Transcript of presentation for farmers and ranchers in the Medicine Hat, Alberta area Jan 27, 2021
PowerPoint Slides at: www.plantsdigsoil.com/media

1. Title Slide (0:00)

Thank-you for the invitation to speak to you this evening. Building up carbon in soils, and specifically the brown soils of our region, is something I've been thinking about for a long time. I was very happy to get the invitation from Kennedy to speak on this topic.

I've called tonight's presentation "Carbon Building: Realistic Expectations" because there is a lot 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. From this I will give you some practical ways you can start working on carbon buildup in your soils.

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.

However, if you wanted to see these soils develop on a human scale and made every year of development 1 day then 27 years is how long you'd need to live to see the soils get to the stage that they were at before agriculture. 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 up new trade networks. New technology in the form of guns and horses allowed greater harvest off the land 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. 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.

5. Seager Wheeler (6:15)

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. Fertilizer Inputs (8:00)

Research on nitrogen response was not initiated until the 1950's as it 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.

Prior to 1970, research published in Saskatchewan found that over 90% of the time a significant yield response could be found by adding phosphorus[4]. This led to a boom in phosphorus application and farmers benefitted from higher yields and greater profit.

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.

Fertilizer is what saved agriculture in the prairies. The ability to mine phosphorus from the earth, transport it to our soils, and apply it to the crop fixed that deficiency. The ability to create nitrogen fertilizer from the air we breathe was able fix that deficiency when it started showing up. Sources of the other nutrients, including the massive source of potash next door in Saskatchewan, were soon able to fix any other deficiency found.

7 "No Fertilizer Needed" (9:45)

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.

Dr. Cynthia Grant, who spent much of her career on phosphorus research in the Prairies, 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? Some was from the readily available supply that shows on the soil test. The rest came from the weakly bound supply of past fertilizer application.

When the land was broken from prairie the only phosphorus in the system was what was mined from the soil particles by soil microbes over multiple millennia of grass and grazing. In only a few decades of grain export this supply was depleted so much that phosphorus application was nearly guaranteed to give an economic response.

Many in the regenerative community believe they are tapping into the microbially mined phosphorus taken from soil particles. In reality, they are tapping into this legacy phosphorus from past fertilizer applications[5]. It may be true that the diverse cover crops are revving up the biology. They may indeed be stimulating microorganisms that normally wouldn't be thriving in a monoculture cash crop. But they are not mining a significant quantity of newly available phosphorus. They are unlocking this legacy phosphorus and leaving it more available for the cash crops that follow.

It's not wrong to rely on this legacy phosphorus. In fact, it may be a good way get started in regenerative agriculture practices as no extra fertilizer is needed. The key is in realizing that this cannot go on indefinitely.

If depleting organic matter was a way to access free nutrients, building organic matter is going to cost you nutrients. Remember that organic matter is not just carbon. It is full of all the other nutrients that plants and soil microbes use.

8 Carbon Building (12:00)

The way we are going to be able to build carbon in our soils is to have a living root in the ground for as long as possible. The only time we are adding carbon to the system is when a living plant is photosynthesizing and creating sugars from CO_2. I shorten this to: Plants dig soil. This concept is what inspired my podcast name and my business name.

Grazing animals can help to increase the efficiency of the system[6]. Exporting meat instead of grain means less carbon and nutrients leave the system. Biostimulants may help developing seedlings to get a head start and produce more over their lifespan. But none of this works without the plants there.

Compost and manure are another way of adding carbon to your fields. It's a bit of bio-hack as they are not new sources of carbon[7] – they are just digested plant material taken from another area. You are robbing Peter to pay Paul, as the saying goes.

Manure is forage or grain that has been processed by an animal. Compost in this area is usually manure that has straw added to it and is broken down more. If the cost of the material, the transportation, application, and incorporation is less than just using plants in place then I'd use it. Otherwise, I think the best effort is in focusing on growing carbon right where you need it – in your field.

In the brown soils, moisture is going to be the biggest limiting factor. If there isn't moisture then the best thing is going be to have the ground covered so it stays in place, holds what moisture there is, and can infiltrate what moisture does come.

Farmers in this area are finding that relay cropping is the best way to establish cover crops. This involves planting the cover crop in the existing crop after herbicide timing just before it enters its rapid growth stage. The cover crop sits below the canopy growing slowly and takes off once it receives full sunlight at cash crop harvest.

Think of harvesting a field and seeing how clean it looks only to come back in a month and find it full of weeds. Those weeds were likely there all along – they were just too small to see from the combine. Relay cropping is deciding what you want growing on your land rather than letting nature decide for you.

9 Example Rotation (14:15)

Let's now shift to an example rotation and how you can integrate relay cropping to maximize the amount of living roots you have in the soil over the growing season.

Peas can be planted very early. Ideally, you'll have cereal stubble and ideally there won't be much nitrogen leftover. Since peas are great at fixing their own nitrogen we might as well be maximizing the amount that they take from the atmosphere.

Since peas are harvested so early the next crop would ideally be winter wheat. I'm not going to worry about a relay crop in this stage because winter wheat will germinate and grow in the fall much better than most of the cover crop seeds. It also gives a crop-free opportunity for dealing with thistles, dandelions, and any other hard to control perennials.

