose perennial crop control consisting of a 50:25:25 mix of Tall fescue/Algonquin alfalfa/Oxley II cicer milkvetch. The experiment was laid out in a randomized complete block design with a one-way treatment structure. Plant root simulator (PRS) probes were installed at the pasture site in the 2020 and 2021 growing seasons. The probes were switched every 14 d during the growing season and analyzed for ammonium- and nitrate-nitrogen (NO3-N). Nitrate N supply rate was significantly higher for the IWG+legume treatment (38.0 μg cm-2 2 weeks-1) than the IWG treatment without fertilizer (29.8 μg cm-2 2 weeks-1). There was also a temporal increase in NO3-N supply rate towards the end of the sampling period for the IWG+legume treatment in 2020 and for the IWG+fertilizer treatment in 2021. Soil NO3-N concentration was significantly higher for the IWG+fertilizer treatment (15.0 mg kg-1) than the IWG treatment without fertilizer (11.8 mg kg-1). However, there was no significant difference between the IWG+fertilizer (15.0 mg kg-1) and the IWG+legume (12.8 mg kg-1) treatments. Soil pH and EC were significantly higher in the 15- to 60-cm (0.53 mS cm-1) than in the 0- to 15-cm layer (0.30 mS cm-1). These results indicate the adequacy of a legume intercrop as an alternative source of N for an IWG perennial forage grain system.

How well does wastewater-derived struvite dissolve and diffuse in MB soils?

Oban Srinathan[1], Joanne Thiessen Martens[2], Inoka Amarakoon[2], and Francis Zvomuya[2]*
[1]Shaftesbury High School, Winnipeg, MB, Canada.
[2]Department of Soil Science, University of MB, Winnipeg, MB, Canada.

Struvite is a phosphorus-containing crystalline compound that is a potential alternative to mined phosphorus fertilizers as it can be precipitated from wastewater. Another potential benefit of struvite is that it dissolves slowly, resulting in less phosphorus runoff. The objective of this experiment was to determine how much phosphorus is released from struvite into two contrasting Manitoba agricultural soils. We hypothesized that struvite would release enough phosphorus for its use as a fertilizer in MB. To test this hypothesis, we set up a laboratory experiment using soil from two MB locations, Libau and Thalberg. The soil was watered to field moisture capacity and placed in petri dishes with a grain of struvite or monoammonium phosphate (MAP) fertilizer containing 8 mg of phosphorus at the center. Soil was then incubated for 20 days before sampling in three concentric circles around the fertilizer granule. Any undissolved fertilizer granules were removed. The samples were then tested for available phosphorus concentration using the Olsen-P method. We found that struvite dissolved in the soils tested and the phosphorus spread out in the soil, with significant increases in the circle containing the granule and small increases in the next circle. However, soil P concentration was much lower for struvite than for MAP. The phosphorus spread out less in the high-pH Libau soil than in the neutral-pH Thalberg soil. We conclude that struvite has the potential to be used as a slow-release phosphorus fertilizer in Manitoban soils.

Impact of Regenerative Agriculture Fertilization Practices on Soil Microbiota and Biomass Production

H. Ripplinger[1], S. Kronberg[2], T. DeSutter[1], and S. Banerjee[3]*

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

[2] USDA-ARS Northern Great Plains Research Laboratory, Mandan, ND

[3] Department of Microbiological Sciences, North Dakota State University, Fargo, ND

