Soil Fertility and Nutrient Management: *40 years and forward*

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We acknowledge that the Saskatoon campus of the University of Saskatchewan is on Treaty Six Territory and the Homeland of the Métis

Why is nutrient management research important?

Nutrients are often the greatest input cost on the farm

Nutrients: Use ‘Em, Don’t Lose ‘Em!

Maximizing Plant Utilization Is of Agronomic, Economic and Environmental Advantage



General Goal

To develop, evaluate and disseminate improved soil and nutrient management strategies for SK, Canada and the World

Soil fertility and fertilizers, manure & organic amendments, cropping practices, soil quality, C storage, GHG mitigation

Emphasis on nutrient cycling processes:

The 1980's



Soils not in good shape, farm economy hurting

Starting to consider alternatives to cereal-tillage fallow:

direct seeding, continuous cropping, multi-crop rotation, pulses and canola

Sulfur in Crop Production

Developed stable S isotope tracer techniques and used for following S through soil-plant system PhD thesis 1988

Nutrient in Cycling in Boreal Forest Uplands and Wetlands

Carbon, nutrient stocks in boreal forest soils, northern wetlands as sources and sinks of carbon, methane
NASA BOREAS PROJECT in early 90's

Chamber techniques for measuring methane fluxes in boreal peatlands

Litter layer in boreal forest major storehouse of carbon and nitrogen. Significant fluxes of methane from open bogs in the boreal north.

The 1990's

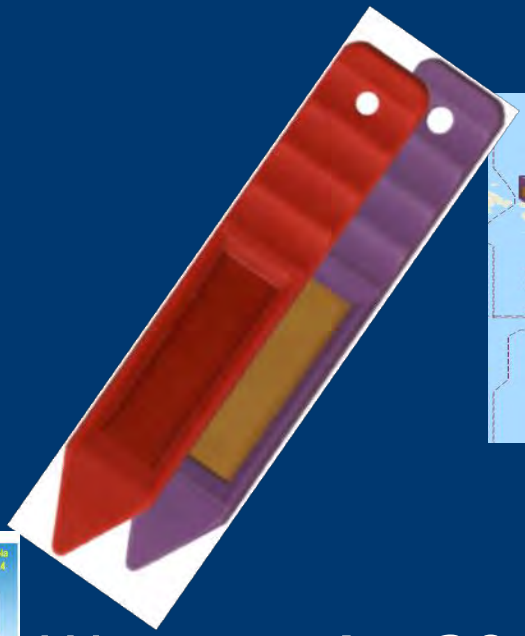
Adoption of no-till, new crops, conversion of marginal lands to permanent cover

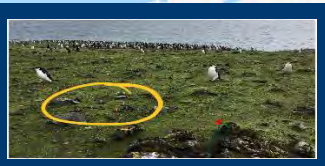
Expand hog production

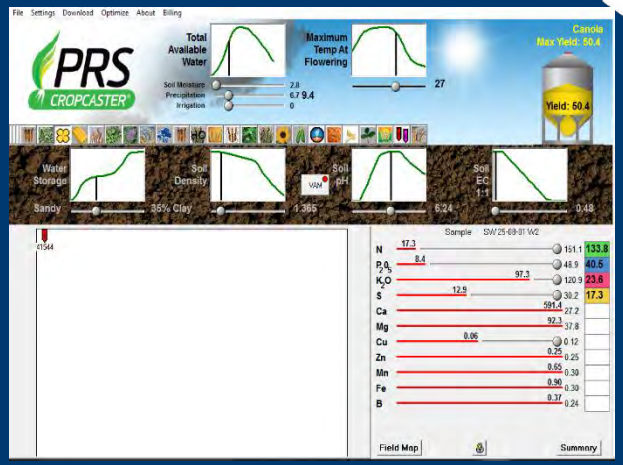
Fertility & nutrient management implications??

NEED SOME TOOLS!

