Greenhouse Gas Sinks and Sources

Tour Guide

For

Canadian Beef Producers

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Writer's Note: Although the term "cowboy" is used exclusively throughout this guide, it refers to cowboys, cowgirls, cattlemen and cattlewomen and anyone else who wishes to have cows, cattle or any other grazing critter attached to their handle. (For example buffalo gals, cowpokes etc.)

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Finding What You're Lookin' For

The Four Laws of Mother Nature

"Everything is connected to everything else.
Everything has to go somewhere.
There are no free lunches.
Mother Nature always bats last."

Author Unknown

Melville, Saskatchewan
Spring, 2004

Howdy There Stranger,

I went to one of those ranch management workshops a few winters back and that note about "The Four Laws of Mother Nature" was tacked up on the back wall. It was the first thing you read as you came into the Community Hall. I have to admit I have forgotten more than my fair share of things learned at the management workshop, but that saying has always stuck in my head. It seems to me plenty of things have happened in this industry that defy all the common sense I can muster – but the above message just keeps on ringing true. And that's what this Tour is all about – working a bit closer with Mother Nature, trying to figure out a few things about her ways and recognizing when nothing else seems to make sense, just maybe Mother Nature can put it all back into perspective.

Happy Trails,
Lee

Working With Mother Nature

Cowboy Common Sense

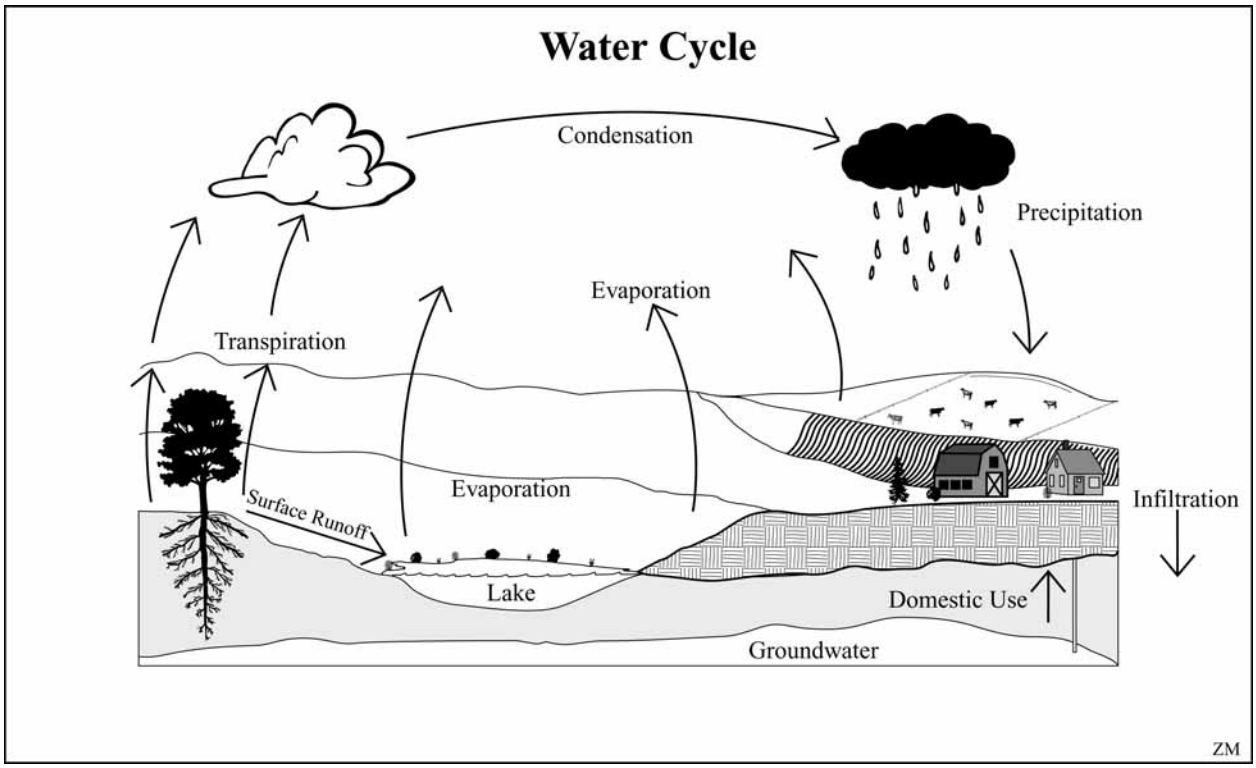
If I'm going to be listening to a story (good or bad), I always like to hear it right from the beginning. There are few things more aggravating than turning on the news and hearing a story part way through. Mind you, it seems that most days there's few things more aggravating than turning on the news in the first place!

So using that bit of common sense, I figured if we are to come to an understanding of this greenhouse gas situation, or apply any of our inherent creativity to the problem at hand, we'd best hear the story from the beginning and from the author herself, Mother Nature. After all, she's the one that ultimately calls the shots.

Cowboy Look-See

Mother Nature has always and will always work through a series of natural cycles – processes by which her elements are constantly recycled through living things and the environment. These cycles are so inter-connected and work so inter-dependently that it's nigh onto impossible to untangle them, nor should we particularly want to. The key to gaining an understanding is to recognize just how complex Mother Nature is. Those of us who make our living on the land have always been humbled by the realization that we need to live in harmony with her. If we are to make it in this industry, Mother Nature has to be our Number One Partner.

The natural balance of these cycles has been relatively stable over time – the cycles continue and life goes on. Let's take a "look-see" and reacquaint ourselves with how she has things set-up, recognizing that this is a simplified version of how things happen.



The Water Cycle - How Does It Work?

The water cycle begins when moisture evaporates from the land and the oceans and heads into the atmosphere. This warm moist air rises and cools, joining up with dust particles to form clouds. These clouds are rounded up and herded around by the prevailing winds. When the clouds are full and the water is too heavy to be suspended in the air that water heads back to the earth as rain, snow, sleet or hail. This moisture can take one of several trails. It can evaporate before it ever hits the ground or thirsty plants can take it up. It can be corralled in solid form as glaciers or as snow-pack. It can take liquid form in lakes, dugouts or swampy areas. It can mosey or stampede over the land into creeks, streams or rivers. Or, it can infiltrate into the ground.

Cowboy Look-See

Most of the moisture held up by trees or taken up by plants, and some of that corralled, will evaporate back into the atmosphere. The water that has penetrated the ground can be stored in the soil or percolate down through the soil until it reaches the water table where it becomes groundwater. That which has been stored in the soil is taken up by plants and then returned to the atmosphere through the plant leaves. The ground water may be just below the surface or it may move at great depths underground in aquifers. Eventually much of the deep groundwater flows to shallower levels in valleys and in down slope areas. There it can be used by plants and transpired back into the atmosphere. It can also discharge into springs, lakes or streams from which it may evaporate or join the stream flow into

larger bodies of water. Some water makes it to the ocean where evaporation again continues to drive the water cycle.

As of this writing, there's no sure fire way I know of that will change the amount of rain or snow that falls. We can however, have a say in how effective moisture will be. When you're in the middle of a dry spell, every drop counts. Whether you're hoping the grass gets a good start in the spring, looking for some re-growth later in the season or wanting water levels to recharge above or below ground, getting the most out of the available moisture is the key. For many of us, an inch of timely rain can be the difference between "make or break."

When the snow melts or the rain comes, we need to be prepared, cause who knows when it will show up again? And we've all had those years that once it gets started, you don't know if its ever going to stop!

Cowboy Tinkering

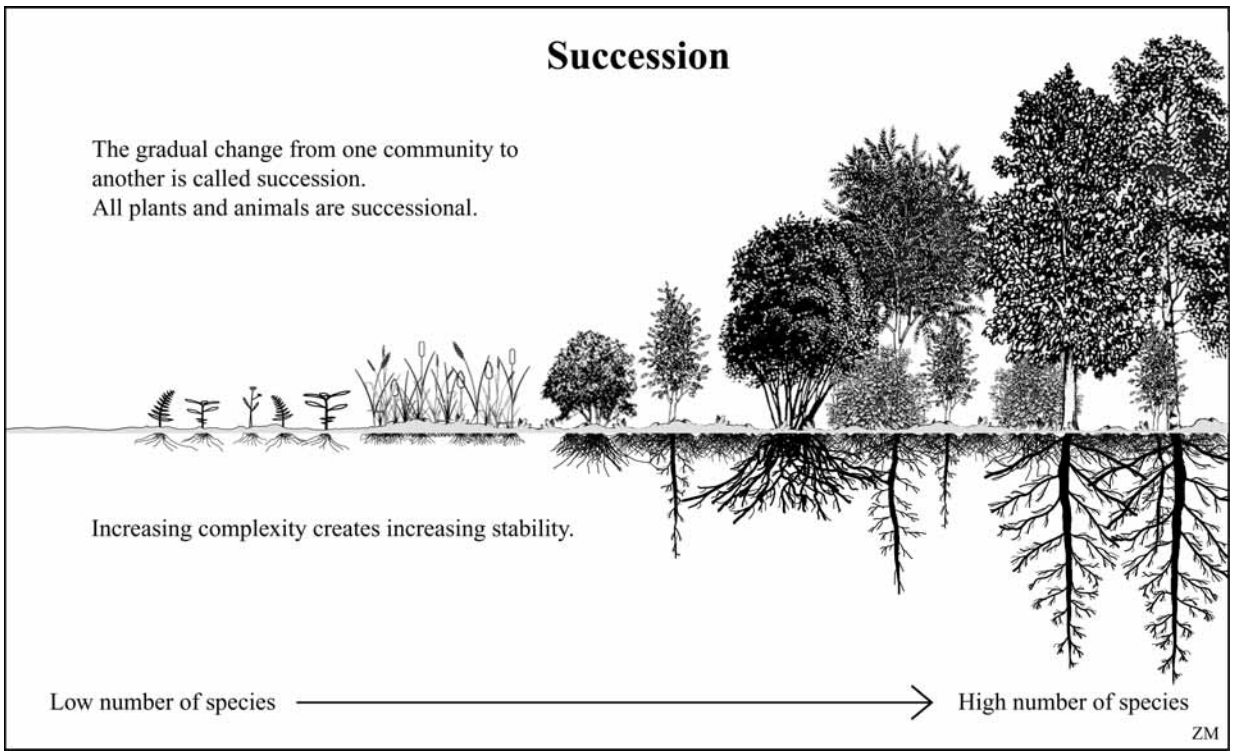
I'm told that the water we use has been around for hundreds of millions of years and the amount available has probably not changed that much – except of course where humans have gotten into big time tinkering. But for the greater part, water moves around the earth, changes forms, is taken in by plants and animals, but never really disappears – just travels along in one continuous cycle.