Both beef manure (BM) and green manure (GM) are common fertilizer inputs used in regenerative agriculture systems. The effect of BM and GM on soil microbiota has been studied extensively, but little is known about which of these two is more beneficial to soil microbiota or if a combination of the two is the best fertilization strategy. In this trial, BM and GM in the form of alfalfa were evaluated in a gradient of combinations consisting of 100% BM, 75% BM:25% GM, 50% BM:50% GM, 25% BM:75% GM, and 100% GM. Conventional mineral fertilizer and an unfertilized treatment were used as controls. All sources of fertilizer were applied based on a goal of 89 kg available N per hectare for white proso millet. Soil samples were taken from each plot four times throughout the growing season. Stem counts, forage mass, and grain yield were collected to analyze the millet productivity and the density of weeds under each treatment. Millet stand counts were not significantly different among treatments. The mass of grain produced was significantly greater in plots that received at least 50% BM than plots that received mineral fertilizer. The mineral fertilized plots produced significantly less millet biomass than all other treatments except the unfertilized control. The mineral fertilized plots produced significantly more weed biomass per plot compared to all other treatments, possibly due to the readily available N compared to BM and GM. The soil will be evaluated for enzymatic activity to determine how each treatment affected soil microbiota. Based on these single year results, the application of both BM and GM can increase the biomass of millet that is produced and reduce the biomass of weeds compared to mineral fertilizer.

Sci-Comm tools for Soil Science in a digital era

Beverly Álvarez-Torres[1] and Thomas M. DeSutter[1]*
[1]Department of Soil Science, North Dakota State University, Fargo, ND

Soil science education is based principally on hands-on experiences, a classic approach that can be disrupted by uncontrollable events such as the COVID-19 pandemic. For adapting to the new digital reality, teachers and professors turned courses and laboratory materials almost immediately to a digital format facilitating the soil science communication and teaching experiences in a remote way. The development of digital platforms and technologies (ie. social media, virtual reality, artificial intelligence) continue increasing as the use of online tools for science education. However, there is a need for understanding the applicability of these tools for soil science and related fields. This video presentation shows and describes emerging technologies with the potential for opening new doors to spread soil science across a changing and challenging digital era.

Peat and biochar effects on revegetation of oil wellsites reclaimed with suboptimal topsoil replacement depth in northeastern Alberta

Takudzwa Nawu[1], Francis Zvomuya[1], Asfaw Bekele[2], Inoka Amarakoon[1], and Michelle Young[2]*
[1] Department of Soil Science, University of MB, Winnipeg, MB, Canada.
[2]Imperial Oil Resources Limited, 9223 23rd Street S.E., Calgary, Alberta, Canada.

Reclamation and revegetation of boreal sites disturbed by oil exploration depend on the availability of topsoil salvaged on-site during the disturbance. For successful reclamation, current regulations require the salvaging of enough soil to attain at least 80% of the original topsoil depth. However, salvaged topsoil at many sites is often insufficient to achieve the 80% topsoil replacement depth (TRD80) required for successful reclamation in western Canada. We conducted a 5-yr study to determine if organic amendments could improve reclamation success at disturbed sites with insufficient salvaged topsoil. Specifically, we examined vegetation responses to 50% topsoil replacement depth without organic amendment (TRD50) or amended with either peat (PTRD50) or biochar (BTRD50), relative to the TRD80 treatment, following wellsite reclamation at Cold Lake, Alberta. Tree and shrub seedling mixes were transplanted into plots that had received the amendments at organic carbon (C) rates equivalent to those in the TRD80 treatment. Across all treatment plots, native plant species richness increased by 5% per year while non-native richness decreased by 19% per year. Tree and shrub seedling heights were significantly greater for the TRD80 and PTRD50 than the BTRD50 and TRD50 treatments and significantly increased in year 5 relative to the previous years. Our findings indicate that peat can improve reclamation success at disturbed boreal sites when salvaged soil is insufficient to achieve the optimal TRD80.

Temporal changes in soil physical properties following reclamation of natural gas pipeline right-of-ways on cropland

Clemence Muitire, Theresa Adesanya, Francis Zvomuya, Inoka Amarakoon, and Afua Mante
Department of Soil Science, University of MB, Winnipeg, MB, Canada

