Western
Forage/Beef Group

Pasture School

Accredited by Society of Range Management

Lacombe Research Centre
Lacombe, AB

June 17 - 19
2003

6000 C & E T Trail
Lacombe, AB T4L 1W1

Pasture School Schedule - Western Forage/Beef Group

Ask Jim Bauer, Grant Lastiwka, or Cathy Hendrickson for further information

Tuesday, June 17, 2003

8:00-8:30 am	Registration	(classroom)
8:30-9:00	Introductions-schedule	Jim Bauer/Grant Lastiwka
9:00-10:15	Pasture Production	Vern Baron
10:15-10:30	Coffee	
10:30-12:00	Understanding Grass and Legume Growth	Vern Baron
12:00-12:45	Lunch	
12:45-1:00	Travel	
1:00-3:00	Pasture Rejuvenation/Establishment	Harvey Yoder/Duane McCartney
	Grazing Legumes	Vern Baron/Bjorn Berg (field)
3:00-3:20	Coffee/Travel	
3:20- 4:20	Pasture Planning	Brian Luce (classroom)
4:20-4:35	Travel	
4:35-6:35	Pasture Plant ID	Fred Young/Myron Bjorge/Cathie Erichsen-Arychuk/Debbie Oyarzun (field)
6:35-7:35	BBQ	

Wednesday, June 18, 2003

8:30-8:45am	Questions?	Jim Bauer(classroom)
8:45-9:45	Pasture Economics	Arnold Mattson/Lorne Erickson
9:45-10:45	Pasture Nutrient/Fertility Cycling	Arvid Aasen
10:45-11:00	Coffee	
11:00-12:00	Grazing Nutrition	Erasmus Okine/Christoph Weder
12:00-12:45	Bag lunch/travel	
12:45 - 2:45	Farm Tour of Leading Edge Grazier	Brian Luce directed (Farm tour)
3:15 - 5:15	Farm Tour of Leading Edge Grazier	Jan Slomp directed (Farm tour)
5:15 - 6:15	Travel	
6:15-7:15	BBQ	
7:15 on	Pasture Networking	Everyone

Thursday, June 19, 2003

8:30-9:30 am	Matching the Cow to the Grass	John Basarab (class room)
9:30-10:30	Extended Grazing-Fall-Winter-Spring	Lorne Erickson/Vern Baron
10:30-10:45	Coffee	
10:45-11:45	Annuals for Grazing/Swath Grazing	Duane McCartney
11:45-12:30	Lunch	
12:30-4:00	Pasture Assessment/Walk	Grant Lastiwka/Lorne Erickson/ Vern Baron/Jim Bauer Fred Young/Arvid Aasen/ Duane McCartney/Cathie Erichsen-Arychuk (field)
4:00	Homeward Bound	

Participants for Pasture School 2003

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This year's Pasture School Manual
is dedicated to these enthusiastic forage graziers.

Lou Hendrigan
Don and Randee Halladay
Ulla Thomsen (DeBruijn)
Frances Gardner
Mike Anderson
Ray Fausak
Don and Bev Campbell
Denis Wobeser
Ernie Nimitz
Bruce McDougall
Jim Bauer
Wyett Swanson
Greg Griffin
Ray Bannister

They have openly shared their experiences, advised for success and mentored for true knowledge.

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Introduction

Grant Lastiwka
Pasture Specialist

On behalf of the organizing and planning committee of Cathy Hendrickson, Ann de St. Remy, Jim Bauer, and myself I would like to thank you for attending this three day workshop. Through the vision and support by our working group, and advisory members of the Western Forage/Beef Group (WFBG) the Pasture School is possible. Key assistance from the Alberta Cattle Commission (ACC), Livestock Development Division of Alberta Agriculture, Food and Rural Development (AAFRD), and Agriculture and Agri-Food Canada (AAFC) have made this annual event possible. Manitoba, BC and Saskatchewan Agriculture, AAFRD Public Lands, Gallagher, PEL and PFRA provided written support materials. Sponsorship also came from several private companies and individuals and they provided their business cards as a key contact information source for participants in need of their services. We encourage you to pick up their literature we have made available on areas that may interest you. We further asked animal handling specialists, Dylan Biggs and Al Schaefer; fencing specialists, Nick Portiek and Jim Stone; lowland forage expert, Neil Miller; forage weed agronomist, Dan Cole; and former forage agronomist, Jerome Lickacz for their written presentations. Thank you also to Jan and Marianne Slomp and Brian and Gail Luce for hosting our farm tours. Also thank you to the Agricultural Research and Extension Council of Alberta and Alberta Environmental Sustainable Association for their support. This rounds out the supportive organizations whose partnership makes the Pasture School manual a better resource for those interested in grazing management. Please feel free to call these key contact individuals as the resource they provide is a valuable one to anyone looking to learn more in the many areas of pasture management.

The art of grazing practiced by graziers is complex, and to be performed at a high level requires excellent management skills. With soil, plant, animal, climate and management interfaces the result of a manager's actions becomes less clear. Determining or learning from the true reason for success and failure is difficult. Because of this, grazing information is valued as a resource to be used wisely in making successful decisions by the farmer or rancher. The present knowledge extension specialists, scientists and graziers have does not answer all the questions about grazing. As graziers strive to come up with new creative ideas to be better pasture managers, scientists try to find out the reasons why these ideas do not or do work. The science of grazing is one researchers and extension people try to unlock daily and at times, as Saskatchewan Agriculture, Crop Development Section, Scott Wright says..”it's not more complicated than we think, it's more complicated than we can think...”. A friend of mine, Don Halladay a Holistic Management consultant and instructor near Leslieville, Alberta said “...as we reach a new plateau of understanding we encounter a new level of confusion...”. The building blocks of knowledge we create allow us to learn more and at the same time better understand what we discovered yesterday.

Over the next three days the mutual respect we as an organizing committee have for the art and science of grazing management will hopefully be evidenced in this workshop. With the combination of seminars, field sessions, tours of grazier's operations and the Pasture School resource manual, we will try to provide you as a participant with some of the information you are searching for. Networking time with fellow participants and instructors will only enhance information gained over the next three days. As an organizing committee we have charged the presenters with the task of providing high quality information. We leave the creativity with you to choose and apply this information in your operation. Making better management decisions accounting for people-soil-plant-animal and climate interactions in your grazing operation is something no one is better equipped to do than you. We as an organizing committee are really excited about putting the art and science of grazing together in one workshop.

Grazing 101:Introduction to the Principles of Controlled Grazing

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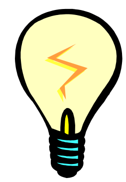
Pasture as an Ecosystem

Pastures should be thought of as a community made up of plants and animals. If you think of one without the other you have an incomplete ecosystem. The pasture ecosystem is made up of parts that are dependent on one another. Climate, soils, plants and animals are the primary parts. Together they form a complex system.

Forage plants depend on sunlight energy to grow. Solar energy is caught by the leaves of a forage plant and converted through the process of photosynthesis to carbohydrates. This energy is used for growth and development of the plant. The forage plant also depends on soil nutrients, moisture and a suitable temperature to grow. Grazing animals have the unique ability to convert the energy stored in grasses, legumes, forbs and shrubs to meat, milk and fiber products usable to humans.



The simple act of grazing by an animal is neutral; it is neither good nor bad, after all the animal is merely trying to satisfy its appetite. However the effect of grazing can be beneficial or detrimental to plants, soils or animals, it depends on how it is done. The process of growing plants and grazing is a dynamic process with many interrelated elements. The challenge to those who manage grazing is that these elements operate in a state of continual change. Day length (sunlight hours), soil moisture levels and temperatures vary throughout the growing season. These variations cause the speed at which pasture plants grow to fluctuate widely. Therefore the responsibility falls to man as steward of agricultural grazing resources to conduct grazing in such a way that it benefits the plants and the animals.

CONTROLLED GRAZING is about meeting the needs of both the plants and the animals.

It is often referred to as "more art than science" because of the complexities involved.

This is what "controlled grazing" is all about; meeting the needs of both the plants and the animals. In his book Grass Productivity Andre Voisin, a French grass farmer and grazing researcher states "When we think of the cow, we will not forget the demands of the grass. When we examine the grass, we will always bear in mind the demands of the cow. It is by satisfying as far as possible the demands of both parties that we will arrive at a rational grazing, which will provide us with maximum productivity on the part of the grass while at the same time allowing the cow to give optimum performance".

What is Controlled Grazing?

Definition: Controlled grazing is a program based on maintaining control of animals, animal numbers, area to be grazed and the length of time the area is to be grazed or rested.

Controlled grazing is not an exclusive system or name, in fact people meaning the same basic thing have called it many different names such as: range management, rotational grazing, intensive grazing, planned grazing, knowledge based grazing and the list goes on. The important thing is to understand the principles of how forage plants grow, how animals graze and how to best manage these resources.

Although there is science involved in grazing, controlled grazing is often referred to as "more art than science"; this is because of the complexities involved. A good manager uses knowledge, experience and skill to evaluate his/her current situation based on growing conditions, forage availability and the livestocks' nutritional and physical requirements and then makes grazing plans accordingly. These management decisions are an ongoing process throughout the year on a grazing operation. Managing a pasture through controlled grazing could be thought of as a "balancing act" consisting of matching grazing periods and rest periods for optimum plant growth and nutritional value.

Controlled Grazing is based on a natural process

There is nothing new about controlled grazing it has been practised since livestock were first domesticated. Nomads were nomadic because it was obvious that they had to keep moving to provide feed for their stock. Wild herds of grazing animals instinctively practice controlled grazing. Animals that graze are prey animals, they are the producers in the grassland ecosystem. They are characterised by having eyes on the side of their heads so they can see in a near 360 degree range to watch for their predators. Bison, zebras, cattle, sheep, and rabbits are examples of prey animals. Predators are the consumers, characterised by having eyes in the front of their heads. Lions, wolves and humans are examples of predators. Herds of large graziers in the wild bunch together for protection from predators. This defence mechanism of bunching together creates a situation that is also good for the grassland. By herding together the forage is grazed uniformly, urine and feces are dropped on the area just grazed and the herd naturally moves to fresh pasture. Moving to fresh pasture allows the grazed plants time to grow and recover. Moving on also helps the animals to leave behind their parasites. This is God's way of maintaining healthy grasslands and animal populations. We mimic a natural situation when practising controlled grazing with domesticated livestock.

The following comments were made by a man named Peter Koch who observed bison grazing in Montana before it was settled (in Brown and Felton 1955): "In March 1870, I travelled from Muscleshell to Fort Browning on the Milk River, and for a distance of forty miles I do not think we were out of easy rifle shot of buffalo... we could see many miles on either side; but... the eye only met herd after herd of grazing and slowly moving buffalo... three days later I passed over the same trail on my return trip, and the vast herds had disappeared as if by magic."

Pasture Principles

Energy Flow

Solar energy flows from the sun to the soil surface. The more energy that can be captured and turned into plant growth the higher the yield will be of the pasture. In essence the grazing manager is farming sunlight. Think of a farm as a large solar panel, the more energy from the sun that is captured and used to produce green leaf the more efficient the farm will be. Sunlight that strikes bare soil or leaves that have matured is wasted solar energy.

There are three general stages of growth that pasture plants go through either from the start of the growing season in spring or following defoliation.

Stage 1
Small leaf area-photosynthesis is low
Slow growth
May be growing from stored energy reserves

Stage 2
Large leaf area-photosynthesis high
Usually fast growth (depending on time of year, available moisture etc.)

Stage 3
Large leaf area but photosynthesis has greatly slowed or stopped because of approaching maturity
Slow or stopped growth

If the three stages were plotted on a graph with time along the bottom and yield along the side, it would form an "S" shaped curve. At the start of growth or following grazing the pasture starts to grow slowly, picks up speed as leaf area increases and then slows and finally stops at maturity.

Keeping as many plants as possible in stage 2 captures more solar energy and optimizes pasture productivity.

Nutrient Cycle
The cycling of nutrients in a pasture is the movement of nutrients from the atmosphere to the soil to the plant to the animal and back to the soil and atmosphere where the cycle begins again.

Dung and urine distribution is affected by:

- Stock density
- Stocking rates
- Water source
- Shade
- Topography
- Preferred grazing areas

Water Cycle
Water cycles in a similar fashion to nutrients. After precipitation is received some evaporates, some runs off, and some is absorbed into the soil. Of the moisture that gets into the soil some is available for plants and some moves through the soil profile and beyond the reach of roots. The ability of the soil to absorb water is more important than the total amount of precipitation received. The soils' ability to absorb and hold water is dependent on the condition at the surface of the ground. If the soil is not covered by plants and litter, moisture will evaporate quickly from the unprotected surface. With bare soil, water is able to run off more quickly and possibly cause erosion. A good plant and litter cover will provide a covering to the soil that will slow runoff, aid water infiltration, and resist evaporation.

Ways to Improve the Water Cycle

- Increase litter
- Increase plant cover
- Increase root mass
- Increase soil organic matter
- Fast manure breakdown

Succession
Plant communities within a pasture are always changing. Plant species are constantly increasing, decreasing, or invading a pasture. This progressive plant development, or the replacement of one plant community by another is called succession.

In order to give you a mental picture of plant succession, imagine a piece of cultivated farmland that has been abandoned in the Parkland region of Alberta. If left undisturbed plant succession would likely move from a simple community of annual and biennial weeds to perennial grasses and forbs to possibly a climax community of aspen forest.

Most pastures should be managed to maintain succession at a productive grassland level. If a pasture is grazed all season long or if very short rest periods are used many plants will be overgrazed. The plants that are adapted to continual defoliation and unpalatable plants that are not grazed will be favored and they will eventually dominate the plant community. On the other hand if no grazing takes place (total rest) the build up of old grass can create an environment where woody plant species thrive and brush will invade the pasture. Succession in a pasture is limited by environmental parameters such as; climate, precipitation, soil type, altitude, and latitude.

Grazing Principles

Severe Grazing

Definition: grazing that removes a high proportion of a plants leaves

Cows, horses and bison are severe grazers, this means they bite by the mouthful and are able to bite a plant short in one or two mouthfuls.

Sheep, goats and deer species who have smaller, narrow mouths are nibblers but are still capable of severely grazing plants.

Selective Grazing

All animals are selective in what they graze. When given a choice of a variety of plants they will generally chose the youngest and most palatable ones.

Overgrazing

Andre Voisin, quoted earlier and Allan Savory founder of Holistic Management were instrumental in bringing to light what overgrazing is and how it occurs. The following definition is a version of the now commonly accepted description on what overgrazing is and how it occurs.