Cowboy Arithmetic

Many processes are at work to bring us the water we need and these processes are always at work although I've been through some years that I really questioned that. A good rancher friend once suggested that maybe the reason we went to the metric system was so we could get a measure on the miniscule amount of rainfall we'd had one real dry year. He figured the rainfall could no longer be measured in parts of inches let alone inches – we had no choice but to go to millimeters.

Cowboy Common Sense

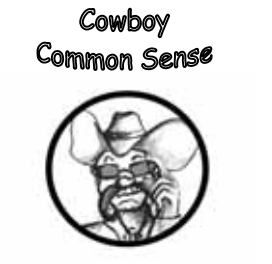
Common sense tells us a few good management practices make all the difference in getting the best use of moisture. Keeping the ground covered with growing plants or litter is probably the biggest one above ground, and increasing soil organic matter the most important below ground. According to my cowboy arithmetic, 100 pounds of dry soil (that's roughly a patch measuring 1′x 3′ and 6″ deep) with an organic matter level of 1.5% to 2% can hold 35-45 pounds of water, equal to ½ inch to 1½ inches of rain. On the other hand, soil with an organic matter level of 4% to 5% can hold 165-195 pounds of water, equal to 4 inches to 6 inches of rain.

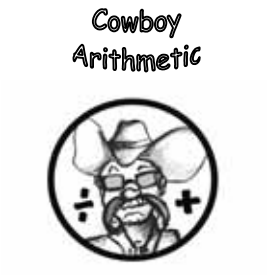


Succession – How Does It Work?

I reckon every one of us has spent more than the occasional moment caught up in a daydream about what this country looked like in its natural state. Whether on horseback or ½-ton, we've parked and looked over Creation in our part of the world and imagined. Maybe it was prairie grass as far as the eye could see, herds of buffalo, intermingled with antelope with fierce plains wolf and grizzly keeping them on the move, while hawks circled high overhead. Or maybe it was forest so thick and bountiful, teaming with wildlife, opening into meadows where Nature's creatures browsed and grazed; and the music of songbirds filled the air. Whatever the case and wherever the place, what we are doing in those daydreams is taking ourselves back to a different successional time in terms of what was birthed, lived, thrived and died within that community, be it plant, animal, insect, watershed and even the air.

All natural communities change. This gradual change from one community to another is called succession. Most natural communities strive to develop greater complexity, which creates greater stability. From unstable bare ground where there are very few living organisms of any kind, more complex and stable forest or grass communities form over time. Although these complex communities continue to change, those changes are often hard for the average person to notice on a day-to-day

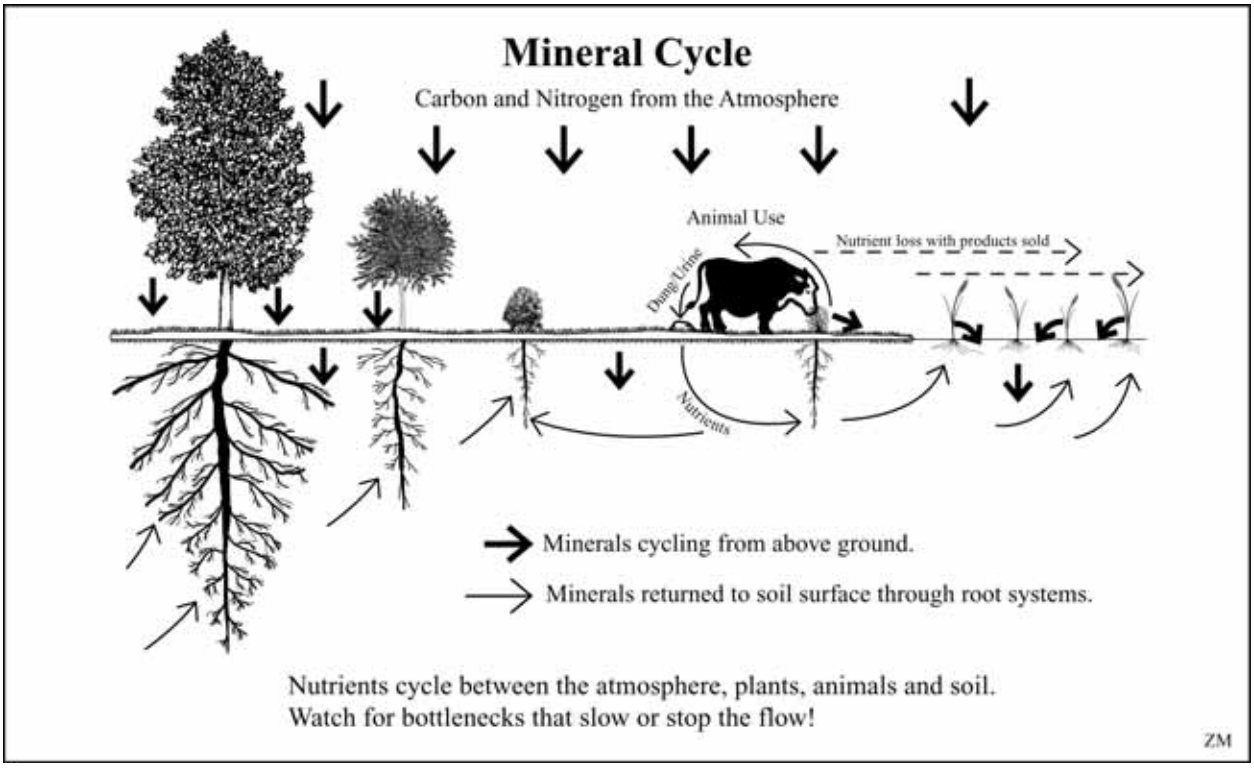




basis, that is until some major disturbance comes along.

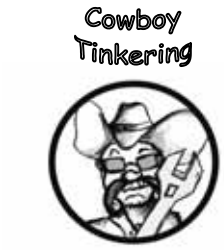
Common sense tells us the burr under the saddle as far as Mother Nature is concerned is humankind. We have tinkered with these natural communities the world over. Fire, which is most often human caused, sets succession back to an earlier stage as does cutting and clearing forest communities. The lack of appropriate grazing management for both domestic stock and wildlife can reduce pasture and range productivity and thus stocking rates. And we have all seen what happens if the ground gets turned "wrong-side up" to grow crops! All of these human actions which set back succession to a more simple state also set up the conditions for explosions of undesirable insects and diseases. Water and soil are likely to erode resulting in the loss of soil organic matter. All of this can translate into trouble at the bottom line of the profit/loss tally sheet.

It's one thing to think about these successional changes above ground based on what we can see, but my understanding is the changes below ground are even more powerful, because there is generally more life below ground than above. (Cowboy arithmetic tells me if there is an average of 7.75 tons of microorganisms [the little fellers the like of which include earthworms, mites, nematodes, bacteria and protozoa] per acre, then the stocking rate below ground may well be higher than above ground!) Add to that all the roots and root hairs (plants also have as much growth below ground as above) and you can begin to see the scope of life beneath our boots. I guess if we carry on with our logic, we can see succession isn't confined to plants and animals on land – water based communities would be successional and the make-up of the air surrounding us could alter as well. As life on earth changes and human activities change the fine balance of gases in the air pocket that surround the earth are bound to change. Keeping the balance gets to be a tricky proposition.



The Mineral Cycle – How Does It Work?

Years ago a rancher friend who ran cattle on the southern prairies told me he figured there was getting to be something wrong somewhere. It was on a grazing lease he first noticed some of the livestock dung pats just weren't breaking down like they used to – fact was, those dung pats were sitting on the soil surface, turning gray and lasting over several seasons. With time, these dried out pats were killing the grass where they sat, rather than fertilizing it as they should have. What he was noticing was a bottleneck in the mineral cycle.



To get a good grasp on how this cycle works at peak performance, maybe it's best to once again go back in time to the days before humans began serious tinkering. According to Mother Nature, the job description of the mineral cycle is to provide a wide range of nutrients to both plants and animals, including the human ones. Most of these nutrients come from the soil and the air. They might be in the form of minerals from decomposed rock. They might be from the atmosphere where they have hitched a ride with a raindrop. Or they may be courtesy of some of those micro-critters that are capable of changing carbon and nitrogen into a useable form. In order to be of any use to animals (human, domestic or wild), these mineral nutrients need to be hoisted from below ground levels

Cowboy Common Sense

Cowboy Tinkering

Cowboy Look-See

Cowboy Arithmetic

to above ground levels in the form of a living plant. Once serving their purpose above ground – that is to say having been used by plant or animal - minerals return to the ground and then to below ground levels where they remain until they are used once again.