Soil disturbance due to pipeline installation can negatively impact soil physical, chemical, and biological attributes and therefore soil productivity. The objective of this study was to examine temporal changes in soil hydraulic conductivity, aggregate stability, and penetration resistance up to 12 yr following reclamation of pipeline right-of-ways (ROW) on cropland. Measurements were taken in cropped undisturbed zones and pipeline ROWs of varying ages (4, 6, and 12 yr since reclamation) in August 2021. Time since reclamation (TSR) had a significant effect on saturated hydraulic conductivity (K_{fs}), with the K_{fs} significantly greater for the 12-yr old (7.5 cm h^{-1}) than the 4-yr old (2.5 cm h^{-1}) ROW. However, even after 12 yr, K_{fs} was still significantly lower than that in the adjacent undisturbed parts of the field (26.4 cm h^{-1}). Soil resistance to penetration in the 35- to 45-cm depth interval was significantly greater for the 4-yr ROW than the 12-yr ROW. These results indicate a significant but slow recovery of these soil physical properties following reclamation. This presentation will also include results for unsaturated hydraulic conductivity and aggregate stability.

The Effects of Oil and Natural Gas (ONG) Reclamation Projects on Soil Properties: A Meta-Analysis

Nicholas Birkhimer[*1], Dr. Thomas DeSutter[1], Kyle Jore[2]*
[1]North Dakota State University, Department of Soil Science
[2]University of Minnesota

The development of hydraulic fracturing and horizontal drilling technologies has allowed for the exploration and extraction of unconventional oil and natural gas (ONG) resources. Increased extraction of ONG requires the expansion of the existing network of ONG related infrastructure to extract and transport these resources, namely pipeline and well pad installation and reclamation. ONG reclamation projects disproportionately affect agricultural land, which is of concern to producers as these projects result in significant land disturbance. Topsoil stripping and subsoil excavation results in soil mixing that leads to varying levels of losses in soil productivity on reclaimed right-of-ways (ROWs). Determining the magnitude of the effects of ONG reclamation projects on reclaimed ROWs would help stakeholders make better management decisions in the long-term following project completion. This project aims to determine the magnitude of the effects of pipeline and well pad reclamation projects on soil properties through meta-analysis. A search for papers was conducted in the spring of 2021 using the Web of Science database to search for relevant papers. Data was collected from 26 published studies that included observations of soil organic matter (SOM), bulk density (BD), soil texture, pH, total nitrogen (TN), electrical conductivity (EC), phosphorus (P), calcium (Ca), magnesium (Mg), sodium (Na), sodium adsorption ratio (SAR), and cation exchange capacity (CEC) on- and -off reclaimed ROWs. Meta-analysis results showed that BD, pH, EC, and Ca significantly increased following reclamation and SOM significantly decreased. These results indicate that changes in BD, pH, EC, Ca, and SOM are significant issues facing stakeholders who managed land affected by ONG reclamation. Best management practices determined by studies incorporated in this analysis that minimize soil disturbance will also be discussed.

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

Jarrett Lardy[1], Tom DeSutter[1], Miranda Meehan[2], Kevin Horsager[1], Nathan Derby[1], Aaron Daigh[1], and James Staricka[3]*

[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

[3] Williston Research Extension Center, Williston, North Dakota, United States

Energy development and construction, specifically construction of natural gas pipelines, has expanded across western North Dakota within the Williston Basin (Bakken and Three Forks formations). This expansion challenges reclamation when vegetative plant establishment is limited post-installation. Limited vegetation establishment increases soil erosion, water runoff, and provides an environment with the potential to allow invasive plant species to encroach, resulting in numerous, expensive attempts of reseeding right-of-ways. This study examines three site-preparation methods near Williston, ND, and their effects on water runoff, sediment loss, and vegetation establishment under rainfall simulation during a severe drought in a semiarid climate. The treatments used in this study were wood-fiber hydromulch, land imprinting, wheat-straw crimping, the combination of hydromulch and imprinting, and bare ground (control), all on 2% and 5% slopes within the same catena. Rainfall simulations were completed in September 2020, and again in June 2021 to examine the treatments over time. Crimping straw, one the most economical options, was the only treatment which reduced runoff long-term with an equivalent depth of 0.7 cm of water, compared to 1.8 cm of water for the control. However, hydromulch and imprinting with hydromulch were the only treatments which reduced sediment load, both reducing erosion by over 58% when compared to the control. Plant establishment was not significant for any treatment, likely due to the severe drought conditions. Cover is necessary in times of drought when plants fail to establish, with straw crimping being the best option during an extended drought.