1990's Invention, Development, Patenting, Commercialization of New Soil Testing Technology "Plant Root Simulator"

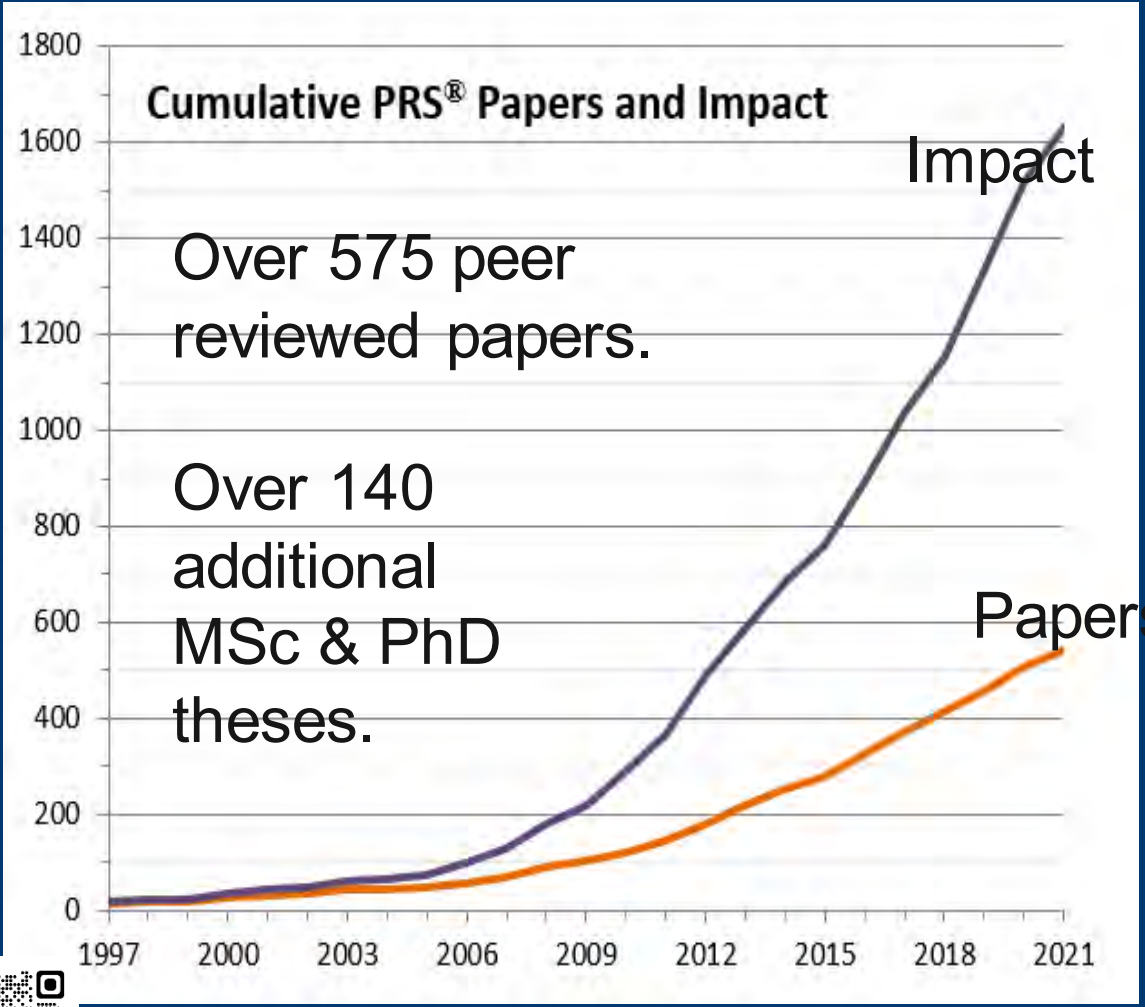




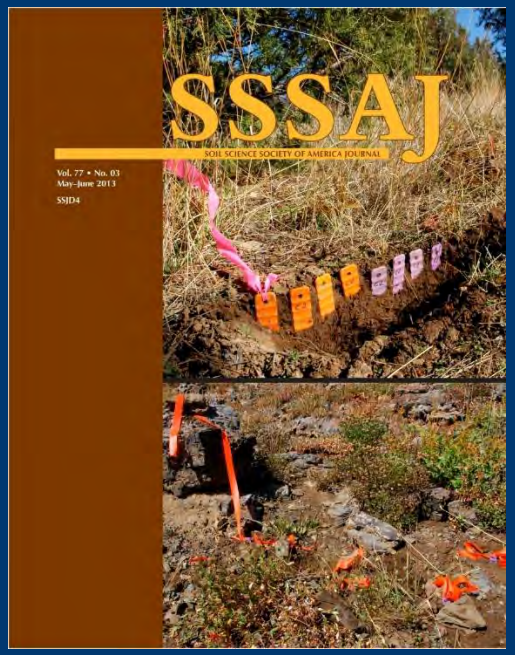


Western Ag 30+ employees in SK
Fertilizer recommendations in prairies, Northern USA
Used as research tool in 58 countries

Peer reviewed research papers written using PRS Data and respective impact.



The 5-year average journal **impact factor** for PRS® publications is **3.0**.



https://westernag.ca/innovations/publications/list

Low Disturbance Manure Injection Technology

Manure nutrients and organic matter are important resource!

Work with PAMI to develop, evaluate manure injection technology to reduce nutrient losses, improve crop response

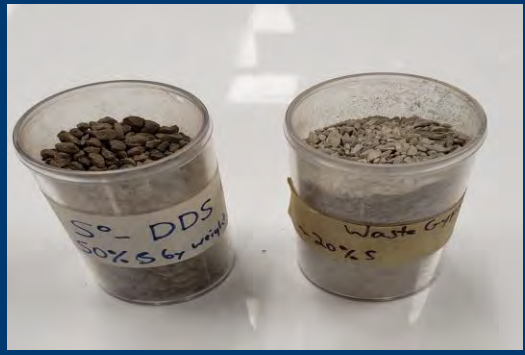
Result: nearly all liquid manure applied on prairies is injected now.

Converting Marginal Lands to Permanent Forage Cover

Documented significant C sequestration rates, soil quality benefits from growing forages across SK.

Organic-Inorganic Fertilizer Synergies

- Combination of elemental S with sewage sludge to produce fertilizer with enhanced oxidation and plant availability



- Waste gypsum sources (e.g. wallboard) evaluated and identified as effective source of sulfur for crops

The 2000's