Common sense tells us Mother Nature's primary recruits for hauling those nutrients around are plant root systems. What with every plant species having its own unique root structure, they are well equipped to take different trails below ground as they seek out their own provisions. Following the same logic, it makes sense that every species of plant is going to end up with a different nutrient make-up – providing the soil is a healthy soil and has those minerals in supply. We already know if the system hasn't been tinkered with, the only way for those nutrients to get there is from decomposing plant and animal remains, unless they are from the air and fixed by legumes or from the weathering of rocks. In order for that decomposing process to take place, there has to be a tremendously high stocking rate of those underground and soil surface critters that take this decomposing on as a full time job. The underground fellers just plain don't have the equipment to get above ground for their daily rations, so they have to depend on other means for the food to come to them – sort of like a corral full of weaned calves waiting for you to feed them.

So how do we get the feed wagon to this hard working crew? Well, let's go back in time once again. If your part of Creation was a vast sweep of prairie then it's pretty easy to see how nutrients cycled. Those huge herds of grazing animals would have put down a fairly heavy supply of fertilizer as they foraged their way across the land. What plants they hadn't eaten, their trampling would have put down to ground level. We can only imagine what the stocking rates of those ground level and underground decomposers would have been like with such a feast provided for them! If your mind congers up a forest picture, then things may not have changed quite so much. Those areas aren't as dependent on grazing animals to break down the plant material before the herds of decomposers get to it. Of course, no matter where you are situated, other forces of Nature, such as temperature, rain, wind, hail or snow melt also have their roles in breaking down plant and animal material.

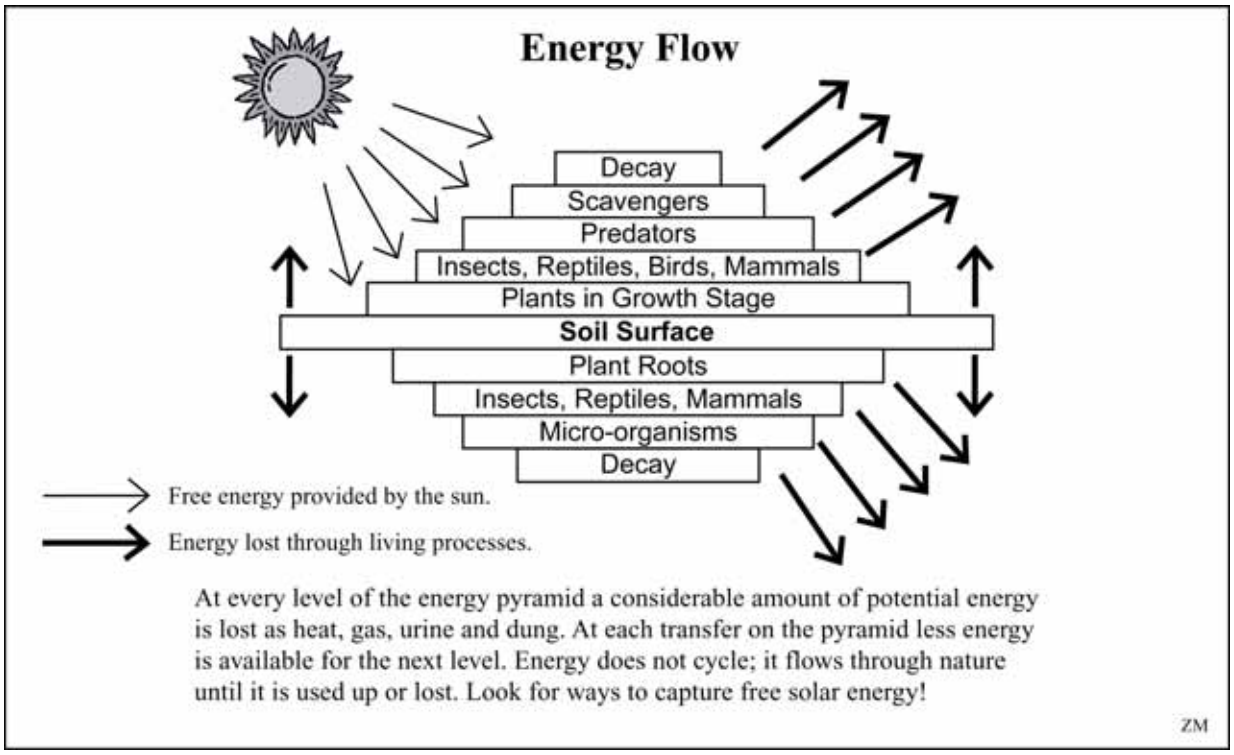
A few things to keep in mind when we ruminate on this mineral cycle: On the prairies, those soil micro-critters can't lasso that plant material down to the soil surface. They need some help getting it there and generally speaking a hoof does the job fairly well, many hooves probably doing a better job. If those soil critters don't get an ample food supply, they will starve to death. Finally, many of these hard workers can be killed off through poisoning. Cowboy arithmetic will confirm that the more we can

keep the nutrients from escaping out of the cycle and the more we can increase the volume of those nutrients cycling in the soil layers, the more benefits are bound to show up on the bottom line.

Now back to my friend who noticed the dung pats weren't breaking down. He knew right off what was missing – dung beetles. These silent partners of the livestock producer come in several different styles and models and make their way in the world by feeding on and developing in livestock dung. Depending on where you live in Canada, dung beetles can be active anywhere from the middle of March until early November. Cowboy arithmetic tells us in a grazing season of 150 days, a herd of 100 cows could cover about 3 full acres in dung – that is if you don't have these critters and a few of their buddies working on your behalf. At peak seasons, a healthy dung beetle population can fully recycle a dung pat within 24 hours. At the same time they are eating and/or burying dung, they are also burying the breeding sites of both the face fly, the horn fly and the larvae of any internal parasites that have passed through the cow. Any dung left out in the sun to dry without being quickly recycled can lose up to 80% of its available nitrogen into the atmosphere as compared to a 15% loss with a healthy herd of dung beetles on call. There's lots of ways to encourage these critters to take up residence. First and foremost they need a good supply of fresh cow dung. It needs to be spaced close enough so it's easy to fly from one pat to another. They seek out dung based on that fresh aroma.

Cowboy Arithmetic

Remember, dung beetles are insects. Products used to protect your cattle from harmful insects and parasites may, at the same time, harm the beneficial ones. If you choose to use vermin killing products, look to choosing those that are the least toxic to the helpful critters. You may prefer to use those products later in the fall or into the winter so by the time spring rolls around, livestock manure will be clean and fresh, just waiting to be recycled.



Energy Flow - How Does It Work?

Cowboy Look-See

Most of you can tell a story about the time you went out just before supper to check a heifer that was about to give birth to her first. Because it was just before supper and just before dark, you were in hurry. When you got to precisely the furthest point from home base, you noticed your trusty ranch ½ ton was starting to miss. Then you noticed that the fuel tank was below empty and before you knew it, you were at a full stop. Being as you were in such a hurry in the first place, you didn't take any communication device with you, or perhaps the truck you were driving was the type that had a communication devise installed, but it didn't happen to work. As the story usually goes, there you were, far from home, no fuel to get the truck going and no fuel to get you going. My point being, neither you nor your truck can run without energy that at some time or other came from the sun.

Hold Up There!

The sun provides the fuel that feeds all living things. Now if we hold up there and give that some thought, we come to realize the basis of every economy and in fact civilization itself is based on sunshine and the process called photosynthesis … but more on that later. Green plants, known as primary producers, capture the energy of sunlight. That energy is now available to plant eaters, including the human kind, who are collectively known as primary consumers. These primary consumers

Cowboy Arithmetic

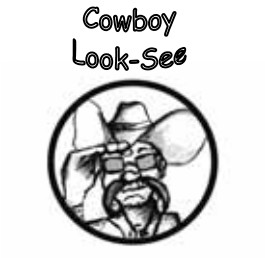
(hopefully not the human ones) become food for the meat-eaters. (I'm guessing most folk reading this will be included in that group.) In the natural state, the meat-eaters are included in the food the scavengers find. What's left after the scavengers get through goes on to decay. A similar process goes on below ground. Now what's particularly important to note about this process is that at every level a considerable amount of potential energy is lost as heat, gas, urine and dung. As you can see in the diagram, at each transfer on the pyramid less energy is available for the next level of consumers. We've all done our share of cowboy arithmetic in figuring our winter feed rations based on feed efficiencies, digestible energy, maintenance and growth – all of these figures being a function of energy flow.

Cowboy Common Sense

I'm guessing we have all had occasion to praise the sun when she's shining down on us during haying season and in all likelihood cursed her during a long, dry spell, but the fact is, all through the growing season she's providing us with the free energy that's the basic fuel to keep life going on earth. Common sense tells us if we were to maximize her generosity we'd be figuring out ways to extend the length of time we have plants actively growing, maximize the number of plants we have growing and be taking a good look at plants with broad leaves as they have more surface area with which to capture free solar energy.

Hold Up There!

Let's hold up here so you can gather a few things. You're goin' to need this Tour Guide (or photocopy pages 12 to 16) and something like a clipboard to keep the wind from blowin' things around, a pencil, a garden trowel, a bottle of water and a "monitoring hoop." Now you don't need anything fancy for a monitoring hoop – I've seen folks use anything from a plastic "hoola-hoop" to a piece of sturdy wire shaped into a circle. It's got to be strong enough to not come apart at the seams when you throw it and big enough for you to get a good "Look-See" at the soil surface. If you plan on making this site a permanent one, you'd best have some way of marking it that the cows won't rub it down the next time they're comin' through. Some folks like to bring the camera to get some photos, but that's up to you.



