Manitoba Soil Science Society

67th Annual
Manitoba Soil Science Society Conference and Annual General Meeting

SOIL SCIENCE EDUCATION AND EXTENSION

February 1-2, 2024

Winnipeg, Manitoba

2023 - 2024 MSSS EXECUTIVE

Directors

Alexander Koiter, President
Brandon University

Inoka Amarakoon, Vice President
University of Manitoba

Baljeet Singh, Past President
Assiniboine Community College

Megan Westphal, Treasurer
Manitoba Agriculture

Lindsey Andronak, Secretary

Student Representative

Ehsan Chatraei
University of Manitoba

Conference Volunteers

Roger Kpankpari
Takudzwa Nawu
Rebecca Agbabiaka
Phoenix Nakagawa
Taurai Matengu
Emmanuel Agyapong
Carlie Johnston

THANK YOU TO OUR GENEROUS SPONSORS!

Ah Horizon:

agriearth consulting ltd.

Agrologists MANITOBA

Manitoba Canola Growers

Nutrien™

Bt Horizon:

T·A·C TONE AG CONSULTING LTD.

ASSINIBOINE COMMUNITY COLLEGE

Ck Horizon:

MANITOBA Pulse Soybean GROWERS

Good Lands ENVIRONMENTAL INC.

Solum Valley BIOSCIENCES

Manitoba Oat GROWERS ASSOCIATION

WESTERN AG

AGVISE LABORATORIES

CONFERENCE PROGRAM

Thursday, February 1, 2024

7:45 am Registration

8:25 am Conference Commences
Opening Remarks – Alex Koiter, MSSS President

GENERAL SESSION: SOIL-WATER MONITORING & MANAGEMENT
Chairperson: Takudzwa Nawu

8:30 am **Protecting Rivers: Validation and Extraction of Pesticides in Biobed System Water Fractions using HPLC-MS/MS**
Phoenix Nakagawa*, Alistair Brown and Annemieke Farenhorst
Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada

8:45 am **Mechanisms of Sulfamethoxazole Sorption onto Swine Manure Dissolved Organic Carbon and Clay Minerals**
M. A. C. K. Hansima*[1], Inoka Amarakoon[1], Srimathie Indraratne[2], Francis Zvomuya[1], Annemieke Farenhorst[1] and Alistair Brown[1]
[1]Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada
[2]Department of Environmental Studies and Sciences, University of Winnipeg, Winnipeg, Manitoba, Canada

9:00 am **Quantitation of Antibiotics and Antiseptics in Wastewater Treatment Plant Effluents using Ultra-High Performance Liquid Chromatography-Tandem Mass Spectrometry**
Jade Wish*[1], Alistair K. Brown[2], Ayush Kumar[1] and Annemieke Farenhorst[2]
[1]Department of Microbiology, University of Manitoba, Winnipeg, Manitoba, Canada
[2]Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada

9:15 am **Estimation of soil hydraulic parameters using inverse modeling and PEST coupled with HYDRUS to simulate soil water flow**
Ishmeet Kaur*[1], Afua Mante[2] and Ramanathan Sri Ranjan[1]
[1]Department of Biosystems Engineering, University of Manitoba, Winnipeg, Manitoba, Canada
[2]Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada

9:30 am **Atmospheric deposition of phosphorus in Lake Winnipeg: application of different scenarios**
Masoud Goharrokhi[1,2], Gregory K. McCullough[3], David A. Lobb[1,4], Philip N. Owens[1,5] and Alexander J. Koiter[1,4]
[1]Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada

[2]*Department of Civil Engineering, University of Manitoba, Winnipeg, Manitoba, Canada*
[3]*Department of Geography and Environment Studies, University of Manitoba, Winnipeg, Manitoba, Canada*
[4]*Department of Geography and Environment, Brandon University, Brandon, Manitoba, Canada*
[5]*Department of Geography, Earth, and Environmental Sciences, and Quesnel River Research Centre, University of Northern British Columbia, Prince George, British Columbia, Canada*

9:45 am **Regional-Scale Bias Correction of MERRA-2 and ERA5-Land Reanalysis Data**
E. RoTimi Ojo[1,2] and Mark Lysack[3]
[1]*Soil Survey and Weather Surveillance, Manitoba Agriculture, Winnipeg, Manitoba, Canada*
[2]*Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada*
[3]*Department of Computer Science, University of Manitoba, Winnipeg, Manitoba, Canada*

10:00 am Nutrition Break and Poster Session

GENERAL SESSION: NUTRIENT MANAGEMENT PART 1
Chairperson: Taurai Matengu

10:30am **Enhancing Zinc Bioavailability in Wheat Grains Through Organic Farming**
Jing Hou*[1], Xiaopeng Gao[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*

10:45 am **Evaluation of Different P and Zn Fertilization Strategies to Enhance Zn Biofortification and Availability in Wheat Grain**
Mathieu Proulx* and Xiaopeng Gao
Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada

11:00 am **Fertilizer application rates for optimizing crop yield and quality on natural gas pipeline right-of-ways of varying ages**
Clemence Muitire*[1], Francis Zvomuya[1], Inoka Amarakoon[1], Theresa Adesanya[1,2] and Afua Mante[1]
[1]*Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada*
[5]*Department of Geography, Earth, and Environmental Sciences, University of Northern British Columbia, Prince George, British Columbia, Canada*

11:15 am **Remote site establishment to assess spring-applied nitrification inhibitors against nitrous oxide emissions in Southwestern Manitoba**
Shannon Mustard* and Mario Tenuta
Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada

11:30 am **Deterioration of Biodegradable-Polymer-Coated Fertilizer Under Optimal Conditions**
Cameron Beaupre*[1,2], Alexander Koiter[1] and Aaron Glenn[1,2]
[1]Department of Environmental and Life Science, Brandon University, Brandon, Manitoba, Canada
[2]Agriculture and Agri-Food Canada, Brandon Research Centre, Brandon,Manitoba, Canada

11:45 am **Farm-scale Research on Stabilization of Fall Anhydrous Ammonia in MB**
Muhammad Junaid Afzal*[1], Mario Tenuta[1] and John Heard[2]
[1]Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada
[2]Manitoba Ministry of Agriculture and Resource Development, Carman, Manitoba, Canada (Retired)

12:00 pm Lunch

PLENARY SESSION: SOIL SCIENCE EDUCATION AND EXTENSION
Chairperson: Alex Koiter

KEYNOTE SPEAKERS

1:00 pm **Agriculture - Who's Telling Your Story?**
Kent Lewarne
Nutrients for Life Canada (Retired)

1:20 pm **TBD**
Kyle Bobiwash
Department of Entomology, University of Manitoba, Winnipeg, Manitoba, Canada

1:40 pm **15 Years of Soil Science Education: What Have I Learned?**
Tom Yates
Department of Soil Science, University of Saskatchewan, Saskatoon, Saskatchewan, Canada

2:00 pm **Panel Discussion and Question Period**

3:00 pm Nutrition Break and Poster Session

Chairperson: Roger Kpankpari

3:30 pm **Extension in Reclamation: Building Collaboration and Engagement in Reclamation Science**
Aaron Ostlund*, Thomas DeSutter and Miranda Meehan
School of Natural Resource Sciences, North Dakota State University, Fargo, North Dakota, USA

3:45 pm **Use of Artificial Intelligence in Enhancing Soil Science Communication and Education**
Beverly Alvarez-Torres* and Thomas M. DeSutter
School of Natural Resource Sciences, North Dakota State University, Fargo, North Dakota, USA

4:00 pm **Water movement in solonetzic soils explained through hands-on demonstrations**
Tom DeSutter and Nathan Derby
School of Natural Resource Sciences, North Dakota State University, Fargo, North Dakota, USA

4:15 pm Closing remarks End of Day 1 – Alex Koiter, MSSS President

Friday, February 2, 2024

8:30 am Registration

GENERAL SESSION: NUTRIENT MANAGEMENT PART 2

Chairperson: Phoenix Nakagawa

9:00 am **A bibliometric analysis of the effects of freeze-thaw cycles on nitrogen dynamics**
Roger Kpankpari*, Afua Mante and Francis Zvomuya
Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada

9:15 am **Meta-analysis of 4R Nitrogen Management on Nitrous Oxide Emissions from Croplands in Cold Climates**
Sakshi*, Xiaopeng Gao and Mario Tenuta
Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada

9:30 am **Soil-building Practices and N_2O Emissions at the NCLE Long-term Research Site in Southern Manitoba**
Jose A. Almodovar-Gomez* and Mario Tenuta
Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada

9:45 am **Arguments Against Human-Induced Climate Change and Why There is no Need for Reduction of Greenhouse Gases from Agriculture**
Mario Tenuta
Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada

---

10:00 am Nutrition Break and Poster Session

10:30 am MSSS Business Meeting

11:45 am Lunch

GENERAL SESSION: SOIL PHYSICAL PROPERTIES, ECOLOGY AND REMEDIATION

Chairperson: Carlie Johnston

12:45 pm **What We Have Learned From Five Years of Field Scale Soil Health Research**
Brady Goettl*[1], David Franzen[1], Tom DeSutter[1] and Abbey Wick[2]
[1]North Dakota State University, Fargo, North Dakota, USA
[2]Syngena Group, Fargo, North Dakota, USA

1:00 pm **Saskatchewan Chickpea Health Issue: Investigating the Nematode Factor**
Fernanda Gouvea Pereira[1], Mario Tenuta[1], Michelle Hubbard[2] and Sara Anderson
[1]Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada
[2]Agriculture and Agri-Food Canada, Swift Current, Saskatchewan, Canada

1:15 pm **Pinto bean '*Phaseolus vulgaris* L.' tolerance to salinity, waterlogging, and combined conditions**
Audrey Rhodes*[1], Thomas De Sutter[1], Juan Osorno[2] and Barney Geddes[3]
[1]Department of Natural Resource Sciences, North Dakota State University, Fargo, North Dakota, USA
[2]Department of Plant Science, North Dakota State University, Fargo, North Dakota, USA
[3]Department of Microbiological Sciences, North Dakota State University, Fargo, North Dakota, USA

1:30 pm **Evaluating the effects of a fall shoulder cover crop on soil strength and trafficability in Manitoba**
Emmanuel Agyapong*[1], Afua Mante[1], Yvonne Lawley[2], Francis Zvomuya[1] and Taurai Matengu[1]
[1]Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada
[2]Department of Plant Science, University of Manitoba, Winnipeg, Manitoba, Canada

1:45 pm **Application of Biochar as Soil Amendment to Improve Health and Quality of Manitoba Soils While Limiting the Carbon Release to the Environment.**
Baljeet Singh, Dustin Bauer, Nevaeh Witherspoon, and Shreyas Gopi Venkatesh Prasad
Assiniboine Community College, Brandon, Manitoba, Canada

2:00 pm **Assessing soil loss and sedimentation using ^{137}Cs technique and soil erosion models within Canadian Prairie wetland catchments**
Ehsan Zarrinabadi and David A. Lobb
Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada

---

2:15 pm Presentation of Awards and Passing of the Shovel

Plenary Session Panel

Kent Lewarne

In his 33 year career, Kent has taught a number of courses with a passion for high school biology, chemistry, environmental programing and research projects. In 2009, Kent was approached by Nutrients for Life Canada to review and pilot a resource and he has been working with NFL in the Education and Extension world ever since. As a Regional Manager for NFL, Kent has visited many schools in Manitoba, and been fortunate to work with some incredible educators and outreach organization in ONT, SK and AB! Kent also is the program coordinator for the Manitoba River Watch program, a student base water quality monitoring program.

Agriculture - Who's Telling Your Story?

In the rapidly changing world of agriculture, education and extension are vital to provide teachers and students with the most current and relevant information. Organizations such as Nutrients for Life Canada and extension from government and higher education provide information to students that was not heard of when our most current curricula were drafted. While our mission is "teaching teachers" we really strive to support teachers and inspire students!