Can calcium acetate be used as an alternative to gypsum for improving hydraulic conductivity in oilfield brine (produced water) impacted soils?

Annalie Peterson[1], Thomas DeSutter[1], Nathan Derby[1], Miranda Meehan[2], and Aaron Daigh[1]*
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Much of the oilfield produced waters in the Williston Basin (USA) contain concentrations of sodium chloride at or near saturation level. Thus, when accidental releases and spills occur onto soils, there is a need to clean up the chloride to protect surface and groundwaters. There is also a need to reduce the concentration of sodium within the soil to prevent any unwanted swelling and/or dispersion which will likely occur if the electrical conductivity of the soil decreases below a threshold required to maintain flocculation. The most common calcium source used on soils that are impacted by releases and spills has been gypsum. Although flue gas desulfurization gypsum is available in North Dakota, it is still a sparingly soluble amendment. The time necessary for in-situ remediation is thus dictated by its low solubility and the volume of water needed to flush out the chloride and to have the calcium from gypsum replace sodium on soil exchange sites. The objective of this research is to investigate the use of calcium acetate as a potential soil amendment instead of gypsum. Calcium acetate has nearly the same concentration of calcium compared to gypsum but it is 187 times more soluble. In addition, we hypothesize that the acetate will be an available carbon source for microbes. This laboratory research will investigate how varying levels of calcium acetate and gypsum, when mixed with produced water contaminated soils, influences saturated hydraulic conductivity and soil chemical properties.

Landscape Restoration Impacts on Eroded, Droughty Soils and Crop Performance in 2021

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In fall, 2020, three sites in south-central MB were established as field experiments for re-distributing 10-20 cm of topsoil from lower slopes onto adjacent eroded hilltops. Subsequent crop performance of spring wheat (*Triticum aestivum L.*) and canola (*Brassica napus L.*), along with various soil properties, were measured at these sites in 2021. The objective of this field study was to compare negative impacts of removing topsoil from lower slope positions (versus untreated check plots) alongside possible positive impacts of adding this same depth of topsoil on the hilltops (also compared to untreated check plots in the same landscape position).

Gravimetric soil moisture to 90 cm was limited at all sites for most of the 2021 growing season due to a lack of timely precipitation events. The lack of moisture also masked differences in crop responses to changes in fertility or seedbed properties. Analysis of laboratory moisture retention in soil cores and preliminary in-field infiltration rates are underway to confirm improvement with the addition of topsoil. Weed populations and species tended to shift with the addition of topsoil, mainly through the burial of weeds that were prevalent in control plots.

Despite the lack of positive data from landscape restoration in a drought year, there was no water ponding in lower slope plots where topsoil was removed. By increasing the soil moisture holding capacity on the eroded hilltops, repeating these measurements for the 2022 growing season is expected to show a positive crop response to added topsoil on hilltops where erosion by tillage has had a negative impact. Other management options to improve crop productivity along with landscape restoration will be discussed.

Modeling Resilience into Crop Nutrition Planning.

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Experiencing drought is not new to farmers though its frequency in regions having higher soil organic matter levels is lower and so can be more dramatic. The timing and volume of precipitation not only influences the current growing season's crop productivity but also impacts nutrient cycling in the soil. With regards to crop nutrition planning after a drought, there is more to consider than under utilized fertilizer. This presentation discusses fall 2021 nutrient supply rate trends measured from farm field samples taken in western MB. Since 1998 MB farmers have used the PRS® (Plant Root Simulator) probe analysis and PRS CropCaster® simulation model to manage production risks and build resilient plans that capitalize on opportunity across the range of wet to dry years.