Once you have things collected, you can head out and get a first hand "Look-See" at how these natural systems are operating. You can choose any place you want to do this. Give it some thought and consideration or just head on out, and throw the hoop. Most of your observations will be based on what you see inside the circle. By the time you get all those questions figured, you'll have a pretty good idea of how things are working at that particular site. And remember as the saying goes, "The earliest changes on any piece of land are most likely to occur at or near the soil surface."

Many of the monitoring principles and techniques discussed in the "Look-See" are derived from Holistic Management materials developed by The Savory Center, Albuquerque, New Mexico, U.S.A. 87102 505/845-5252 www.holisticmanagement.org

Water Cycle "Look-See"

Place an **"X"** on the line where it best reflects your observations at the site.

Ineffective		**Very Effective**

In looking at the soil surface, the ground is:

exposed with bare patches	OR	covered with vegetation and litter

In trying to penetrate the soil surface with the garden trowel, it is:

hard to penetrate	OR	easy to penetrate

The soil beneath the surface is:

compacted	OR	aerated and permeable

The soil beneath the surface has a:

poor crumb (aggregate) structure	OR	good crumb (aggregate) structure

In looking at the soil, I think that soil organic matter levels are:

low and decreasing	OR	high and increasing

It looks as though the vegetation production is:

low with a slow growth rate	OR	high with a fast growth rate

In slowly pouring the bottle of water onto the ground from a height of 1 inch, the water:

runs off from a capped soil surface	OR	slowly penetrates from a covered soil surface

Based on my knowledge of the area, under ground water storage is:

diminishing and not replenished	OR	stable and replenishing

The evidence of soil, wind or water erosion* is:

high	OR	low

The incidence of flooding is:

severe and frequent	OR	moderate and occasional

Droughts are:

severe and frequent	OR	moderate and occasional

*Look for evidence of litter banks and/or pedestaling plants or rocks.

Succession "Look-See"

Place an **"X"** on the line where it best reflects your observations at the site.

Decreasing Complexity (Instability) Increasing Complexity (Stability)

In looking at the variety of plants, there is a:

low number of species	OR	high number of species

In looking at the variety of insects, birds and other animals, there is a:

low number of species	OR	high number of species

I would think that the temperature at the soil surface is:

subject to daily extremes	OR	relatively stable

In looking at the general plant community, it is made up of:

mostly the same species with some weedy types	OR	a variety of species with few weedy types

In looking at the plants within the grass community, the majority has:

narrow leaves	OR	broad leaves

Most of the plants are:

annuals	OR	perennials

The seasonal diversity of the plants is:

one season species only	OR	a combination of cool, mid and warm season species

In looking around the area, I see:

no evidence of young plants or animals	OR	evidence of healthy young plants and animals

My knowledge of this community tells me that the human population consists of:

mostly "older" people	OR	a mix of children, young, middle aged and older people

Mineral Cycle "Look-See"

Place an **"X"** on the line where it best reflects your observations at the site.

Ineffective **Effective**

In looking at the spacing of the plants, they are:

far apart	OR	close together

In looking for mulch or litter on the soil surface, I see:

bare ground	OR	covered ground

It looks as though the breakdown of the vegetation/mulch is:

slow and oxidizing	OR	rapid and decaying

The soil beneath the surface is:

impermeable with no crumb structure	OR	porous with a good crumb structure

In smelling a handful of soil, I would say that it:

is putrid or sour	OR	has no smell	OR	is fresh, earthy and sweet

The animal dung is:

crusted, capped and oxidizing	OR	breaking down quickly with evidence of dung beetles

The general colour of the plants are:

pale green	OR	dark green

An examination of the root systems show they are:

shallow and scarce	OR	of varying depths and abundant

Plant diversity consists of:

one or few species with no legumes	OR	many species including legumes

Mineral losses seem to be:

high due to wind erosion	OR	low due to wind erosion

Mineral losses seem to be:

high due to water erosion and leaching	OR	low due to water erosion or leaching

My observations show that there is/are:

an insect outbreak	OR	few varieties of insects	OR	numerous varieties of insects

An assessment of the soil health tells me that it:

requires inputs from the outside	OR	is self- sustaining

Energy Flow "Look-See"

Place an **"X"** on the line where it best reflects your observations at the site.

Low Energy Flow		**High Energy Flow**
In looking at the soil surface, the ground is:		
exposed and sealed	OR	covered with plants or litter
In looking at the spacing of the plants, they are:		
far apart	OR	close together
Plant diversity consists of:		
one or few species with no legumes	OR	many species including legumes
The leaves of the plants are primarily:		
narrow leafed or waxy	OR	there is a high proportion of broad leafed plants
After being harvested, it looks as though the plants receive:		
inadequate recovery time	OR	sufficient recovery time
It looks as though the vegetation production is:		
low with a slow growth rate	OR	high with a fast growth rate
The seasonal diversity of the plants is:		
one season species only	OR	a combination of cool, mid and warm season species
In penetrating the soil surface with the garden trowel, it is:		
hard to penetrate	OR	easy to penetrate
An examination of the root systems show they are:		
unhealthy and shallow	OR	vigorous and of varying depths
An assessment of the soil health tells me that it:		
requires inputs from the outside	OR	is self-sustaining
I believe that within the food chain* there are:		
few links present	OR	many links present

*Examples of food chains would be: plant, insect, bird or gopher, coyote OR grass, grasshopper, mouse, garter snake, hawk

Greenhouse Gas Lingo

It seems every trail we head down in this industry serves us up with a few new words that need to be added to our vocabulary before we can rightly figure out our own take on the situation. I figure that a good many words in a cattleman's conversation today, wouldn't have made any sense to the cowboy of yesteryear. For example, what we used to call "the good grass down by the crick" has been all fancied up to be called "the riparian area" and includes not only the good grass, but the bush, the trees, the banks and anything else that's situated down there. I'm guessing that's an example of some "whole picture thinking" necessary in these times. That's how she goes if we expect to stay in the game.

For starters, here is some of the lingo that's part of this Tour. I've listed these words like you'd see them in the movies (in order of appearance) as compared to a dictionary (alphabetical).

Adapt:	A change in structure, form or habit to fit different conditions; to acclimatize or "get used to."
Mitigate:	To make or become milder, to alleviate, lessen, moderate or "take the edge off."
Nutrients:	Elements required by organisms for normal life and activity.

Greenhouse Gases:	Certain gases in the Earth's atmosphere that absorb some of the outgoing long wave radiation or heat energy. These gases include carbon dioxide ($C0_2$), methane (CH_4) and nitrous oxide (N_20).
Greenhouse Gas Emission:	Greenhouse gases (carbon dioxide, methane and nitrous oxide) given off or emitted through a variety of activities such as burning fossil fuels, decomposing plants and animals and fertilizer application. Other powerful greenhouse gases include man-made ones such as hydrofluorocarbons (HFC's), perfluorocarbons (PFC'S) and sulphur hexafluoride (SF_6). Our tour will focus on carbon dioxide, methane and nitrous oxide.
Greenhouse Gas Sink:	Any process, activity or mechanism that removes a greenhouse gas from the atmosphere either by destroying it through chemical processes or storing it in some other form.
Greenhouse Gas Source:	Any process or activity that releases greenhouse gases into the atmosphere.

Carbon Dioxide:	The most common greenhouse gas. It is produced by the aerobic (in the presence of oxygen) decomposition of organic matter, respiration by plant and animal life, as well as through the combustion of materials and fuels. This gas is removed from the atmosphere through photosynthesis and ocean absorption.
Methane:	Is derived from the decay of plant material without the presence of oxygen (anaerobic). Primary sources include wetlands, rice paddies, animal digestive processes, fossil fuel extraction, as well as manure storage handling. Methane is 23 times more potent as a greenhouse gas than carbon dioxide.
Nitrous Oxide:	The primary natural sources are soils and oceans. Human contributions may take place through soil cultivation, fertilizer and manure application and by burning organic material and fossil fuels. Nitrous oxide is 310 times more potent a greenhouse gas than carbon dioxide.

Photosynthesis:	The process by which green plants covert solar energy into chemical energy and produce organic (carbon containing) compounds such as sugars, carbohydrates, cellulose and lignins.
Combustion:	The more rapid process of oxidation that occurs when organic matter ignites and burns, producing light and heat. It is the same chemical reaction that occurs during decomposition and respiration.
Decompose:	To rot or decay. It is the same chemical reaction that occurs during combustion and respiration. An organism that lives by breaking down dead bodies, which releases the minerals they contain into the environment, is a decomposer.
Respiration:	The process by which animals oxidize organic (carbon-containing) sugars to convert energy to heat and release carbon dioxide and water as by-products. It is the same chemical reaction that occurs during combustion and decomposition.

Carbon Sequestration:	The capture and storage of carbon dioxide in the form of plant material or ocean absorption. As part of photosynthesis, plants remove carbon dioxide from the air, strip the carbon out of it and make leaves, branches, roots etc. Plant residue (carbon) is returned to the soil and soil carbon is increased.
Carbon Sink:	A place where carbon accumulates and is stored. For example, plants are carbon sinks. As they accumulate carbon dioxide during the process of photosynthesis and store it in their tissues as carbohydrates and other organic compounds.
Carbon Source:	A place where carbon is produced or released. For example, plants release carbon in the form of carbon dioxide when their tissues are broken down during combustion.