Definition: Overgrazing is grazing a plant before it has recovered from the previous grazing.

Overgrazing can occur in a few ways at different times of the year;

A. At the beginning of the growing season when the plant is coming out of dormancy and growing from energy reserves.

B. Leaving stock in a paddock so long that they re-graze plants that are re-growing. During fast growth periods this can be just a few days.

C. Bringing livestock back to a paddock too quickly. In other words the paddock was grazed the animals were removed and then brought back to graze again before enough time had elapsed to allow the plants to recover their energy balance.

Biological Time

You will notice that the overgrazing definition didn't say anything about how many animals were grazing but only that the plant had not received sufficient time to grow and recover from the grazing event. Recovery time needs to thought of as biological time not just days on a calendar. Biological time means that the growing conditions; light, moisture, temperature, soil nutrients etc. were adequate to support growth and recovery of the plant

Inadequate recovery weakens the forage plant. When a plant is severely bitten during the active growing season root growth stops and energy reserves stored in roots, crown and stem bases are then used to grow new leaf material. The reserves are used until the new leaf material has enough surface area so that photosynthesis can resume and eventually replenish energy reserves. Once the energy balance is restored and adequate forage is accumulated for grazing the grass could be bitten again and the plant would not be overgrazed.

Stocking Rates
Stocking rate is the number of animals that can graze a pasture area for a specified length of time. For example; 40 cows grazing a 160 acre pasture for 150 days. You could then express this stocking rate as 4 acres per cow for 5 months. A stocking rate is only a rough estimate of how many livestock a pasture will support. It is most useful when a long term history is known about the pastures' productivity. The following calculations can be used to determine a stocking rate.

Example Stocking Rate Calculation
Acreage (A) eg. 160
Yield (Y) eg. 4000 lbs/ac dry matter
Grazing Season (GS) eg June 1-Sept. 15, 107 days
Average Weight of Animals (AW) eg 800 lbs
Forage Allowance (FA), often calculated at 4% of body weight; 2.5% intake, .5% fouling loss, 1% residual pasture

A x Y divided by AW x FA x GS = Stocking Rate (#'s of livestock)

160 acres x 4000lbs divided by 800lbs x .04 x 107 days = 187 head

Stock Density
Definition: The number of animals in a particular area at any moment in time.

Uniform grazing is a function of stock density. The higher the stock density the more uniform the grazing.

A combination of low stock density and low stocking rates will cause a pasture to look "patchy", i.e. patches of short overgrazed grass beside patches of long "wolfy" undergrazed grass.

High stock density effects grazing the following ways:

1) you alter the livestock's behaviour by concentrating them which creates competition for food and reduces selectivity.
2) the feed on offer will be more uniform because plants are in a similar growth stage due to more uniform grazing previously.
3) there will be a more uniform distribution of manure and urine which will improve the nutrient cycle.
4) the animals will impact the area by trampling and fouling plants which will improve nutrient and water cycles.

You have control over stock density by either adjusting paddock size or animal numbers. A general rule of thumb for stock density is to use the highest stock density for the shortest period of time. If you have a high stock density you will see most plants in the paddock have been either bitten, fouled or trampled following grazing.

Calculate Stock Density

$$\text{Stock Density} = \frac{\text{\# of animals in paddock}}{\text{\# of acres in paddock}}$$

e.g. A farm has 100 cows and the paddocks are 10 acres in size

$$\text{Stock Density} = \frac{100}{10}$$

Stock Density = 10 cows/ acre

Rest Period and Graze Period

Definition: Rest Period; The length of time a specific area is rested following grazing, allowing plants to recover.

Formula to calculate a rest period: Rest Period = Graze Period x # Paddocks resting

Definition: Graze Period; The length of time animals are allowed to graze a specific area.

Formula to calculate a graze period:

$$\text{Graze Period} = \frac{\text{Rest Period}}{\text{\# of Paddocks - 1(occupied)}}$$

Example

A farm has 160 acres divided into 16 paddocks of 10 acres each, the grazier wants to calculate a 30 day and a 60 day rest period. How long will his grazing periods be in order to achieve his required rest?

$$\text{Graze Period} = \frac{30}{16 - 1} \qquad \text{Rest Period} = 2 \times 15$$

Graze Period = 2 days   Rest Period = 30 days

$$\text{Graze Period} = \frac{60}{16 - 1} \qquad \text{Rest Period} = 4 \times 15$$

Graze Period = 4 days   Rest Period = 60 days

Pasture Nutrition Principles

The feed value of a pasture is determined mainly by the amount of fiber contained in the forage plants that make up the pasture plant community. In simple terms high quality forage is low in fiber and high in protein. Fiber is the cellulose, lignin and hemicellulose that make up the cell walls of the plant, fiber is what gives the plant strength so that it will stand upright. The amount of fiber in a forage plant and its' nutritional value are inversely related. High fiber in a forage plant means it will be of lower feed value than a low fiber plant.

Three Factors Affecting Forage Quality

Species
Stage of Maturity
Leaves vs Stems

Species

Plant species has an impact on forage quality. Legumes tend to have higher protein values than grasses. Within species some grasses and legumes are higher quality than others. Some forage species contain compounds that negatively affect forage quality or intake. Examples of these are; alkaloids, tannins, nitrates, prussic acid, coumarin and endophytes.

Maturity

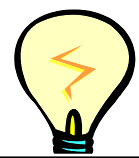
Remember the 3 basic stages of growth discussed previously which were described in the 'S' shaped curve. We will use the same 3 stages to describe general pasture nutrition. As the plant matures the amount of fiber increases in the plant which decreases protein, energy, palatability & digestibility.

Stage 1
-high quality - low quantity
-fiber is low, protein & energy high
-the plant is very palatable and nutritious at this stage
-small leaf area, hard to get a belly full

Stage 2
-high quality - high quantity
-fiber medium-low, protein & energy medium-high
-the plant is nutritious and palatable
-large leaf area and requires less effort to get a belly full

Stage 3 (reproductive stage)
-low quality-high quantity
-fiber high, protein & energy low
-poor nutritional value and palatability
-large leaf area but due to high amounts of fiber grazing intake is low

Leaves vs Stems
In stage 1 the plants are so low in fiber there is usually no discernable difference between the leaves and the early beginnings of stem formation. Therefore there is no real nutritional difference between leaves and stems. In stage 2 and even stage 3 we have degrees of feed quality where leaves are quite a bit higher in feed value than the stems.



HIGH QUALITY PASTURE is leafy and succulent and extremely palatable.

What Does High Quality Pasture Look Like?
High quality perennial pasture is leafy and succulent, it can be a monoculture of one forage species or a polyculture of various grasses, legumes and some forbs like dandelion. It is low in fiber and high in protein and energy. High quality pasture is extremely palatable. It needs to be of sufficient height and density so the animal can easily grasp mouthfuls allowing them to fill quickly. Filling quickly allows the livestock to spend less time grazing and seeking feed and more time lounging and ruminating, this will lead to higher production as less energy is expended.

Indicators of nutrition level that a grazing manager can look for are:

A) Amount of leaf compared to stem.
B) Consistency of manure produced. The more fibrous the diet (lower quality) the more fibrous the manure will be. Stiff cow pies that pile up when dropped are a sure indicator of a low quality diet. Runny manure indicates low fiber and high digestibility, therefore high quality.
C) Residual grass remaining when stock leave the paddock, ie. more residual grass indicates a high level of nutrition was consumed.

Length of Grazing Period Affects Nutrition
The nutrition level is related to the length of the grazing period. The longer the grazing period is on a particular paddock the lower the feed value will become. Forage quality and consumption (Dry Matter Intake) are highest on the first day livestock are in a paddock. Upon entering a paddock, the leafy forage is selected first. When stock graze below the leafy part of the sward into the stems their plane of nutrition drops.

While in the paddock, livestock step on, defecate, urinate and lay on some of the forage. Trampling of grass, defecation and urination all foul the grass, causing refusal to eat what they have fouled. The effect of fouling is more pronounced under higher stock densities. If a great deal of fouling has taken place in a paddock forage intake will quickly decline. The manager needs to be aware of this as animal performance will suffer.

Gain per Head vs Gain per Acre

If high average daily gains are desired it is important to understand the following concept: *high forage utilization per acre and high individual animal performance are opposites.* You could say that gain per acre and gain per head and are on opposite ends of a teeter-totter (Allan Nation, Pasture Profits with Stocker Cattle, p 88). In other words if gains per acre go up, individual gains go down. This is simply a case of declining levels of nutrition, i.e. as more forage is utilized per acre the stock consume a declining plane of nutrition.

Leader/Follower Grazing

A leader / follower system of grazing optimizes both animal performance and utilization of the pasture. Leader / follower is a method that gives the high production class animals the first graze of a paddock followed by animals with lower nutritional requirements. For example stocker steers followed by beef cows with calves, or lactating dairy cows followed by dry cows and young stock. The leaders would consume roughly the top 1/4-1/3 of the forage available and the followers would eat the next 1/3-1/2, leaving 1/4-1/3 for regrowth.

Grazing Management Principles

How Many Paddocks?

How many paddocks do you need to practice controlled grazing? An 8 paddock system should give the manager enough control to satisfy the rest requirements of the grass. To better manage nutrition and nutrient cycling higher paddock numbers are recommended. A system that has larger paddocks that can easily be divided into smaller paddocks with temporary fencing allows much management flexibility.

Vary Rest Periods with Time of Year and Growing Conditions

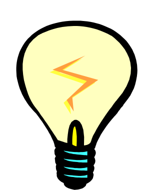
The amount of rest required changes with the season and the seasonal climatic conditions. Remember to think in terms of biological time. In the Parkland region of Alberta a grass at the same stage of maturity grows approximately twice as fast in June as it does during the month of August. This is mainly due to day length. Of course faster or slower growth is also dependant on temperature, moisture and soil nutrients. This is why we have to vary the rest period according to the season.

Controlled grazing has to allow for a flexible rest period. Rigid rotations based on a fixed calendar rest period will not work. Without a flexible rest period you will end up practicing controlled overgrazing because at one time of the year your rest period may be adequate for plant recovery, at another time in the season it may be too short or too long. The rule of thumb is;

Fast growth = Fast moves   Slow growth = Slow moves

Plan Ahead

Fast growth is the hardest but most important aspect of controlled grazing to manage properly. This is where you make or break your grazing year. It is important to note that the growing season and the grazing season are not the same thing. A successful grass



farmers' grazing season will be much longer (possibly year round) than the growing season. Therefore it is important to be planning ahead. Plan what your forage needs will be 1, 2, 3 months or more from now. And make management decisions accordingly. In other words you will have to decide if you should speed up your moves or slow them down. This takes constant planning and monitoring of what is occurring in the pasture.

Build Pasture Mass During Periods of Fast Growth
During periods of fast growth the goal is to "top" the grass in order to keep it vegetative and growing while increasing pasture mass. This pasture mass is called a forage bank. You will be able to slow your moves down during slow growth periods because of the forage bank that you built during fast growth. The forage bank will allow you to meet the needs of the animal and meet the needs of the grass. Because there is plenty of grass the livestocks' nutritional needs will be satisfied and because there is plenty of grass the plants that are resting will have enough time to recover their reserves before being grazed again. Once growth stops you can then extend your grazing season far beyond the growing season by rationing this forage bank just as you would a haystack.

Fast growth is the hardest but most important aspect of CONTROLLED GRAZING to manage properly.

To manage fast growth you should be moving through the paddocks quickly or giving the stock a larger area for a longer period of time and allowing them to move themselves. The danger with closely controlling the stock during fast growth is that if you are a little slow in getting them moved they can very severely graze the plants. If very severely grazed the paddock will require a longer rest period to recover because the plants will have to initiate new leaves using energy reserves. If you can "top" the grass, that is to say remove less than 40-50% of the green leaf then the plant is able to continue with photosynthesis and is not required to use energy reserves to grow. The stock can do a very good job of "topping" the grass during periods of fast growth, by giving them a larger area. They can move themselves much faster and easier than you can move fences! The critical thing when giving a larger area for a longer period of time is to watch closely for overgrazing, i.e. watch closely that they are not going back and biting the same plants. During fast growth rapidly growing plants could produce enough height to be bitten again in less than a week.

There are various ways to deal with this spring flush of fast growth. One way is to set some paddocks aside to cut for hay or silage. Another is to alter your stock numbers by adding stock during fast growth and removing them when growth slows (put and take).

A combination cow/calf and yearling operation works well for put and take.

Summary
To sum up "Grazing 101" we have learned that any given pasture should be thought of as an ecosystem made up of soils, plants and animals and their interrelationships. Of course any individual farmers' pasture is itself part of a larger ecosystem.

We have seen that "controlled grazing" is an attempt by man to mimic what happens in the wild wherever there are grasslands, grazing animals and their predators.

We have discovered that grazing is about harvesting sunlight energy. We learned that nutrients and water cycle through the pasture system. We also saw that plant communities are dynamic and change through the process called succession.

We discussed the effects that grazing has on a plant and most importantly how to stop or at least minimize overgrazing.

We learned that a pasture is a good source of nutrients for livestock and if managed well can provide very good animal performance.

Lastly we discussed how the grazier actually goes about the process of planning and managing his pasture so that it will as Andre Voisin so aptly stated “provide us with maximum productivity on the part of the grass while at same time allowing the cow to give optimum performance.”

It is my hope that this “Introduction to the Principles of Controlled Grazing” will give you a strong foundation on which to build your own grazing operation.

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Pasture Production

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Definitions

Above ground net primary production: Dry matter produced from photosynthesis over a period of time (i.e the growing season). It includes growth, dead and consumed material, but it is that new material produced after the onset of the time period.

Secondary production: Product that arises from the consumption or utilization of the primary product (mostly plant material). In pastures this is the meat, milk or animal gain derived over a set period of time. Also, it includes gain by gophers, rabbits, deer and other small herbivores.

Leaf area index (LAI): This is the area of leaf lamina per unit ground area. For instance 1 square meter of leaves over a ground area of 1 square meter is an LAI of 1.0. The leaf area that is considered in LAI is green leaf material that actively fixes carbon through photosynthesis. As plants grow they are likely to have LAI's less than 1.0. As layers of leaves develop, LAI's can be greater than 1.0. LAI's in pasture stands vary from 0.5 to about 6.0. A heavily grazed pasture will have a LAI of less than 1.0, where lots of soil or ground is visible. Many good pastures will have a LAI of 3 to 5.

