Transcript of presentation for farmers and ranchers in Southern Alberta Feb 16, 2021
PowerPoint Slides at: www.plantsdigsoil.com/media

1. Title Slide (0:00)

Thank-you for the invitation to speak to you this afternoon. Looking at how to integrate regenerative practices into nutrient management plans is a passion of mine. I was very happy to get the invitation from Brad to speak on this topic.

I've called today's presentation "Realistic Regenerative Nutrient Management" because there is a lot of hype out in the ag media sphere, and especially in the ag social media sphere. If it weren't for Covid I'm sure we would have seen a lot more of the celebrity farmers, consultants, and academics coming up to speak in the area.

In this presentation I want to provide a baseline for what the soils and climate of this area are capable of. For any of you who attended the Cypress mini conference on soil health in late January this first part will be review. From the baseline I will look at how exactly we can look at building a regenerative nutrient plan for our farms.

2. Timeline of Southern Alberta Soils (1:00)

When you think of making changes to the soil on your farm you may be thinking in terms of years or maybe even decades. If you think about agriculture in this area as we know it, you would be thinking in a century or maybe a century and half at best. But to truly think about these soils you must think in millennia.

We have very young soils in a geological timeline. In a human timeline it is almost unfathomable. The soils in this region are about 10000 years old. To put this in perspective if you took every year and condensed it to a day, so we are talking about 10000 days now, it would take 27 years to see these soils develop. Think of a 27-year span. This could be how long you've been farming. Perhaps its how long you've been married. If you're just starting out farming you may not have even lived 27 years.

Now when we put agriculture into the picture, you will only need wait another 5 months. Five months is a typical growing season here – mid April to mid September. Imagine living for 27 years, seeing these soils develop, and then in the span one growing season watching agriculture completely change them.

To help you visualize this for the rest of the presentation the green bar at the bottom of the slides was created to represent the 10000 years of soil development. The red rectangle on the right edge is scaled to represent 150 years of agriculture.

3. Human Management of the Soils (2:30)

Agriculture is new in this area, but human management is not. The human management that I am speaking of must be thought of in hundreds or thousands of years. The changes were at landscape scales. The land management was truly sustainable at that point. The number of people that could live on it was directly tied to what it could give. The people had a close connection to the land. It was a closed system.

Starting about three centuries ago there was a change in the management. The colonists arrived and opened new trade networks. New technology in the form of guns and horses allowed greater harvest off

the land by the Indigenous than had ever happened before. There was now export off the land as buffalo products were sent to far off areas of the world. More were taken than could sustain the herd. The change was so gradual that most people did not see it coming.

It is unfortunate how events unfolded. None of us were around in the late 1800's when change accelerated and culminated in the Indigenous forced into signing treaties and being put on reserves. However, we can work now to understand what happened and work in the present to make a better future.

4. Buffalo Bird Woman (3:45)

In this area the Indigenous populations were mostly based on the buffalo but there was a pocket near us that did support agriculture. In what is now the Dakota's, in the United States, there were tribes that practiced agriculture in the bottom land by the Missouri River. They never tried in the lands that we are trying to farm on because it was too hard and dry to be worth their effort.

I found some remarkably interesting parallels to how we farm today.

Buffalo Bird Woman[1] talked adamantly about having to keep up with weeding. Letting them go meant less crop. If she could kill them before they set seed, she would leave them in place but if they had seed heads, she removed them from her field so they wouldn't cause more problems in the following years.

She was very careful in saving seed. Varieties had been passed down through generations of selection and trading and she knew that you saved the best seed at harvest to plant next year, not what was leftover in the spring. She kept a two-year supply of seed because she knew that years would come when early frosts meant poor seed. She had scorn for the unwise families that did not save as much as she did. She didn't share with them, she sold to them. The price of 65 ears of corn was a tanned buffalo skin.

Fallow was practiced. New fields were opened by clearing the timber on the river flats, digging up the grass, and burning it in place the season before starting to farm it. The first crop was always the best. The second was never greater than the first but it often equaled it. After three or four years she would rest a field for one or two years for it to regain its vigor.

It is estimated that this kind of agriculture developed around the 12th century. It continued to evolve for 700 years until the colonists took over the land, moved the tribes to reservations, and tried to change them to their style of agriculture.