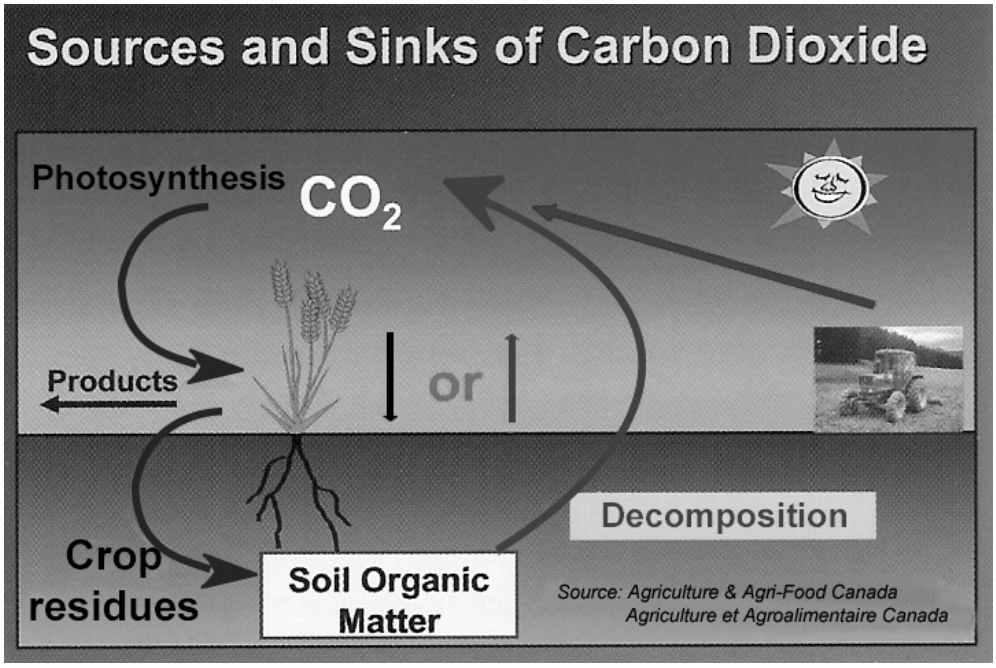
Emission:	A substance that is released or discharged, usually into the air.
Emissions Reduction:	A decrease in emissions released into the atmosphere by a source.
Emissions Removal:	A removal of greenhouse gases from the atmosphere (for example, carbon sequestration).

Sequestration:	The process of increasing the carbon in a carbon pool other than the atmosphere.
Sink:	Any process, activity or mechanism that removes a greenhouse gas from the atmosphere.
Source:	Any process or activity that releases a greenhouse gas into the atmosphere.

Cowboy Common Sense

What the Heck is a Greenhouse Gas?

I have to admit that for a good while I figured a greenhouse gas was some newfangled product belonging to the folks who grow those oversize tomatoes and the long cucumbers that come wrapped in plastic. After paying a little closer attention I have come to a new understanding. It seems a greenhouse gas is any gas (naturally occurring or human created) that absorbs heat energy from the sun and holds it in the atmosphere. We depend on these gases to make the earth warm enough for us to survive. Without them, we'd be in for year-long winter conditions. That could cut out that time of year we've come to call "Putting Up Winter Feed Season." Carbon dioxide is the main greenhouse gas emitted by most industries, but methane from animals and nitrous oxide from manure handling and storage are the main gases emitted by the livestock industry. These gases work in cycles; cycles that have been relatively stable over time.

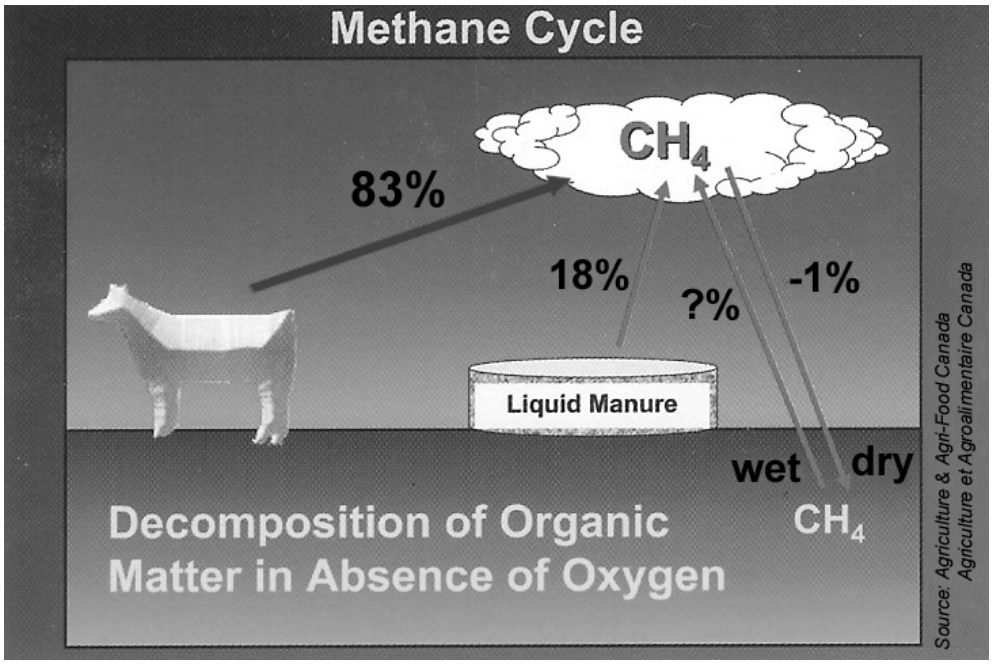


C = Carbon
CO_2 = Carbon Dioxide

Cowboy Look-See

The Carbon Cycle

The carbon cycle has often been called the cycle of life and is very closely tied to energy flow – except for one big difference. Remember how with energy flow, energy in the form of heat or waste was lost at each level? Well, with the carbon cycle, carbon is not lost. It always has to be somewhere; either in the atmosphere as carbon dioxide or in some animal form, plant form (land or ocean based) or in the ground as soil organic matter. It cycles between soils, plants, oceans and the air. Prior to our use of fossil fuels, there was relative stability in the global carbon cycle. The amount of carbon released into the atmosphere was balanced by the amount recaptured through photosynthesis and ocean absorption. The process of carbon sequestration is simple. Plants take carbon out of the air in the form of the greenhouse gas carbon dioxide. Some of the carbon is converted to energy for growth, but a large amount is stored in their root systems and ultimately the soil. However, some soils will not be as efficient at sequestering carbon, especially those that have plant-growth limiting characteristics. Examples would include soils that are regularly disturbed, those that have more material harvested than is replenished and those high in salt content. From an agricultural perspective, carbon is given off (returned to the atmosphere) as carbon dioxide when plant material or manure decomposes in the presence of oxygen. The net effect of an agricultural system on atmospheric carbon is the increase in soil carbon minus the amount of carbon released.

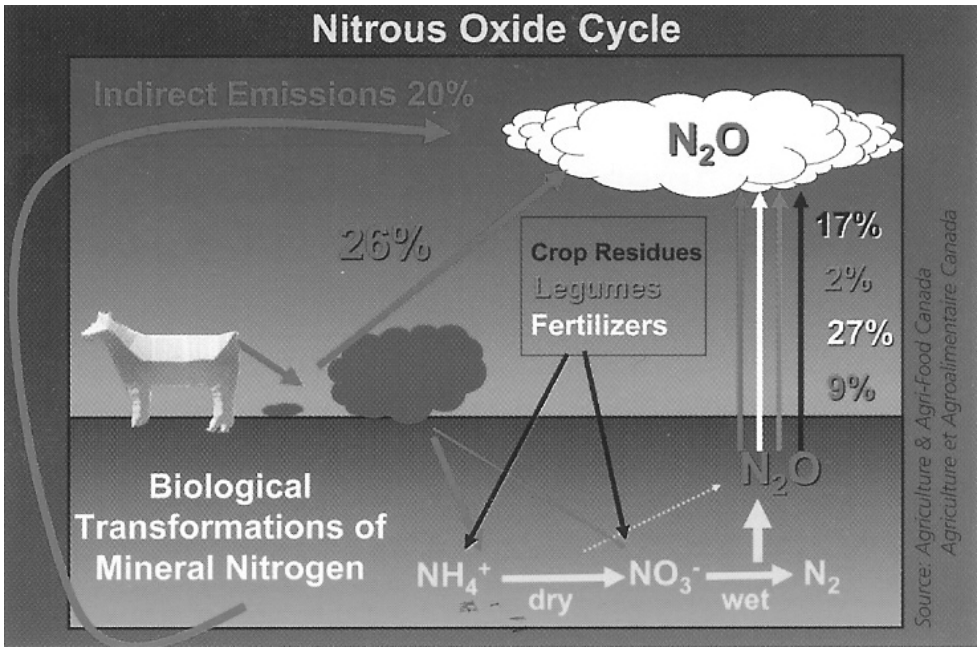


CH_4 = Methane

Cowboy Look-See

The Methane Cycle

Methane, from livestock digestion and manure, is one of the primary greenhouse gases emitted by agriculture. If oxygen is absent when plant material decomposes the process emits methane. When livestock manure is stockpiled or stored in liquid form the lack of oxygen forces the decomposition pathway to produce methane. Microorganisms in the soil will convert methane to carbon dioxide and thus soils are able to absorb methane. When organic materials decompose in submerged or water-laden soils, the water reduces the oxygen supply causing the release of large amounts of methane. In the agricultural soils of Canada, methane emission is confined to localized wetland areas and to brief periods when low-lying soils are submerged during snowmelt or after high precipitation. Soils can either release or absorb methane, depending largely on moisture content. There are also natural sources of methane. These include wetlands, permafrost, termites, oceans, lakes and wildfires. Ruminant animals such as cattle, sheep and goats digest forages through an anaerobic (without oxygen) process. This occurs in the rumen, the first of four stomachs. While all animals produce methane during digestion, cattle and other ruminants produce more due to the relatively slow feed fermentation in the rumen.