Kyle Bobiwash

Dr. Kyle Bobiwash, a member of Mississauga First Nation, is an Assistant Professor in department of entomology and the Indigenous Scholar in the Faculty of Agricultural and Food Sciences at the University of Manitoba. He studied at the Cool Climate Oenology and Viticulture Institute at Brock University before completing a M.Sc. on the genetics and pollination biology of lowbush blueberry at McGill University. This led to his Ph.D. at Simon Fraser University, describing the pollination ecology of highbush blueberry in British Columbia. At the University of Manitoba, his lab focuses on understanding the ecology of beneficial insects in agro-ecosystems and the greater landscape. Their goal is to better characterize the landscape and resources utilized by insects to understand how land management might affect insect community composition and ecosystem service delivery. In addition to his ecological work, Kyle is also researcher in residence with the Office of the Chief Science Advisor of Canada, and seconded to the Interdepartmental Indigenous STEM cluster, where he combines his academic work on building Indigenous science capacity with government-wide efforts to build a Canadian science ecosystem that is driven by Indigenous leadership and collaboration.

TBD

Ecosystem services are defined through processes, or functions performed by species and ecosystem features that benefit humans. This partnership, and the reciprocity required to maintain these services and functions are the basis of many Indigenous Knowledge traditions. Increasingly, the role of anthropogenic modifications to ecosystems are being incorporated into our understanding of the provisioning and resiliency of ecosystem services. This trend has resulted in an increasing ability and need to create space for Local Knowledge and Indigenous Knowledge in the future of science and policymaking. Through providing the opportunity for communities to better elaborate locally-relevant Knowledge Systems and research priorities we are enabling the ability of agriculture, ecology and scientific research to better fulfill its responsibility to society. As agriculture and land management increasingly face global challenges to remain productive and profitable, implementable solutions can be developed with new approaches and frameworks that prioritize and incentivize the maintenance of the entirety of agroecological communities (from humans to microbial biodiversity).

Tom Yates

Dr. Tom Yates is an Associate Professor in the Department of Soil Science and the Associate Dean Academic for the College of Agriculture and Bioresources at the University of Saskatchewan. His teaching and research is centred on teaching and learning in soil science and related resource management with a focus on experiential learning and high impact practices. Dr. Yates primarily teaches soil classification and mapping with a focus on field skills and understanding landscape-scale soil processes.

15 Years of Soil Science Education: What Have I learned?

Over the last 15 years the focus of my research has been on soil science education and teaching soil science. I have had the good fortune of collaborating with colleagues from across Canada to look at where soil science teaching is nationally, collaborating with colleagues within my own institution on experiential learning, and the freedom to explore my own interests in teaching and learning. What have I learned over that time? This presentation looks back at and squints into the future of teaching and learning in soil science.

Oral Presentation Abstracts

Poster Presentation Abstracts

ORAL PRESENTATIONS

Protecting Rivers: Validation and Extraction of Pesticides in Biobed System Water Fractions using HPLC-MS/MS

Phoenix Nakagawa, Alistair Brown, and Annemieke Farenhorst*
Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada

Biobeds are systems designed to prevent point-source pesticide pollution that otherwise may arise when disposing, into the environment, the rinsate generated during the cleaning of spraying equipment. Biobed cells are filled with composted biomixtures developed from wheat straw, local topsoil, and peat in a 2:1:1 volumetric mixture. This slightly acidic, organic matter-rich matrix allows for pesticides to degrade rapidly or sorb strongly, so that biobed effluent contains pesticide concentrations that are only a fraction of that detected in the original rinsate. Biobeds are common in Latin America and Europe; Canada has begun to promote biobed systems for agricultural and non-agricultural applications. This study reports on the development and application of a pesticide quantification method for monitoring a biobed system utilized at the Ian N. Morrison Carman Research Farm in Manitoba, Canada. Out of 88 compounds analyzed for by ultra-high performance liquid chromatography-tandem mass spectrometry (UHPLC-MS/MS), 15 pesticide active ingredients were detected in the biobed between mid-June to mid-October 2023. Overall pesticide concentrations were reduced >90% except for herbicides clopyralid, bentazon, and imazethapyr that were detected in effluent at greater concentrations than other pesticides. Future studies on biobed systems should focus on enhancing the remediation capabilities of these three herbicides, however, most pesticides were able to be remediated without any additional input or factors.

Mechanisms of Sulfamethoxazole Sorption onto Swine Manure Dissolved Organic Carbon and Clay Minerals

M. A. C. K. Hansima[1], Inoka Amarakoon[1], Srimathie Indraratne[2], Francis Zvomuya[1], Annemieke Farenhorst[1], Alistair Brown[1]*

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

[2] Department of Environmental Studies and Sciences, University of Winnipeg, Winnipeg, Manitoba Canada.

Sulfamethoxazole (SMX) is widely used in the swine industry, and also detected in manure and the broader environment. Dissolved organic carbon (DOC) in swine manure is primarily controlled by the presence of humic substances such as fulvic (FA) and humic (HA) acids. The physicochemical properties of FA and HA present in swine manure might control SMX adsorption mechanisms by surfaces, such as on smectite clays. Sorption is among the key factors influencing SMX mobility in the environment. This study used the resin-alkaline method to extract FA and HA from DOC in fresh liquid swine manure. Subsequently, these FA and HA fractions were used in batch sorption studies to quantify SMX sorption. The study objective was to investigate the impact of FA and HA derived from fresh liquid swine manure on SMX sorption by bentonite clay. Bentonite clay is represented in soils around the world, and this study is contributing to understanding SMX environmental behaviour. Data showed that variations in the secondary structures of FA and HA resulted in diverse polar and non-polar SMX binding mechanisms, creating multiple unique adsorption sites. Interactions between SMX and aqueous colloidal HA involved non-fluorophore quencher mechanisms, interacting with surface-oriented carboxylic and amide groups. Conversely, interactions with aqueous colloidal FA involved fluorophore quencher mechanisms, engaging with surface-oriented phenolic groups. The complexation of humic substances on bentonite alters their physical conformation, significantly modifying SMX binding mechanisms. SMX complexed with free FA is desorbable. The abundance ratio of 10 FA:1 HA in the DOC fraction may trigger SMX complexation with free FA, thereby enhancing SMX mobility and its transport to the environment via runoff or leaching. We propose oxidizing FA-phenolic groups in lagoon storage or composting to reduce SMX environmental dispersion.

Quantitation of Antibiotics and Antiseptics in Wastewater Treatment Plant Effluents using Ultra-High Performance Liquid Chromatography-Tandem Mass Spectrometry

Jade Wish[*1], Alistair K. Brown[2], Ayush Kumar[1], Annemieke Farenhorst[2]*
[1]Department of Microbiology, University of Manitoba, Manitoba, Canada
[2]Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada

Antibiotics and antiseptics are detected in various environmental compartments at concentrations ranging from ng/L up to mg/L. One of the main factors contributing to this environmental loading is that current wastewater treatment plant processes and technologies do not completely remove antibiotics and antiseptics residues prior to the release of treated wastewater into the environment such as surface waters. There is a need to develop reliable and rapid analytical techniques for quantifying a wide range of antibiotics and antimicrobials at various stages of the wastewater treatment process, for example to better understand removal efficiencies and assess environmental impacts up on final effluent release. This study developed a multi-residue method to quantify in different stages of the wastewater treamtnet process a total of eight antibiotics (ampicillin; cephalexin; ciprofloxacin; meropenem; methicillin; sulfamethoxazole; tetracycline; trimethoprim) and ten antiseptics (benzalkonium chloride (BAC): BAC-C10, BAC-C12, BAC-C14, BAC-C16, BAC-C18; benzethonium chloride; chlorohexidine; didecyl dimethyl ammonium chloride; triclocarban; triclosan). Analyte extraction was performed using Oasis® HLB cartridges and the elution volume was optimized to maximize analyte recoveries and reduce matrix effects. Quantification was accomplished utilizing ultra-high performance liquid chromatography-tandem mass spectrometry (UHPLC-MS/MS) and results are presented using the various performance characteristics outlined in the Eurachem Guide. The method was applied to wastewater treatment samples collected from the City of Winnipeg North End Wastewater Pollution Control Centre, as well as a wastewater treatment plant in a First Nation reserve in Manitoba.

Estimation of soil hydraulic parameters using inverse modeling and PEST coupled with HYDRUS to simulate soil water flow

Ishmeet Kaur[1], Afua Mante[2], and Ramanathan Sri Ranjan[1]*
[1]Department of Biosystems Engineering, University of Manitoba, Winnipeg, Canada.
[2]Department of Soil Science, University of Manitoba, Winnipeg, Canada.

Frequent occurrences of flood and drought events due to climate change can lead to moisture stress in crops. Effective soil water management systems such as irrigation, drainage, or their combination are needed to create a conducive environment for plant growth and performance. To design such water management systems, there is a need to understand the soil water flow dynamics. HYDRUS is well known for simulating the water flow in variably saturated soil using the Richards equation and requires input parameters in the van-Genechten and Mualem soil hydraulic functions. However, physical measurements of the parameters are laborious and time consuming. The objective of this study is to evaluate the effectiveness of inverse modeling and PEST as parameter estimation tools coupled with HYDRUS to simulate soil water flow. The simulation is done for one of the Real-Time In-Situ Soil Monitoring for Agriculture (RISMA) stations situated at Elm Creek, MB. The simulated results are compared with observed soil water content determined at the site within the 0- 10, 10-30, 30-70 and 70-130-cm layers during the 2016 growing season. Results on the performance of inverse modeling- HYDRUS and coupled PEST-HYDRUS in simulating the soil water movement at the site will be presented. The findings from this study will lead to enhancing the accuracy of parameter estimation to support soil water predictive tools to advance the design of soil water management systems for sustainable crop production.

Atmospheric deposition of phosphorus in Lake Winnipeg: application of different scenarios

Masoud Goharrokhi[1, 2], Gregory K. McCullough[3], David A. Lobb[1,4], Philip N. Owens[1,5] and Alexander J. Koiter[1,4]

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

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

[3]Department of Geography and Environment Studies, Centre for Earth Observations Sciences, University of Manitoba, Winnipeg, Canada.

[4]Department of Geography and Environment, Brandon University, Brandon, Canada.

[5]Department of Geography, Earth, and Environmental Sciences, and Quesnel River Research Centre, University of Northern British Columbia, Prince George, Canada

Based on the most recent State of Lake Winnipeg report (2020), the estimate of phosphorus loading into Lake Winnipeg from atmospheric deposition is about 500 t yr^{-1} (20 kg TP km^{-2} yr^{-1}). This value, which is about 7 % of the total annual load, is derived from a single study of a small lake in Alberta in the 1980s (i.e., Narrow Lake, surface area = 1.1 km^2). This ongoing research endeavors to verify and improve the accuracy and precision of the current estimate of atmospheric deposition of phosphorus. This objective can be achieved, partially, by conducting a comprehensive review of existing, relevant published data on the production, transport, and deposition of sediment/dust/smoke and associated phosphorus over land and water surfaces. The global database used in this presentation includes data for more than 400 sites (e.g., Great Lakes) and covers the period 1954 to 2021. Using data and approaches available in the literature, a transport model is developed and used to estimate the atmospheric loading of phosphorus for Lake Winnipeg under different scenarios. Recommendations for future assessment of atmospheric deposition of phosphorus into Lake Winnipeg are also discussed.

Regional-Scale Bias Correction of MERRA-2 and ERA5-Land Reanalysis Data

E. RoTimi Ojo[1, 2], and Mark Lysack[3]
[1]Soil Survey and Weather Surveillance, Manitoba Agriculture, Winnipeg, Manitoba, Canada.
[2]Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada.
[3]Department of Computer Science, University of Manitoba, Winnipeg, Manitoba, Canada.