5. Seager Wheeler (6:00)

I have another firsthand account of one of the first farmers. This one is based in the area north of Saskatoon and is made by a colonist by the name of Seager Wheeler[2]. He is most widely known for his prize-winning wheats, but he was also a highly successful farmer. What struck me about reading his book was his attention to detail.

He sorted out the best seeds from his grain to be planted the next year. He was just as adamant about weeds as Buffalo Bird Woman. He scorned his neighbours for letting them go and not controlling them in newly broken land. When breaking land, he had a similar process as Buffalo Bird Woman. He held the same belief that you needed to start the work in the year before you wanted to produce a crop.

Where he differed from Buffalo Bird Woman was in his belief that there was an inexhaustible supply of plant food in the soil. He believed that with proper tillage he could replace all that the crops removed. He advocated for deeper plowing once the soil was getting too loose and erodible. Bringing up and mixing in a new layer of humus was seen to restore it.

He mentions the actions of bacteria helping to release nitrogen a few times, so I don't believe he thought of the soil as a completely inert substrate. However, he still seems to have been following the theories of the 1700's that believed that you needed to pulverize the soil to a powder to allow the plants to take up the actual particles – that is, the silts and the clays and perhaps the fine pieces of humus or organic matter[3].

6. Three Pillars (8:00)

So, here's where I want to get realistic in expectations for what regenerative agriculture can do. The current hype in regenerative agriculture has been going off experiences in the past 5-10 years, possibly up to 20 years. After watching agriculture develop for 5 months on the compressed timeline, you'd only need to wait 2-3 weeks to see regenerative agriculture develop.

From my perspective, there are three pillars that are propping up regenerative agriculture right now. Dr. Andrew McGuire from Washington State University's Center for Sustaining Agriculture and Natural Resources department was a key person that clarified my thinking on this[4]. These pillars are largely based on one his articles, but the concepts are built through many of his posts.

The three pillars that I see are:

1) Inflated expectations of microbial mining of soil particles
2) Mining of the legacy nutrient applications
3) Faulty accounting of nutrient flows

7. Microbial Mining (9:00)

Let's start with microbial mining of the soil particles. I hear the phrase "get the biology working for you" a lot. The idea is that if you just get a healthy population of microbes working for you in the soil, they will provide everything you need to grow a crop. They will often cite stats such as there are 6000-9000lb of phosphorus[5] in your soils that plants can't access but the microbes can.

While it is true that there is a massive quantity of nutrients available the rate of their release by microbes is greatly over estimated. Two years ago, Dr. Monika Gorzelak was speaking at Agronomy Update about the new research program that she was setting up at AAFC Lethbridge. She highly recommended a book called "Functional Diversity of Mycorrhizal Fungi and Sustainable Agriculture"[6]. I have read the book cover to cover. I didn't find any reference to the rate of mining anywhere through the book.

I emailed Monika to ask her if she was aware of any numbers. She was not, but she kindly did some searching of the databases that she has access to. She was not able to find any studies that gave numbers to the potential amount that microbes may be able to mine for us. The best answer I've been able to find is in a blog post by Dr. Andrew McGuire where he references a 2004 study that shows it may be higher than previously thought, but still nowhere near what we export in agriculture[7].

8. Fertility Research (10:45)

Last year Bruce Barker posted a download link on his site, Canadian Agronomist, about a long-lost print publication from 1993 generally referred to as "The Red Book"[8]. The full name of the publication is "Impact of Macronutrients on Crop Responses and Environmental Sustainability on the Canadian Prairies". It's a title only an academic could come up with, which is why it's known as the Red Book, but it gives a great picture of fertility research from the beginning of agriculture as we know it in the late 1800's and right up to its publication in the 1990's.

One of the most fascinating things I learned is that there was a time when Dr. Ross McKenzie wasn't an old guy! There was even a time he wasn't a doctor. His Ph.D. from the eighties is referenced in the book. Just to be clear it was from the 1980's, not the 1880's.

Back to the book and the real reason I was reading it. Research on nitrogen response was not initiated until the 1950's. Nitrogen was not the main limiter in the early fallow systems. It only became limiting in the early to mid twentieth century. The first research was into phosphorus deficiency. That was the most limiting nutrient there was on the prairies.