Net assimilation rate (NAR): Is the dry matter produced per unit of LAI. This is a measure of the efficiency with which the sward produces dry matter in a unit of time (i.e daily).

Carbon fixation: This is another phrase for photosynthesis. It means the process of turning carbon dioxide into dry matter.

Crop growth rate (pasture growth rate): In technical terms it is the LAI x NAR, but it is also the rate of accumulation of above ground net primary productivity (i.e daily).

Grazing efficiency: The ratio of consumed forage over total forage produced within a time frame.

Grazing intensity: The frequency and severity (closeness) of defoliation during grazing.

Dry matter intake (DMI): The amount of wet forage consumed by the animal converted to a dry basis

Pasture mass: The amount of dry matter per unit area above ground level at any time.

Residual pasture mass: The amount of dry matter per unit area left after grazing.

Framework for Pasture Yield

Geographical location, soils and climate place the first limitation on the amount of pasture that can be produced. These factors set the maximum rate of production and the number of days over which productivity can occur. Either we have naturally adapted forage crops that can achieve the production goals or we find new types through introduction or breeding. Beyond these generalities temperature, light, water and soil nutrients limit or shape production on a day to day or seasonal basis.

First and foremost the length of the frost-free season and day length shapes seasonal production. In the Parkland of the Canadian Prairies the frost-free period is 90 to 105 days. The time of maximum daylight or the longest day is June 21. Cool season grasses and legumes fix carbon dioxide into plant material (photosynthesis) optimally between 20 and 25 ^{o}C and fixation rates decline rapidly above 30^{o} C. Carbon fixation rates of alfalfa peak at temperatures above those of cool-season grasses. Mean maximum temperatures during June and July are 20.6 and 23.6 ^{o}C, respectively at Lacombe. Generally air temperatures decrease rapidly after August 15 and again after October 15 as days become shorter and much shorter, respectively.

Soil water content is almost always highest after snowmelt in the spring and precipitation is highest during June and early July. Perennial cool-season grasses begin to use water as soon as they green up in the spring. In the Western Parkland in normal years soil water deficits are often limiting from late July on. In the southern prairies in normal years soil water may become limiting as early as mid to late June. Therefore this climatic and geographical framework is the powerful maker or breaker of net productivity. It should be no surprise that June is the month of maximum production and that management must use this fact as a way to set up a season of 150 or more days of grazing.

Dry matter production patterns on pasture in the Northern Hemisphere are known to decrease from spring to fall as shown in Figure 1. From these patterns we can see that the majority of above ground net productivity occurs during the early part of the season. The greatest difference between the Canadian Parkland and other areas of the world is that our net production accumulates in a relatively short period of time, if not because of short days, because of the cool temperatures in spring and fall. What is common to all areas is the role of plant morphology (height and LAI), light and temperature in the decreasing efficiency of growth from spring to fall. These factors dramatically influence how we manage our pastures.

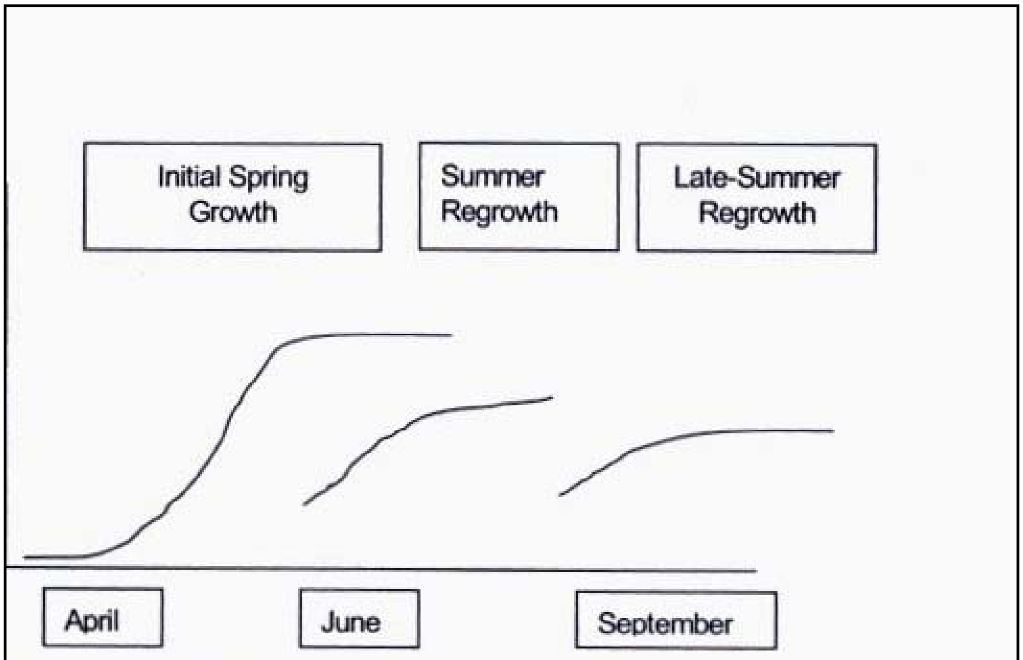
Light and Leaf Area Index (LAI)

Leaves intercept 85% or more of the incoming solar radiation at any time. Stems and leaf sheaths intercept the remaining 15% at full light interception. The uppermost leaf layer intercepts the most light and shades the remaining layers of leaves below it. A flat compact canopy may intercept most of the light in a short area below the top of the plants. This is not as efficient as intercepting light over a broader distribution of leaf layers, which would occur in a more erect canopy. In the flat canopy the light may be intercepted by LAI of 1.5, compared to LAI of 3 for the erect canopy. Both canopies might have produced the same amount of leaf material, but the erect canopy intercepts the most light.

These differences in the efficiency of light interception differentiate initial spring growth from regrowth. Leaf canopies from initial growth are erect with leaves being held up in the sunlight by stem material. Of course the leaves of regrowth are usually closer together and tend to lie flat against one another. Note that this refers to grasses. Alfalfa leaflets are held up into the sunlight and actually track the sun during the day. Leaves that develop in direct sunlight are much more efficient in collecting direct solar radiation, than leaves that develop under shade. This allows leaves from initial growth to have higher maximum photosynthetic rates than leaves from regrowth.

Respiration uses the sugars produced by photosynthesis for maintenance and growth. Maintenance respiration grows as a percentage of plant dry weight. During regrowth respiration is larger as a percentage of gross photosynthesis than during initial growth, because of the difference in maximum photosynthetic rate between initial growth and regrowth. Thus a combination of factors limits and reduces the potential to produce pasture mass from spring to fall.

Shape of Forage Production



. Schematic of three cycles of pasture production.

Nitrogen Processes and Cycles

Nitrogen (N) is critical to the efficient production of dry matter by pasture. First, N is responsible for the production of enzymes that carry out photosynthesis. These enzymes in cool-season forage are not very efficient so it takes a lot of enzyme to get the job done. About 50% of the protein in the leaf deals with carbon fixation. Thus photosynthetic rate will increase up to a point with increasing leaf N levels. Once new leaves exceed 4% N there is little additional advantage. However, the greatest impact of an adequate soil N supply is to ensure a high LAI. This is especially important in recovery and regrowth of stands after grazing. Nitrogen enhances leaf area expansion and new tiller growth. Nitrogen additions or increased soil N levels are known to dramatically increase light interception, which will eventually be translated into animal grazing days.

There are two cycles of nitrogen to be concerned about. The first cycle occurs within the plant and the other from air-soil-plant and animal. Optimal dry matter production is known to occur at very high N levels within the plant. As pasture mass develops the N percentage of the stand decreases, as does growth efficiency. Nitrogen cycles within the plant, particularly from old dying leaves to new leaves and areas of growth. It has been shown that 75 to 80% of N in new leaves is derived from other areas within the plant. After cutting or grazing the sward is in a N deficit situation. Once foliage is removed from the sward, in an intensively managed grazing system this is quite uniform and at times severe, pools of above ground N are insufficient to fill the demand. For massive amounts of new growth to occur, cycling of N from older leaves, crowns and roots takes place. The aboveground N deficit is not so huge in continuously grazed swards because an array of growing, mature and dying material is available to act as sources and sinks for N.

The second N cycle also occurs in other crops, but is much more significant on pasture, because of the direct involvement of animals. Nutrients are consumed as organic products, and are turned over in mineralized forms, similar to fertilizer additions. Ruminants retain only 10 to 20% of ingested N, passing the rest as urine and feces. Under extensive grazing systems this is a very efficient process. However, under very intensive systems, particularly in short season areas, build up and loss of soil nitrate will occur. When pastures are high in quality (alfalfa stands, frequently grazed grasses) most of the ingested N is passed as urine. Urine is readily available for plant uptake. Nitrification (to nitrate) may occur within two weeks in summer. Because of the pattern of plant growth (Figure 1) and consumption, plant uptake can't keep up to soil availability, leaving unused N in the soil. Some management strategies can be developed to make use of this unused N, but we need to understand more about the responses of soil-Nitrate to grazing and pasture production in the parkland.

Tissue Turnover

Above ground production in pasture swards is dependent on a net production of new leaves and tillers in grasses and new stems, petioles and branches in legumes. For net above ground productivity to be positive, appearance of new tissue has to offset and exceed those that die. Turnover of tissue in grasses is much more dynamic than in legumes and contributes more to efficiency of growth.

During the process of plant and sward development a base of tillers and a set of mature leaves develops. This has to sustain an adequate LAI / residual pasture mass to maintain growth at a viable level. From measurements taken at Lacombe we have observed that tiller density increases until mid summer and decreases again. These changes reflect tiller appearance and death. During the increase in tiller density more tillers are forming than dying, with the reverse occurring, in late July after the peak of tiller density.

Leaves turn over more rapidly than tillers. The life span of a leaf may be about 30 to 40 days, depending on the time of the season. Throughout the growing season meadow bromegrass had from 1.5 to 2 growing leaves and from 2 to 4 mature leaves on tillers. There was a trend for fewer mature leaves per tiller from spring to fall. This trend for a decreasing number of leaves later in the year was indicative of leaf death exceeding leaf appearance. At Lacombe, as we move through July the plant machinery for producing new above ground material is decreasing and helps explain the trends shown in Figure 1.

These trends for tissue turnover indicate decreasing live sward content from spring to fall and lower sward productive capacity (NAR) per unit LAI. Because more new material is forming than dying during spring or initial growth, dead material in the sward is usually insignificant. However, it may be highly significant for late season growth. The amount of dead material in the sward and the rate at which it forms is a consequence of other factors. Dry and cold weather, particularly in late summer and fall will only increase death rates and/or reduce appearance rates for leaf material. Our approach to pasture management could be affected by the live/dead tradeoff. Grazing efficiency may be maximized by grazing leaf material before it dies. If the life expectancy of a leaf appearing at the top of the canopy is 30 days, and if maximizing grazing efficiency is our main goal, rest periods should not be longer. However, if 30% of the material is dead, does this accomplish our objectives? Yes if maximizing forage yield is our goal and not maximizing green leaf mass. Stockpiling forage for periods of two months to six weeks may result in adequate pasture masses for grazing when gross dry matter production is considered.

Effects of Grazing on Net Productivity

Above ground net productivity is closely related to the maintenance of LAI. In fact crop growth rate is linearly related to LAI, but decreases per unit LAI as the season moves from spring to fall. Secondary production is a function of pasture mass and utilization of the mass. The rate of utilization is governed by grazing intensity. As grazing intensity increases, LAI and crop growth rate decrease, but forage nutritive value increases.

As grazing intensity increases:

1. Efficiency of solar radiation capture decreases (decreasing LAI)
2. Increased harvest efficiency (higher utilization rate).
3. Decreasing conversion of forage to meat (lower DMI).

Secondary Production per Individual or per Acre. The predator + prey relationship between cattle and the sward dictates that as grazing intensity increases average LAI decreases. The capacity for the sward to intercept light is diminished. Over a whole season gross production decreases. However, there is compensation. Lack of forage production is offset by higher forage quality so that, as grazing intensity increases, intake per animal of digestible dry matter increases. This is the part of the relationship that management tries to exploit. With improved nutritive value more cattle can be maintained per acre at the same or lower dry matter productivity or LAI. Nutritive value increases because grazing efficiency becomes higher (i.e. leaf material is consumed before it dies). However, ultimately conversion efficiency decreases as intake, limited by decreasing forage mass, can't fulfill nutrient requirements for growth. At this point secondary production decreases.

A management note should be taken here. In the predator + prey relationship, when the rabbits are gone, the coyotes leave and the rabbits replenish. The good manager must move the cattle leaving enough residual mass to produce new leaf material to graze in the next rotation. If the manager needs the paddock in 30 days, then there must be enough residual LAI remaining to produce the quantity of dry matter needed in that time. Also, the previous paragraph seems to infer that there is an optimum to be achieved... this is not so! A compromise has been achieved. Both animal (secondary) production and plant (primary) production can not be optimized at the same time. When we optimize animal production we reduce leaf area so much that we reduce plant net productivity as well as the contribution of plant primary residues to the soil. When we maximize plant LAI and primary productivity we under use the sward.

Pasture Management. Pasture mass, residual mass (LAI), animal intake and season length interact to provide the framework for management. The response for animal intake to pasture mass is discussed in the intake article following this section. Researchers in Europe and New Zealand realized in the 1980s that primary production did not vary as much as they thought it should due to management.

What they found was that they could reduce LAI considerably by increasing grazing intensity without suffering a great loss in dry matter production or gross photosynthesis.

Closer to home, recent research at Lacombe over three years showed that meadow bromegrass, smooth bromegrass and spring planted winter triticale could be grazed six times compared to three times and only suffer a 10 % decrease in seasonal dry matter production.

Table 1. Characteristics of six (Heavy) and three (Light) times over grazing systems for seasonal and mean (per grazing) and mean dry matter production averaged over three years at Lacombe.

	Heavy	Light
Seasonal Production (lbs. per acre per season)		
LAI	3.0	5.0
AGNP (above ground net production)	5190	5720
Disappearance	4410	3650
Residue	840	2070
Mean per Grazing (lbs. per acre)		
Pasture mass	1750	3540
Residue mass	1030	2080

At Lacombe average LAI was higher for light vs. heavy grazing, which resulted in slightly more AGNP. The big difference was that 85% compared to 64% of AGNP was consumed/disappeared in heavy and light grazing treatments, respectively. This happened even though per grazing utilization was remarkably similar (42%). On the other hand little residue was left to return to the soil in the heavy grazed treatments.