The number of weather monitoring stations continue to increase as new weather applications are developed. Current weather conditions are often evaluated against historical data to provide contexts in terms of deviation from normal, rating extreme weather events, and determining the probability of occurrence. However, many new locations outfitted with weather stations do not have observed historical data. NASA's MERRA-2 and European Space Agency's ERA5-Land are two widely used atmospheric reanalysis products. They provide global daily and hourly historical weather data at a mesoscale. In this study, the hourly reanalysis data from MERRA-2 and ERA5-Land were compared to observations from a network of 108 weather stations maintained by the Manitoba Agriculture Weather Program. Five weather variables were analyzed: air temperature, relative humidity, wind speed, precipitation, and atmospheric pressure. Three bias correction approaches - monthly mean error correction (ME-Cor); monthly linear regression correction (LR-Cor), and random forest correction (RF-Cor) were tested to reduce the bias from the reanalysis data. The results showed that ERA5-Land had a lower root mean squared error for air temperature, relative humidity, wind speed and pressure compared to MERRA-2. For air temperature, ERA5-Land had a root mean square error of 2.25 °C compared to 2.68 °C. After bias correction, the RF-Cor showed the best improvement and reduced the ERA5-Land air temperature root mean squared error to 1.08 °C.

Enhancing Zinc Bioavailability in Wheat Grains through Organic Farming

Jing Hou[1], Dr. Xiaopeng Gao[1], Dr. 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

Zinc (Zn) is an essential micronutrient for the health of plants, animals and humans. Zn deficiency is a major global health concern associated with low concentration and low bioavailability of Zn in cereal-based staple food. Agronomic biofortification, the process of increasing micronutrient bioavailability in edible tissues of crops through the adopting of agronomic practices, is an effective strategy for addressing this Zn malnutritional problem. The objective of our project is to investigate the effects of crop rotation and farming system on Zn bioavailability in wheat grains.

We used the wheat grain samples from Glenlea Long-term Crop Rotation Study, which is the longest running study on organic farming in Canada. Two crop rotations including continuous annual (oat, soybean, spring wheat, flax) and annual-perennial (spring wheat, flax, alfalfa, alfalfa) both managed organically and conventionally were fully phased for ten years since 2011. Grain concentrations of Zn and other mineral nutrients, as well as protein were determined. A three-way ANOVA was conducted using SAS software to assess the main and interactive impacts of farming system and crop rotation on grain Zn content over the test years.

Our result shows that organic farming consistently enhanced Zn concentration in wheat grains compared to conventional farming, and annual-perennial rotation had higher concentration over annual rotation. In addition, grain Zn concentration was positively correlated with protein, but negatively with phosphorus (P) concentration and wheat yield. These findings can be employed in enhancing nutritional quality of wheat grains for human consumption and contribute to solving global micronutrient deficiencies.

Evaluation of Different P and Zn Fertilization Strategies to Enhance Zn Biofortification and Availability in Wheat Grain

Mathieu Proulx and Xiaopeng Gao*
Department of Soil Science, University of Manitoba, Winnipeg, MB, Canada

Zinc deficiency in plant-based diets poses critical challenges, especially for impoverished populations with limited dietary zinc intake. Agronomic biofortification, which refers to enhancing the nutritional quality of food crops through agronomic practices, offers a promising solution. Despite many studies that have investigated the impact of Zn fertilization on crop productivity, few have explored its impact on grain bioavailability. Previous research in controlled environments demonstrated the influence of P fertility, alone or with biostimulants, on grain Zn biofortification and phytate concentration. However, there is limited knowledge available on the interaction between farmers' current fertilization strategies and novel biofortification approaches.

This study aims to compare the impact of various fertilization strategies, including different combinations of P and Zn fertilizer placements and sources, along with foliar biostimulants, on wheat grain yield, and the Zn content, phytate concentration, and Zn bioavailability in the whole grain. This field experiment is conducted on calcareous heavy clay and sandy loam soils for 2 years. Plant nutrients will be extracted by a wet oxidation method and measured with an ICP-MS. The phytic acid to Zn concentration ratio will indicate bioavailability.

Preliminary data from the first year have shown a significant yield increase when applying a cogranulated P and Zn product in the seedrow rather than being side-banded. Further details on nutrient concentration and bioavailability will be presented during the session. This research will demonstrate the possibility of maintaining and even increasing nutrient concentrations and bioavailability in conventional wheat production as yield improves to support a growing global population.

Fertilizer application rates for optimizing crop yield and quality on natural gas pipeline right-of-ways of varying ages

Clemence Muitire[1], Francis Zvomuya[1], Inoka Amarakoon[1], Theresa Adesanya[1,2], and Afua Mante[1]*
[1]Department of Soil Science, University of Manitoba, Winnipeg, Manitoba
[2]Department of Geography, Earth, and Environmental Sciences, University of Northern British Columbia, Prince George, British Columbia

Several studies have shown lower soil productivity on reclaimed underground pipeline right-of-ways (ROW) than on adjacent undisturbed sites (off-ROW). The objective of this growthroom bioassay was to determine fertilizer application rates that optimize wheat (*Triticum aestivum* L.) and canola (*Brassica napus* L.) yields on underground natural gas pipeline ROWs of varying ages (time since reclamation, TSR of 4 and 10 yr). Bulk soil samples were collected from the 0-20 cm layer on the two ROWs and on off-ROW sites on the same field. The experiment was laid out in a completely randomized design with a 3 × 3 factorial treatment structure replicated three times. The factors were TSR and application rates of nitrogen, phosphorus, potassium, and sulphate: (i) no fertilizer (check), (ii) recommended rate, and (iii) 1.5 times the recommended rate. The recommended fertilizer rate produced 38% lower canola dry mass yield (DMY) and 32% lower wheat DMY on the 4-yr ROW relative to the off-ROW. Increasing the rate to 1.5 times the recommended rate increased canola and wheat DMY on the 4-yr ROW to levels similar to the 10-yr ROW and the off-ROW. These results indicate incomplete recovery of the ROWs within the first 4 yr following completion of reclamation. However, productivity appears to have been restored by year 10 following reclamation, as indicated by the similar DMY for the 10-yr ROW and the off-ROW.

Remote site establishment to assess spring-applied nitrification inhibitors against nitrous oxide emissions in Southwestern Manitoba

Shannon Mustard[*] and Mario Tenuta
Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada.

Enhanced efficiency nitrogen fertilizers (EENF), a Right Source under the 4R Nutrient Stewardship program, could benefit initiatives such as a 30% reduction in fertilizer emissions by 2030. Nitrification inhibitors (NI), an EENF, work to delay the transformation of ammonium (NH_4^+) to nitrate (NO_3^-) in soil to improve plant nutrient use efficiency (NUE) and reduce nitrogen loss as N_2O through denitrification. The objectives of this study are 1) establish a remote long-term emissions monitoring site in Southwestern Manitoba and 2) assess the impact of spring-applied NI on i) N_2O and CO_2 emissions and ii) crop biomass production. Trace Gas – Harvest Moon (TGAS-HM), located 2.5 hours SW of the University of Manitoba, was established on a clay loam mix, and composed of two 200m x 200m (4 ha) experimental plots. Sonic anemometer-thermometers, gas sample intakes, CR1000 and CR3000 dataloggers, a trace gas analyzer, and multiple RS-485 Multidrop Interfaces (MD-485) allow for the successful application of the flux gradient method for N_2O and CO_2 flux estimation and remote data accessibility. In 2023, Pioneer 7211 corn was seeded to all plots and the control plot received 112 kg ha^{-1} NH_3^+, while the NI plot received 112 kg ha^{-1} Centuro® treated NH_3^+. During the 2023 growing season, the NI-treated plot produced 1.64 kg N_2O-N ha^{-1}, while the control plot produced slightly lower emissions of 1.47 kg N_2O-N ha^{-1}. A cumulative $F_{C\text{-}NEP}$ of 1,039.0 kg C ha^{-1} was demonstrated by the NI-treated plot, while the control plot displayed a cumulative $F_{C\text{-}NEP}$ of 1,422.5 kg C ha^{-1}. The control plot produced an average air-dry grain yield of 55.14 bu/ac while the NI-treated plot produced a slightly lower average air-dry grain yield of 53.38 bu/ac. The 2024 growing season will represent the second year of the NI-study and the experimental plots will receive the opposite treatment from 2023.

Deterioration of Biodegradable-Polymer-Coated Fertilizer Under Optimal Conditions

Cameron Beaupre[1,2], Alexander Koiter[1], Aaron Glenn[1,2]
[1]Deparment of Environmental and Life Science, Brandon University, Brandon, Manitoba, Canada
[2]Agriculture and Agri-Food Canada, Brandon Research Centre, Brandon, Manitoba, Canada

Slow-release polymer-coated urea was conceived to achieve higher nitrogen-use efficiency and reduce soil N_2O emissions. Determining the deterioration of polymer within Manitoban soil is necessary for fostering sustainable land use. An incubation study was designed to assess the deterioration of polymer coating (poly-methylene polyphenylene isocyanate) in two Manitoban soil series. Dezwood and Stockton/Wheatland series were selected with a range of soil characteristics such as organic matter content and fertility. Preliminary findings from a field-based study demonstrated that deterioration of the polymer is substantially slower than the four-year international standard and an accumulation of polymer occurred across field sites following repeated annual fertilizer applications. A known amount of polymer was added to a total of 135 pots of soil to measure the deterioration of polymer coating over an eight-month period under uniformly controlled environmental conditions. Through destructive sampling, the polymer was isolated, cleaned and weighed at regular intervals. A linear mass percent change in the polymer was used to determine the deterioration rate. The change in mass percentage was extended to zero mass to determine the total amount of time for deterioration under optimal soil conditions. Under optimal soil water and temperature conditions the rate of deterioration was 0.56 μg day^{-1} for the Stockton/Wheatland soil series, and 0.88 μg day^{-1} for Dezwood. The total amount of time for full deterioration under optimal conditions would occur in 360.69 days for Stockton/Wheatland and 299.56 days for Dezwood, which meets the international standard. Natural field conditions are variable which may lead to unoptimized polymer deterioration, as there is less microbial deterioration of the polymer during the winter months or during times of extreme moisture. The results from this study can help land users make informed decisions with polymer-coated fertilizer applications and environmental stewardship.

Farm-scale Research on Stabilization of Fall Anhydrous Ammonia in MB

Muhammad Junaid Afzal[1], Mario Tenuta[1], and John Heard[2]*
[1]Department of Soil Science, University of Manitoba, Winnipeg, MB, Canada
[2]Manitoba Ministry of Agriculture and Resource Development, Carman, MB, Canada (Retired)

Fall application of anhydrous ammonia (AA) is a common practice in Manitoba, but it is susceptible to the nitrification process and subsequent losses through leaching and denitrification. Three farm-scale research trials were conducted in Southern Manitoba to investigate the effects of nitrification inhibitors (NIs), nitrapyrin (N-Serve) and pronitridine (Centuro), in combination with AA on slowing down nitrification and improving yields and nitrogen (N) recovery from spring-sown crops. Nitrogen (N) was applied in late fall as AA (82-0-0) at 80% of the recommended N rate (based on soil test and target yield) with and without NIs. Additionally, treatments without N addition (as a control) and with 100% of the full recommended N rate were included. Soil was sampled (0-30 cm, both on and between the AA bands) in late fall, early, and late spring before sowing for all sites. Results indicated that nitrapyrin and pronitridine-treated AA did not significantly increase the retention of N in the ammonium form compared to AA without NIs at any site. At Silverwinds, nitrate (NO_3^--N) tended to be recovered more on bands at the late spring sampling with NIs. This, coupled with a tendency for lower NO_3^--N between bands at the late spring sampling at Silverwinds, suggests that delayed nitrification may have limited the diffusion of NO_3^--N from bands by planting time. At Notre Dame and Manitou, there was a tendency for lower NO_3^--N on bands with NIs at the early spring sampling, as well as for both sites with N-Serve at the late spring sampling. At Manitou, NO_3^--N concentration between bands tended to be lower for NIs, indicating a potential reduction in NO_3^--N diffusion from bands by planting. However, no notable differences were observed in agronomic yield and crop N uptake among the AA treatments. These findings do not provide substantial evidence to support the recommendation of using NIs with fall AA banding.