Frequency of Extreme Precipitation and Associated Risk of Soil Nitrogen Losses with Fall Applications

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Effective nitrogen management strategies using the right source, rate, timing and placement can help to reduce nitrogen losses and optimize profitability. Soil moisture is at the nexus of, and plays an important role in many nitrogen form conversions and loss pathways. The objective of this study was to develop a data-based decision support to help farmers assess and manage the potential risks associated with fall nitrogen fertilizer management under extreme moisture conditions. Fall precipitation data from 1950 – 2012 were analyzed at sixty-six locations in MB. These locations were divided into five regions using the MB Agriculture and Resource Development reporting delineation and analysis conducted for coarse, medium and fine textured soils. The amount of water filled pore space (wfps) at the top 30 cm were used to determine the risk of nitrification/denitrification and the wfps at the entire 130 cm depth was used for the leaching loss risk. This study provides a good proof-of-concept that the combination of historical precipitation and the use of soil physical properties with defined thresholds can be used to determine the risk of nitrification/denitrification and leaching based on the amount of additional precipitation.

Snowmelt runoff of phosphorous from manured agricultural lands

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The release of phosphorous (P) with the snowmelt runoff from agricultural lands during the spring is one of the major challenges faced in the Canadian prairie regions' agriculture and water management. The runoff nutrients such as phosphorus and nitrogen can cause eutrophication which can be detrimental to the freshwater ecosystems. Surface and subsurface application of liquid swine manure to the farmlands is commonly practiced, and the injection of swine manure is identified as an effective way in terms of increasing yields and lowering runoff rates of nutrients. This study was focused on investigating the nutrient runoff losses against their method of manure application under the simulated snowmelt flooding conditions. Intact soil columns from swine manure amended (surface and subsurface-applied) and unamended field plots with four replicates were collected. The snowmelt was simulated by flooding soil columns with deionized water at +4 °C. Sampling was carried out for 7 consecutive weeks. Soil redox potential was measured weekly. Dissolved reactive P (DRP) and pH were measured for the extracted porewater and flood water samples. The average pH values for pore and surface water of all the treatments stayed around 7 to 8. Overall, the DRP concentrations in porewater and surface water increased with time of flooding. However, soils with subsurface-applied manure showed comparatively lower DRP values of 0.13-0.82 and 1.48- 2.29 mg L^{-1} for surface water and porewater, respectively. Soils with surface-applied manure showed higher DRP concentrations of 0.07-0.95 and 2.08-2.90 mg L^{-1}, for surface water and porewater, respectively. Results suggest that the soils with subsurface-applied manure had a lower release of P to the water under simulated snowmelt conditions.

Residual benefits of soil amendments in reducing phosphorus losses from soils under simulated snowmelt flooding

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Runoff caused by snowmelt is the main pathway of nutrient transport from agricultural lands to freshwater systems in the Canadian prairies. Spring snowmelt occurs rapidly and causes flooding in low lying areas, inducing anaerobic soil conditions. Anaerobic conditions often enhance P release from the soil into the floodwater. Additions of soil amendments, such as gypsum, alum, and magnesium-sulphate have been shown to effectively decrease P release from soils to floodwater. However, the residual benefits of these amendments have yet to be determined. This study investigated the effects of gypsum, alum, and magnesium-sulphate in reducing P losses 18 months after amendment application during simulated snowmelt flooding. Sixteen intact soil columns collected from four replicated plots amended with gypsum, alum, magnesium-sulphate, including an unamended control, were flooded at +4 ℃ for 49 days to simulate spring snowmelt flooding. On a weekly basis, redox potential was measured, and samples of pore water and floodwater were extracted and analyzed for dissolved reactive P (DRP), and pH. The average of the 4 replicates for each treatment were plotted and analyzed. The unamended control treatment showed pore water DRP concentrations ranging from 1.12 mg/L at 0 days after flooding (DAF) to 1.57 mg/L at 49 DAF, and surface water DRP concentrations ranging from 0.15 mg/L at 0 DAF to 0.64 mg/L at 49 DAF. Both the gypsum and magnesium-sulphate treatments did not show any significant differences from the unamended control treatment indicating there are no residual benefits 18 months after initial application. In contrast, the alum treatment showed significantly lower pore water DRP concentrations ranging from 0.83 mg/L at 0 DAF to 0.99 mg/L at 49 DAF, however surface water DRP concentrations ranging from 0.15 mg/L at 0 DAF to 0.62 mg/L at 49 DAF were similar to that of the control treatment.