This indicates that primary productivity per se is relatively unaffected by management, but grazing efficiency and therefore animal production is highly influenced by management.

Compensation at the sward level. How can a heavily grazed sward produce almost as much dry matter over the year as a lightly grazed one, even though the LAI of the latter is over 1.5 times larger? The answer is compensation for a reduced LAI. European literature suggests that as grazing intensity increases tillers size decreases, but tiller density increases, at least partially offsetting the reduced LAI. Our data indicates that heavy grazing reduced tiller density, to about 64% of the light treatment. So compensation through yield components offsetting each other was not likely.

The European research was conducted under continuous grazing, whereas we were simulating rotational grazing. Severe rotational grazing removes a lot of mature leaf growth. New leaves that develop under the influence of sunlight (heavy grazed) have a higher photosynthetic capacity than new leaves developing under shade (light grazed). Therefore production per unit of LAI was higher under the heavy than the light grazed swards. Another factor which influenced production differences between grazing treatments was that soil-N under heavy grazing exceeded 200 lbs. per acre compared to about 100 lbs. per acre under the light grazed treatment (Note: A fertilizer mix with 100 pounds of actual N, 50 of actual P, 100 of actual K and 25 of actual S fertility was applied to all stands at the start of each season). Sward N content of the heavy and light grazed treatments were 3.4 and 2.8%, respectively. The combination of higher sward-N content and greater consumption resulted in a high turnover of N under heavy grazing, which should have enhanced production processes under that grazing regime.

Grazing efficiency. In the example in Table 1, both pasture mass and residual mass of the light grazed were twice that of the heavy grazed treatment. Why did total consumption of the heavy treatment exceed the light? Besides the compensation by the heavy sward for its lower LAI, grazing efficiency was almost at maximum. After the first growth, very little new leaf material was allowed to die without being grazed. Everything was harvested. Only the equivalent of about 270 lbs. per acre of carbon (C) was returned to the soil. On the other hand considerable amounts of dead material accumulated in the light grazed sward, resulting in about 800 lbs. per acre of C returned to the soil. The mean rest period for the heavy and light treatments were 20 and 40 days, respectively. Forage quality of the heavy grazed treatment was higher than the light treatment, partly because there was less dead material in the stand. Thus animal productivity should have been high on the heavy grazed treatment, specially true if animals are moved frequently, perhaps as often as twice a day.

Pasture Mass and Use

It is difficult in advance to estimate your total forage yield per acre, target pasture mass, for the upcoming season and especially productivity at points within that season. So how can grazing management and stocking rate be dealt with in the planning and actual decision making of how to use that forage? By considering several factors first time planners are usually surprised at how accurate they are with budgeting forage production and animal use.

Previous records of yield or Animal Unit Days/Acre (ADA), no matter how rough, and an immediate yield calculated with a pasture meter, or by a person with a trained eye, are excellent tools to help with the above decisions. Now, together with taking a conservative planning strategy consider the following things:

1. Yield potential of pasture decreases as the season advances from spring to fall. Inevitably both pasture mass and residual mass will decrease; pasture growth rate will not keep pace with increasing animal requirements. In fact, forage growth and animal needs go in opposite directions.
2. Floral growth in spring will limit how large you can allow pasture mass to increase before stems limit intake.
3. The growing season is short. You have to start grazing sooner than you would like at a lower pasture mass than the average and graze at masses higher than average, just to achieve the target (animal use of most forage growth). Also, matching pasture mass with grazing efficiency is very difficult during both spring and fall. The good strategist doesn't tie him or herself to a rigid formula. They realize a pasture plan is meant to be changed so they plan with various options for being flexible.

The full season pasture mass yield needs to be assessed individually to paddocks and in total for all pastures. Once done, producers should do their planning for an average pasture mass for the season, making adjustments when it makes sense, based on class of animals grazed and nutritional requirements needed. The mass will have to be spread over enough acres to supply the animal units on hand for the duration of the grazing season. Then given all the limitations described, develop an achievable strategy.

European researchers, working mostly with continuously grazed swards, concluded that the best trade-off between gross tissue production and grazing efficiency was to use lower pasture masses than previously thought. In continuously grazed swards they suggested letting the sward come to a supply, harvest equilibrium, at an average pasture cover equivalent to LAI of 2.5 to 4.0 instead of exceeding 5.0. Translating this into rotational grazing, this could mean: start grazing at LAI = 3.5 and graze down to a residual pasture mass of about LAI 2.0. Compare LAI and mean Pasture mass shown in Table 1.

So now the producer says: "Keep it to lbs. and acres mate!"
In all cases choice of residual mass (what you leave behind) is the most important. This will be the base of tillers and leaves that set up the next rotation of grazing for each paddock.

The "Ball Park" Pasture Mass. New Zealand literature indicates that average pasture masses should not exceed 3000 lbs. per acre to minimize stemmy swards with dead material and not graze below 1800 lbs. per acre to keep animal intakes high. However, under some conditions they recommend reducing the residual pasture mass to 1400 lbs. per acre. It is important to realize that these values may have to change due to species, climate and time of year.

Spring Growth. This is the period of floral development in grasses. In a short season environment the timing of turn out is critical to maximizing grazing days. Some paddocks will suffer (not provide optimum regrowth) to achieve the sward average pasture mass. Table 2 shows times when lower or higher pasture masses will occur for cool-season grass species during spring at Lacombe. There are some species differences. This is an important point to be built into part of a stay flexible strategy. Use more than one species or the same species but different cultivars with varying days to maturity to spread out times of tiller elongation and dry matter production. Table 2 shows a range of about three weeks (meadow foxtail + May 15 to orchard grass - June 6) to provide pasture mass between 1400 and 2300 lbs. per acre. During initial growth and at 1400 lbs. of pasture mass per acre, the bromegrasses were 15 to 20% stem, while meadow foxtail was 36 % stem; at 2300 lbs. of pasture mass per acre the bromegrasses were 35 to 45 % stem, while meadow foxtail was 54% stem. While you can start grazing meadow foxtail early there is more stem per unit of pasture mass at any time than in the bromegrasses.

During spring growth, initiating grazing at about 1500 lbs. per acre is advisable because:

1. We know growth rates will increase daily. (The pasture mass growth rates for initial growth at 1400 and 2300 lbs. per acre were 98 and 128 lbs. per acre per day, respectively, averaged over the species in Table 2.) (Note: Stands were vigorous and well fertilized)

2. There will be a lot of stem material if we wait until after 2300 lbs. per acre. Stems reduce intake.

Table 2. Date for reaching 1400 and 2300 lbs. per acre pasture mass by cool-season grass species at Lacombe, Alberta during spring and after severe cutting in late July.

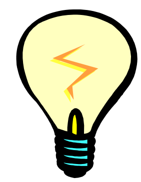
Spring growth pasture mass (lbs. per acre)

Species	1400	2300
Meadow bromegrass	May 20	May 27
Smooth bromegrass	May 17	May 25
Meadow x Smooth hybrid	May 23	May 29
Meadow Foxtail	May 15	May 24
Orchardgrass	May 27	June 6

Regrowth (lbs. per acre)

	1400	2300
Meadow bromegrass	Aug. 24	Sept. 2
Smooth bromegrass	Sept. 2	Sept. 12
Meadow x Smooth hybrid	Aug. 24	Sept. 2
Meadow Foxtail	Aug. 27	Sept. 13
Orchardgrass	Aug. 26	Sept. 6

Because of periods of stem elongation some species are quite vulnerable. When grazed during stem elongation, they do not regrow well. This occurs with meadow bromegrass when grazed during the last week of May. It can be argued that hard grazing should occur in spring to set up vegetative regrowth later. My opinion is that hard grazing would seriously damage meadow bromegrass during the last week in May, at least for the current season. If hard spring grazing is carried out then the producer should be prepared for long rest periods (i.e. 40 days). Also paddocks that are grazed during times of stem elongation should be varied from year to year.



The best advice is begin grazing a bit early, but move cattle quickly. If you want to graze hard to set up leafy regrowth, don't graze all paddocks hard - it may backfire.

The reason for a varied strategy at this time is that it is hard to predict exactly when these vulnerable periods occur from year to year. Out of necessity we have to move cattle according to pasture mass. Some years, because of high or low yields, we have to move faster or slower than we want or expected. The rate of cattle movement may not coincide with expected rate of plant development.

Regrowth - Early. This applies to paddocks that have been grazed once and are regrowing for grazing in June and July. The strategy for first grazing of regrowth should be to set up grazing for the rest of the year. During early summer set up a good base of residual pasture mass by not grazing below 1400 lbs. per acre. If high gains are desired keep residual pasture masses higher. It needs to be noted that stands from which regrowth productivity was recorded were vigorous, had high fertility applications and each grazing period was a short duration one. These factors will also combine with species and environment to determine regrowth potential. As indicated in Figure 1 yield potential for pasture is relatively high and it consists of almost all leaf material. Note that in Table 2, it took about 30 days to grow 1400 lbs. of pasture mass (smooth bromegrass took 40 days) from a very low LAI (a mean growth rate of 47 lbs. per day). But, it only took 14 days to reach 2300 lbs. after reaching 1400 lbs. (a mean growth rate of 60 to 90 lbs. per day, depending on species). Cool-season grass species like meadow bromegrass, orchardgrass, Italian ryegrass and spring planted winter triticale can all be grazed every three weeks from mid June to late July under good climatic conditions and good fertility and vigour if they have been grazed in a vegetative state and have been left with an adequate residual pasture mass. Stocking rate and cattle movement would have to be appropriate for removing about 1000 lbs. of material per acre quickly (71 head per

Stands from which regrowth productivity were recorded were vigorous, had high fertility applications and each grazing period was of short duration. These factors will also combine with species and environment to determine regrowth potential.

acre at 14-lbs. dry matter per day).

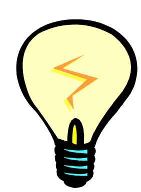
Regrowth - Late. To be conservative this applies to grazing from August 1 on. Growth rates will be in decline from this point. If we are lucky rainfall will be adequate and air temperatures moderate. We always have to be reminded that most of the growth occurs from mid May until Mid July. As the season progresses yield potential decreases (Figure 1). Our stocking rates have difficulty adjusting to the slower growth and before you know it we are grazing below our 1400 lb. per acre residual pasture mass limit. This can begin with two weeks of hot dry weather, where growth rate is near zero. This time of the year could be called the late season "pinch". It is important to maintain respectable residual pasture masses to keep growth rates up. The mean growth rate will be lower in late August, than mid July, but as a rule, a small residual pasture mass results in a small growth rate compared to a larger one (Crop growth rate = LAI x NAR). However, the pinch comes because we have a decreasing leaf appearance rate (because of decreasing temperatures), but leaf death rate remains constant or increases. So the rate of accumulation of green tissue will decrease. Because there is no point sacrificing grazing efficiency, grazing frequency should not slow. Long rest periods will simply build up dead material. Just don't graze to the ground.

Stockpiling. In order to graze during times of slow growth rates or near zero net accumulation, stockpiling some paddocks may be in order. This may have to occur from growth initiated as early as mid July. Data shown for regrowth in Table 2 and in the section on intake, shows that it may take six weeks to produce pasture masses exceeding 2500 lbs. per acre after severe grazing. Keep in mind this is true for reasonably normal climatic conditions, for a vigorous and well fertilized pasture. If this is not true more time is needed. As mentioned previously, keeping residual pasture masses high can shorten the rest period. However, if we wish to save pasture for grazing in late September and early October it may be difficult to keep green leaf mass high. If the stockpiled pasture has to begin rest period in July, then severe grazing in July may be required.

Using meadow bromegrass as an example: This species can support about 3.5 leaves per tiller during the fall. If we remove two of them by grazing, leaf death will begin 1.5 leaves later. Thus after 20 to 25 days of rest dead material would begin to accumulate. If we grazed on July 15, dead leaves would begin accumulating by mid August. By October, dead material could exceed 30% of the stand. If the meadow bromegrass stand was reduced to 1 leaf per tiller, it would have to grow 2.5 new leaves before leaf death would occur. This would take us into September before dead material would accumulate and perhaps result in a greener leaf mass. In any event our grazing efficiency would have been improved.

Choice of species may be important in maintaining green leaf mass of stockpiled forage. Smooth bromegrass seemed to have less accumulated dead material than meadow bromegrass and orchardgrass, and the latter species were improved over bluegrass and creeping red fescue. Low growing grasses, like Kentucky bluegrass and creeping red fescue, may turn over leaves as fast as meadow bromegrass, but because their mature leaves are held very close to the ground, they cannot be removed by hard grazing and dead material will accumulate anyway. Alfalfa does not turn over leaf and stem material quickly and is a good crop to stockpile from second growth so long as it is grazed by early to mid October.

A good strategy for stockpiling is to have some paddocks designated for use in late August from relatively high residual pasture masses. For later grazing have paddocks which have been grazed more severely and had relatively long rest periods.



Grazing Frequency. It is important to note that the high grazing efficiency, which occurred as a result of the heavy grazing treatment in Table 1, did not occur from severe grazing. Severe grazing hurt net accumulations in this treatment as early as August, in each year, especially dry years. The high grazing efficiency occurred because of frequent grazing (i.e. grazing new growth as it appeared). A higher percentage of forage would have disappeared from the Light grazing treatment had the residual mass been decreased, and number of grazing times increased to four. This would have been a practical way of improving consumption of digestible dry matter intake for that treatment. The bottom line on grazing frequency is to graze before significant leaf death occurs. Other aspects related to grazing frequency have been discussed in various parts of this article.

A good strategy for stockpiling is to have some paddocks designated for use in late August from relatively high residual pasture masses. For later grazing have paddocks which have been grazed more severely and had relatively long rest periods.

It is also important to note that there is no ideal grazing frequency, pasture mass or residual pasture mass. All three are tools that have to be used in various combinations with appropriate species to deliver enough nutrients to grazing animals to accomplish the producer's goals.

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Intake: Harvesting Pasture with Cattle

Vern Baron

Some Definitions

Pasture mass. The amount of pasture per unit area above ground level.
Pasture allowance. Pre grazing pasture mass for each animal per unit area per unit time.
Residual pasture mass. The amount of pasture per unit area left after grazing.