Extension in Reclamation: Building Collaboration and Engagement in Reclamation Science

Aaron Ostlund, Thomas DeSutter and Miranda Meehan*
School of Natural Resource Science, North Dakota State University, Fargo, North Dakota, USA.

The leading industries in North Dakota are agriculture and energy. While energy development has had positive impacts to the state's economy there can be negative impacts to soils associated with development and spills. Annually, 500 miles of pipeline are constructed in the state, disturbing over 6,000 acres of soils. Additionally, there are three accidental spills of oil products or produced water each day. Reclamation is critical to return these soils to their former levels of crop, forage, or native plant production.

As North Dakota continues its commitment to environmental stewardship, reclamation programs stand at the forefront of transformative initiatives. Researchers and Extension specialists at North Dakota State University (NDSU) have been at the forefront of these efforts for the last decade, leading multi-faceted initiatives that encompass groundbreaking research, cutting-edge management tools, and collaborative platforms like the Reclamation Advisory Group (RAG).

The success of NDSU's reclamation programs hinge on collaboration. Industry representatives, landowners, and experts actively contribute to the dialogue, ensuring a comprehensive and inclusive approach to reclamation. The RAG was formed to identify and guide reclamation opportunities in North Dakota including research, education, and outreach. Comprised of key stakeholders, such as landowners, industry leaders, agency personnel and experts, RAG serves as a hub for effective communication, knowledge dissemination, and the exchange of ideas.

The presentation will highlight NDSU's reclamation program and outline our goals include expanding outreach efforts, pushing the boundaries of research, and fostering collaboration to navigate the dynamic landscape of environmental challenges.

Use of Artificial Intelligence in Enhancing Soil Science Communication and Education

Beverly Alvarez-Torres and Thomas M. DeSutter*
Department of Natural Resource Sciences, North Dakota State University, Fargo, North Dakota, United States of America

The integration of Artificial Intelligence (AI) in soil science education and extension offers a revolutionary approach to enhancing understanding and appreciation of soil's vital role in our ecosystem. The use of AI in soil science communication presents unique opportunities for personalized learning experiences, efficient data analysis, and interactive engagement with soil science concepts. AI algorithms can also process vast amounts of soil data, translating complex information into accessible insights for various audiences, from young students to experienced soil scientists. These immersive tools can bring soil science to life, allowing learners to explore soil properties, management practices, and ecosystem services in a dynamic, hands-on manner. As well, the potential of AI in social media and digital outreach highlights how AI can optimize content delivery and engage wider audiences in soil science discussions. In conclusion, the presentation will emphasize the importance of embracing AI in soil science education and extension. By leveraging AI, we can significantly enhance the dissemination of soil science knowledge, fostering a deeper understanding and appreciation of soil as a critical resource.

Water movement in solonetzic soils explained through hands-on demonstrations

Tom DeSutter and Nathan Derby
School of Natural Resource Sciences, North Dakota State University, Fargo, North Dakota, United States

Solonetzic or sodic soils are soils negatively impacted by sodium compared to other base cations but also have an overall low electrical conductivity, which can induce swelling and dispersion. Often, there can be difficulty in explaining how these two conditions occur to audiences who do not have backgrounds in the principles of soil science. Helping farmers, land managers, crop advisors, and students better understand why water moves or does not move in these soils is necessary so that proper management strategies for these soils can occur. This talk provides an overview of two strategies that can be used by educators and extension specialists to help describe water movement through sodium and non-sodium affected soils. The first demonstration links how altering the concentration of sodium and soluble salts influences water movement. The second demonstration allows audiences to link the movement of water through soil horizons having varying concentrations of sodium, soluble salts, and clay. These demonstrations may be useful educational tools on how and why amendments are used for improving water movement within solonetzic soils and also to show restrictions in water movement, in general, through soils with varying clay-enriched horizons.

A bibliometric analysis of the effects of freeze-thaw cycles on nitrogen dynamics

Roger Kpankpari, Afua Mante and Francis Zvomuya*
Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada

In prairie cropping systems, most farmers apply urea fertilizers during the fall before freezing. This practice is inspired by the lower fertilizer prices at the end of the growing season and the need to minimize tillage and other farm operational tasks in the spring. It is recommended that farmers should apply the fertilizers at a temperature of 5°C or lower based on the assumption that the nitrogen (N) remains stable at lower temperatures, thus minimizing transformations that would otherwise lead to N losses. However, considering the freeze-thaw cycles (FTCs) typical of the prairies, it is conceivable that N losses are inevitable. Therefore, to advance our strategies for reducing N losses for sustainable agroecosystem and healthy environment, it is important to understand how freeze-thaw processes interact with N. In this study, a bibliometric analysis of the effects of freeze-thaw cycles on N dynamics was conducted to identify research opportunities that can be explored to advance N management in the Canadian prairies. A total of 2604 documents were retrieved from the Scopus online database from 1944 to June 2, 2023, and evaluated based on the worldwide distribution of studies, author keywords, and scientific collaborations between countries. China leads in publications (29.91%) followed by Canada (16.51%), the United States (14.02%), and Germany (11.53%). The most researched subject was “nitrous oxide” (n = 34), based on the author keywords. The strongest collaboration was between China and Germany with link strength of 13.33%. The analysis revealed the following research opportunity areas: 1) intensifying controlled laboratory experiments to help explain the mechanisms and processes of FTC-N interaction, 2) increasing FTC research on nitrate leaching and ammonia volatilization as they are potent pathways of N loss, 3) further research into biochar's potential in mitigating N losses, and 4) intensifying collaborations to adapt solutions to N management.

Meta-analysis of 4R Nitrogen Management on Nitrous Oxide Emissions from Croplands in Cold Climates

Sakshi[*]*, Xiaopeng Gao and Mario Tenuta*
Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada

The earth's climate has been steadily warming up over the last few decades, owing mostly to the rising levels of greenhouse gases such as methane (CH4), carbon dioxide (CO2) and nitrous oxide (N2O) in the atmosphere. Agricultural soils are a major source of direct and indirect N2O emissions. The 4R nutrient stewardship, which involves using the right fertilizer source at the right time, rate, and place, can significantly impact N2O emissions and agronomic yield. Enhanced efficiency fertilizers (EEFs), such as polymer-coated urea or products incorporated with nitrification or urease inhibitors, is recommended as a mitigation strategy for N2O emissions from agriculture as it enables precise timing of nitrogen release with crop growth and nitrogen demand. We conducted a meta-analysis to review and compare the cumulative N2O (ΣN2O kg N-ha^{-1}) emissions reported by different studies conducted in Western Canadian region and areas with similar climatic conditions (Köppen Dfb, warm summer humid continental climate), using different fertilizer sources (conventional urea versus EEFs), applied at different rates, times (Spring versus Fall) and placement depths (Broadcast versus Band). The results showed that the effect size of inhibitors is -0.3 (p=0.007), Dual inhibitors is -0.4 (p=0.001), PCU is -0.15 (p=0.004) and UAN is -0.1 (p=0.1) on N2O emission as compared to granular urea and UAN application, respectively. The banding of fertilizers resulted in lower N2O emissions in comparison to broadcasting. We expect that adopting the 4Rs can greatly reduce N2O emissions among the reviewed and sorted datasets. This study will quantify the 4R effects on N2O emission mitigation across cold climate zones and help to optimize the fertilizer management techniques for sustainable agriculture.

Soil-building Practices and N_2O Emissions at the NCLE Long-term Research Site in Southern Manitoba

Jose A. Almodovar-Gomez and Mario Tenuta*
Department of Soil Science, University of Manitoba, Winnipeg, MB

Climate change poses a significant threat to our world today, with agriculture being the largest contributor of nitrous oxide (N_2O), a potent greenhouse gas. Balancing the need to reduce emissions without compromising food security and farmers' livelihoods is a pressing concern. To address N_2O emissions, various soil-building practices, such as cover crops, nitrogen stabilizers, no-tillage, accounting for N supply in the soil at planting, and manure application, were combined and compared with conventional farming practices. This study, which represents the third phase of the National Centre for Livestock and the Environment (NCLE) Research Study, is located 15 km south of Winnipeg. Phase I examined perennial and annual cropping with different manure and fertilizer sources and rates. Phase II examined mineralization from previous manure applications. Phase III and the current study examine the conversion of perennial cropping to annual cropping and the use of soil-building practices to preserve soil health. Results from the 2020 to 2022 growing seasons are reported here. Static-vented chambers were used to determine N_2O fluxes. Growing season cumulative N_2O emissions averaged over the study were lower for the Past Perennial Soil Building Treatment (3.9 kg N ha^{-1}) than the Past Perennial Conventional treatment (4.4 kg N ha^{-1}). Similarly, average growing season emissions for the Past Annual Soil Building treatment were lower (2.4 kg N ha^{-1}) than the Past Annual Conventional treatment (3.5 kg N ha^{-1}). Past perennial management increased emissions by almost twice. However, soil building management reduced emissions from past perennial and annual cropping.

Arguments Against Human-Induced Climate Change and Why There is no Need for Reduction of Greenhouse Gases from Agriculture

Mario Tenuta
Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada.

Farmers and Ranchers of the Prairies consider themselves good stewards of the environment. Many also consider cities and urbanization the major problem for the environment. They see high CO_2 concentrations in the atmosphere as good for crop productivity. Reducing the emissions of CO_2, CH_4 and N_2O from agriculture and society is unwarranted. Yet climate scientists are nearly unanimous that greenhouse gases from human activities cause certain recent warming and climate trends. Further, food processors, several financial institutions, and the insurance sector see a reduction in emissions of great priority. As a result, many state governments, including Canada, have set reduction targets and a general need to achieve net zero emissions. How reductions in greenhouse gases from agriculture can be achieved without farmer and rancher buy-in is uncertain. This presentation will discuss the arguments largely used by farmers and ranchers to not prioritise greenhouse gas emission reductions on the farm.

What We Have Learned From Five Years Of Field-Scale Soil Health Research

Brady Goettl[*1], David Franzen[1], Tom DeSutter[1], and Abbey Wick[2]*
[1]North Dakota State University, Fargo, ND, USA
[2]Syngena Group, Fargo, ND, USA

Long-term, field-scale research projects not only serve as a foundation for science-based recommendations to producers, but also enable producers to see practices implemented first-hand and evaluate the efficacy of practices on their operations. In 2019, a field scale project was established in East-central North Dakota to evaluate the transition of a conventionally-tilled (CT) field to no-till (NT) practices. To establish a baseline for changes in soil properties and crop productivity, three replicate CT strips were installed at the project's inception, spanning the entire length of the field and capturing a range of soil and crop conditions. For monitoring agronomics and crop productivity in the dry bean-corn-soybean-barley rotation, 36 paired sampling points were arranged in a grid across the 110-acre field. Throughout the growing season, soil temperature and moisture were monitored at 2- and 6-inch depths. After five years of data collection, no differences in yield were observed between the CT and NT treatments. While soil temperature at planting was more favorable in the CT treatments, the mid-season soil temperature remained cooler in the NT and exhibited less daily temperature fluctuation. Although there were no differences in crop yield between CT and NT systems, the direct financial benefit of avoiding the expense of multiple tillage passes before planting may offset the costs of more intensive management.