10 Example Rotation (15:15)

In the following spring there is an opportunity to plant your relay crop. It could be as simple as broadcasting clover seeds onto frozen ground and through the day as the surface thaws and then refreezes at night the seeds are drawn in. In the cold temperatures of March and early April the ground will stay moist longer and may get them growing.

This will not work if you still need a herbicide for broadleaf control. If you need spray the crop for weeds, you'll need to wait until after this to seed the relay crop. Broadcasting may still work if there are good spring rains that keep the surface moist. Using an interseeder to place the seeds in the ground will have a better chance of success. If you haven't heard of an interseeder don't worry – as far as I know they are all farm made right now.

11 Gemstone Interseeder (16:15)

On a field tour in 2019 Gemstone Cattle Company showed us their toolbar that used a Valmar to blow seed to shanks that ran between the rows. There was a small harrow where the seeds blow onto and a chain that drags behind to cover them. This particular bar was used for interseeding covers between 22" corn rows and so didn't use a lot of iron. It was also being used on irrigated land so most seeds will germinate even if near the surface.

12 Josh Beck Interseeder (16:45)

The most effective way to seed relay crops on dryland is going to be to place the seed in the ground. Last year Josh Beck used an old toolbar with some disc openers feed with a Valmar. It worked very well in establishing the clovers. When the rain stopped in July & August and the heat come the clovers died.

To me this is a success – the cash crop was dominant and took the moisture to make grain. Had there been rains the clovers would have taken off because they were already established. However, in some years there won't be moisture to grow a cover crop. This is why it's so important to keep costs low in seeding equipment and seed and to have realistic expectations.

13 Example Rotation Continued (17:15)

After winter wheat harvest you should see the field green up as the clover gets sunlight. Moisture and weeds will need to be monitored as you may want to terminate it early to prevent problems in the succeeding cash crop. It will likely not overwinter but if it does you'll want to be ready to kill it in spring.

In areas of the eastern United States and Canada there is opportunity plant green and kill it later. They often have more time for it to grow and they generally deal with excess moisture in the spring. Here in southern Alberta, we need to hold onto our moisture supplies, and we don't have a long shoulder season to get a little extra growth[8]. Most of the time we are seeding as soon as the ground thaws. There may even be a little frost still a few feet down when seeding.

14 Example Rotation Continued (18:15)

The next crop to grow will be canola. It is non-mycorrhizal and so it will not work with the fungal networks that colonize your soils. They will not die off completely, but they will go dormant if nothing is there to feed them the sugars through the root exudates[9]. This is where hairy vetch may have a place.

I do not have any field experience with this, so I caution you to only try this on a limited amount of acres if you do decide to try this. My experience comes entirely from my garden where I have found it to be a particularly good relay crop that sits below the canopy all season and explodes in growth as I harvest things from my garden. I have seen it stay green until January and even make it through -35C weather when there was a cover of snow on top. I've never had it make it the entire season as -12C will kill it, but there is potential, and you'll need to watch it just like you would the clovers.

The hairy vetch may start climbing the canola near maturity, but I believe between swathing and drying it should not cause much problem. Again, I would caution you to only try this on a small number of acres as I don't know what exactly will happen with it.

15 Example Rotation Continued (19:30)

To complete our four-year rotation lets look at using spring barley or wheat. If you have the legume the wheat may benefit from a mid-season nitrogen release and increase the protein. Barley may be easier to grow as it can be planted a little later than wheat if there is spring growth to control. Since peas will be the next crop in the rotation planting a legume relay crop may not be the best option. An option here is simply to rely on the volunteer growth after harvest. A light harrowing will plant these seeds. The goal is to use up the additional nitrogen so that the peas will fix as much as possible.

16 Summary (20:00)

Building up carbon in our brown soils must be seen as a marathon, not a sprint[10]. You may not see much of the benefits in your farming career, but you will pass on an improving resource to the next generation. Moisture is the biggest limiter and must always be monitored. The carbon will help to hold moisture in place more efficiently in time, but you must still be economically viable in the present.

The carbon that was built up over millennia was depleted providing nutrients for the crops of the early settlers. It follows that in order to build up the carbon nutrients are going to need to be tied up again. The first pool of nutrients to use may be the legacy ones that have built up from past fertilizer applications.

It may appear that the system is releasing new nutrients from the soil as you start into cover crops but in time you find that the legacy nutrients have been depleted and you will need to be replacing those nutrients. No system can continue indefinitely with exports greater than imports so you must always be looking for cost effective nutrients to bring into the system what is taken out.

If you want to go deeper into this subject check out my podcast – Plants Dig Soil. It should be available on most apps but if you can't find it just go to my website (www.plantsdigsoil.com) on your mobile device and touch the podcast button to subscribe. Over the past few seasons, I've went deeper on topics such as single species vs mixtures in cover crops[11], soil health tests[12], and whether carbon capture payments[13] are worth signing up for. This coming season I'll be continuing with the theme of tonight by digging deeper into #RealisticRegenAg.

Thank-you again Kennedy for asking me to present. I'll take any questions there are now. If there are not, I have a few questions prepared that I think people should have asked to get things started.

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