Cropping systems more complex, technology advancing, cost of production going up, environmental issues surrounding nutrient losses gaining attention

Phytotoxicity and Persistence of Soil Active Herbicides

Many herbicides (flucarbazone, thiencarbazone, sulfentrazone, pyroxasulfone) have soil activity, but not much known behavior in prairie soils: herbicide carryover, crop injury issues, grower complaints, insurance claims

Root and shoot length inhibition bioassays developed, and used to determine and predict impact of soil organic matter, pH, texture, moisture on phytoxicity and carry-over. Used by industry to develop soil-specific guidelines for growers.

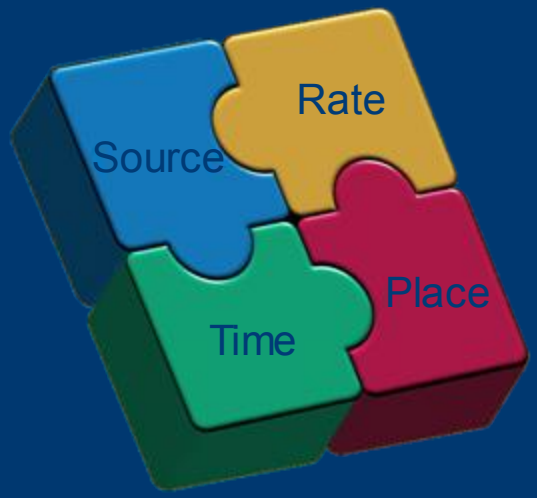
(Szmigielski et al.)

Identification of superior cattle overwintering systems for cow-calf producers

In- field feeding is more efficient in nutrient recycling, economical than in-yard lot feeding

Better than

Determining Effective "4R" Strategies for Fertilizer Application in Prairie Soils



- **Most effective sources** of S and P for canola, pulses and cereals field, lab, Canadian Light Source
- **Best rate and placement** of N and P fertilizer for annual crops & forages, **crop requirements**
- **Safe rates** of seed-row fertilizer for all crops
- Crop responses to micronutrients at **different times** in rotation.