Saskatchewan Chickpea Health Issue: Investigating the Nematode Factor

Fernanda Gouvea Pereira[1], Mario Tenuta[1], Michelle Hubbard[2] and Sarah Anderson
[1]Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada.
[2]Agriculture and Agri-Food Canada, Swift Current, Saskatchewan, Canada.

Chickpea crops in southern Saskatchewan have been facing health problems characterized by symptoms such as chlorosis, wilting, and plant die-off. First noticed in 2019, this issue has affected a wide area, including the main chickpea-growing region in the province, with 25 to 80% of fields impacted. Field soil surveys were carried out from 2020 to 2023, from symptomatic and asymptomatic locations (143 soil samples total) by crop specialists and analyzed at the University of Manitoba for the presence of plant parasitic nematodes. The pin nematode (*Paratylenchus ssp.*) was recovery at unusually high densities and fairly frequently from samples. To investigate if *Paratylenchus* were feeding on chickpeas, we conducted a growth chamber study utilizing soil samples with high *Paratylenchus* density collected from the 2022 survey. Three treatment groups were used: infested soil with chickpea (CDC-Corrine, 17 reps) present, infested soil without plants (4 reps), and non-infested soil with chickpea (3 reps). Infested chickpea soil had an initial *Paratylenchus* population of 502 $100g^{-1}$ dry soil. After 16 weeks, nematodes from soil and roots were extracted by Cobb sugar-flotation. *Paratylenchus* and other prominent nematodes were identified to the genus by morphological features and to species by molecular means (sequencing of the partial 18S, 28S (D2-D3), and ITS (ITS 1 & ITS2) regions of the rDNA gene). Sequencing showed the species of *Paratylenchus* to be *P. projectus*. At the end of the experiment, chickpea soil and roots in infested pots had a mean of 5,518 *Paratylenchus* per 100g-1 dry soil (±1180 s.e.), with a reproduction factor of 10.9 (±2.35 s.e.), highlighting chickpeas as an excellent host. Without the chickpea host, pin nematode population declined by 96%. However, the plants did not exhibit any disease symptoms. This study confirms that *Paratylenchus projectus*, recovered from Saskatchewan, is a parasite of the tested chickpea variety. Future greenhouse and microplot experiments are necessary to investigate the effects of *Paratylenchus* on chickpea health, if other crops are hosts, and to understand its impact on the chickpea health issue in Saskatchewan.

Pinto bean '*Phaseolus vulgaris* L.' tolerance to salinity, waterlogging, and combined conditions

Audrey Rhodes[*1], *Thomas De Sutter*[1], *Juan Osorno*[2], *Barney Geddes*[3]
[1]*Department of Natural Resource Sciences, North Dakota State University*
[2]*Department of Plant Science, North Dakota State University*
[3]*Department of Microbiological Science, North Dakota State University*

Soil salinization is an increasing problem that negatively impacts agricultural lands. In addition, ponding water during wet periods of the growing season creates a compounding effect of waterlogged soil with saline concentrations, posing a more difficult challenge for producers to overcome. No matter the growing region, salinity and waterlogging are threats to crop yield and global food security. Dependent of the tolerance levels to each of these factors gives way to how a crop will respond and to what magnitude of yield reduction will occur. Dry bean (*Phaseolus vulgaris* L.) is highly sensitive to both waterlogging and salinity, often having reductions in crop yield upwards of 100% when conditions are at their worst. Over recent years, research into increasing saline tolerances of various crops, such as soybean (*Glycine max* L. Merr.), has grown in popularity. There is, however, need for advanced focus on the tolerance and improvement in tolerance thereafter, of dry beans, which will allow for breeding programs to identify genotypes that are able to withstand waterlogging and/or salinity stresses to develop new cultivars. This project aims to improve cultivar selection of dry beans for waterlogged and saline soil conditions. This goal was accomplished through conducting water logging tolerance and salinity tolerance screenings under greenhouse conditions. Commercial pinto bean cultivars within the North Dakota State University dry bean breeding program were used throughout the greenhouse trials. Hypocotyl length and chlorophyll content were recorded throughout the study, and dry weight of above ground biomass was recorded at the end of the experiments. An adventitious root score was established to assess its role in tolerance of waterlogged conditions. Tolerant pinto bean cultivars found in the greenhouse will be confirmed using future field trails.

Evaluating the effects of a fall shoulder cover crop on soil strength and trafficability in Manitoba

Emmanuel Agyapong[1], Afua Mante[1], Yvonne Lawley[2], Francis Zvomuya[1] and Taurai Matengu[1]*
[1]Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada
[2]Department of Plant Science, University of Manitoba, Winnipeg, Manitoba, Canada

Manitoba's short growing season necessitates effective soil water management strategies to attain sufficient soil strength to support soil trafficability. This is particularly crucial at seeding and harvest when excess soil moisture impedes timely field operations. Over the years, subsurface drainage systems, access mats, and low ground pressure traffic systems have been used to overcome excess soil water challenges in the region. The use of cover crops to improve soil strength has been documented elsewhere. However, caution is needed when interpretating and implementing findings from other regions as these are influenced by agronomic practices, climatic conditions, and soil characteristics. This study evaluated the effects of fall shoulder cover cropping on soil strength that supports soil trafficability prior to seedbed preparation for annual grain production in Manitoba. A multi-year field experiment was established near Cartwright, MB as a randomized complete block design in fall of 2020. The treatments were overwintering fall shoulder cover crop (fall rye) and no cover crop and were replicated four times. During the 2022 growing season, soil water content was measured continuously to evaluate soil water dynamics under the treatments. The criterion for assessing soil strength sufficient for supporting soil trafficability was soil water content less than or equal to 90% of the lower plastic limit of the soil. Results on treatment effects on soil water dynamics and enhancement of soil strength to support soil trafficability will be presented. Findings from this study will contribute towards addressing an important question posed by the agronomic community: Can incorporation of a fall shoulder cover cropping system into annual grain production systems improve soil trafficability and build soil resilience in the face of extreme weather events to support farmer agronomic goals while contributing towards climate change adaptation and mitigation?

Application of Biochar as Soil Amendment to Improve Health and Quality of Manitoba Soils While Limiting the Carbon Release to the Environment.

Baljeet Singh, Dustin Bauer, Nevaeh Witherspoon, and Shreyas Gopi Venkatesh Prasad
Assiniboine Community College, Brandon, Manitoba, Canada

Biochar is a charcoal product produced by heating a high-carbon material in an environment with limited oxygen content. Biochar production and subsequently field application would be a good method of utilizing excess wood waste to restore soil carbon to croplands while limiting the carbon release to the environment (carbon sequestration). Biochar is known for supporting carbon sequestration in the soil and can retain up to 5 times its weight in moisture. Biochar improves soil porosity and nutrient absorption making them more readily available to crop plants. Biochar lasts for hundreds of years in the soil and is always active. Incorporating biochar in farmland has many benefits, including converting the waste material to soil amendments and improving air, water quality, and soil health while protecting the environment from hazardous and toxic chemicals. Many soil health parameters are known to be improved by applying biochar such as soil organic carbon content, water, and nutrient holding capacity, soil pH, drainage, and soil structure which positively impacts crop yield. Biochar serves many purposes in regenerative agriculture ranging from improving soil quality, livestock feed production, and water filtration treatments**.** Research data is available for biochar soil applications elsewhere, in Canada and globally however, field trials in Manitoba are needed to investigate the effects of biochar application rate and techniques of incorporation on soil health and crop yield. The current research study highlights some of the preliminary results to explore biochar application rates and methods of application to improve soil health and fertility of Manitoba soils while reducing greenhouse gas emissions and returning waste carbon into the soil.

Assessing soil loss and sedimentation using ^{137}Cs technique and soil erosion models within Canadian Prairie wetland catchments

Ehsan Zarrinabadi[a] and David A. Lobb[a1]*
[a]Dept of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada

Human-induced soil erosion is a serious problem throughout Canada, particularly in topographically complex landscapes of Prairie provinces, which contributes to loss of soil productivity, and on- and off-site damages resulting from sediment transport and deposition. The Prairie Pothole Region is populated by a high density of shallow depressional basins storing surface water runoff. This expansive wetland region occurs in a topographic and land use setting, where they are subject to exacerbated soil erosion and varying degrees of sediment deposition that can result in impairing natural wetland functions. Furthermore, sediment flux from agricultural fields through tillage-, water- and wind-induced soil erosion has potential to infill wetlands and shorten their effective life-span. The general objective of this study was to estimate and model the relative contributions of tillage, water and wind erosion to total soil erosion. The field measurement of soil erosion was conducted using ^{137}Cs technique. In addition, tillage, water and wind erosion predictions were performed using accepted soil erosion models (i.e., TillEM, RUSLE2 and SWEEP) that were validated by comparison to the total soil erosion estimates. Moreover, soil/sediment properties were analyzed to discriminate spatial heterogeneity of soil/sediment within wetland landscapes. The results of this study demonstrate that the highest soil loss rates are generally found on the upper slope position, while the areas characterized by deposition are largely located in the lower slope positions and particularly the outer riparian area that receive sediment delivered from the eroded areas. Furthermore, the area subject to soil loss greatly exceeds the area where deposition is found, and the field portion of wetland catchments are characterized by average erosion rates between 5.3 and -14.6 kg m^{-2} yr^{-1} for Manitoba, and between 2.0 and -1.3 kg m^{-2} yr^{-1} for Alberta.

POSTER PRESENTATIONS

Effect of Subsurface Drainage on Water Table Depth and Soybean Yield

Thushyanthy Akileshan[*], Ramanathan Sri Ranjan[1] and Nirmal Hari[2]*
[1]Department of Biosystems Engineering, University of Manitoba, Winnipeg, Manitoba, Canada
[2]Prairie East Sustainable Agriculture Initiative and Manitoba Agriculture, Manitoba, Canada

Subsurface drainage in poorly drained soils with seasonally shallow water tables can help avoid excess water and improve crop performance and yield. In Manitoba, most studies examining the effect of subsurface drainage on crop yield were limited to fewer crops including corn, potato, and canola. A two-year field study (2021-2022) was conducted to evaluate the drainage influence on soybean yield under shallow water tables. Two different drainage treatments were carried out in replicated field plots on heavy clay soils in Arborg, Manitoba: tile drainage and no drainage as control treatment. Tile drain spacing of 4.5 m (15 ft) and 13.7 m (45 ft) were used during the 2021 and 2022 growing seasons, respectively. Tiles were installed at a depth of 0.9 to 1.1 m. Piezometers were installed with water level sensors (Solinist Levelogger) to measure the water table depth. The soybean yield was obtained from three different strips: over tile, midway between tile, and from control plots where no tile drains were used. In 2022, a significantly higher yield ($p < 0.05$) was observed over the tile compared to the midway between the tile and control plots. The yield impact of the wider spacing (13.7 m) in clay soils was similar for midway between tiles and the control plots. The average water table depth over the tile and midway between tile was 1 m in 2022 and depth was 2 m in 2021 in drained plots from the ground surface. However, in 2021, the soybean yield over the tile and midway between the tiles was significantly higher ($p < 0.05$) compared to the control plots.