N_2 = Nitrogen
N_2O = Nitrous Oxide
NO_3^- = Nitrate
$N0_4^+$ = Ammonium

Cowboy Look-See

The Nitrous Oxide Cycle

Although nitrogen gas is the major constituent of our atmosphere, in its gaseous form, neither plants nor animals can make use of it. All living things need nitrogen to build proteins for growth and the way they get it is quite complex. Nitrogen gas must first be converted into nitrites and then nitrates before it can be used. The nitrogen cycle is characterized by fixation of atmospheric nitrogen by nitrogen-fixing plants. Involved in the nitrogen cycle are the processes of ammonification, nitrification and denitrification. Nitrous oxide, the most powerful agricultural greenhouse gas, can originate from two places in the nitrogen cycle: during nitrification (converting ammonium to nitrate) and during denitrificaton (converting nitrate to gaseous nitrogen). In a grazing operation the dung and urine from the animals contributes to nitrous oxide emissions. Research shows that more than 80% of the nitrogen animals digest is excreted. As protein content increases, the proportion of nitrogen excreted as urine increases. In grazing situations most nitrous oxide emissions come from urine spots. In addition, as a general rule, the longer the dung lays in the field, the more nitrous oxide is lost to the atmosphere and fewer nutrients are then available to plants.

Extensive grazing rarely causes excessive soil nitrates to accumulate, which could cause nitrous oxide emissions. However, problems can occur if cattle are allowed to congregate on some areas repeatedly, leaving manure piles and dung patches. Intensive grazing systems could result in a buildup of excess soil nitrate and nitrous oxide emissions if the stocking density is too high and if excessive amounts of fertilizer nitrogen or manure high in ammonium (hog or dairy slurry) are applied. Intensive grazing accompanied by high levels of management that give plants adequate rest for recovery between grazing

periods will help the pasture crop take up excess soil nitrate that could become nitrous oxide. The release of nitrous oxide from the soil is most significant when moisture content is high, oxygen levels are low and nitrate and carbon concentrations are high.

About That Greenhouse Gas Issue

Cowboy Tinkering

You might be wanting to ask, "If these greenhouse gases are naturally occurring, what's all the fuss about?" Well now, if we once again go back in time we will find all of Mother Nature's cycles worked in what is called a steady state. Greenhouse gases were recycled through natural processes. Sources, (processes that release greenhouse gases into the air), were balanced by sinks (processes or activities that remove greenhouse gases from the air). This balance between sources and sinks determined the levels of greenhouse gases in the air. But because we humans, by nature, like to tinker, over the centuries we have figured out ways and means to fiddle with these natural cycles and upset that steady state. Using more than my usual amount of creativity, I have come to compare the atmosphere above the earth with the "Open Range" of the Old West. In those days, it seemed as though just about anybody could turn out their herd of sheep or cattle and let them graze their way through Paradise. At first, it seemed the range couldn't be damaged, but sooner or later, the stocking rate got to be too high. The range started to suffer. Rules and regulations were made about how many cattle could be turned out and for how long and some folk weren't allowed to turn out any. Land was fenced, bought, sold and plenty of it was turned "wrong side up." The Open Range was changed forever.

Cowboy Arithmetic

If we take this picture and replace the grazing critters with greenhouse gases, you have a pretty good idea of what's going on in that Range Up In The Sky. Most of the increase in the greenhouse gas "stocking rate" in the atmosphere is in the form of carbon dioxide and most of that is from our discovery and continued use of fossil fuel. It kind of overpowers me when I try to get a handle on just how much we depend on fossil fuels, from heating our homes to fertilizing our fields. Not to mention our replacement of the horse with the horseless carriage. I read the earth's stocking rate of motor vehicles has gone from it's initial invention in 1885 to over half a billion by 1995 and in the process has consumed 700 billion barrels of oil. With each one of those fossil fueled activities releasing carbon that hasn't been in circulation for millions of years, you can see how the steady state might be upset. Picture resurrecting

all of the buffalo and cattle of the bygone days and include those currently present, and giving them free access to Open Range!

Cowboy Arithmetic

But, just as all cattle don't have the same impact on the range, neither do greenhouse gases. The folks who prefer to make their living as scientists as compared to raising cattle have determined carbon dioxide has a global warming potential of 1; lets compare that to a 100-pound calf. Methane has a global warming potential of 23; let's compare that to a 2300-pound bull. Lastly, nitrous oxide has a global warming potential of 310; let's compare that to a 31,000-pound critter of whatever you can imagine. No cowboy I know would want to be messing with something of that size be it on this earthly range or the Range Up In The Sky. So even though we, as the livestock industry, aren't responsible for a whole lot of carbon dioxide emissions, the "critters" we do release into the atmosphere can pack a powerful punch.

Now this is where this issue gets a little tricky. As you may well know, there's been considerable heated discussion as to what impact these greenhouse gases have as they stampede uncontrolled through the atmosphere.

Cowboy Common Sense

First of all you have to appreciate I was raised up to believe if a cowboy was to stay on the right side of the fence in terms of getting along with friends and neighbors there were a few subjects best left off the discussion table. Topping the list were religion, politics, breed of cows and the colour of paint on the tractor. Nowadays it seems "the best science of the day" needs to be added to the list of subjects that might put neighbors at odds. I was also raised knowing there's nothing like a first class fence to keep neighbors on good speaking terms. So, for the length of our time together, I'm going to suggest we put up the following "good neighbor fence:"

"While it is indeed true that human activity is accelerating the concentration of greenhouse gases in the atmosphere, it is important to remember that not all of the international science community is behind the conclusion that our climate is indeed changing because of that concentration."

Canadian Cattlemen's Association
Ratifying Kyoto – The Potential Impact on the Canadian Cattle Industry
Standing Committee on Agriculture and Agri-Food
December 05, 2002

Cowboy Common Sense

Being as folks, scientific and otherwise can't come to agreement as to whether things are warming up or cooling down or staying just the same, I used our cowboy common sense to take that issue out of the debate and focus on what we could agree on. The message as I see it is "greenhouse gas emissions represent a loss of production efficiency." Now there is nothing like the word "loss" to perk up our ears and ways to reduce those losses hold special interest not only to us, but to our good friends in the banking industry as well. That being said, this Greenhouse Gas Tour will focus on improving production efficiencies by reducing or removing greenhouse gases. By so doing we will have a positive effect on the natural cycles, increase profitability and move our industry further along the trail of sustainability.

This, of course, frees you up to make up your own decision regarding that bigger issue known as Climate Change plus it keeps me from getting into one of those discussions my folks warned me to stay away from.

Cowboy Look-See

Another Side to the Greenhouse Gas Story

Now, there is another important side to this Greenhouse Gas Story folks like you and me who manage land that can grow grass, trees or crops of any sort might be interested in. You see, soon after scientists got into this discussion about increasing levels of greenhouse gases and their potential impact on the climate, politicians got wind of the fact there was a good debate going on. Sure as spring follows winter, they got involved. Well, about that time, most every industry you can think of figured they should have some say in this too. There have been meetings from Rio de Janeiro in South America to Kyoto in Japan with meetings in between and meetings since and meetings in the planning. The one most of us has heard about was held in Kyoto. Some of the countries attending that "chin-wag" came to create the Kyoto Protocol. The way I heard it is the squabble that took place in Kyoto's Community Hall would shame a flock of magpies fighting over a dish full of dog kibbles. Some countries, by being part of this agreement, have decided to reduce their "greenhouse gas emissions stocking rate." Canada has chosen to partake and through that agreement we, as a country, have some pretty serious reductions to make. It's my understanding some industries are going to be highly regulated in how much they have to reduce their emissions. Agriculture on the other hand – given the importance of producing food – is not to be formally regulated. We are however, expected to do our part voluntarily. That should sit well with us, given our preference to "doing the right thing" as compared to "being told what to do."

Cowboy Tinkering

As the story goes, there are two ways for industries to meet their "greenhouse gas stocking rate" reductions. They can implement technology to reduce the amount of their emissions - that creates something with the fancy term of a greenhouse gas reduction credit. The other option is a greenhouse gas removal credit. That situation occurs when a change in a management practice results in the removal of carbon dioxide from the air. This occurs through plant photosynthesis. Photosynthetic carbon is returned to the soil in the form of crop residue and/or soil organic matter. This is better known as carbon sequestration. The places where the carbon is stored (the plant roots and soil) are known as sinks. (Just so you're clear on this, if carbon is released back into the atmosphere through plant combustion, decomposition or respiration, the process is now called a source. That's how systems came to realize a "steady-state,' prior to humankind's tinkering with them.)

If we go back to our Range Up In The Sky, that means the greenhouse gas stocking rates have to result in critters actually being removed from the range or by figuring out some way to reduce their impact. Any cowboy that's tried to feed through a drought knows the challenges in either option.

Hold Up There!

But, let's hold up here for a bit on this plant photosynthesis. I was at a workshop a bit ago on this exact subject. A feller spoke up and got everyone all fired up about what he called, "The Power of Photosynthesis." See, when it comes right down to it, photosynthesis is Mother Nature's way of restoring order to that Range Up In The Sky. Well now, it doesn't take too much common sense to figure out if carbon is to be captured from the Range Up In The Sky, then Sheriff Photosynthesis is best suited to the job. And in what kind of territory does Sheriff Photosynthesis best work in? Yup, on rangeland, on pastureland, on cropland and in bush and forest land! Bingo! I'm figuring maybe each and every one of us managing land should be wearing a Sheriff Photosynthesis Badge to recognize our land's contribution to this greenhouse gas issue!