Become incorporated into SMA provincial guidelines, fact sheets

Effective Nutrient Placement

- Agronomic and environment benefits from banding systems in direct seeding
  - Can place N away from seed-row and get good response

- Fate of fertilizer and manure P and S
  - New method for assessing run-off potential
  - In - soil placement enhances availability, reduces losses in run-off compared to surface
  - CLS used to reveal P and S species originating from fertilizer

Precision Agriculture

- Using crop protein- yield relationships at harvest to identify field N limitations and develop variable rate N fertilizer prescriptions

- Precision subsoiling to address compacted areas in fields.
  - Not economical to subsoil entire fields, economical to subsoil identified compacted areas: wheel tracks

Crop Nutrition and Quality

- Nutrient requirements, N fixation by peas, soybeans, fababeans

- Fertilization strategies for biofortification of micronutrients in pulse crops.
  - Identified Zn fertilizer forms and application strategies that were most effective in increasing human bioavailability of Zn in grain

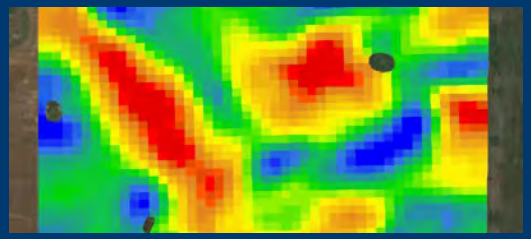
Bioenergy Crops and By-Products

- Identified willow clones tolerant to salinity, nutrient requirements and removal, nutrient cycling in willow systems

- Use of chars, ash, distillers grain, manure as soil amendments to return nutrients in crops used in bioenergy production back to soil.
  - Thin stillage, distillers grain, ash good fertilizer
  - Chars can reduce nitrous oxide emissions, retain nutrients to protect against losses

Today: Examples of Current Projects

- Precision cattle manure management: variable rate according to long-term productivity and set-back from water



  - More uniform production and nutrient distribution, reduced nutrient, coliform, hormone in run-off, reduced nitrous oxide production

Building Productivity of Eroded Knolls



- Addition of P and micronutrient fertilizers can help, but cannot replace all the benefits that topsoil provides.

Forage, Grazing, Cropping Systems and Soil Properties

- Benefits of seeding salt tolerant grasses and legumes on soil properties and productivity.
  - Can achieve grass growth on saline soils similar to that on non-saline soils

- Long-term conservation cropping and soil organic matter
  - Across prairies, 21 yrs of soil conservation significantly increased SOC, microbial biomass
- Sod-seeding non-bloat legumes to rejuvenate old pastures: effects on soil C and N

INTERCROPPING

Intercropping oilseeds with pulse crops has benefits:

- Lower input costs
  - Legumes fix their own nitrogen and can also supply to partner
  - Legumes are great scavengers of phosphorus and other nutrients

- Synergy between crops beneficial for organic growers

4R Fertilizer Management

- Effects of P,N fertilizer form, rate, placement and timing on yield, recovery, fate in soil and run-off water.
  - Less soluble P fertilizers tend to have reduced availability under dry conditions, but also have reduced loss in run-off water

- Management of drained wetland basins to reduce nutrient loss in water: forages, variable rate, tillage
  - Strategies like growing forages, reducing fertilizer rate in basin beneficial in reducing nutrient in water moving of drained basin

Influence of chars on nutrient retention and loss

Fertilization-plant nutrition-disease interrelationships

Potassium, chloride, micronutrient metals

International

- China IPNI (80's and 90's) Soil Fertility Evaluation Training
- Ethiopia CIDA Student Exchange Soil Management (90's- 2000's)
- Mongolia CIDA: Introduction of Soil Conservation Technologies (2000's)
- Sub-Saharan Africa: Fertilizer and cropping systems (last decade)

Looking Ahead

- Straw harvesting, management
- Sod-seeding, legume re-introduction
- Improving productivity, increasing C storage, reducing GHG in marginal lands
- Alternative sources of P for crop production

A Team Effort!