Seasonal response of CO_2 and N_2O emissions to nitrogen management strategies in annual cropping systems in New Brunswick

Takudzwa Nawu[*1,2], *Ikechukwu Agomoh*[1,2], *Francis Zvomuya*[1], *and Cedric MacLeod*[3]
[1]*Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada*.
[2]*Agriculture and Agri-Food Canada, Fredericton Research & Development Centre, Fredericton, New Brunswick, Canada*
[3]*Agriculture Alliance of New Brunswick*

Nitrogen (N) plays a pivotal role in agriculture, serving as an indispensable element in both the sustenance of global food security and the intricate dynamics of climate change. Nevertheless, poor management of N fertilizers in agricultural systems has led to adverse effects of nitrous oxide (N_2O) and carbon dioxide (CO_2) emissions to the environment. Consequently, researchers have devised many solutions aimed at mitigating N_2O and CO_2 emissions originating from agricultural soils. However, the effectiveness of these solutions varies due to regional variations in climate, geography, and management practices. Therefore, to support the Canadian government's 40% target for reducing greenhouse gas *(GHG) emissions by 2030, this 4-yr on-farm study aims to facilitate the adoption of beneficial* management practices by farmers that reduces GHG emissions, improve carbon storage and other co-benefits in New Brunswick. The study focuses on implementing and evaluating N fertilizer timing (split application) and the use of urease and nitrification inhibitors as strategies for mitigating CO_2 and N_2O losses from cropping systems. The study was conducted in 2023 on three farm sites where corn, oats and potatoes were grown. Treatments included the recommended fertilizer N rate applied at planting (N100) with no inhibitors (urease and nitrification inhibitors), the recommended rate applied with inhibitors at planting (T100), split application of fertilizer N (50% applied at planting and 50% as a topdressing) with inhibitors (TSPLIT), and split application of N fertilizer with both inhibitors and rate reduced by 15% (TSPLIT85). Samples for measurement of N_2O and CO_2 were throughout the growing season using circular static chambers. Ancillary soil and environmental measurements were also taken throughout the growing season. Regression analysis will be conducted to identify the primary factors influencing CO_2 and N_2O emissions. Preliminary results on treatment effects on CO_2 and N_2O emissions will be presented.

Optimizing Struvite Application for Increasing P Efficiency of Organically Managed Green Manure-Spring Wheat Sequences in Manitoba Soils

Manushi Henagama Liyanage[*1], Joanne Thiessen Martens[1], Martin Entz[2], Kimberly Schneider[1, 3], and Francis Zvomuya[1]*

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

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

[3] *Department of Plant Agriculture, University of Guelph, Guelph, Ontario, Canada*

Organic anions enhance struvite ($MgNH_4PO_4.6H_2O$) dissolution, a phosphorus (P) fertilizer with slow-release properties. Therefore, green manure crops (GMC) that exude abundant organic anions may increase struvite-P availability. The mechanism remains unclear, as evidence suggests increased struvite-P availability even without crops. This study examined spring wheat response to factorial combinations of P source (struvite and monoammonium phosphate (MAP)) and application timing (previous and current year) as affected by the preceding GMC species (faba bean, buckwheat, and field pea) at two organically-managed sites (Libau and Notre Dame) in southern Manitoba. A control (no P fertilizer) was included for comparison. Fertilizers were applied in a band with the seed. Results showed no wheat response to preceding GMC species or to P application at Notre Dame where background soil P concentration was moderately high. Buckwheat exhibited greater capacity to access struvite-P than field pea and faba bean at Libau but did not increase the grain yield of a subsequent wheat crop. Struvite application to a preceding buckwheat crop increased P uptake by the buckwheat-wheat sequence compared to application to wheat. Averaged across GMC and P sources, P application to the previous GMC increased wheat yield and P uptake of the GMC-wheat sequence relative to P application to the current wheat crop. These results will inform strategies for optimizing yields and overall struvite-P use efficiency based on struvite application timing in organic crops in Manitoba.

Soil water extraction patterns and soybean ET_a under subirrigation through tile drains in heavy clay soil

Komlan Koudahe[*], Ramanathan Sri Ranjan[1] and Nirmal Hari[2]*
[1]Department of Biosystems Engineering, University of Manitoba, Winnipeg, Manitoba, Canada
[2]Prairie East Sustainable Agriculture Initiative and Manitoba Agriculture, Manitoba, Canada

Effective soil water management requires information on soil water extraction dynamics and crop water use. The objective of this study was to evaluate the effects of subsurface irrigation through drainage systems on soil water extraction patterns and soybean actual evapotranspiration in a humid climate conditions. Field experiments were conducted in 2023 at Prairies East Sustainable Agriculture Initiative (PESAI), Arborg, Manitoba, Canada. Two subsurface irrigation treatments (on tile and midway between tiles) and rainfed conditions were evaluated with soybean at a rate of 444,789 plants per ha in three replicated plots. The change in soil moisture as measured by Meter probes in each layer (0-30, 30-60, and 60-90 cm) were added to compute the water extraction on a daily time step, and these values were added through the growing season. Furthermore, seasonal ET_a (mm) was computed using a general soil water balance model comprising runoff estimated using USDA-Natural Resources Conservation Service curve number procedure and deep percolation estimated through the daily water-balance method with a computer program. Results indicated a water deficit in the irrigated treatments while in the rainfed treatment, average seasonal moisture was above the field capacity which might be detrimental to crop yield. The greatest amount of extraction occurred in the irrigated treatments while the dryland recorded the lowest extraction. Among the soil layers, the water extraction was highest in the first layer with 43.1% of extraction on midway between and 44.9% of extraction on tile treatments. It was maximum on the rainfed setting in the 90 cm layer with 36.7% of extraction. Soybean seasonal ET_a ranged from 183 to 239 mm on rainfed and midway between tile treatments, respectively. The ET_a of the subsurface irrigated treatments averaged 236.2 mm. This study showed the importance of subirrigation through the drainage systems during the early drought experienced at the study location.

Soil microbial community structure dynamics of underground natural gas pipeline right-of-ways of varying ages

Clemence Muitire[*], Francis Zvomuya[1], Mario Tenuta[1], and Fernanda Gouvea Pereira[1]*
[1]Department of Soil Science, University of Manitoba, Winnipeg, Canada

Underground pipeline construction activities change the soil ecosystem of pipeline right-of-ways (ROW). Microbial communities, integral to soil health, offer insights into overall soil fertility, supporting plant growth, and sustaining agricultural productivity. However, the structure of microbial communities on reclaimed ROWs remains poorly understood. In this study, we examined the changes in soil microbial communities with increasing time elapsed since reclamation (TSR) of underground natural gas pipeline ROWs that are cropped. Soil samples were collected in September 2021 from the 0-20 cm layer on five ROWs with TSR ranging from 4 to 12 yr and from adjacent undisturbed locations (off-ROW). Metagenomic analyses of the 16S ribosomal RNA (rRNA) and Internal Transcribed Spacer (ITS) rRNA genes, were performed by Macrogen US. Analysis involved steps of next-generation sequencing and clustering of reads (MiSeq Illumina sequencing, CD-HIT-OTU package), filtering, trimming and chimeric removal of reads (rDnaTools package), and OTU assignment (QIIME 2 platform). The results showed the following: (1) bacterial and fungal abundance and richness varied with site, (2) the diversity and abundance of bacterial and fungal communities were lower in the 6-yr ROW than the 12-yr and off-ROW for two out of the three sites, (3) the dominant bacteria included members of the phyla Actinobacteria and Acidobacteria while the dominant fungi included members of the phyla Ascomycota and Basidiomycota, and (4) the bacterial phyla were more abundant in the off-ROW than the 6-yr ROW for two of the sites while fungal phyla were the opposite. These findings indicate that underground pipeline construction activities impact bacterial and fungal communities on ROWs and that the structure of these communities would improve with increasing time since reclamation. This research improves our understanding of microbial communities in reclaimed pipeline areas, crucial for informed decisions promoting environmental sustainability and successful land reclamation in areas affected by pipeline construction.

Modelling of the effect of nitrification and urease inhibitors on N_2O emissions, grain N, and crop yield – Challenges of using the DNDC model

Rida Sabirova[*1], Brian Grant[2], Ward Smith[2], and Mario Tenuta[1]*
[1]Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada
[2]Ottawa Research and Development Centre, AAFC, Ottawa, Ontario, Canada

The application of nitrification inhibitors and subsurface banding of fertilizer nitrogen can effectively reduce N_2O emissions from cropped soils. Field experiments with inhibitors and banding are important to understand beneficial practices to reduce N_2O emissions. However, estimating the benefit of practices on regional and even national levels can't be done through experiments. This is where models come in. Simulations through models can account for field properties and weather. They can be fast and cheap to use, and different practices and adoption levels by farmers can be tested. The N_2O prediction model we have used is Denitrification-Decomposition (DNDC). Nitrification inhibitor parameters are in the model but very limited. Currently, only a parameter for the efficacy of inhibitors (from 0 to 1) to inhibit nitrification and the duration in days of the effect can be adjusted. The aim of this study is to compare predicted and measured N_2O emissions from field studies with different inhibitors (eNtrench, LIMUS, SuperU) using published data (Wood et al. 2023). The sampling in the fields was for on-band and off-band areas. The following statistical coefficients were calculated to verify the model results: the coefficient of correlation (Pearson, *r*), root mean square error (RMSE), normalized root mean square error (nRMSE%), and index of agreement (*d*). Soil moisture, soil temperature (5 cm), as well as crop yield, and grain N, showed a great correlation between measured and predicted values. In general, DNDC significantly underestimated measured N_2O emissions for all treatments. The closest prediction was for the SuperU treatment, and the worst for eNtrench. A major limitation of the model is banding cannot be simulated; rather, nitrogen addition is assumed to be homogeneously mixed into the soil. The research is continuing, and the next steps are to update the model so that it can predict emissions from on-band and off-band, as well as the effect of soil properties on the inhibitors' effectiveness.

Enhancing soil health and soybean production through livestock integration

Joshua Wianecki[*1], Miranda Meehan[2], Kevin Sedivec[1,3], Zachary Carlson[2], Lindsay Malone[1] Colin Tobin[4], Michael Ostlie[4]*

[1]School of Natural Resource Sciences, North Dakota State University, Fargo, N.D.

[2]Department of Animal Sciences, North Dakota State University, Fargo, N.D.

[3]Central Grasslands Research Extension Center, North Dakota State University, Streeter, N.D.

[4]Carrington Research Extension Center, North Dakota State University, Carrington, N.D.

Producers in the Northern Great Plains are looking to maximize the economic and soil health impacts of cover cropping. Livestock integration has demonstrated positive effects to soil health while providing income through forage utilization. The objective of this study is to evaluate the influence of winter rye (*Secale cereale* L.) management through livestock integration on soil health and soybean (*Glycine* max (L.) Merr.) production. Management treatments include dual (spring and fall) grazing (DG), spring grazing (SG), no grazing (NG), and no winter rye (NR). Two study locations were established near Carrington N.D., and Streeter N.D. in fall of 2022. Forage yield and absolute ground cover were evaluated pre- and post-grazing. Stocking rates were calculated for each location and cattle were grazed in fall (DG) and spring (DG and SG). Post-grazing evaluations of soil bulk density, aggregate stability; nutrient analysis of nitrate (NO_3), phosphorous (P), potassium (K), and total carbon; and biological analyses of mycorrhizal fungi (AMF) hyphae count, and microbial biomass carbon (MBC) were completed. Soybeans were seeded following rye termination and performance was evaluated through yield data. Grazing during fall establishment did not affect spring yield or ground cover of the winter rye. Post-grazing bare ground was greatest within DG and SG, however annual weed establishment was significantly greater in NR compared to all other treatments. Bulk density and wet-stable aggregation did not differ between treatments post-grazing. Soil NO_3 was significantly higher at 15-30cm depth in NR at Carrington, but no other differences in nutrient analyses were observed. Soil AMF hyphal count did not differ, and MBC analysis is pending. Soybean yield was not significantly different. Year one of this two year-study demonstrated the ability to integrate livestock into crop production systems without compromising soil health attributes of a winter cover crop or impacting cash crop performance.

Mapping Manitoba's Grasslands Using Remote Sensing Data and Random Forest Method on Google Earth Engine

Mirmajid Mousavi Choobeh, Nasem Badreldin*
Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada.