Beneficial Practices for Soil and Water Management in Undulating Soils in Southwestern MB: A Research and Demonstration Project

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A commercial field and plot-scale applied research and demonstration site has been established at Hartney, MB, to evaluate beneficial management practices (BMPs) for soil and water management in undulating soils in southwestern MB. The site has been established as part of a group of projects under the Extremes of Moisture initiative supported MB crop commodity organizations (MB Crop Alliance, MB Canola Growers, and MB Pulse & Soybean Growers), and the Canadian Agriculture Partnership – Ag Action MB program. Objectives of the study include: 1) improving the understanding of BMPs to reduce impacts from excess water and salinity, improve drought resilience, and limit effects to water quality from nutrient and salt export, 2) transferring knowledge to industry on practical and effective BMPs to reduce productivity limitations, improve economic returns, and improve operational and environmental sustainability, and 3) developing a demonstration site for soil and water management in southwestern MB. The research and demonstration site was established in 2021 following baseline condition inventory and designs completed through 2020 and 2021. The site includes paired tile drainage research plots, designed to monitor water table, soil moisture, and tile drainage discharge across discrete landscape positions. An overview of the site and baseline conditions will be presented, along with preliminary environmental monitoring data. Environmental monitoring will continue through 2022, including tile discharge flow and water quality by landscape position. Mathematical modelling using DRAIMOD-S is planned for 2022 in order to evaluate impacts of BMP adoption over the long-term.

Fall Nitrification Inhibition of Anhydrous Ammonia in MB

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Fall-applied anhydrous ammonia (AA) is prone to nitrification losses in the soil by the time of next growing season. Farmers often apply higher fall nitrogen (N) rates than spring to compensate N losses. In 2020, a preliminary trial was set up on a commercial field at the Silverwinds Farms to determine whether nitrification inhibitors (NIs) with fall-applied AA can slow down the conversion of ammonium (NH_4^+) to nitrate (NO_3^-). Stabilizing fall-applied AA in NH_4^+ form may prevent N losses and cut short the higher fall N rates requirements. Nitrogen (82-0-0) was applied on September 30, at 110 lb N ac^{-1} with Centuro®, N-Serve®, and without any nitrification inhibitor (NH_3 110N), while treatments without N addition as control and with full N rate at 140 lb N ac^{-1} (NH_3 140N) were also included. Extractable NH_4^+ and NO_3^- concentrations (mg N kg^{-1} dry soil) were obtained for the soil sampled (0-12” on band rows) in late fall, early, and late spring. We found that the use of NIs allowed more inorganic N and NH_4^+ persistence, and Centuro tended to show better inhibition than N-Serve. We continued following a similar setup at two different sites this fall to get more detailed patterns.

Earthworm Species in Agriculture and Adjacent Land in Brandon, MB

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Earthworms are commonly referred to as ecosystem engineers due to the chemical, physical and biological impact they have on the soil they inhabit (Tomlin and Fox 2003). Despite the important role earthworms have when it comes to soil quality, earthworm biodiversity is under-reported in Canada, with only one publication addressing all the earthworm species found in MB (Reynolds 2000; Cameron et al. 2018). There are a total of 12 different species in MB, all non-native as they were introduced from Europe (Tomlin and Fox 2003). Earthworms, like other living organisms, have ecological tolerances that will affect what environments they can inhabit, which can differ between species. We were interested to see what species of earthworms would be found at the Brandon Research and Development Center located in MB, and if the differences in soil properties between the sampling locations related to earthworm species diversity and abundance. Earthworm collection occurred at 3 different locations at the research center. Each location was divided into arable and adjacent land (non-agricultural land next to the arable land) and was sampled using the hand sorting method. Of the 54 earthworms collected, 15 of those were mature and able to be identified based on external anatomy. No earthworms on either the arable or adjacent land were found at location one (loamy fine sand). At location two (clay), three earthworms were collected from arable land and 11 from adjacent land. At location three, 16 individuals were collected from arable land (clay loam), while the adjacent land (silt clay loam) had the highest abundance of earthworms with 24 individuals collected. Initial results about the properties of soil and earthworm species collected will be presented.