After millennia of grass growth and grazing there should be excess supplies of phosphorus, but there was only enough there to supply a few decades of farming with moderate exports of nutrients. Remember that yields were much lower, and most fields were only cropped every other year. If microbial mining could indeed supply all that was needed, don't you think it would have kicked in and supplied the needs of the crops?

In one of the summary articles the authors found that prior to 1970, research published in Saskatchewan found that over 90% of the time a significant yield response could be found by adding phosphorus. This led to a boom in phosphorus application and farmers benefitted greatly.

In the decades after 1970 researchers were puzzled because they couldn't get the same level of response. It dropped to only a 30-50% chance of a response. The reason for this decline in response was that phosphorus was building up in the soil. It isn't as mobile as nitrogen and tends to get weakly bound with soil particles not long after application.

Dr. Cynthia Grant estimates that only 15-30% of applied phosphorus ends up in the current cash crop. Some claim the rest is lost, never to seen again. In fact, most of it will eventually make it into your cash crops, it just takes time. So where did the other 70-85% of the crops needs come from? A small portion may have come from newly mined soil particles. Some was from the readily available supply that shows on the soil test. The rest came from the weakly bound supply that doesn't show on the soil test and is not tightly bound in soil particles. It's not easily available to plants but it's not so tightly bound than it can't return to the soil solution in time through chemical exchange or microbial action.

9. "No Fertilizer Needed" (14:00)

So how can it be that we see pictures of diverse cover crops growing without any applied fertilizer? The claim once again is that all the fertility that we need is in the soil, we just need to unlock it. Instead of tillage being the tool, it is now cover crops that do the work.

It may be true that the diverse cover crops are revving up the biology and stimulating microorganisms that normally wouldn't be thriving in a monoculture cash crop, but it's not because they are mining the soil particles. They are using the legacy phosphorus, built up over decades of fertilizer application.

It's not wrong to rely on this legacy phosphorus. In fact, it may be a good way get started in regenerative agriculture practices. Having roots in the ground keeps these cycles going past cash crop harvest and into the shoulder seasons. Any plant is better than no plant but adding some diversity helps tap into different microbial communities and capture nutrients from varying depths. If the root mass and above ground mass break down fast enough then they can supply this previously weakly bound phosphorus to your cash crop without it having to do the work to find it.

10. Faulty Accounting (15:15)

This leads me into the final of the three pillars that is propping up regenerative agriculture – faulty accounting of nutrient flows. The soil particles can only produce a small amount of the nutrients that we export in a year. The legacy nutrients can prop you up for a little while, but eventually you need nutrients brought back into the system.

To put some numbers to this, consider a dryland four-year cycle of peas, wheat, canola, and barley. Nitrogen[9] and phosphorus[10] are the most limiting nutrients in Southern Alberta so for simplicity I'm only going to illustrate using them.

The peas will make their own nitrogen if properly inoculated and so the only nutrient export per acre in the form of the grain (assuming the straw is left on the ground) on a 50bu crop will be 35lb of P. A 40bu wheat crop will export 60lb N and 25lb P. A 35bu canola crop will export 65lb N and 35lb P. Finally, a 60bu barley crop will export 60lb N and 35lb P. Over the four years you will have exported 185lb of nitrogen and 130lb of phosphorus. On average, this means every year you must replace 47lb of nitrogen and 33lb of phosphorus.

Comparing this annual system to a perennial system with grazing animals shows a drastically different level of export. The Alberta Forage Manual says that a cow-calf pair will remove 11lb N and 4.5lb P in a grazing season[11]. At a stocking density of 5 acres per cow-calf pair this means you are only removing approximately 2lb/ac of N and 1lb/ac of P per year.

11. Regenerative Nutrient Management (17:00)

The only way we are going to be truly regenerative in nutrient management is to close the cycle. In the example of Buffalo Bird Woman, she used fallow to unlock nutrients that were built up in the carbon. This system was regenerative, in my opinion, because of the time scale and the population.

I don't recall her saying how long they stayed at a site, but I imagine that they would move to a new area of the river whenever the tribe grew, or the resource had been depleted. There was enough land and so few people that an area could be intensively used and then left to regenerate through natural processes until it was needed again. If a plot was farmed for 50 years and then left for 500 years nutrients would accumulate again.