Grasslands play a crucial role in soil carbon sequestration, biodiversity conservation, and agricultural support through livestock grazing. This study uses remote sensing and machine learning to assess remaining grasslands in Manitoba's Prairie Ecozone, estimating native, tame, and mixed grassland classes across 69,647 km^2. Due to the large area of our case study, Google Earth Engine (GEE) was selected as a planetary-scale platform for big data analysis. This study utilized monthly Sentinel-1 (S1) and Sentinel-2 (S2) images, both satellites launched by the European Space Agency (ESA), along with auxiliary data such as slope and aspect extracted from a Digital Elevation Model (DEM). For each monthly S2 scene, surface reflectance (covering spectral bands Blue, Green, Red, Red Edge 1, Red Edge 2, NIR, Red Edge 4, SWIR 1, and SWIR 2) and five key indices (NDVI, PSRI, NDMI, RVI, and RDVI) were extracted. Additionally, the ratio of VV (vertical transmit/vertical receive) and VH (vertical transmit/horizontal receive) bands of S1 ground range detection (GRD) for each month were included as features. A total of 66 features were included into the random forest (RF) method on GEE. Initially, an RF classification was employed to differentiate the grassland class from the non-grassland class, utilizing 3,004 ground truth survey points for the general grassland class and samples extracted from the Canada AAFC Annual Crop Inventory and ESA WorldCover 10m products. Subsequently, a second RF classification was applied specifically to the grassland class to identify three distinct grassland classes (native, tame, and mixed). The overall classification accuracy was 75.16%, with producer's accuracy for tame, native, and mixed at 81.73%, 80.89%, and 61.01%, respectively, while user's accuracy was 76.30%, 77.91%, and 69.83%, respectively. This research approach effectively maps large areas with advanced analytics, offering valuable data for stakeholders like government, growers, and NGOs.

Influence of Temperature on a Thin-Layer Active cap for the Remediation of Potentially Toxic Elements in Contaminated Sediment.

Dylan Mckenzie[*1], Srimathie Indraratne[2], Nora Casson[3]*

[1] Master of Environmental and Social Change Program, Department of Geography, The University of Winnipeg, Winnipeg, MB,Canada

[2] Department of Environmental Studies and Sciences, The University of Winnipeg, Winnipeg, MB, Canada

[3] Department of Geography, The University of Winnipeg, Winnipeg, Manitoba, Canada

Metal and metalloid contamination of aquatic ecosystems is an extensive environmental issue, which has the potential to be exacerbated by an increased demand for rare metals used in the electrification of the global economy. Once introduced, metal(oid)s persist and accumulate in sediment, where they may be resuspended into the overlaying water. In excess, metals such as lead, copper, and zinc may become toxic to aquatic ecosystems. Over the last few decades, research has increasingly focused on remediation strategies for persistent pollutants. Our research wanted to assess the viability of an active capping system containing amine-modified biochar and zeolite to immobilize multiple contaminants, including arsenic (64.6 mg/kg), cadmium (14.75 mg/kg), copper (330 mg/kg), lead 134 (mg/kg), and zinc (2840 mg/kg). In addition, we wanted to explore an existing knowledge gap in the research by investigating the potential influence that sizeable seasonal temperature fluctuations, like those seen across the boreal forest, may have on the immobilization of the contaminants of interest. Our research has been organized into three primary experiments. First, we chemically altered pristine biochar to amine-modified biochar through a two-step nitrification process and subsequent reduction. We then conducted a microcosm study to test contaminated sediment collected near a decommissioned metal smelter. Biochar, amine-modified biochar, and zeolite were tested in warm (20° C) and Cold (4°C) conditions to assess if the temperature significantly influences the adsorptive properties of the amendments. Water quality parameter data and surface samples were collected to assess changes in chemistry and metal(oid) concentrations. Sequential extractions of metal(oid) fractions in active capping material will be conducted to assess the ability of the amendments to immobilize the potentially toxic elements of concern. Finally, an adsorption experiment will be conducted on each amendment type to assess their viability in mono-metal and multi-metal solutions to assess their adsorptive capacities.

Quantifying plant heights with aerial based Light detection and ranging (LiDAR) sensor

Kamalpreet Singh[*1], Dilshan Benaragama[1], Nasem Badreldin[2], Ehsan Chatraei Azizabadi[2], Curt A. McCartney[1]*

[1]Department of Plant Science, University of Manitoba, Winnipeg, MB, Canada

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

Measuring plant heights is a key part of wheat breeding program as breeders aim to develop semi-dwarf varieties as they are less prone to lodging. In most breeding programs, plant height is measured with a marked meter stick and usually this process is very labor intensive. Advances in technology related to sensors have shifted focus on automating plant height measurements. Light detection and ranging (LiDAR) is a laser-based sensor that can be used to measure plant heights. It is an active sensor having its own light source, thus making it independent from light conditions, air temperature and wind. Although, ground-based LiDAR has been used to measure plant heights, the applications of aerial based LiDAR remain unexplored. Lidar sensor 'DJI Zenmuse L1' was mounted on a medium sized drone 'DJI M300 RTK' and the drone was flown over preliminary yield trials located at University of Manitoba campus. The initial pre-processing of the data was done in Cloud-compare software where "segmenting tool" was used to segment each plot. Quantile method previously used in plant height estimation in Wheat by LiDAR mounted terrestrially was used to calculate plant heights. In this method lower quantile in the point cloud is assigned as the base of the plant/soil and the upper quantile is assigned to top of plant heads (ideally excluding awns). The difference between lower and upper quantile values will give the plot's plant height. Regression analysis was used to compare the heights calculated with LiDAR and heights calculated manually with a meter stick. The upper and the lower quantiles were selected based on the coefficient of determination (R^2) and the Root Mean Square Error (RMSE).

Optimizing Potato Nutrient Management in the Canadian Prairies Using High-Throughput Technologies

Ehsan Chatraei Azizabadi[*1], *Nasem Badreldin*[1]
[1]*Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada*.

Potatoes hold a vital position in the agricultural domain of the Canadian Prairies, constituting approximately 45% of the total potato production in Canada. The imperative lies in refining fertilizer application methods for heightened precision, effectively mitigating the risk of nutrient losses and environmental consequences, including gas emissions and leaching. Achieving precision in using fertilizers becomes crucial to promoting sustainable potato farming practices in this region. To achieve this goal, this study will leverage high-throughput technologies to optimize the assessment and management of potato nutrients (specifically nitrogen and sulfur) with high precision. The objectives of this study are to evaluate the influence of timing and application rate of two control-release fertilizers (ESN and SuperU) on various characteristics of potato, to identify variations in spectral patterns associated with N and S deficiencies, and to predict potato crop yield and nutrient status with robust machine learning algorithms (i.e. ANN, RF, and SVR). During the 2023 growing season, we gathered data by utilizing of multispectral and LiDAR drones, a high-resolution satellite, and spectrometers, as well as conventional soil and plant nutrient analysis. Combined with advanced machine learning techniques, these tools were employed in a research potato field in Carberry, Manitoba, which is responsible for about 70% of the province's processing potato production. The field underwent various fertilizer treatments, including applying different fertilizers administered at different times and rates. Overall, this diverse and rich data set will enable us to gain deep insights into the dynamics of crop growth and health, ultimately leading to more effective and sustainable farming practices.

Multi-year Cover Cropping with Living Mulches – Year 1 Establishment with Wheat

Jessica F. Frey[*1,2], *and Joanne R. Thiessen Martens*[1]
[1]*University of Manitoba Department of Soil Science, Winnipeg, MB*
[2]*Parkland Crop Diversification Foundation, 117 2nd Ave NW, Roblin MB*

The use of perennial cover crops in temperate regions outside of the usual margins of the growing season provides well-documented benefits to the soil. The nitrogen-fixing ability of legume crops is of particular interest. In a growing season that typically consists of 90-110 frost-free days, establishing a living mulch system at the time of seeding the grain crop may be necessary to allow sufficient time for cover crop growth. To achieve the producer's goals, the intercrop must provide sufficient grain yield. A well-established living mulch using perennial legumes allows the understory crop to maintain its performance throughout a subsequent growing season with the continued presence of living roots in the ground between cash crops.

Preliminary results are for a spring wheat-living mulch system established in May 2023 at four Manitoba sites. Four legume species and one grass species were seeded in the same row and at the same depth as wheat. Data collection included wheat and living mulch establishment; wheat and cover crop mid-summer biomass; wheat yield and protein; and cover crop fall biomass. Results show that compared to wheat-only controls, wheat emergence, wheat biomass, wheat yield and wheat protein were not significantly affected by the presence of the living mulch. Results also demonstrate that more deeply tap rooted mulches produced more biomass than fibrous rooted mulches.

Exploring the impact of natural salinity on common lambsquarters and kernza

Chantel Mertz[1], Thomas DeSutter[1], Clair Keene[2], Mike Ostlie[3], Miranda Meehan[4], and Aaron Ostlund[1]*

[1]School of Natural Resource Sciences, North Dakota State University, Fargo, North Dakota, United States

[2]Department of Plant Sciences, North Dakota State University, Fargo, North Dakota, United States

[3]NDSU Carrington Research Extension Center, Carrington, North Dakota, United States

[4]Department of Animal Sciences, North Dakota State University, Fargo, North Dakota, United States

Regardless of time or geography, whether occurring naturally or exacerbated by anthropogenic activity, soil salinity is a persistent issue that poses a growing concern. For the oil and gas industry there has been a noticeable lack of information concerning the effectiveness of phytoremediation, and the identification of suitable plant species and their tolerances to salinity as well as to accidental releases of oil-field produced waters (aka brine). After a preliminary growth chamber experiment screening five plant species for their salinity tolerance, *Chenopodium album* (common lambsquarters) and *Thinopyrum intermedium* (kernza) were selected as candidates for further study. A field experiment was conducted to determine the relative salinity tolerances of these species from germination to maturity as well as their potential as phytoremediators by monitoring their ability to uptake and store salt. A site with a natural salinity gradient was mapped using an EM38 and divided into eight distinct EC ranges. Common lambsquarters and kernza were planted in June of 2023 in the designated areas, and within each salinity range, sample locations measuring $1m^2$ were established. In October of 2023 lambsquarters was harvested, however, kernza failed to establish as a result of soil crusting post planting followed by a dry growing season. Kernza was replanted in September and will be assessed in 2024. Future analyses of lambsquarters and kernza biomass will include dry weight, animal feed values, seed yield, and ion concentrations (including Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, SO_4^{2-}, and NO_3^-). Soil samples were collected during biomass harvest from each sample location, dried, and will be analyzed for electrical conductivity (EC_e), sodium adsorption ratio, pH, as well as the aforementioned ion concentrations.

'*Phaseolus vulgaris* L.' tolerance to waterlogged conditions: 2023 North Dakota field study

Audrey Rhodes[*1], Thomas De Sutter[1], Juan Osorno[2], Barney Geddes[3]*
Department of Natural Resource Sciences, North Dakota State University[1], Department of Plant Science, North Dakota State University[2], Department of Microbiological Science, North Dakota State University[3]

Ancient geological events throughout the Red River Valley (RRV) of North Dakota and Manitoba have resulted in an accumulation of fine silt and clay particles, as well as an extensive flat landscape. Precipitation infiltration is reduced in areas with higher clay concentrations and runoff is slow due to the unvarying topography. The combination of these conditions can often lead to periods of waterlogged soil. Increased precipitation variability and intensity during the spring and early summer months has led to the occurrence of waterlogged fields across the RRV. Most modern crop species are intolerant to waterlogged conditions, including dry bean (*Phaseolus vulgaris* L.), which North Dakota contributes over 30% of the US dry bean production, with a majority produced within the RRV. The goal of this project was to improve cultivar selection of dry beans for waterlogged soil conditions. This goal was accomplished through a field trail of dry bean cultivars previously screened for waterlog tolerance in greenhouse conditions. Flooding was controlled using a continuous drip system. Hypocotyl length, chlorophyll content, growth stage, and an established visual score were recorded throughout the study. Dry weight of above ground biomass, nodule count, nodule wet and dry weight, and average nodule size of rhizobium were also recorded. Tolerant cultivars found in this field trial will be confirmed in a 2024 field trial and to the understanding of dry bean-rhizobia interactions during waterlogging conditions.