An understanding of how intake affects cattle performance on pasture is critical in achieving management expectations. Intake has a very complex relationship with sward characteristics, primarily pasture mass. Pasture mass is the same layers of leaf material (LAI) that supply and contribute dry matter to the sward and nutrients to the animal. As soon as grazing begins pasture mass and LAI change. They usually decrease with grazing so that both the potential supply (photosynthesis - plants) and potential intake (nutrients - animal) decrease. There is a continual and dynamic give and take between supply and harvest of leaf material or pasture mass. Because of these dynamics in supply and harvest, grazing management strategies are forced to compromise, to achieve a positive endpoint for both short and long term plant and animal productivity.

We know that intake is the major limitation to maximum performance for ruminants feeding on forage in a feed bunk. While other theories exist this amounts to the rumen filling with forage before it has attained a high enough digestible dry matter intake to produce a high rate of gain. This intake-limitation to gain would not occur with animals fed concentrate. Therefore, when animals are fed forages we want to maintain the rumen near capacity to maximize gain. However, on pasture, cattle rarely have full rumens, particularly day to day over a 100 to 120 day pasture season. The degree to which animals attain rumen fullness, daily, is highly related to pasture mass and pasture allowance. The degree to which animals approach rumen fullness day after day or season-long should be highly related to residual pasture mass. A good reason why cattle seldom achieve rumen fullness every day in intensive grazing systems is because stocking rates are usually set to maximize gain per acre, resulting in less than a maximum rate of gain. However, this is a planned goal by the manager, where specific daily performance goals are being fulfilled based on a given pasture allowance. In continuous grazing systems they may not reach rumen fullness later in the season when regrowth is poor from overgrazing favorite spots or forage is mature, lower quality, less desirable and rumen passage is slowed in undergrazed areas.

Here is a simple example of a pasture scenario. Animals should gain a certain weight per day based on a given pasture allowance. The amount of gain will be directly proportional to intake. Lets say a 700 lb. steer on pasture will meet expected gains when he consumes 14 lb. of dry matter, daily. To do this he grazes about 6 to 10 hours a day. Then he will have to move to another part of the pasture to do the same thing next day. Because waste is a part of the equation, we have to allocate 28 lb. per day, just to achieve a 14-lb. intake. To achieve some kind of efficiency on an area basis we have 100 steers grazing together. They require 2800 lb. dry matter per day to achieve their goals. The pasture mass at onset of grazing was 3000 lb. per acre. After the first grazing day there would be a residual pasture mass of 1600 lb. per acre (1400 lb. consumption and 1600 lb. of residue). Given the perceived condition of the sward on day two the animals might only achieve 25 % of rumen fullness, by consuming 4 to 5 lbs per day, each. Thus over two days the animals might have full rumens and reach expected gain on one of two days. Producers who move cattle every three days would not have full rumens and should expect lower gains on two of the three days. Thus the consequences of limiting intake on pasture add up over the season.

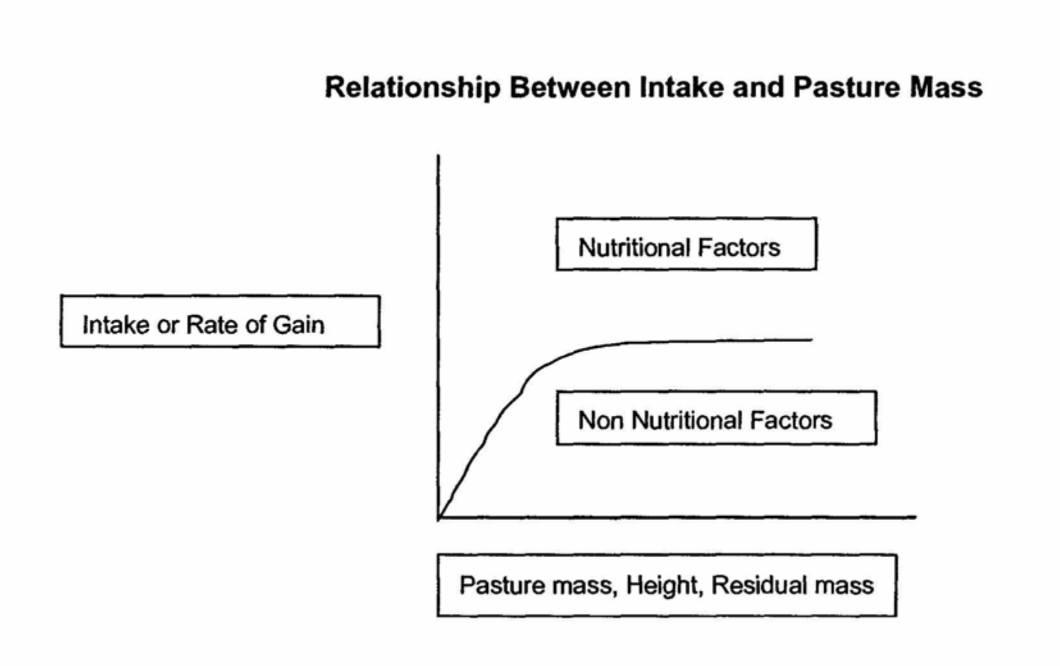

Figure 1. After Poppi et al. 1987

When cattle are given unlimited access to forage, as in a feed bunk, intake is proportional to nutritional factors like forage quality. At a feed bunk cattle consuming forage having higher digestibility (vegetative vs. mature grass) or lower neutral detergent fibre concentrations (NDF) will take in more digestible dry matter for a given rumen fill or over a period of a day. The only time these nutritional factors come close to having the same impact on pasture as at the feed bunk is when pasture masses are very high. Unless cattle are managed to pasture on high pasture masses or allowances, most of the time factors other than nutritional factors affect intake and therefore rate of gain. These are mostly physical factors, which affect the animal's ability to bite and remove plant material (prehension) or to maximize the amount of plant material taken into the mouth in one sweep of the tongue and jaws. The impact of pasture mass and other non-nutritional factors decrease and impact of nutritional factors increase when pasture masses are between 1800 and 2700 lbs. per acre for grasses. At pasture masses these large nutritional factors (those that affect feed bunk-intake) become important. Digestibility is important, but selection (leaves over stems) at these high pasture masses often negates differences for digestibility between cool season grasses and legumes. Factors that reduce residence time of grazed material in the rumen and passage through the gastro intestinal tract are nutritional factors which have more impact on intake at these pasture masses than digestibility.

Species Effects on Intake

The pasture mass, where intake levels off with increase in pasture mass, is lower in legumes than in grasses. The reason for this difference is a combination of physical and nutritive factors. The quantity of digestible dry matter held in the rumen per unit of rumen fill is greater for legumes under most circumstances than in grasses, because of a lower neutral detergent fibre. Passage through the digestive tract is more rapid for legumes compared to grasses, as well. Also, leaflets and petioles of legumes are placed high in the grazing zone so that cattle can access a relatively dense plant profile on the first horizontal grazing sweep of the pasture.

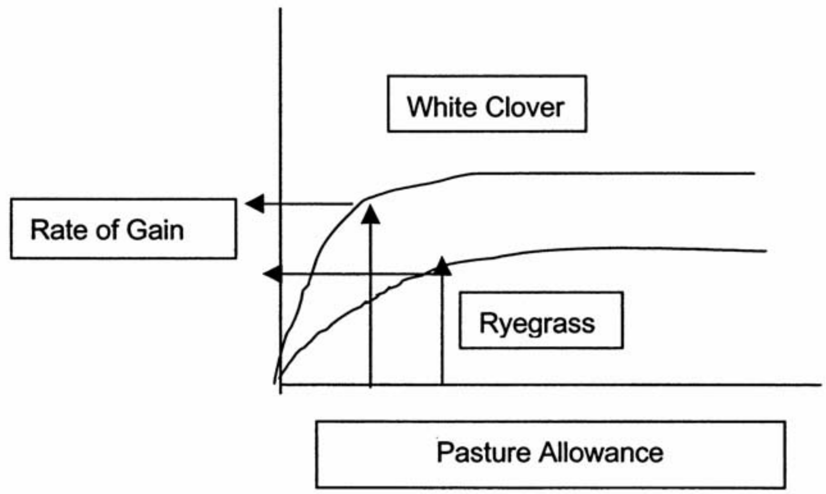

Figure 2. Rate of gain in lambs vs. pasture allowance for Perennial ryegrass and white clover. Diagram after Poppi et al (1987).

Factor	**Species**
Ease of Prehension	Legume > Grass
Digestibility	Cool-season > Warm-season
Rate of Digestion	Legume > Grass

Non Nutritional Factors

Over the range of pasture mass, from 500 to 1800 lbs. per acre, factors which affect apprehension of forage influence intake can be summarized through the function of:

Intake = Bite Size x Bite Rate x Grazing Time

The components of this function compensate for one another, but each has its limits.

Bite Size. It is generally agreed that the larger the bite size the greater intake. In effect, fewer trips with a larger load make the intake job more efficient. The depth, density and volume of the sward within the bite sweep of the animal are critical to bite size and grazing behaviour. Cattle graze preferentially in horizontal zones. If the upper surface of the sward is dense with plant material that is easy to remove, the bigger the bite size. A good comparison here would be a pure stand of alfalfa at the bud stage (big bite) vs. a variable stand of grass, some of which has seed heads exposed (small or variable bite). Depth becomes a factor when the animal begins to bump its nose on stubble or the ground, before the mouth and jaws are fully immersed in the sward. Here the bite size is reduced. Thus pasture mass, height and residual mass may be visualized as surrogates for depth, density and volume of the sward.

Bite size is highly influenced by selection. Species composition plays a role, but is highly controversial. In sheep it is felt that legumes are preferred over grasses. Cattle are less sensitive to selection for species, except in patches, because they lack dexterity in their mouth parts compared to sheep and deer. It has been shown that cattle prefer to graze those species that are lower in abundance (legume over grass when legume is the lower quantity and vice versa). However, learned response and experience, also are factors and can provide unexpected results. For example, animals may pass through an undesirable upper level to graze green leafy material below if they have trained themselves to do so. Cattle prefer to graze leaves over stems and green leaves over dead. This appears in part due to the relative ease in removal from the sward. Thus green leaf mass has become a useful variable to explain intake on pasture.

Bite Rate. When bite size gets smaller, bite rate will increase. However, after a time fatigue will prevent total compensation (the cow gets tired chewing).

Grazing Time. Grazing time is of more interest because it can be used to evaluate animal behaviour, rather than overcoming the effects of low bite size on intake. As animals graze down a sward and pasture mass decreases grazing time will increase. Eventually prehension becomes too difficult and grazing time decreases. The reward of having a full rumen is too difficult to attain. Grazing time on good pastures usually does not exceed 6 to 10 hours, although can reach 13 hours. Fatigue is a factor, but other activities will eventually take precedence at some point (pecking order or herd behaviour, drinking water, resting, ruminating, and breeding). Thus there will only be so many productive grazing hours in a day.

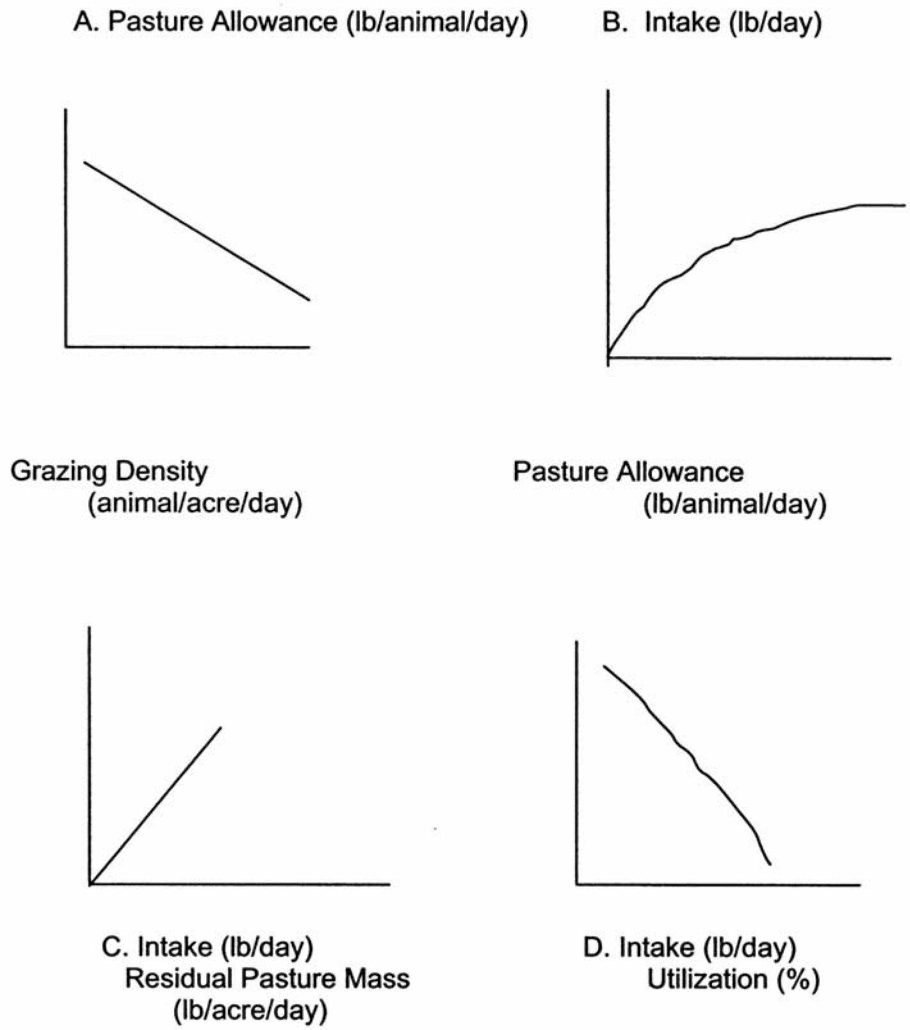

Figure 3. After Thompson and Poppi 1990.

