AGS

ADVANCED GRAZING SYSTEMS

MENTOR HANDBOOK

MODULE 1 GOALS

Canadian Forage & Grassland Association
Association Canadienne pour les Plantes Fourragères

GREENER PASTURES RANCHING

FARMERS FOR CLIMATE SOLUTIONS
FERMIERS POUR LA TRANSITION CLIMATIQUE

MODULE 1 - GOALS

A	Healthy vs Unhealthy Water Cycle
B	Photosynthesis and Exudation
C	Soil Health and Nutrient Availability
D	Biodiversity
E	Recycling Nutrients
F	"Weed" Management
G	Polyculture of Roots

Module 1 – Goals

A – Healthy vs Unhealthy Water Cycle

Water is our most important nutrient in agriculture. For every 50 pounds of Nitrogen that we need to grow a crop, we also need approximately 10,000 pounds of water. In every environment, there can be a huge difference between actual rainfall and effective rainfall, depending on management. Actual rainfall is what ends up in your rain gauge. The effective rainfall is the amount of that rainfall that the plants get to use. If you receive 2 inches of rain, how much do you think your plants actually benefit from? We can't control the amount of actual rainfall that we receive, but we can control the amount of effective rainfall we get to use.

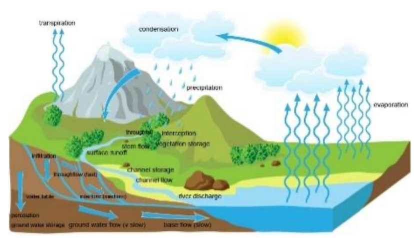
There are 3 factors that we need to manage.

Run Off - Without a protective layer on the surface of the soil, one raindrop will come down and impact the bare soil. That one raindrop can damage the soil structure. It breaks apart the soil structure causing soil capping. A capped soil is that smooth surface that eventually cracks when it dries. During the rainstorm, this smooth surface causes the ensuing rain drops to run off. They cannot penetrate through this capped soil, so they run off. As these raindrops run off the land, they take with them the best parts of the damaged aggregates; our valuable organic matter, along with some of the residual chemicals and fertilizers, washing these into our water systems and our rivers.

Evaporation - What moisture did manage to get into your soil is now vulnerable to evaporation. Rainfall is controlled by gravity. The moisture in the soil however does not work through gravity. It works through diffusion. This is a movement from an area of greater concentration to an area of lesser concentration. Or in other words, wet to dry. If the top layer of the soil's moisture evaporates, the moisture from lower in the soil profile will then move up to the drier area. It will then also evaporate and leading more moisture to move up. Suddenly our water cycle has been reversed. Instead of moisture infiltrating down through the soil profile, it is moving up and evaporating from the surface. As this moisture moves up, it can also bring with it salts and when the water evaporates, these salts will be left behind at the surface which can be detrimental to plant growth.

Infiltration - If we have a very compacted soil, water infiltration can be very limited. If we have a very permeable soil, moisture can infiltrate too fast and disappear down through the soil profile. Either way it is our job to manage infiltration. If it is very permeable, what we need to do as producers is to build organic matter in our soil. We need to use the plants to add organic matter to hold onto the water. In comparison to a very permeable soil, if we have a very clay soil, the soil may become overly saturated if the water has no were to go. Deep rooted fibrous and tap rooted plants can help dig through this compacted layer allowing water to infiltrate down into the profile. This is an unhealthy water cycle that will have capped soil, which causes runoff, along with excess evaporation from the surface and infiltration that occurs too fast.

A healthy water cycle is when water evaporates from our lakes, ponds, and rivers to form clouds. These clouds will then become dense enough to precipitate back to the ground as rain. We then need those raindrops to hit living or dead plant material. This is what we call our soil armor. With adequate soil armor, the raindrop will break apart into tiny droplets and then soak into the soil slowly. This is our opportunity to hold on to the water. That thatch layer on top helps to reduce the evaporation. The soil is protected from the sun and the wind by this soil armor and the water will not move up through the soil profile. Instead, moisture can infiltrate down through the soil gently to replenish the water bodies from below ground at a gradual pace. We accomplish this by building organic matter in our soils. The more exudate we can add to the soil through the roots, and the more residue we can add to the soil surface, the faster we can build water holding capacity in our soils.