Cowboy Common Sense

And like any good story, this one has another twist to it. Seems as though some of those industries that are going to be regulated, just might be interested in talking to us about buying our carbon credits. You'd think that would be as easy to organize as a rock fight in a gravel pit, but that doesn't seem to be the case. Fact remains though, governments are working on the design of an "off-set and emissions" trading framework, so keep your ears perked for more information and make darn sure you get it from a reputable

Cowboy Arithmetic

Cowboy Common Sense

Cowboy Look-See

source. I reckon I'd be interested in hearing more about carbon credits – especially when practices that increase carbon sequestration also contribute to production efficiency. Cowboy arithmetic tells me that just might pay off on the economic side of things in more ways than one.

So that's my plan. But before I get too far ahead of myself, I'm a goin' to first of all take a look at what kinda common sense is necessary to improve production efficiencies while keeping an eye out to reduce or remove greenhouse gases. We are all likely to be familiar with a bunch of these ideas, but the idea is to put on your "greenhouse gas glasses" and look at them in a different light. Next we'll need to get a handle on what on the operation is a source of greenhouse gas emissions and what creates a sink for carbon. From there, a cowboy can make the best decision of the day. And all the while, keep in mind what we talked about first off on this tour. Those of us who make our living on the land have always been humbled by the realization we need to live in harmony with Mother Nature. It seems to me our greatest hope as humankind lies in respecting our place in Nature rather than closing our eyes to it.

Let's take a look at some of these ideas, then you can head on out for a "Sinks and Sources Tour"…..

Cowboy Considerations for Removing or Reducing Greenhouse Gases	
Grassland and Grazing Management	
Cowboy Consideration	**Potential Outcome**
Subdivide pastures and rotate cattle to manage stock densities and grazing duration. Avoid overgrazing!	A grazing system that shifts between use and recovery increases productivity and improves the quality of the forage. Healthy forage can also increase carbon sequestration. Although more management and labor is required, increased stocking rates, returns per animal, forage production, number of grazing days, net income and improved herd health are among the reported benefits. Overgrazing and continuous trampling decrease the efficiency and viability of plant systems.
Learn how to and regularly perform a proper assessment of Range and Tame Pasture Health. Manage pastures to maintain a long term "Healthy"* rating.	Managing pastures to achieve a "Healthy" rating improves forage quality, improves animal performance and likely has a net reducing effect on greenhouse gas emissions while sequestering carbon in the soil.
Implement a riparian grazing plan.	A properly managed riparian area provides highly productive vegetation that is capable of sequestering more carbon than it emits. The carbon can be quickly lost if the vegetation is damaged or removed.
Implement a grazing plan that takes into consideration areas that require special management. (For example areas of native pasture in a field of tame pasture.)	Grazing areas of special vegetation need to be monitored in terms of timing (time of year and length of stay) to optimize production and carbon sequestration.
Develop off-stream watering sites.	In addition to improving water quality, off-stream watering sites protect riparian areas, increase vegetative production and sequester carbon.
Utilize distribution tools such as placement of salt and mineral.	Distribution tools can be used to encourage cattle to spend time in designated areas and out of areas that require special management.

*"For rangelands (including grassland, grazeable forestland, shrubland, pastureland and riparian areas), the functions of healthy range include net primary production, maintenance of soil/site stability, capture and beneficial release of water, nutrient and energy cycling and functional diversity of plant species." (Rangeland Health Assessment for Grassland, Forest and Tame Pasture. Alberta Sustainable Resource Development)

Assure the health of plant systems by controlling the time of year and the amount of time that cattle have access to grazing areas.	Healthy plant systems have the potential to sequester carbon and offset greenhouse gas emissions while providing a high plane of nutrition for livestock.
Extend the grazing season with stock piled forage or by swath grazing.	Extending the grazing season results in the field distribution of manure reducing both nitrous oxide and methane emissions. Swath grazing may reduce costs, workload and the fossil fuel use and greenhouse gas emissions associated with putting up hay or silage.
When seeding tame pasture, reseeding degraded pastures, or returning cropland to pasture, choose perennial species that are taller, with broader leaves and deeper roots. Use a minimum disturbance seeding method.	Choosing the right plant composition can make a big difference in productivity and long-term sustainability. A large amount of carbon is stored in plant root systems and ultimately the soil. A minimum disturbance seeding method will reduce the amount of carbon lost in the seeding process.
Consider using a mix of legumes and grasses when developing forage mixes.	Legumes provide grasses with nitrogen, creating a more balanced system. This reduces the need for inorganic nitrogen fertilizer (and the greenhouse gas emissions associated with its production).
Fertilize tame pastures with compost, manure or inorganic fertilizer.	Increasing the production of pasture grasses can result in more carbon sequestered and an increase in overall grazing days.

Cowboy Considerations for Removing or Reducing Greenhouse Gases	
Feeding and Breeding	
Cowboy Consideration	**Potential Outcome**
Analyze the nutrient content of feed-stuffs and balance rations using protein and mineral supplements as required.	A balanced ration ensures the most efficient use of the chosen feed. Such efficiency can minimize the rumen methane emissions and manure output per pound of feed eaten by the animal.
Avoid feeding more nutrients than required.	Feeding excess nutrients increases costs unnecessarily. It also results in higher greenhouse gas emissions from rumen fermentation and manure output.
Consider adding grain to the diet.	Diets high in grain reduce methane emissions, although one would need to offset that with the greenhouse gases emitted in producing the grain.
Feed ensiled forages rather than dry forages.	The higher digestibility of ensiled feeds results in fewer greenhouse gas emissions per pound of feed as compared to dry forages.
Whenever possible use high quality feeds in the winter ration.	In ruminants, the faster the feed is digested, the less methane that is produced per pound of feed consumed.
Chop, grind or pellet straw or low quality feeds.	Chopping, grinding or pelleting low quality feed makes it easier to digest. The emissions reduction (methane) would have to be balanced against the emissions created (carbon dioxide) in chopping, grinding or pelleting.
Consider the addition of ionophores to the feed ration.	Ionophores are feed additives that reduce methane formation in the rumen. The effect however is not long lived as the microbes in the rumen that create the methane quickly adapt to the presence of the ionophore.
Consider the addition of lipids (plant derived edible oils add energy to the diet and inhibit methane production).	Plant derived edible oils (in appropriate amounts) add energy to the diet and inhibit methane production by “mopping up” hydrogen in the rumen that might otherwise be converted to methane.

Put into practice a Herd Health Program that includes: Preg-testing cows and culling accordingly. Evaluating bulls for breeding soundness. Improving calf survival rates from birth to weaning. Implementing a comprehensive cow and calf vaccination program.	Greenhouse gas emissions per pound of live-weight gain are reduced as production efficiencies increase. Overall costs per weaned calf are reduced.
Take advantage of new and developing opportunities to select breeding stock identified as having higher feed efficiency.	Cattle come with genetic differences, some being more efficient than others in utilizing the nutrients in their feed. Researchers and breeding stock suppliers are beginning to be able to identify these individual cattle.

Cowboy Considerations for Removing or Reducing Greenhouse Gases	
Nutrient and Manure Management	
Cowboy Consideration	**Potential Outcome**
Compost manure. Composting is the biological breakdown of manure into a more stable organic form. Compost is rich in carbon, free of pathogens and substantially reduced in terms of mass and volume.	Both field application of raw manure and composting of manure results in greenhouse gas emissions as the manure decomposes. However, in the form of compost, manure volume is significantly reduced, thus reducing fossil fuel use in field application
Field apply raw manure and compost at a time when growing plants can make use of it.	Applying raw manure or compost when plants can immediately make use of its nitrogen will reduce the potential for losses in the form of nitrous oxide, a potent greenhouse gas. The efficient use of manure nutrients also reduces the need and cost for inorganic fertilizers and the greenhouse gas emissions associated with its production.

Avoid stock piling manure.	Stockpiling manure can result in anaerobic decomposition, which increases both methane and nitrous oxide emissions.
Complete soil tests prior to applying manure.	The application of more nitrogen than a crop needs via manure or compost will result in nitrogen accumulation in the soil. This potentially increases the amount of nitrogen released into the atmosphere in the form of nitrous oxide.
Plan winter feeding areas on level ground away from riparian areas.	Nitrogen loss in the form of manure run-off is reduced.
Move winter feeding and bedding areas around the field.	Managing these areas to ensure the cattle more evenly distribute manure around the fields results in more effective decomposition of manure by insects and micro-organisms in the spring. This also results in more efficient application of manure nutrients for spring forage and/or crop production.
Encourage healthy populations of beneficial insects that break down dung.	By incorporating the dung back into the soil, dung beetles return tons of nitrogen to the pasture that otherwise would have been lost to the atmosphere. As a result of the incorporation of this organic matter into the soil, there is the potential for increased forage yields as the soil is able to retain more water, is better aerated and has a better structure.

Hold Up There!

Greenhouse Gas Sinks and Sources "Look-See"

You can hold up here once more before you get started. Remember, this is an opportunity for you to get a handle on:

- what activities, processes or practices are sources of greenhouse gas emissions;
- what activities, processes or practices reduce greenhouse gas emissions and;
- what activities, processes or practices create greenhouse gas sinks.

It's a chance fore you to take a look at things, well shucks, for not bein' able to think of a better way of sayin' it, through greenhouse gas glasses. Now remember, there isn't necessarily goin' to be a clear-cut answer to these questions and some points in the chart might have a checkmark in all 3 columns. Fact is, the primary purposes of doin' this is to get the wheels turning on this greenhouse gas sinks and sources situation. Give it a try and see how it goes.