Figure 3 is a good summation of how the relationships involving intake influence other management factors. It has a great deal of relevance for season-long management. Pasture allowance is what influences intake and therefore rate of gain per day. Therefore in order to maximize intake compromises are required. The first compromise comes as a tradeoff between animal production per acre and rate of gain; they go in different directions. Therefore seasonal goals must be clear and a good idea of average pasture mass, carrying capacity and rate of gain is required. As pasture allowance increases, intake (daily) will only increase so much, within the limits of animal capacity, stocking density and pasture mass. Thus to increase intake at the expense of per acre productivity makes no sense. It is much more practical to be somewhere on the upward third of the Intake/Allowance curve (B), but not at the top. Relatively high season long (average) daily gains and intakes are probably best controlled through an observation of residual pasture mass. Intake is highly responsive to residual pasture mass, (curve is steeper + C), because cattle must be moved before the pasture mass gets too low. By being aware of the residual pasture mass we prevent low intakes too many days in a row. If the residual forage mass consists almost entirely of green leaves, we are leaving an adequate LAI to create a new supply of pasture mass quite quickly. Another compromise is the relationship between intake or gain and percent utilization. The greater the intake, the lower utilization. Low utilization on a season-long basis makes no sense, so gains per acre and per animal must balance. Utilization must be low enough to provide for an adequate residual pasture mass that will bring the pasture mass rapidly back up to capacity, but it must be at a level where enough dead and stemmy material does not accumulate in the sward. This would negate efforts to reach intake and rate of gain goals. On the other hand we should be aware that species and stands which enhance intake will be utilized at a faster rate (legumes vs. grasses) over a given grazing period, leaving less residual forage mass and necessitating a longer rest period to replenish the pasture mass.

<u>Considerations for Short Season Environments</u>

How much pasture mass is enough pasture mass? While the functional variable that defines daily intake and rate of gain is pasture allowance, pasture mass is still the critical variable. There has to be enough pasture mass, height or LAI (layers of leaves) that when animals are turned out they can place their nose and mouth parts into the stand and come up with a large bite of pasture. This has to occur over a grazing period of at least one horizontal pass of the area. After that the animal will run into stubble, ground, etc. and grazing over a 6 to 10 hour period will not be as efficient. Research has shown that a minimum of about 1800 lbs acre is required. In fact some say this should be the residual pasture mass. So that means you probably need more than 1800 lbs per acre at turn out.

In a short season environment like the Canadian parkland, managing for pasture mass may be difficult. Researchers in southeastern US have found that seasonal average rate of gain on Italian ryegrass pastures are higher when turnout onto the pasture is delayed as long as possible (David Bransby). This meant that pasture mass was allowed to increase to a high level before turnout and by moving frequently, leaving a correspondingly high and productive residual pasture mass, it was easier to maintain performance throughout the grazing season. However, in a short season area we have less days to graze to accumulate dry matter. In perennial grasses we spend about one quarter to one third of the grazing season growing floral tillers and stems. While floral tillers produce a great deal of yield, they are not made up of a lot of leaf material. Thus it is conventional wisdom around the world to graze at least a portion of paddocks down hard, early, to maximize green leaf production during a later part of the year. This must be done in conjunction with a long rest period. Using grasses which provide high pasture masses early in the spring are important. Research at Lacombe indicated that the earliest of five grass species (meadow foxtail) reached a pasture mass of 1800 lb/acre on May 19, while the latest (orchardgrass) reached that level on June 3. At that pasture mass both species had about 40% stem. This compares with about 20% stem or leaf sheath at the same pasture mass for late summer regrowth. Generally orchardgrass and meadow bromegrass produced high yields of leaf material at all times of the year.

Stockpiling pasture has been proposed as a method to provide adequate pasture masses during the fall. However, when pasture masses become too large, dead material accumulates in the sward. This would be counterproductive towards intake and high rates of gain. Averaged over four lengths of rest periods alfalfa varieties averaged 8% dead; smooth bromegrass 15% dead; meadow bromegrass and orchardgrass 24% dead; and creeping red fescue and Kentucky bluegrass 33% dead. With good fertility, only the alfalfa varieties and the bromegrass species exceeded 1800 lbs. of green pasture mass in October, after a simulated severe grazing time of July 15.

In a short season environment, the producer must take the entire season and all of his or her paddocks and species into consideration. With any class of livestock, where the goal is a performance level greater than maintenance, the pasture objective must be towards a target green leaf mass averaged over all pasture resources. It will not likely be possible to match animal requirements with one paddock or one plant species to the livestock goals all of the time. However over the season it may be possible to set up desirable pasture-livestock goals by delivering green leaf pasture masses at appropriate times by using two to three species and varied grazing schemes (times of year vs. utilization and species and rest).

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Pasture Productivity: Managing with Growth and Development

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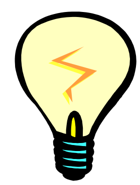
Pasture System

Meat and milk are the secondary products of pasture. Components of the entire system are:

1. Forage production or pasture yield
2. Utilization or harvest of the forage by livestock, as a percentage of yield
3. Conversion efficiency of pasture on a per animal and on a per acre basis

All components are of economic importance, but primary production from the pasture (#1) (plant dry matter) is vital, because it allows the second and third components to happen. Compared to cereal grain, forage, and in particular pasture production, is less well understood by the producer. Grain is the plant component of interest to the grain farmer. Leaf is the component of interest to the pasture farmer. Compared to stems and seed heads, the leaf is the most desirable part of the pasture, because it generally has the highest nutritive value and is consumed most easily and to the greatest extent by livestock. Further, leaves intercept light and carry out most of the crop photosynthesis, which produces yield or dry matter. As leaf area increases more light is intercepted. In turn pasture growth rate increases and yield or dry matter accumulates. But, grazing reduces leaf area, light interception and pasture growth rates decrease below potential. Leaf material is grazed as it grows (continuous grazing) or is grazed periodically and intensely over the season and allowed to re-grow (rotational grazing). Good pasture management must allow for light interception and growth by the crop as well as efficient grazing for livestock. This amounts to a balance between production and consumption.



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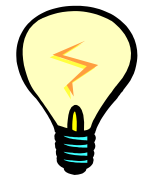
Generalized Scheme of Pasture Growth.

It is well known that the accumulation of yield or dry matter for crops follows an “S” shaped curve from spring until some point in the summer. This is partly due to increasing temperature, photoperiod and the pattern of increasing light interception by leaves as the crop grows. Forage crops are no exception. In spring or early phases of re-growth, accumulation of dry matter is slow. A lot of light hits the ground. As leaves emerge and new tillers are formed the canopy closes and most of the light is intercepted. The plant grows rapidly at this point. During initial (spring) growth, stems elongate and add to yield, but leaves stop emerging. Soon all of the light is intercepted, growth slows down and the growth curve flattens out as a maximum or ceiling yield is approached. At the same time there is a general decline in nutritive value. By mid June stem material contains more structural cell wall material than leaves. As the cells of stems mature their cell walls become lignified and therefore less digestible than leaf cell walls. At the right hand side of the growth curve the stem occupies a large percentage of the crop so nutritive value decreases. To optimize the opposite trends of yield and quality, grazing some where near the mid point of the curve makes sense.

Initial Growth and Re-growth.

The climate on the Black and Grey Soil Zones of the prairies should allow grazing to occur two to three times if appropriate species are used. Patterns of re-growth and initial spring growth differ. Re-growth material is composed mostly of leaves with little true stem material in grass species. The leaf to stem ratio of alfalfa will be higher in second growth than in the first cut. A single growth curve oversimplifies the pasture production system. It is better to think of pasture production as an overlapping series of growth curves that begin in the spring. They are affected and interrupted by the grazing method and system used. Re-growth nutritive value doesn't decline as rapidly as first growth pasture, because it doesn't contain as much stem material. However, re-growth may contain some dead leaf material, which has a lower nutritive value than green leaves, but it won't have the same negative effect on nutritive value as mature stems.



Managing for re-growth is very important. Multiple grazing cycles on the same land, even at a reduced stocking rate, increases the number of grazing days per acre and may make the difference between profit and loss in managed intensive grazing. Second and third growths generally have lower maximum potential yields than first growths and the rate at which they approach these maximum yields depends partially on how severely they were grazed on the previous grazing cycle. Drought and soil nitrogen deficiency also reduces the re-growth rate of pastures. The ideal management for re-growth depends on what the producer wants to accomplish. Management required to save forage for fall stockpiling might be different than for attaining three grazing cycles between June 1 and October 1.

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Pasture Crop Yield Components.

Contrary to grain crops pastures are usually composed of more than one species. The species are usually adapted or suited to slightly different climatic and soil conditions and to different grazing or cutting systems. Generally one or two of the species will dominate, because they are favored by management, climate or soil factors compared to the others. This allows them to exploit most of the resources (light, water, nutrients). Plants of species which are allowed to grow largest, first and fastest and can survive from year to year tend to dominate stands. In tame pastures species which are reduced to small percentages rarely return to dominate a stand. Over years larger plants of favored species tend to grow in size, taking up most of the resources, diminishing resources left for less aggressive smaller plant species. The latter don't survive or only represent minimal proportions of the stand. In tame pastures, you start out with plant species in proportion to seeding rate (seed number per unit area). Given that the species composition is equal and compatible, the species composition in two to three years is mostly a result of management and climate.

Units of Growth

There is a hierarchy of plant component parts that begins with plants per unit area, tillers or branches per plant and leaves per tiller. All impact the space and shape a plant takes up, defining a growth habit. Shoots (above ground) can be broken down into growth units called phytomers, which are repeated over and over again during vegetative growth. In grasses the phytomer or growth unit is composed of a leaf blade, ligule, leaf sheath, internode, node and an auxiliary bud. In legumes the phytomer consists of a petiole, stipules, internode, node, leaf and an auxiliary bud. These parts all arise from meristems or growing points. Meristems are the blueprint of plant structure, as all parts of the phytomer grow from it.

Apical Meristem or Growing Point

The main growing point originates on the crown or stem base of plants and is found on tillers of grasses or shoots of legumes. Grasses evolved in ecosystems with fire, drought and grazing. They survived by protecting the meristem from being eaten or burned. Once the meristem is gone the tiller is dies. In spring four or five phtytomers, each carrying a leaf blade and sheath arise on the growing point. For bromegrass the meristem becomes floral (seed head formation) in early May before all leaves have emerged. After this no more leaves form on the meristem for that tiller. New tillers must form from axillary buds, within the leaf sheaths. The tillering pattern is laid down before floral initiation and is vital to plant survival. After floral initiation, another meristem, an intercallary meristem, pushes a stem (internodes) up through the leaf sheaths. This process places the growing point at risk during grazing. After this point regrowth depends on younger vegetative tillers that have growing points at or near the base of the plant, out of the reach of grazing animals.

Legumes did not evolve in grassland ecosystems and are not as well adapted to grazing. Meristems on legumes are generally found in the grazing zone. In alfalfa most meristems are well elevated above the ground. After grazing, new branches must arise from the crown or maxillary meristems on the lower branches. Growth from these auxiliary meristems is not as vigorous as from the crown. Red and alsike clovers are better adapted to grazing because they grow a few large petioles from the crown. White clover is more effective as petioles are elevated from both crown and stolons. Thus in clovers many growing points are spared during grazing and growth is more continuous than for alfalfa.

Managing Growing Points, Tillers and Shoots

Really we manage around growing points. They don't cause a lot of problem for our first grazing cycle, but the stage at which they are grazed in the first cycle can affect the second cycle growth. In rotationally grazed pastures paddocks are grazed sequentially at different stages of development. If all plants are vegetative, then ideal management would be to leave enough residual leaf area to intercept light and provide enough vegetative growing points to maximize re-growth rate. In spring this is not the case. Species which are grazed when their growing points are elevated will likely suffer from a reduced tiller density for a while after grazing. These paddocks will require longer rest periods than those grazed earlier.

Choice of species for rotational grazing is important. Species which maintain most of their growing points close to the ground (bunch grasses and Kentucky bluegrass) most of the year work best. Tiller synchrony (similarity) for age and floral development on the same plant varies with grass species and is critical to pasture management. Synchronized development of tillers means all are at the same size and stage vs. asynchrony, which means a wide range for tiller sizes, ages and stages. Tiller synchrony is most important during initial growth when apical and axillary meristems move from vegetative to floral states. Beyond a certain stage of development, usually "jointing", axillary buds are dominated by apical meristems on larger floral tillers. A balance of growth hormones produced in the apical meristem and the root delay development of daughter tillers. In a highly synchronized species like smooth bromegrass daughter tillers do not emerge until being released from dormancy, near heading of the mature mother plant. Smooth bromegrass is susceptible to grazing between jointing until past the boot stage. Because of synchronous development of tillers, cutting or grazing during this interval can remove most active apical meristems. As a result regrowth is slow, because it must be initiated from axillary buds at or just above ground level. By contrast, orchardgrass is more asynchronous, having an array of tillers of different stages and sizes. When grazed after tiller elongation in the spring, many small tillers with active apical meristems remain below grazing height. These tillers resume or continue growth. Some younger tillers are vegetative, which may allow them to survive an entire year or until they produce floral meristems. Meanwhile they go on to become vital components of regrowth, within the current season.

Pasture swards tend to maintain a stable or steady state tiller density, depending on the sward management and resources available to the stand. On average as many tillers form as die within a season. This turnover is important to maintain stand viability and longevity. Because tillers die after flowering, they may have life spans from two months to a little over a year. Tillers may be induced to flower in fall or spring, although the tendency to under go floral initiation in the fall varies with species.

Construction of a Grass Leaf

To understand grass regrowth further we need to understand how leaves grow. New leaves emerge on either apical or axillary meristems. *Axillary meristems* are found in the axils of leaves in grasses (base of leaf sheath) and at petiole bases within the stipules of legumes. In tall fescue or meadow bromegrass, about three small leaf buds, approximately 1 mm in size, emerge, alternately, on opposite sides of the meristem. About the time a fourth bud is ready to emerge on the meristem, the first leaf tip is being pushed up telescopically inside the older leaf sheaths by growth from the bottom. Intercalary meristems complete the construction, as the leaf blade begins to push through the older leaf sheaths. All active growth is going on just above ground level at the tiller base inside the older leaf sheaths, so the meristems are not directly exposed to the sward surface or grazing zone. All portions of the leaf blade are formed before it emerges from the whorl.

Leaf blade meristems have distinct zones of cell division and cell elongation, totaling 40 mm in length, in well-fertilized swards. The leaf blade grows from the ligule out, not from the tip down. The ligule will become the axis between leaf blade and sheath. The leaf blade is formed as it pushes up until it can be seen emerging from the whorl. Then the leaf sheath is formed from the bottom side of the ligule down. This ratchets the leaf blade the rest of the way out of the whorl, until the collar appears.

Leaf Turnover for Re-growth

When growing points of grasses are vegetative they form phytomers and leaves indefinitely. On a vegetative tiller there are usually two growing leaves and one or two mature leaves. When a fifth leaf emerges the oldest one dies, so that on average a tiller can maintain about four leaves (two growing and two mature). Generally, leaf death rate equals appearance rate, but after rotational grazing, appearance rate exceeds the death rate until there is a build up of mature leaves. At some point after two mature (leaves with collars) leaves appear leaf death begins. Under these conditions yields cease to increase and plateau.