How to Repair the Water Cycle

We need to leave more residue and we need to build soil through root growth. We need to make sure that the first raindrop cannot hit bare exposed soil. We need living or dead plant material to protect the soil from run-off and evaporation. We also need to have plenty of organic matter built up in our soil to hold onto this water. This organic matter helps to create a sponge within our soil which can hold water.

We also need to manage our runoff. Flooding is becoming a more and more common occurrence. Draining wetlands and low areas is very common and is incredibly detrimental to the water cycle. Let's say every farmer drains three riparian areas in the effort to gain more crop land. Each riparian area holds an average of 10,000 gallons of water. On a single watershed, we might have 2500 farmers. That adds 75,000,000 gallons of water to the watershed. This is a major contributing factor to flooding issues. We have millions in taxpayer dollars spent on flood prevention and repair each year. We are also washing away our topsoil and this has a dramatic effect on the amount of biodiversity on our landscape.

B - Photosynthesis and Exudation

Photosynthesis is the key to life on our planet. This process takes place in the chloroplasts of the plants. Carbon dioxide (CO2) from the air, and water (H2O) from the soil, combine to capture sunlight energy which is stored in the form of a simple sugar - glucose (C6H12O6). This glucose molecule then transforms and is the base for a great diversity of carbon compounds.

Exudation is the process of this glucose being transported to the root system of the plant and being pushed out into the soil. Through this process we are adding carbon to the soil as well as feeding the soil biology.

If we look at the basic glucose molecule, it is made up of C, H and O. The elemental breakdown of all plants is approximately 45% Carbon, 45% Oxygen, 6% Hydrogen and 1.5% Nitrogen. All of these are available in the air. Did you know that the air we breathe is 78% N? We just need the biology in our environmental system to help us get it. In total, 97.5% of the nutrients that every plant needs comes from the air. Not the soil. Most of the other nutrients needed by the plants are measured in parts per million.

We need a mindset switch in agriculture. Instead of growing plants from the soil, we need to grow the soil from the plants. We need to think about how we can use the plants and the soil organisms to add carbon to the soil. As we add carbon, the nitrogen levels will also increase. The system wants to balance the C:N ratio.

C - Soil Health and Nutrient Availability

Soil health is defined as the continued capacity of soil to function as a vital living medium that will sustain the ecosystem. A healthy soil contains millions of living organisms that interact with the plants to form symbiotic relationships. In exchange for glucose, the soil organisms will provide needed nutrients to the plants. As producers, we need to be aware of and manage this living ecosystem. 80-90% of plant nutrition is micro-biotically mediated. This requires healthy soil and soil biology to access the needed nutrients. Nutrients that are 'unavailable' are bound up in the soil. With a healthy living soil, when the plants need these nutrients, the soil biology will deliver them.

D - Biodiversity

Nature works in whole systems. There are millions of symbiotic relationships that all coexist within a single ecosystem, yet every ecosystem also interacts and relies on other ecosystems around it. The aquatic ecosystem has a dynamic interaction with the riparian area ecosystem which interacts with the uplands ecosystem which interacts with the woodland ecosystem. We are part of one very complex, yet simple system. If we walked away, nature would heal itself. The water cycle would repair itself; carbon would balance out again and ecosystems would heal. Pests are one of the common issues that we have in agriculture. They are prolific when the conditions favor them. Usually a pest problem is caused by a change in the environment that favors their reproduction and/or removes the predators. Dealing with pest issues is about balance and there will always be a ripple effect when we attempt to control one part of the system.

Examples of Biodiversity That We Want in our System.