The Impact of Manure and Perennials on Soil Health indicators in the Red River Valley

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Soil health is a relatively new term in agricultural research which incorporates new and old soil metrics. Monitoring and improving soil health is one way to dampen the impact of climate change and increase food security. There are different ways of measuring soil health however, the main premise is the use of multiple soil health indicators to evaluate soil. With ever growing attention from farmers and industry comes a need to research soil health on the prairies. The research I have been conducting over the past year focuses on assessing the impacts of historical management on soil health using the Cornell Soil Health Test. The NCLE long-term nutrient management field laboratory is the study that was used to evaluate the impact of management practices on soil health. The NCLE site has multiple contrasting treatments and a well documented history of those treatments making it a great site to research soil health. Samples from 2020 showed that solid dairy manure application at the nitrogen rate can improve the status of the following soil health indicators: Active Carbon, Soil Protein, Potentially Mineralizable Nitrogen and Total Organic Carbon. In addition, perennial crop history has shown improvement for Aggregate Stability, Potentially Mineralizable Nitrogen and Soil Respiration. Soil building practices such as no-till and cover cropping have shown no effect on soil health indicators after two years of treatment.

Quantifying the transport potential of antibiotics and their degradation products in spring-thaw snowmelt runoff from manure-amended cropland.

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Veterinary antibiotics are used to maintain animal health by reducing the spread of diseases among herds. However, there are concerns about antibiotic runoff in manure amended fields because up to 90% of the initial antibiotic dosage can be excreted from the animal. Liquid swine manure is widely used as fertilizer on the Canadian Prairies, leading to a high risk of soil and freshwater contamination. In this region, an average of 75% of annual runoff occurs during the brief snowmelt period, when soils are frozen. Controls on the transport of antibiotics and their degradation products during this important hydrological period are not well understood but are critical to understand the fate of these contaminants. Our study aims to quantify the dissolved and sediment-bound sulfamethoxazole (SMX) and its metabolites in spring-thaw snowmelt runoff in an agricultural field in MB, following two different manure application methods. We will be collecting snowmelt runoff and pre-concentrating SMX and its metabolites through solid-phase extraction, then quantifying the concentrations and loads of SMX and its metabolites using liquid chromatography-tandem mass spectrometry. In addition, we will perform a lab incubation experiment to assess differences in SMX concentrations in snowmelt and soil porewater under controlled conditions. Understanding antibiotic transport via snowmelt from manure application will help minimize antibiotic loss into the environment during land application. Additionally, with the large agricultural industries in the prairie provinces, this study will be critical in guiding policies for sustainable manure management.

Evaluation of Natural and Synthetic Substrate in Aeroponic Systems for Vegetable Production

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Soilless culture is becoming more popular in recent times due to its compact production environment. In a vertical aeroponic system, different substrates were used with a continuous irrigation process that supplies water and nutrients. Synthetic material (rock wool) has been extensively used as a growing medium in greenhouses, while natural substrate materials are preferable due to their availability and sustainability. Substrate material must possess essential physical, chemical, and biological properties as a growing medium. Irrigation in the aeroponic system is crucial in determining plant growth as plants get their necessary nutrients through the circulating water. Substrates should take up the water-nutrient solution and supply the nutrients for the plant root for absorption. Therefore, the irrigation schedule must have a specific on-off cycle that will allow the substrate to absorb and drain the excess water. This research focuses on the determination of optimum irrigation scheduling for both natural (cattail fibre block) and synthetic (rock wool) substrate for better plant yield and efficient use of resources (e.g. power). In this research, an irrigation schedule has been set for arugula (*Eruca sativa*)(N=18), tomato (*Solanum lycopersicum*)(N=21) and lettuce (*Lactuca sativa*)(N=18) on cattail fibre block and rock wool with different on-off water application cycles. The plant survival rate and growth showed better performance in the three-minute off schedule than the six-minute off water circulation schedule.