Managing Leaf Turnover for Grass Regrowth

Under good growing conditions it takes about 11 days for a meadow bromegrass leaf to appear at Lacombe, Alberta in July. Under equivalent conditions for all four leaves it might take 44 days to grow the 4-leaf compliment.

Does this mean a pasture rest period should be 44 days? First, under good management all of the leaves will not be consumed at one grazing. If two leaves were removed by grazing, the residual tiller should have two old leaves remaining. Therefore, it takes 22 days to grow the full compliment of four leaves, and a little longer for the oldest leaf to

die. Thus, a rest period of 30 days is more optimal in a perfect world.
In stressed conditions it is difficult to maintain a positive (increasing) balance of new leaves and tillers, necessary to keep yield accumulating. When periods of dry weather and high temperatures occur, more mature leaves may die than new leaves form, causing a net loss in green tissue and no increase in yield. Under cool conditions in the fall appearance of new leaf decreases to the extent that there is a larger quantity of mature leaves. More mature leaf material dies than new leaves form resulting in a net reduction of green leaf material. Under these conditions swards will not yield as much or support the same stocking rate as they would under non stressed conditions. Producers can compensate by using longer rest periods, reducing stocking rates or both.

Managing for Tillers or Leaves on Grasses?

All pastures have to be managed for tiller growth or with special consideration for growing points, because a certain tiller and plant density is required to produce a minimum yield. Pastures that are composed of dry land grasses (wheat grasses etc.) usually carry growing points relatively high on the shoot. Where they are adapted soil moisture reserves usually dictate no more than two grazings or two sets of tillers. After grazing the second set of tillers requires time to develop and grow. This may only occur after a long rest period combined with grazing before the growing points become elevated too much or before the main tillers suppress development of younger tiller buds. Early grazing sets up the regrowth, consisting of a new set of tillers. During the rest period livestock may have to be moved to another grazing cell (another piece of land) containing another species grown specifically for summer grazing. In this case we are managing for tiller growth and development to get a second grazing.

By contrast in areas having adequate moisture and soil nutrients to support rapid regrowth, species such as tall fescue, meadow bromegrass and orchardgrass may deliver three to four grazings. Observation of floral growing points during the first grazing cycle is still important. Some paddocks may suffer from a lack of tillers on the second cycle, but it isn't that harmful to seasonal yield as for the dry land grasses. The former species produce regrowth consisting of new leaves coming from a relatively constant set of vegetative tillers, that grow quickly after the first grazing cycle. In fact a high percentage of the seasonal total yield will come from the second, third and growth cycles. So in this case we are managing more for leaf than tiller growth and the concepts of leaf area production and light interception pay off.

Persistence

Perennial forage crops are economical because they don't have to be planted every year. Plants die because they become energy starved, due to drought, low or high temperature, defoliation or competition. The energy deficit predisposes plants to disease and winter-kill. Plants can adapt or acclimate to stresses. This is an important part of choosing appropriate adapted species and cultivars for pasture. The acclimation process is beyond the scope of the presentation. However, the simple management tool of rest after grazing goes a long way to maintaining a positive energy balance in the plant, because it ensures leaf and tiller growth.

Pasture swards with abundant leaf cover can capture enough light energy to supply more energy than required in the short term. When this occurs a reserve or buffer of carbohydrates and other nutrients may be stored for later use. These reserves are stored in a variety of storage organs depending on species and end use. Examples of storage organs are roots and crowns in alfalfa, stolons in white clover, rhizomes in smooth bromegrass, haplocorms in timothy and stem bases in orchardgrass. Excess carbohydrate can simply be stored in leaves. Generally legumes store starch and cool season grasses store water-soluble fructans. Warm season grasses may store some starch. Fortunately growth slows down more than photosynthesis in response to most stresses. This prevents plants from becoming energy starved. For example cool temperatures slow growth more than photosynthesis, so that as fall approaches there is a buildup of carbohydrate in leaves and crowns.

Alfalfa Vigor and Carbohydrate Reserves

Most producers are familiar with the cycles of root and crown carbohydrate of alfalfa during the growing season. Carbohydrate is at a low level in spring (after using carbohydrate over winter) until a full canopy is developed. Carbohydrate continues to increase until near full flower. After cutting or grazing the carbohydrate is used to provide energy to grow new stems and leaves until sufficient leaf area is developed to enable photosynthesis to supply all energy requirements of the plant.

The timing of the carbohydrate cycle, in relation to plant maturity can create problems for successful alfalfa grazing. During first growth alfalfa has to be grazed at stages surrounding the bud stage to optimize animal utilization. In cooler areas, such as central and northern Alberta, sufficient alfalfa may be available by mid June for the first graze. Subsequent attainment of sufficient alfalfa regrowth for grazing may take six weeks. This places the second grazing during the critical period (early August) and may prevent plants from attaining sufficient carbohydrate reserves in preparation for winter. On the southern prairies warmer temperatures should move alfalfa growth at a faster rate and as a result allow a second grazing prior to the critical period (6 weeks prior to frost). When the second grazing cycle occurs during the critical period a stand may appear vigorous for one or two years, then lack of vigor will show up in slower recoveries each spring, stand die-off and weed encroachment. When vigorous grass growth occurs in a mixture with alfalfa, the alfalfa survival will be less than in a pure stand when alfalfa carbohydrate levels are low.

Recent research indicates that alfalfa varieties bred for grazing can withstand more frequent grazing than hay types. Also we know that other biochemical entities such as vegetative storage proteins play a role in alfalfa stress tolerance and that the amount of carbohydrate stored in the root and crown is probably more important than the percentage or carbohydrate. This evidence comes from studies comparing vigorous and non vigorous plants from the same stand, which were grazed or treated the same way.

Fortunately carbohydrate reserves of all pasture species are not as sensitive to cutting and grazing as alfalfa and some legumes have ways of circumventing large carbohydrate reserves to survive. A certain level of reserve carbohydrate is required to sustain plant processes, which promote vigor. However, it is normal that reserves fluctuate throughout the season and the amount found in the reserve is a fraction of the carbohydrate turned over in the photosynthetic/respiratory systems. Keeping plants at maximum carbohydrate levels will minimize risk of stand loss, but is not always realistic. All that is required is to maintain a balance among leaf area, rest period and carbohydrate reserve for a particular time of the year. These relationships are not identical across all species. Species such as bunch grasses and Kentucky bluegrass are much less prone to long term reserve deficits, because a higher percentage of leaf area is left after grazing than in alfalfa or smooth bromegrass and the wheatgrasses. They are harder to overgraze, because the green leaf material is very close to the ground.

Other Mechanisms for Persistence in Legumes

In contrast to grasses, legumes seldom approach a stable population in mixed stands of hay and pasture. Legumes have three adaptive characteristics, which allow them to persist in stands. They may be crown formers, clone formers or re-seeders or combinations of all three. Alfalfa is the typical crown former. It is adapted to conditions of minimal competition and infrequent defoliation. It depends on the establishment of a large crown and taproot and ultimately on its size to procure more nutrients than neighbors. Red and alsike clover are also crown formers, but usually have more limited life spans, because they are unable to entirely exploit their environments the way alfalfa can. During the first years of an alfalfa stand self-thinning occurs, where plant number may be reduced by 30%. Thereafter plant losses are due to stresses such as disease, winter injury and defoliation. Alfalfa stands compensate for thinning by dominant plants enlarging, producing more crown shoots and branches and by producing heavier shoots. Clone formers are able to spread via rhizomes and stolons. Some alfalfa varieties have the ability to creep in some environments, but white clover is better adapted than alfalfa to exploit pasture environments for this reason. Creeping stolons allow white clover to take up open spaces to start new crowns. Most annual legumes depend on reseeding to survive in pastures. Almost none are used in western Canada. However, species such as red clover and birdsfoot trefoil require management systems where they are allowed to produce seed every other year to maintain plant numbers. Thus they are a combination of clone formers and reseeders. The downside to this strategy is that rest periods that are sufficiently long to produce seed must be incorporated into the pasture management. This may be uneconomical in short-season areas.

Summary

Knowledge of how forage species develop and grow is important in designing profitable grazing systems. Growth habits of grasses and legumes differ greatly. However, substantial differences occur within grasses alone. Growth and development characteristics are dynamic, changing throughout the year. Choosing species that fit the goals of the grazier is important. Graziers may change animal management and paddock design to make the best of existing species, by accommodating characteristics of growth and development. Knowing the differences and attributes among forage species should help producers improve pasture yield and distribution to achieve more productive grazing days. Understanding the relationships of plant growth, survival and competition should provide productive pastures for many years.

Pasture Algebra

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The process of developing a pasture plan involves gathering specific information in order to perform some simple calculations. If you are going to make management decisions based on facts, rather than assumptions, then time spent learning and performing these calculations is worth the effort.

This presentation will start by explaining how to calculate stocking rate. Stocking rates are based on estimated yield and the number of days that you want to graze. Then we will look at how to determine a rest period or a range of rest periods. Then we will calculate a grazing period for each paddock based on its yield. Last, we will examine how to use this information to quickly monitor for surplus or shortages and how to make adjustments. These calculations are tools that will allow us to make management decisions based on facts.

Definitions:

Animal Days per Acre (ADA) – The volume of forage taken from an area in a specified time. The figure is calculated as follows:

$$\frac{\text{Animal numbers x days of grazing}}{\text{Area of land (in acres)}} = ADA$$

Grazing Cell – An area of land that is *planned as one unit* to regulate the time that plants and soils are exposed and re-exposed to grazing and trampling.

Paddock – A division of land within a grazing cell. Several paddocks together make up a cell, provided they are planned as one unit on a planning chart.

Paddock Rating – An estimated rating of each paddock relative to each other, in terms of quality and size.

Animal Unit (AU) – A pregnant cow of approximately 1000lbs is used as the standard against which different classes of stock in a herd, and their physiological states are compared. This enables you to better plan for and meet varying nutritional requirements.
AU x days = **Stock Days**

e.g. 750lb yearling = 0.75AU
1400lb cow + 600lb calf = 2000lbs or 2AU

Stock Days per acre (SDA) – The volume of forage taken from an area in a specified time, but based on Standard Animal Units instead of total animals. The figure is calculated as follows:

$$\frac{\text{animal numbers (in AU) x days of grazing}}{\text{Area of land (in acres)}} = SDA$$

Rest Period – the number of days between grazings

Grazing Period – the number of days that a paddock is grazed within a rotation

Formulas for Calculations:

A. Calculate Average Grazing Periods

1. One herd with a single long rest period:

$$\frac{\textit{Rest period}}{\textit{Number of paddocks} - 1} = \textit{Average Grazing Period}$$

2. One herd with a range of rest periods: Calculate two average grazing periods – a minimum for fast growth and a maximum for slow growth.

$$\frac{\textit{Minimum rest period}}{\textit{number of paddocks} - 1} = \textit{Average Minimum Grazing Period (AMGP)}$$

$$\frac{\textit{Maximum rest period}}{\textit{number of paddocks} - 1} = \textit{Average Maximum Grazing Period (AMxGP)}$$

3. Two or more herds using any paddock in the cell:

$$\frac{\textit{Minimum rest period}}{(\#\textit{ of paddocks} \div \#\textit{ of herds}) - 1} = \textit{Average Minimum Grazing Period (AMGP)}$$

$$\frac{\textit{Maximum rest period}}{(\#\textit{ of paddocks} \div \#\textit{ of herds}) - 1} = \textit{Average Maximum Grazing Period (AMxGP)}$$

4. Two or more herds with certain paddocks allocated to each herd: Calculate four average grazing periods – two per herd.
Herd one:

$$\frac{\textit{Minimum rest period}}{\#\textit{ of paddocks allocated} - 1} = \textit{Average Minimum Grazing Period (AMGP)}$$

$$\frac{\textit{Maximum rest period}}{\#\textit{of paddocks allocated} - 1} = \textit{Average Maximum Grazing Period (AMxGP)}$$

Herd two:

Repeat the above calculations using the number of paddocks you have allocated to the second herd.

5. Two or more herds on follow-through grazing: If you are using one recovery period you will calculate one grazing period, but that grazing period will be used by each herd.

$$\frac{\textit{Rest period}}{\#\textit{ of paddocks} - \#\textit{ of herds}} = \textit{Average Grazing Period}$$

If you are using a range of rest periods you will calculate two average grazing periods

$$\frac{\textit{Minimum rest period}}{(\#\textit{ of paddocks} \div \#\textit{ of herds}) - 1} = \textit{Average Minimum Grazing Period (AMGP)} \quad \textit{(for each herd)}$$

$$\frac{\textit{Maximum rest period}}{(\textit{\# of paddocks} \div \textit{\# of herds}) - 1} = \textit{Average Maximum Grazing Period (AMxGP) (for each herd)}$$

B. Calculate Actual Grazing Periods

This is used to determine how long our grazing period is for each paddock.

1. One herd with a single long recovery period:

$$\frac{\textit{Paddock rating}}{\textit{Average paddock rating}} \times \textit{Average Grazing Period} = \textit{Grazing Period}$$

2. Two or more herds in any combination:

$$\frac{\textit{Paddock rating}}{\textit{Average paddock rating}} \times \textit{AMGP} = \textit{Minimum Grazing Period}$$

$$\frac{\textit{Paddock rating}}{\textit{Average paddock rating}} \times \textit{AMGP} = \textit{Maximum Grazing Period}$$

Pasture Rejuvenation- Establishment

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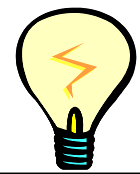
With the increasing demand for productive pastures, some farmers may wish to improve pasture production by rejuvenating and improving existing pasture stands. The cost for traditional methods of breaking and re-seeding pasture results in at least one-year loss of production, possible erosion and requires expensive cultivation operations. Most rejuvenation methods are cheaper than traditional break and re-seeding but the success rate of rejuvenation methods is dependent on weather and improved grazing management. This presentation will review a few of the common methods used to rejuvenate pastures based on results of research and demonstrations used to increase pasture production in the Parkland areas. Improved grazing management can be one of the cheapest methods to improve pasture production and should be used where possible to help with rejuvenation methods.



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When evaluating pastures for rejuvenation it is important to realize the difference between a symptom and the actual problem.