Place a checkmark in the appropriate box(es).

Winter Feeding: Cow-Calf Operation	***Source of Greenhouse Gas Emissions***	***Reduces Greenhouse Gas Emissions***	***Sequesters Carbon (Greenhouse Gas Sink)***
Tractor operating (running or idling)			
Truck operating (running or idling)			
Winter feeding using a horse and wagon/sleigh			
Analyzing and balancing winter feed rations			
Chopping, grinding or pelleting feed			
Grazing stock piled grass (native or tame)			
Swath grazing			
Feeding hay			
Feeding silage			
Adding grain to the diet			
Using high quality feeds			
Over feeding or over supplying nutrients			
Cattle digesting (cudding)			
Manure and urine output			
Manure distribution (stockpiled or evenly distributed)			
Feeding area (location, slope, breakdown of manure, pattern of use)			
Watering area			
Riparian area management			
Use of wind-breaks (natural or manmade)			
Bedding area (location, slope, breakdown of bedding)			
Corral cleaning and spreading manure			

Place a checkmark in the appropriate box(es).

Winter Feeding: Backgrounding Lot	***Source of Greenhouse Gas Emissions***	***Reduces Greenhouse Gas Emissions***	***Sequesters Carbon (Greenhouse Gas Sink)***
Tractor operating (running or idling)			
Truck operating (running or idling)			
Hauling hay using a horse and wagon/sleigh			
Forking feed by hand			
Analyzing and balancing winter feed rations			
Chopping, grinding or pelleting feed			
Grazing stock piled grass (native or tame)			
Swath grazing			
Feeding hay			
Feeding silage			
Adding grain to the diet			
Adding ionophores to the diet			
Adding lipids to the diet			
Using high quality feeds			
Over feeding or over supplying nutrients			
Selecting stock for high feed efficiency			
Cattle digesting (cudding)			
Manure and urine output			
Manure distribution (stockpiled or evenly distributed)			
Feeding area (location, slope, breakdown of manure, pattern of use)			
Watering area			
Riparian area management			
Use of wind-breaks (natural or manmade)			
Bedding area (location, slope, breakdown of bedding)			
Corral cleaning and spreading manure			

Place a checkmark in the appropriate box(es)

Management of the Calving Operation (See also Winter Feeding on a Cow-Calf Operation and Grazing and Grazing Management)	***Source of Greenhouse Gas Emissions***	***Reduces Greenhouse Gas Emissions***	***Sequesters Carbon (Greenhouse Gas Sink)***
Pregnancy testing cows			
Semen testing bulls			
Checking cows and calves using a ½ ton, ¾ ton or 1 ton vehicle			
Checking cows and calves using a quad/atv or motorcycle			
Checking cows and calves on horseback or walking			
Improving calf survival rates from birth to weaning			
Implementing a comprehensive cow/calf vaccination program			
Calving/bedding area (location, slope, breakdown of bedding timing of use)			

Place a checkmark in the appropriate box(es)

Grazing and Grazing Management	***Source of Greenhouse Gas Emissions***	***Reduces Greenhouse Gas Emissions***	***Sequesters Carbon (Greenhouse Gas Sink)***
Perennial pasture actively growing			
Annual pasture actively growing			
Equipment use in seeding annual pasture			
Forage mix (including legumes)			
Range and tame pasture health assessments performed			
Soil testing on hay or crop land			
Applying inorganic fertilizer to grazing land			
Applying manure to grazing land			
Applying compost to grazing land			
Water management:			
Flood irrigating			
Natural flow system			
Irrigation pumps			
Use of a grazing plan			
Intensive/rotational grazing system			
Extensive grazing system			
Exposed or bare ground			
Manure distribution			
Manure breakdown			
Managing riparian areas (age of trees, understory regeneration, canopy health)			
Using off-stream water sites			
Using distribution tools			
Stockpiled grass/forages – dormant season grazing			
Using solar water pumps or solar fencing panels			
Hauling water for livestock			

Place a checkmark in the appropriate box(es)

Putting Up Winter Feed	***Source of Greenhouse Gas Emissions***	***Reduces Greenhouse Gas Emissions***	***Sequesters Carbon (Greenhouse Gas Sink)***
Soil testing on hay or crop land			
Applying inorganic fertilizer to hay or crop land			
Applying manure to hay or crop land			
Applying compost to hay or crop land			
Breaking or cultivating land			
Reseeding to a perennial crop			
Seeding to an annual crop			
Adding legumes to forage mix			
Equipment use for seeding			
Seeding method (minimum tillage)			
Forage actively growing			
Water management:			
Flood irrigating			
Natural flow system			
Irrigation pumps			
Swathing or cutting hay			
Raking and baling hay			
Hauling and stacking hay			
Stored hay			
Twine use (poly or sisal)			
Making and hauling silage			
Stored silage			
Silage wrap disposal			

Place a checkmark in the appropriate box(es)

Farm or Ranch Site	***Source of Greenhouse Gas Emissions***	***Reduces Greenhouse Gas Emissions***	***Sequesters Carbon (Greenhouse Gas Sink)***
Tree shelterbelts			
Manmade windbreaks			
Grassed and lawn areas			
Farm/ranch vehicles (fuel, power, efficiency, use)			
Farm/ranch equipment (fuel, power, efficiency, use)			
Fuel tanks (type of fuel used)			
Power and heat sources for buildings:			
Natural gas			
Solar			
Wind			
Wood			
Geothermal			
Coal			
Propane			
Heating use and peak periods of use			
Energy use and peak periods of use			
Yard lights			
Crop drying facilities			
House, yard and farm/ranch waste disposal:			
Recycled			
On-site landfill			
Off-site landfill			
Burning			
Burying			
Building materials (house outbuildings, fences, corrals)			
Septic and sewer systems			

Cowboy Look-See

Keep Your Ear To The Ground!

For more information contact:

The Canadian Cattlemen's Association
www.cattle.ca
310 – 6715 – 8TH Street N.E.
Calgary, Alberta T2E 7H7
Telephone: (403) 275-8558

Agriculture and Agri-Food Canada
www.agr.gc.ca

Alberta Agriculture Food and Rural Development
www.agric.gov.ab.ca

British Columbia Ministry of Agriculture Food and Fisheries
www.agf.gov.bc.ca

Manitoba Agriculture, Food and Rural Initiatives
www.gov.mb.ca/agriculture

Saskatchewan Agriculture, Food and Rural Revitalization
www.agr.gov.sk.ca/

The BIOCAP Canada Foundation
www.biocap.ca

The Kyoto Cowboy

I've heard it said by some folk that of "climate change" they have some doubt.
"It won't happen in my life-time, so there's nothin' to worry about."
But after thinkin' closely, of grandkids comin' on someday,
I figure I'd rather be safe than sorry, I'll make Kyoto pay.
I'll be the Kyoto Cowboy, I hold Ranchin' deep within my heart,
And about those greenhouse gases, I guess I can do my part.

My cows I'll highly manage - through small fields they'll daily graze.
With fresh, green grass a growin' it'll show that fencin' pays!
There's no manure build-up, dung beetles work to fertilize.
Manure disappears so quickly - it has no time to volatize.
The creek will be protected, with very limited access.
I'll capture tons of carbon through photosynthesis.

Yes, carbon I will sequester, in soil and roots beneath the ground
For a pay cheque I will be waiting, with interest paid compound.
Crop lands I'll seed to pasture with grass and some legume.
Too often I won't graze it, nor "too fast, too long, too soon,"
Now when I do that seeding, a min till drill will sure be found
It'll keep my land turned right side up, the carbon in the ground.

Cows will graze outside this winter, eat swaths or stock piled feed
And when I have to feed them, it'll be no more groceries than they need.
I'll be sure they are well nourished so that they rarely belch methane.
I'll chop or grind or pellet; add some oil or maybe grain!
The herd is safe and sheltered from the Great North's winter chill
I'll use a manmade windbreak to help reduce my danged feed bill.

My mare's another story as some gas she's wont to pass,
But with the fuel I'm saving, I'll still reduce that greenhouse gas.
We'll plant some trees around the place; they'll spruce it up in style,
Plus help reduce the heating bill, sequester carbon by the mile.
I'll get the ranch all decked out with solar panels and pumps galore,
And if I get a windmill, I'll need the power grid no more.

I'll hobble my 1-Ton Dually. I'll have to lock her in the shed.
When I'm off to town on business, it's with 4-cylinders instead.
Yes, I'll learn to manage carbon. Science says that is the key.
And I'll send to all a challenge to remove some elemental C.
So heads up to you City Folk, and to Industry far and wide -
See this Kyoto Cowboy and the eco-service I provide!
.
But there's another story, and a story sad to share,
For it's really hurt this Cowboy to have to lose his meal-time fare.
You know how 'round the campfire, we cowboys like to sing and eat,
And how a cowboy's favorite meal is always biscuits, beans and meat?
I guess the beans, they gotta go...Trust me, I've tried and tried again,
But no matter how I cut it, I'm over quota on methane!

N. Lee Pengilly

Before You Head On Home……..

I'd like you to know I'm mighty grateful that you chose to take this Tour. I hope you've learned a little bit more about this greenhouse gas issue. If you have questions, would like some extra copies of the Greenhouse Gas Sinks and Sources Tour Guide for Canadian Beef Producers, or maybe you'd like some help with a tour for you and your neighbours, give Pat Walker a call. (403) 601-8991 (email: pgwalk@shaw.ca) or Peggy Strankman (403) 275-8558 (email: strankmanp@cattle.ca). Either one of them can help you out.

Thanks again.

Happy Trails,
Lee

Giving Credit Where Credit Is Due

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