The only way that I can see our farming to get truly regenerative is to cut the exports of nutrients off the land to match what we can import.

12. Regenerative Nutrient Management (18:00)

The way that most of the celebrity farmers and ranchers have made this work is to change their operation to a grazing based system and to direct marketing of their meat. Some have even vertically integrated – now controlling the processing, distribution, and wholesale side of the business. They capture a large portion of the consumer dollar which allows them to run only the amount of cattle that the land can handle. They have matched the exports to the regeneration of the land.

Most grains are shipped across the ocean. Hay may be used closer to your farm, but manure is usually more expensive to haul back than just to apply chemical fertilizers. If you are fortunate to have manure near you and do not have excessive levels of nutrients already then, I would use that resource as much as you can. For the rest of your nutrient budget don't be afraid to use chemical fertilizers (such as urea and monoammonium phosphate (MAP)).

13. Cover Crops (19:00)

To increase the efficiency of the system keeping living roots in the soil for as long as possible is a great way to start. Moisture must always be factored in. In most areas of southern Alberta there is rarely excess moisture so you must always be ready to kill cover crops before they cause problems for the cash crop. In the very dry areas, you will need to accept that there are going to be years when nothing beyond the cash crop will grow.

The first priority for anyone in southern Alberta is to grow something that holds onto the soil and prevents wind erosion. If your soil is blowing it really doesn't matter what is going on below the surface. You are losing much more to the wind than you'll ever gain from roots in the ground[12].

It will always pay to hold onto your soil. Scavenging nutrients, unlocking legacy phosphorus, and fixing atmospheric nitrogen may not. Seed costs can quickly get higher than just applying more fertilizer or manure.

14. Cover Crops (20:00)

Contrary to popular belief, a well picked single species cover crop will do as well or better than a diverse mixture[13]. In a recent review of the results of studies where monocultures were compared to mixes in 9 out of every 10 studies there was no significant difference between the monoculture and the mixture. In the remaining cases where there was an effect, the monoculture was better over 80% of the time.

Once you have this foundation you can look at ways to supercharge the system. Grazing cattle on stubble and/or cover crops in the off-season can speed up nutrient cycling if you are setup with water and fencing. This is only worth it if you love cattle or have a neighbour that does and wants to do all the work.

15. Supercharging the system (21:00)

Wide row cropping was popularized with 60" corn (yes, 5' row spacing)[14]. This is where you plant cover crops between the cash crop and grow both at the same time. You sacrifice some yield but if the gain in nutrients is greater than the loss in yield it can be worth it. If you are into grazing cattle, this can be a way to get 2-3x the amount of cover crop for them to graze over the winter.

Biostimulants and humic acids have promise but have yet to prove to me their worth. When some products come along that can do better than the native microbes or hold onto nutrients more efficiently than a well cycling soil these may be worth trying. For now, I suggest any money you are thinking of putting into these is best diverted to cover crop seed and/or the machinery you need to make cover cropping work for you.

And finally – top up your hail insurance. Don't put any money into rescue products. Farming Smarter research done right here in southern Alberta is beyond clear that that these don't work[15]. Instead, when hail comes, be happy that you are getting paid to grow a green manure crop. If it's not a complete green manure and you must harvest the crop don't worry – you're still exporting less than you had planned on and have got paid to leave some of it behind.

16. Summary (22:30)

I've covered a lot so far but I'm up against my time limit. I suspect it's also near the end of how much information you can take up at a time. When I was putting this together my initial presentation was over an hour long. If you want to review the slides and the transcript with references, I'll be posting them to my site on the media page[16].

As a quick summary, remember that these soils took millennia to develop and were sustainable when there were no exports, there were less people, and there were centuries for regeneration. Fertilizer was able to replace what ends up across the ocean and can't be cycled back into the system. Regenerative agriculture is using this legacy fertilizer right now when it thinks it is mining new nutrients from the soil particles. It will survive in the short term but when these nutrients run out it will need to replace them and/or drastically cut the exports off the land. Cover crops are a tool to increase the efficiency of the system and they don't have to be complicated. Hold onto your soil first, and then work at the nutrients.

