ORAL PRESENTATIONS

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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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

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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.

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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

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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.