Evaluation of Raspberry Pi-based soil water content sensors for real-time data collection to measure the root zone water uptake

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Soil water content is one of the most important factors affecting crop development. Knowledge of soil water content (SWC) in agricultural fields helps us sustainably manage water. Several methods are available to monitor SWC, including labour-intensive gravimetric methods and different types of sensors. Although SWC sensors enable the farmers to monitor SWC, they are costly and lack spatial resolution, accuracy, and precision. For optimal design of sub-irrigation systems, it is imperative to know the plant root zone water uptake pattern using miniature soil water sensors installed within the root zone. There is a need to test the accuracy, ease of use, and precision of different soil water sensors in MB soils, to enable remote monitoring. Raspberry Pi-based data acquisition systems will be helpful 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 and followed by a study on root water uptake patterns conducted in the field.

Comparative Study of Reference Crop Evapotranspiration Estimation Using Temperature Based Models in Winkler, MB

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As the agricultural sector is the most vulnerable sector to water scarcity, accurate calculation of crop water requirements plays a vital role in conserving water. An accurate estimate of crop evapotranspiration (ET_c) would help sustainably manage water resources. The ET_c is calculated using reference crop evapotranspiration (ET_o) estimated using weather variables. Several models were developed for estimating ET_o, categorized based on the significant functional weather parameters, including temperature, radiation, mass transfer, and some combinations. As air temperature data are more readily available among other weather parameters, the temperature-based models are straightforward in application. The primary objective of the current study was to compare the performance of two temperature models: the Hargreaves (HG) and the Baier and Robertson (BR) and the Food and Agriculture Organization's (FAO) Penman-Monteith (FPM) for estimating ET_o for Winkler, MB. The temperature-based models were compared statistically with the FPM model because the model has been considered as a universal model by FAO. For this purpose, weather data from 2011 – 2021 were collected. The results showed that the temperature-based models (HG and BR) underestimated the ET_o because the computed ET_o by HG and BR models were not influenced by wind. Further, the daily ET_o of the HG and BR models were significantly different ($p < 0.05$) from the FPM model. The mean absolute deviation between the ET_o of the FPM and HG model was 1.66 mm/day and between the FPM and BR model was 2.11 mm/day. The coefficient of determination (R^2) of the linear regression analysis between the FPM and the HG models and between the FPM and the BR models were: 0.94 and 0.99, respectively. Therefore, the linear regression equations can convert daily ET_o from the temperature-based models to their equivalent in the FPM model.

Building and evaluating a plant-controlled atmometer

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Irrigation depth and timing are essential to attain better crop yield and economic return on investment. In this scenario, accurate measurement of crop evapotranspiration is vital to apply the precise depth of water to meet crop water demand. The evaporation rate from an atmometer is indirectly used to estimate crop water use. However, crop water use is determined by the weather variables and the soil water content. The traditional atmometer ignores the soil water content, thereby overestimating the crop water use based on weather variables only. Traditional atmometer ignores the soil-limiting phase of crop evapotranspiration. The primary aim of this study was to build and evaluate a plant-controlled atmometer that accounts for the crop water use during the soil limiting phase as well. The rate of evaporation from a water reservoir at various suction levels was determined as a first step in constructing a plant-controlled atmometer that mimics crop water use. Three comparable systems were built in this experiment, each having a ceramic plate connected to a burette to measure the water loss by evaporation through the ceramic plate. All three systems were tested under the same atmospheric conditions, which showed an inverse relationship between evaporation rate and suction imposed on the ceramic plate. This information will be used in the final programming of the plant-controlled atmometer that will account for weather variables and the soil water content in determining crop water use accurately.

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: Managing soils after droughts	1	2	3	4	5
SOIL NUTRIENT MANAGEMENT AND CYCLING	1	2	3	4	5
SOIL RECLAMATION AND REMEDIATION	1	2	3	4	5
SOIL AND WATER MANAGEMENT	1	2	3	4	5
3 MINUTE STUDENT PRESENTATIONS	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 2023 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 2022, 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: __ 2022 Summer Field Tour __ 2023 Conference & AGM

Name: _____ Email address: _____
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