The Dragon Fly - Dragonflies are an apex predator in the insect world. They are fast, agile and eat anything smaller than themselves. Their adult life span is only about two weeks long, so we need quite a few hatchings of this very beneficial predator throughout the summer. Their teenage aquatic nymph stage can be up to four years long. This stage needs a healthy water system in order for them to survive. Excess chemical or fertilizer run off can be detrimental to the nymphs. Allowing livestock access into the water can also be detrimental. It can take between 2-4 years (depending on the species) to get a healthy population of adults that prey on pests. In both the nymph and adult stages dragonflies consume a lot of pests for producers. The adults need the long tall grasses around the edge of the riparian areas for reproduction.

Dung Beetles - Dung beetles play an important role in agriculture. While burying and consuming dung, they improve nutrient recycling and soil structure. They are also important for the dispersal of seeds found in the dung of animals. They can protect livestock by removing dung which, if left, could provide habitat for pests such as flies. They are also helpful in breaking the life cycles of many types of livestock parasites. There are three basic types of dung beetles. Rollers, Tunnellers and Dwellers. We just need to make sure that we take care of them by providing desirable environmental conditions.

Tardigrades – These microscopic soil organisms are also known as water bears, or moss piglets. They are known as the toughest critters on the planet. Some Tardigrades can withstand extremely cold temperatures down to 1 K (−458 °F; −272 °C) while others can withstand extremely hot temperatures up to 420 K (300 °F; 150 °C)[36] for several minutes. They can also survive pressures six times greater than those found in the deepest parts of the ocean and can live through ionizing radiation at doses hundreds of times higher than the lethal dose for a human. They can even live in the vacuum of outer space. Tardigrades can go without food or water for more than 30 years, drying out to the point where they are 3% or less water, only to rehydrate, forage, and reproduce. Tardigrades that live in harsh conditions undergo an annual process of cyclomorphosis, allowing for survival in sub-zero temperatures.

Most Tardigrades are plant eaters or bacteria eaters, with some being carnivores, as they eat other smaller species of tardigrades.

Tardigrades work as a pioneer species by inhabiting new developing environments. This movement attracts other invertebrates to populate that space, while also attracting predators. If ever an environment is damaged, these guys survive and can initiate the environmental healing process.

Freshwater Shrimp - These little freshwater Gammarid crustaceans are commonly known as scuds. They are the aquatic ecosystem's clean up crew. They scavenge in detritus and aquatic vegetation. It is important to protect our water bodies from contaminants to ensure that these crustaceans can survive and to keep our water systems healthy.

Arbuscular Mycorrhiza Fungi (AMF) - This is a network of fungus that forms unique structures like root hairs, called arbuscules, that help plants capture nutrients such as phosphorus, sulfur, nitrogen and even micronutrients from the soil. This symbiosis is a highly evolved mutualistic relationship found between fungi and plants. The AMF provides the plants with needed nutrients in return for glucose.

Many modern agronomic practices are disruptive to mycorrhizal symbiosis. Conventional agricultural practices, such as tillage, heavy fertilizers and fungicides, poor crop rotations, and selection for plants that survive these conditions, hinder the ability of plants to form symbiosis with AMF.

If we manage for AMF, it can improve the quality of the soil and the productivity of the land. AMF is also the transportation system through the soil, moving needed nutrients around to the plants and helping to provide water when conditions get dry. It also produces Glomalin which is a soil building component. The fungus exchanges nutrients with the plants for sugar and then converts it to glomalin, which is a more stable form of carbon in the soil. Glomalin takes 7–42 years to biodegrade and is thought to contribute up to 30 percent of the soil carbon where mycorrhizal fungi are present.

The Earthworm- Earthworm populations depend on the balanced physical and chemical properties of the soil, such as temperature, moisture, pH, salts, aeration, and texture, as well as available food. The most important factor for earthworms is pH with the majority of species favoring neutral to slightly acidic soils. Not only do earthworms decompose organic matter and manure, but they open up tunnels for water infiltration, aeration and they buffer the pH of the soil. The slime that earthworms produce also helps to provide the ideal conditions for many bacteria.

Brown Headed Cowbird- These birds forage on the ground while following cattle in order to catch insects that have been stirred up by the animals grazing. Cowbirds primarily eat seeds and insects and are great at helping with natural parasite control. The brown-headed cowbird is an obligate brood parasite, it lays its eggs in the nests of other birds. The young cowbird is fed by the host of the hijacked nest. More than 140 different species of birds are known to have raised young cowbirds.