I'll be expanding on the cut-out portions in my podcast over the coming summer so be sure to check that out if you want to explore #RealisticRegenAg further. Past episodes that may be of interest to you would be on single species vs mixtures in cover crops[17], whether we should strive to plant green as we see growers do in the United States[18], and looking beyond cover crops at things like soil crops, relay crops, and intercropping[19]. Thank-you again Brad for asking me to present and I'll take any questions you have now.

---

[1] Gilbert L. Wilson. 1917. Buffalo Bird Woman's Garden: Agriculture of the Hidatsa Indians.
Full text online: https://digital.library.upenn.edu/women/buffalo/garden/garden.html
Current publishers' site: https://www.mnhs.org/mnhspress/books/buffalo-bird-womans-garden
[2] Seager Wheeler. 1919. Profitable Grain Growing. (Not in print but some booksellers have used copies.)
Full text: https://www.canadiana.ca/view/oocihm.991508/8?r=0&s=1
[3] University of Minnesota Extension. 2017?. Upper Midwest Tillage Guide
https://extension.umn.edu/soil-and-water/soil-management-and-health
[4] Andrew McGuire. 2020. How does regenerative agriculture reduce nutrient inputs?
http://csanr.wsu.edu/how-does-regenerative-agriculture-reduce-nutrient-inputs/
[5] John Kempf. 2021. Kind Harvest post. Supplying 100% of crops N requirements.
https://kindharvest.ag/discussion/supplying-100-of-crops-n-requiremnts/

[6] Michael J. Goss, Mário Carvalho, and Isabel Brito. 2017. Functional Diversity of Mycorrhiza and Sustainable Agriculture. https://www.sciencedirect.com/book/9780128042441/functional-diversity-of-mycorrhiza-and-sustainable-agriculture

[7] Andrew McGuire. 2020. How does regenerative agriculture reduce nutrient inputs? http://csanr.wsu.edu/how-does-regenerative-agriculture-reduce-nutrient-inputs/

[8] Canadian Agronomist. 2020? The Red Book. https://canadianagronomist.ca/resource/the-red-book/

[9] Government of Saskatchewan. Nitrogen Fertilization in Crop Production. https://www.saskatchewan.ca/business/agriculture-natural-resources-and-industry/agribusiness-farmers-and-ranchers/crops-and-irrigation/soils-fertility-and-nutrients/nitrogen-fertilization-in-crop-production

[10] Government of Saskatchewan. Phosphorus Fertilization in Crop Production. https://www.saskatchewan.ca/business/agriculture-natural-resources-and-industry/agribusiness-farmers-and-ranchers/crops-and-irrigation/soils-fertility-and-nutrients/phosphorus-fertilization-in-crop-production

[11] Arvid Aasen & Myron Bjorge. 2009. p 241. Alberta Forage Manual. https://open.alberta.ca/dataset/077326082x#summary

[12] Real Agriculture. 2021. Soil School: Does organic matter really matter? https://www.realagriculture.com/2021/01/soil-school-does-organic-matter-really-matter/

[13] Andrew McGuire. 2020. Contrary Science; Cover Crop Mixtures, Monocultures, and Mechanisms. http://csanr.wsu.edu/contrary-science-cover-crop-mixtures-monocultures-and-mechanisms/

[14] Practical Farmers of Iowa. 2019. Planting Corn in 60-in. Row-Widths for Interseeding Cover Crops. https://practicalfarmers.org/research/planting-corn-in-60-in-row-widths-for-interseeding-cover-crops/

[15] Farming Smarter. 2019. Hail Damage Recovery Relies on Timing and Early Preparation. https://www.farmingsmarter.com/hail-damage-recovery-relies-on-timing-and-early-preparation/

[16] Scott Gillespie. 2021. https://www.plantsdigsoil.com/media

[17] Scott Gillespie. 2020. 012 Simplicity in Cover Crop Mixes https://www.plantsdigsoil.com/podcast/012-simplicity-in-cover-crop-mixes

[18] Scott Gillespie. 2020. 010 Plant Green? Plant Brown? https://www.plantsdigsoil.com/podcast/010-plant-green-plant-brown

[19] Scott Gillespie. 2020. 009 Beyond Cover Crops. https://www.plantsdigsoil.com/podcast/009-beyond-cover-crops