Soybean Cyst Nematode, *Heterodera glycines* Ichinohe 1952, Spatial Distribution and Impact in a Manitoba Coarse Texture Field

Fernanda Gouvea Pereira[1], Nazanin Ghavami[1], Jason Voogt[2], and Mario Tenuta[1]
[1]Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada.
[2]Field to Field Agronomy Inc., Miami, Manitoba, Canada

Soybean Cyst Nematode (SCN) is a devastating pathogen, known for causing significant yield losses in soybean and certain dry bean varieties across North America. Although SCN was first identified in Manitoba in 2019 with low cyst populations, a subsequent investigation in July 2021 revealed an SCN symptomatic and cyst-laden roots of soybean in a field located in the Rural Municipality of Thompson. The affected area was at the field entranceway for machinery. Detailed soil sampling in the affected area was conducted in a grid patten (6 m x 10 m) covering a 1,680 m^2 area. Molecular analysis confirmed the cysts to be *Heterodera glycines*, establishing the presence of SCN in the field. The maximum egg density was 7,797 eggs 100 cm^{-3} soil, which is moderate to high for SCN levels, concentrated in the centre of the patch. Densities tapered to zero in visually healthy soybean growth areas. We were then curious if SCN had spread to other areas of the field and thus sampled the entire 93-acre field using a 1-acre grid pattern, yielding 91 soil samples. Four cores were taken at evenly spaced points within each grid, from 0 to 20 cm depth, and then composited for analysis. Soil samples were extracted for eggs, eggs stained, and counted to determine soil densities. Analysis of soil properties, pH, electrical conductivity (EC), total nitrogen (TN), soil organic carbon content (SOC), and the C:N ratio, were also done. Data analysis was conducted using SAS University, transformed to fit normality. Multiple Linear Regression was employed for modeling density relation to soil properties. No statistically significant correlations between soil properties and SCN egg counts were observed at the 5% significance level. The maximum observed egg count was 933 eggs 100 cm^{-3} soil, and the spatial distribution of SCN eggs reflected a nematode spread pattern based on translocation within the field. The highest egg density was at the affected field entrance, with spread in a north-south orientation attributed to direction of soil disturbance during seeding and tillage operations. Of note, the entrance area with SCN disease symptomology and highest egg densities did not reach complete reproductive maturity and consequently did not yield.

Do Tillage, Cover Crops, and N Stabilizers Affect Growing Season N_2O Emissions and Corn Yield in Southern Manitoba?

Mikhail Maslov, Brad Sparling and Mario Tenuta
Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada.

Corn is a major agricultural commodity in Canada with recent yield and planted area increases in Manitoba. Nitrogen inputs are high relative to other crops and are expected to increase with genetic improvement of yield potential. Thus, it's important to find ways to reduce N_2O emissions without compromising farm productivity and profits. We tested the combination of cover crop (fall rye - *Secale cereale* L.), tillage method (No-till vs. Conventional tillage), and nitrogen stabilizer (nitrification inhibitor Centuro and combined urease + nitrification inhibitor Tribune) in 2023 on growing season N_2O emission and corn yield in Southern Manitoba at the Ian N. Morrison Research Farm in Carman. For each treatment (except control), 105 kg ha^{-1} N was applied: 26.25 kg ha^{-1} N (urea) was side-banded at corn sowing, and an additional 78.75 kg ha^{-1} N (UAN) was split applied as a side-dress injection at about 4-5 leaves stage. The stabilizers were applied with the split application of UAN. No-till reduced soil N_2O emissions (in average by 40%) as well as increased corn yield by 16% compared to conventional tillage. The cover crop increased N_2O emissions in average by 16% as well as reduced yield by 15%. The highest cumulative N_2O emissions were observed with combined cover crop and conventional tillage. Despite the hot and dry summer, inhibition of nitrification was effective in reducing N_2O emissions without compromising yield. The reduction in cumulative emissions was 23-36% for No-till and 45-51% for conventional tillage. There was no additional effect of including the urease inhibitor as Tribune on N_2O emissions or yield. However, this is just the first year of five-year study, results are thus preliminary.

Effect of Fall Rye Cover Crop on CO_2 and N_2O Fluxes in the Red River Valley, Manitoba, Canada

Kathryn Webb, Mario Tenuta, Brian Amiro, and Matt Gervais
Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, Canada.

Cover crops can increase carbon (C) sequestration in soils. However, there is limited understanding of how cover crops affect carbon dioxide (CO_2) and nitrous oxide (N_2O) fluxes from agricultural soils in the Canadian Prairies. Research was conducted at the Trace Gas Manitoba (TGAS-MAN) long-term research site to determine the effect of a fall rye (*Secale cereale* L.) cover crop on spring-thaw and post-fertilizer N_2O emissions, CO_2 fluxes, and grain yield. Fluxes were measured over four years (2019-2022) from four 4-ha fields using the flux gradient method. In the fall of 2018 two fields were seeded no-till with fall rye and two were cultivated and left into winter. The cover crop was terminated the following spring with an herbicide application and the cash crops oats (*Avena sativa*), canola (*Brassica napus*), and spring wheat (*Triticum aestivum* L.) were grown in 2019, 2020, 2021, and 2022. 2020 and 2021 CO_2 fluxes were removed due to unreliable data caused by flux measurement equipment. In 2019, C assimilation by the cover crop resulted in the system being a C sink of 424 kg C ha^{-1} after accounting for harvest removals, and the conventional system was a C source of 248 kg C ha^{-1}. In 2022, wet growing conditions resulted in both cropping systems being a C source, with the conventional and cover crop system losing 1,366 kg C ha^{-1} and 1,558 kg C ha^{-1}, respectively. The cover crop fields saw lower spring-thaw N_2O emissions during years of good cover crop establishment. N_2O emissions following fertilizer application and cumulative N_2O fluxes were lower in cover crop fields in all study years. Combining cumulative CO_2 fluxes and N_2O emissions in CO_2-equivalents (CO_2-eq) in 2019 and 2022, the cover crop system was a net greenhouse gas source of 5,665 CO_2-eq ha^{-1} and the conventional system was a source of 7,653 CO_2-eq ha^{1}. The cover crop did not significantly affect crop yields.

An Updated Soil pH Map for Agro-Manitoba

Ronggui Wu and Megan Westphal
Climate Resilience, Manitoba Agriculture

Soil pH is an important factor that can affect soil nutrient availability, microbial activity, pesticide efficiency and crop production. So, it is vital to have an accurate soil pH map for soil and crop management. The last Manitoba soil pH map was delineated in 1987, mainly based on climate, parent material and soil texture. As topography, one of soil forming factors, has a great influence on variations of soil pH in the A horizon, soil pH data from individual soil series was used to create the updated soil pH map. This is because soil series is a production of all soil forming factors. Soil pH values are categorized into eight pH classes: Extremely acid (pH 3.5 – 4.4), Very strongly acid (pH 4.5 – 5.0), Strongly acid (pH 5.1 – 5.5), Moderately acid (pH 5.6 – 6.0), Slightly acid (pH 6.1 – 6.5), Neutral (pH 6.6 – 7.3), Slightly alkaline (pH 7.4 – 7.8) and Moderately to Strongly alkaline (pH 7.9 – 9.0). A total of 3,644 new soil pH values in the A horizon and 850 previous values are analyzed. The results indicate that soil pH can be as low as 4.4 in an imperfectly drained Gleyed Dystric Brunisol in the South Easten region and as high as 9.0 in an imperfectly drained Gleyed Rego Black Chernozem in the South-Central region of Manitoba. Overall, most soils in Agro-Manitoba fall within the Neutral to Slightly alkaline class with 35.5 and 31.4 percent, respectively. Reporting and visualization of soil pH data will greatly aid with best agronomic practices and decisions within Agro-Manitoba.

Comparison of soil properties with and without long term swine manure application in North Dakota

Nathan Derby [1], Thomas DeSutter [1] and Miranda Meehan [2]
[1] *School of Natural Resource Sciences, North Dakota State University, Fargo, ND, USA.*
[2] *North Dakota State University Extension, Fargo, ND, USA.*

To investigate the effects of repeated swine manure application, areas of similar soil (silt loam-silty clay loam) were selected from six small grain production fields in northern North Dakota. Three fields had no recent history (ten or more years) of manure application and three fields had received annual applications of liquid swine manure. After grain harvest in 2022, a 4x5 grid of 20 soil sample locations with 25-m spacing was established on each field. At each grid point, a hand trowel was used to collect soil from 0-15 cm depth for 26 chemical parameters and for wet aggregate stability analysis. In addition, a Veris P4000 probe was used to measure EC, penetration resistance, and IR reflectance at 2 cm increments to 1 m. Significant within-field variability of the measured parameters was observed. Principle Component Analysis indicated different correlations of the measured parameters between manure and non-manure sites. Organic matter, TOC, POXC, and total wet-stable aggregation were significantly greater for non-manure sites while salts, nitrate-N, P, Zn and most other micronutrients were significantly greater for manure sites.

Update on Detailed Soil Survey Activities in Manitoba

Megan Westphal & Ronggui Wu, Manitoba Agriculture

Detailed soil survey information is a key tool in making appropriate, economical and sustainable land use and land management decisions to aid in improving agricultural production for Manitoba's land and soil resources. These surveys also contain important agronomic information that can aid in soil and nutrient management decisions on farm. This information includes soil texture, salinity, pH, soil organic carbon and more. Manitoba's soil resource information is also more than just maps. Documents such as "The Description of Soil Series in Manitoba" contains even more information on almost all the soil series found in Manitoba. For example, most soil maps will display soil surface texture only. However, in Manitoba our soils tend to be quite variable in some areas and some soils will consist of medium to moderately coarse surface textures such as fine sandy loam over fine textured soil material such as clay within 1 metre from the surface. These texture differences within the soil profile can have a great impact on water movement and nutrient availability through the soil. Consulting both soil resource maps and other soil resource documents is the best way to make agronomically sound and economically viable decisions on your farm.

Effect of drainage spacing and soil moisture dynamics in wheat yield in a heavy clay soil

Dasinija Karikalan[*,1]*, Ramanathan Sri Ranjan*[1]*, and Nirmal Hari*[2]
[1]*Department of Biosystems engineering, University of Manitoba, Winnipeg, Manitoba, Canada*.
[2]*Prairie East Sustainable Agriculture Initiative and Manitoba Agriculture, Manitoba, Canada*

Poor drainage in Manitoba's heavy clay soils pose challenges to crop growth. Tile drainage can help overcome this challenge. The aim of this study is to find the effect of subirrigation, soil moisture distribution over time on wheat yield under different drainage spacing. The wheat yield experiments were conducted at PESAI research plots, Arborg, during 2022-2023. The experiments were conducted in plots having drain tiles installed at two different spacings: 13.7 m (45ft) and 9.1 m (30ft) with no drain control plots. Real-time soil moisture data was collected using Meter sensors at different depths (20, 60 and 90 cm) in each plot. Yield data was collected at locations midway between the tiles and on over the tile as well as the control plots. Weather data was collected throughout the season. In 2022, a significantly higher yield was observed midway between the tile (9.1m spacing) compared to the control plots. Whereas in 2023, a significantly higher wheat yield was observed in the control plots compared to over the tiles (9.1m spacing). The response to subirrigation during early season and rainfall events throughout the season led to significantly different volumetric water content at different depths within each plot. Future analysis on ground water level and simulation by DRAINMOD will provide more insights into the soil moisture dynamics arising from subirrigation and tile drainage and its effect on wheat yield. This research has the potential to optimize water management and contribute valuable insights to global agricultural sustainability.