Undergraduate Student Projects
Graduate Students
Post Doctoral Fellows, Research Associates
Summer students and technicians

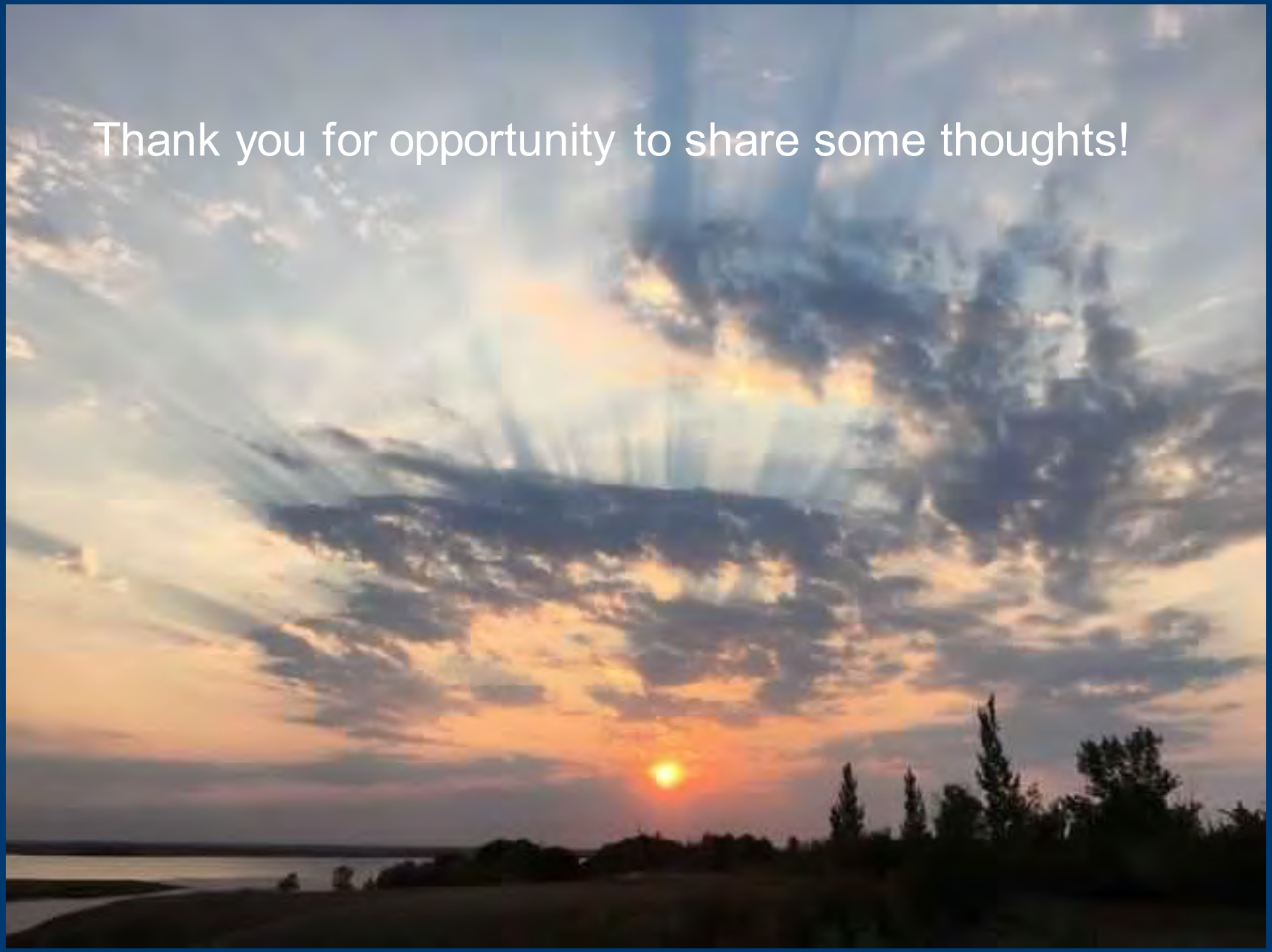
Collaborations: e.g. SMA, CDC, GIWS,GIFS, AAFC, ECCC, PAMI etc.






If we look after our soils, they will look after us!

Thanks for SRP and ADF support of Soil Nutrient Management!


Thank you for opportunity to share some thoughts!