Microbats – These nocturnal mammals love to eat insects. They are also the only mammals to have achieved true flight and are faster and more agile than birds. The navigational system of bats consists of a highly developed sonar or echo-location system. Ultrasonic sound waves produced in rapid pulses ranging from 20 to more than 500 pulses per second are bounced off objects around the bat.

Interpretation of the returning sound waves (the echo) allows the bat to determine the distance, speed, direction, texture, and size of an object. This system of echolocation is extremely precise and individual bats have a remarkable ability to identify their own signals and avoid confusion even when surrounded by thousands of other echo-locating bats. Vision is also important in navigating at short range. The aphorism "blind as a bat" has no factual basis. They sleep in hot dry places all day and need to re-hydrate soon after they wake up each evening. Water also helps them to digest the dry crunchy insects. In order to drink, a bat flies low over a pond, lake, or stream and simply opens its mouth scooping up a mouthful of water. This is another reason to keep your riparian areas healthy. Bats are a tremendous asset to our farms; however, in North America, the fungal disease White-nose Syndrome has devastated bat populations.

Fly Parasites - Fly Parasites are tiny wasps, and they are a unique predator because they target only the pupa of flies. The parasite females search for a fly pupa and can dig down six inches into manure or compost in order to reach the prey. They then deposit their eggs into the fly pupae and the young parasites will consume the fly pupae while developing into adult fly parasites. Each female will lay between 50 to 150 eggs at a time, depending on the species. These adults emerge fully grown and ready to search out more fly pupae and start the reproductive cycle again. Normally, this cycle takes 18-21 days depending on the species of fly parasite and temperature. The adult fly parasites also consume some of the fly pupae, providing a secondary method of reducing the potential fly population.

E - Recycling Nutrients

Here in Canada, we live in an environment with a short growing season and a long dormant season. For a large portion of the year our soil is too cold for the biology that lives within it to decompose plant material. The plant materials need to be broken down and recycled back into the system. This is where we need the ruminant animal (cow, sheep, goat, bison etc.), because about 80% of the nutrients consumed by a ruminant comes out as manure. The ruminant animal was designed for environments with a dormant season, which is an extended dry season or a winter season. In comparison, a rain forest soil is never dormant and is full of microbiology all year long to decompose plant material. The rain forest did not naturally have ruminants. The ruminant was placed in dormant season environments to give the decomposers a suitable place to do their job. Inside the rumen of the livestock.

In most agricultural practices, nutrients from the soils are continually exported. Only with livestock grazing are we effectively recycling the nutrients. If the land is healthy and our livestock are out grazing, we will only be exporting 20% of what she consumes. If you are mechanically harvesting the crop, you may be removing 75% to 90% of the nutrients with the crop and exporting them to somewhere else. Livestock are very important in the regeneration of soil because of their ability to recycle.

Grazing residues on grain land is also a step forward in soil regeneration. We will still be exporting a large portion of the nutrients while farming crops, but by integrating livestock we can help to recycle what remains behind after harvest.

F – "Weed" Management

Every plant has a purpose in nature and many of our undesirable plants are there to heal the soil in one way or another. If one species of plant is taking over an area, it is only a symptom that is telling you that something is favoring them. The system is out of balance. A few of these undesirable plants in a pasture is not a bad thing, as they are adding species to a desired perennial polyculture. We need to manage for the grazing concepts and these symptoms will not be a problem. If we solve the root of the issue, the symptom will go away.

G - Polyculture of Roots

An important part of building healthy soil is developing a system of roots that promote soil biology. The greater the diversity of root systems, the more diverse the soil life will be. When establishing a new stand, it is good to aim for a diversity of root types. (Tap rooted legumes, creeping legumes, bunch grasses, creeping grasses, C3 plants, C4 plants, annuals, perennials, broadleaf, etc.) Every environment is different, so the species of plants may differ, but diversity is the key to developing a strong soil biology.