When evaluating pastures for rejuvenation, it is important to realize the difference between a symptom and the actual problem. A symptom is an outward sign that something is wrong or out of balance. For example, brush re-growth, poor utilization or poor growth in some areas of the field are symptoms. The actual problem could be a soil fertility problem or poor grazing management. The first step when considering rejuvenation of pastures is to determine the cause or the need for rejuvenation. As indicated poor fertility, abnormal weather conditions, poor grazing management, the invasion of undesirable species and the need for more productive species are possible reasons for considering rejuvenation. If the problem is grazing management, consideration should be given to correct the problem before rejuvenation plans are considered.

Pasture rejuvenation methods can be divided into four major areas: fertility, controlling invading plants such as woody plants and weed growth, introduction of new species and improved grazing management.

When planning rejuvenation consider present production versus expected increased production from the rejuvenation method, the cost of the method being considered, length of time the pasture is out of production and the number or percent of desirable and undesirable plants.

When to Consider Rejuvenation

Existing plant population should be assessed to ensure the need for rejuvenation. Plant counts of 6-10 plants/sq. ft. of bunch type grasses and legumes should be sufficient numbers for reasonable production. In the case of alfalfa, a more accurate method may be stem counts with 45-55 stems/sq. ft. providing maximum yield. Good to excellent pasture conditions require 75% or more production coming from desirable species. Less than 50% of total dry matter production coming from desirable species indicates poor pasture or hay land condition. Using grazing cages or fencing off a small representative pasture area will allow an assessment of pasture conditions.

Soil and possibly tissue samples should be taken to determine soil nutrient deficiencies. Taking soil samples from poorer areas of the field will help to ensure deficiencies are identified. Tissue sampling is not used as widely, however the results can help to identify deficiency problems. It is important these steps be taken before any rejuvenation process begins to ensure large amounts of money are not wasted without knowing the problem. In many cases changes in grazing management especially increasing the length of rest periods and reducing the grazing period of pastures can begin to correct the problem without spending large amounts of capital.

Methods of Pasture Rejuvenation

1. *Controlled or Managed Grazing*

Continuous grazing allows animals to continuously graze the most desirable species and in most cases never forces animals to utilize undesirable species such as aspen, pasture sage or other woody plants. Overgrazing occurs when plants are re-harvested before a sufficient rest period. Plants and the soil surface become stressed from too many disturbances. More subdivision within a given area by using electric fencing will allow for higher stocking density for shorter grazing periods. This will allow for equal utilization of desirable and undesirable plants and allow the desirable plants or species to compete effectively with the undesirable species. The key time for resting tame forage species is during the growing season. Plants are actively growing and can rebuild stored carbohydrates and root mass if they are not stressed from grazing. The most critical time of the growing season for desirable plants is late May, June and early July. In drier areas of the Province a full year rest period may be required to fully rejuvenate a pasture. To practice controlled grazing may require supplementary pasture, additional fencing and water management. For any rejuvenation project, controlled grazing should be considered to ensure rejuvenation practice treatments are successful. Details on grazing management principles are discussed in other chapters in this manual.

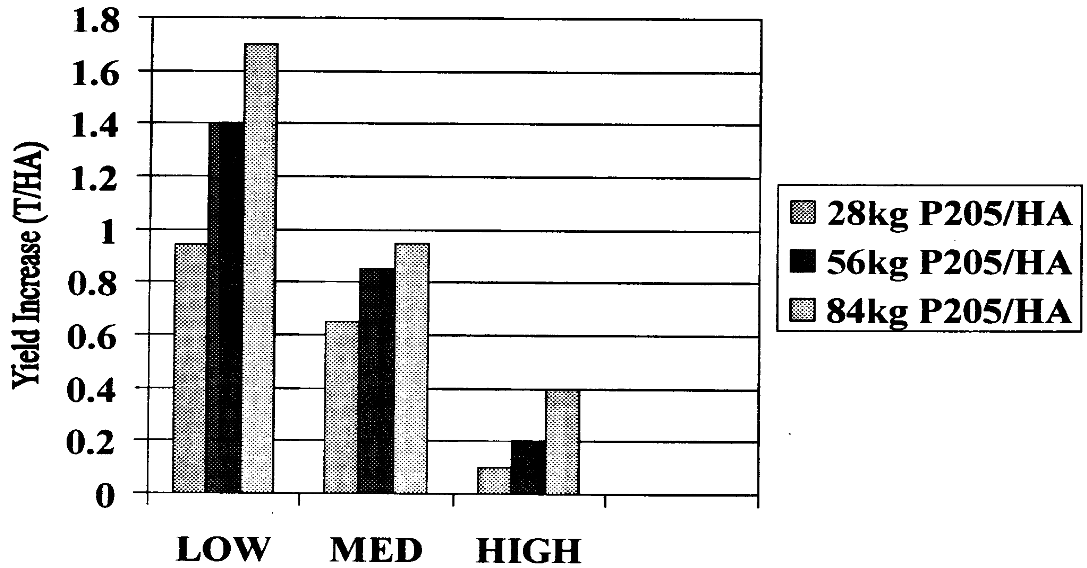
2. *Fertilization*

Pastures with sufficient plant numbers and a desirable species will respond to annual applications of fertilizer and manure. The response is very dependent upon species, moisture conditions and nutrient levels in the soil. Fertilizer requirements for pasture are not as great as those for forages used for hay or silage production. A certain level of nutrient recycling occurs in pastures. When forages are harvested as hay or pasture, all top growth is removed and very little nutrient recycling occurs.

Fertilizer recommendations for pastures in most cases are based on yield response from mechanically harvested stands that have been harvested two or three times. A few research projects have compared two cut hay management with four cut management to simulate grazing. In all cases herbage yields were reduced with more frequent cutting systems. Frequent cutting or grazing systems reduce the amount of leaf area of forage plants and may reduce photosynthesis resulting in less dry matter production.

Pastures with 20% or less legume can be treated as a pure grass stand and will respond to nitrogen application depending upon the species and soil moisture conditions. Pastures with 20% or less grass can be treated as a pure legume stand. These pastures will respond to sulphur, phosphorous and potassium if the nutrients are required. Legumes respond very readily to sulphur.

Influence of Soil P Levels on Yield (Based on Average of N at 28 and 56 kg/HA)

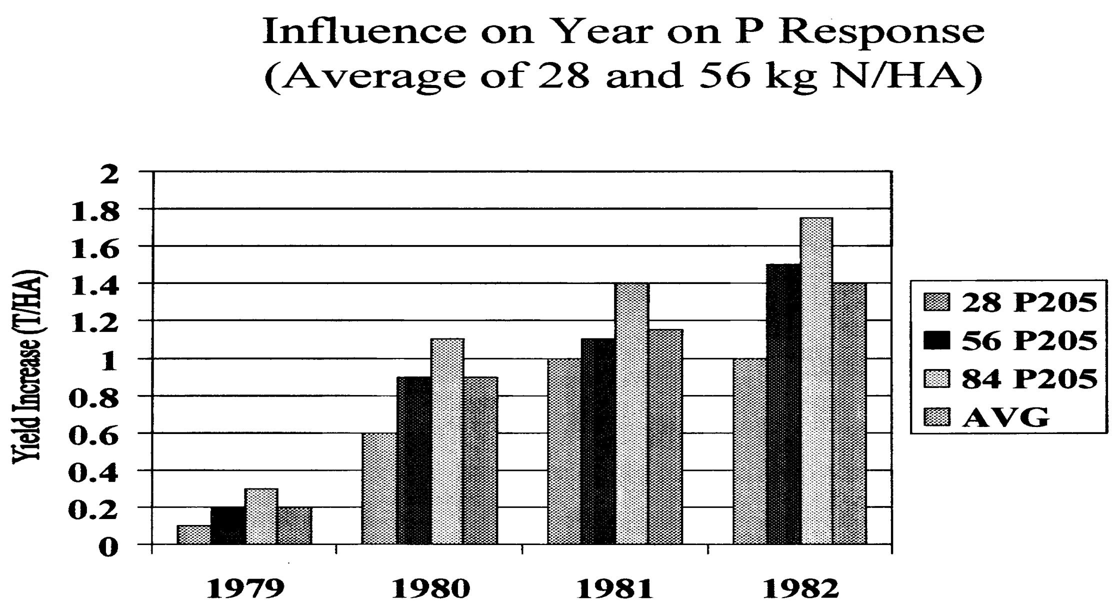


Average yield response of mixed forages as influenced by soil phosphate levels and rate of phosphate application (WCFL, 1979-82).

Ammonia nitrate (34-0-0) is the most commonly used source of nitrogen. However urea (46-0-0) can also be used providing there are cool temperatures and good soil moisture conditions at the time of application. In most cases spring applied nitrogen will be used up by the plants by mid July. The exception may be during dry weather conditions or pastures continuously grazed. Economic levels of applied nitrogen are 40-75 pounds of nitrogen per acre on pure grass stands.

Grass legume mixtures are a bit more difficult to fertilize. High amounts of nitrogen will provide a competitive advantage to the grass. Applying high levels of sulphur and phosphorous with no nitrogen may provide a competitive advantage for the legume. In most cases there will not be an economic return by applying nitrogen to grass legume stands with 40% or more legume in the stand. Depending upon the nutrient level in the soil one will receive response from sulphur, potassium and phosphorous. Some research work has indicated a legume-grass mixture will provide more dry matter yield when grown as mixtures compared to straight grass or straight legume. Using alfalfa in pasture mixes can certainly reduce nitrogen bills. Fertilizer application is very dependant upon the species, the soil nutrient level and soil moisture conditions. Legume and grass stands should have at least 25 pounds of phosphate, 350 pounds of potash and 15-25 pounds of sulphate in the soil on a per acre basis.

Phosphorous response is dependent upon the phosphorus level in the soil and requires more time to become available to plants. Soils with phosphorus levels of 10 PPM or lower may respond to phosphorous quicker than soils with higher levels of phosphorous as indicated in Figures 1 & 2.



Successive average first cut yield responses of mixed forage stands to annual applications of three rates of Phosphate based on 62 site years of data (WCFL, 1979-82).

The majority of fertilizer applied to forage stands is broadcasted as dry fertilizer on the soil surface. Incorporating fertilizer with the use of disc coulters or narrow knives may improve dry matter yields when compared to broadcasting. However, the increased yields may not pay for the extra cost associated with soil banding equipment to incorporate fertilizer. The effectiveness of broadcasting nitrogen fertilizer on pastures with high plant residue can be reduced due to nitrogen being tied up especially with dry weather conditions.

Fertilization should be considered only when the extra production is required or if nutrient levels in the soil are extremely low. Early spring application of nitrogen on some pastures will allow earlier grazing and restore plant vigor.

3. *Sod Seeding and Direct Seeding Forages*

Sod seeding consists of seeding forage species into an existing grass or legume stand without breaking up the stand using direct seeding equipment. Sod seeding can occur in land previously treated with a glyphosate product or without the treatment of glyphosate. Not using a glyphosate product greatly hampers the establishment of new seedlings especially if the existing grass species has a creeping root such as smooth brome grass or creeping red fescue. If sod seeding is used, it is recommended a glyphosate product such as Roundup or Touchdown be applied to control the existing vegetation. Rates of 1 ½ to 2 liters per acre should be applied when grasses have at least 3-4 leaves per stem and legumes are in the bud or blooming stage. Roundup and Touchdown are registered as a pre-harvest treatment and can be sprayed on actively growing forage crops and harvested as hay or grazed 3-4 days after treatment. Fine bladed grasses such as creeping red fescue are extremely hard to control with just one treatment. Table 1 provides an indication of the effectiveness of

Roundup on grasses.

If legumes are in the pre-bud stages, Banvel or 2,4-D should be added to the glyphosate product for effective control of legumes. Banvel can be added at 200 ml per acre or 2,4-D at ½ litre per acre. Please follow label recommendations.

Table 1. Tolerance of Established Grasses to Roundup Percent Visual Control

Grass Species	June/94	Sept./94	July/95
Timothy	90	96	74
Meadow Fescue	78	44	31
Western Wheatgrass	93	98	96
Intermediate Wheatgrass	95	96	85
Orchard Grass	86	26	14
Crested Wheatgrass	91	91	68
Creeping Red Fescue	66	34	0
Smooth Brome	68	40	51
Meadow Brome	90	65	30
Tall Fescue	96	94	86
Pubescent Wheatgrass	94	95	94
Meadow Foxtail	45	65	30

Timing of application of glyphosate products can be done any time during the growing season providing there is sufficient top growth to absorb the herbicide. However to date better control has been achieved by spraying the later part of August or early September providing plants are actively growing. A higher level of control of dandelion and legume is achieved at this time. Seeding can occur the following spring.

Work in Saskatchewan indicates seeding should occur shortly after spraying. However under Alberta conditions we have found more success by waiting until the plants have decomposed somewhat before re-seeding. To date sod seeding into an existing treated forage stand has provided inconsistent results. Presently there is research being conducted to determine the problems. A higher success rate occurs when an annual crop is grown for one or two years before reseeding into forages.

Disc type seeders or seeders with narrow openers have been the most effective for re-establishing the forage crop. Ensure there is proper penetration, proper seeding depth and good seed-to-soil contact. It is also critical there is good soil moisture when seeding.

4. Aeration

Heavy intensive grazing particularly early in the grazing season or at times with high precipitation can increase soil densities and penetration resistance. The term *sodbound* is used many times to describe a condition that in most cases occurs when an area has been continuously grazed or over grazed. No humus layer exists and plants have a very shallow root system resulting in poor growth. The soil surface is capped and hard to break open, reducing water infiltration.

These conditions result in the commonly used phrase *soil compaction.* Soils with this type of structural problem are detrimental to root development resulting in reduced yield and growth of desirable plants. Controlled grazing will help maintain soil surface conditions that can withstand the grazing action and reduce soil compaction. For those interested, equipment is available through some of the soil specialists to measure compaction.

Recently there has been increased interest in using equipment to mechanically aerate soils that may have compaction problems. Any tillage equipment that will moderately disturb the top 2-6 inches of soil in a pasture can be considered. Tillage will enhance the decomposition of the forage root systems, thus releasing nutrients to the plant. Implements to consider include cultivators with 1-inch spikes or knives, rotary harrows and AerWays. Research in the U.K. has indicated slitting the soil with an aerator has doubled herbage yield on some pasture lands.

Work in Saskatchewan was conducted using fluted coulters as a deep band treatment and 2 cm knives as a spike treatment with and without fertilizer. There was no response from just using the knives or the coulters. The treatments were done early spring and dry matter yields were taken for the following three years. The work was completed on 3 grey-wooded sites and 3 black soil zones of parkland in Saskatchewan.

Work with aerator equipment under Alberta conditions has provided varying results. Just mechanical disturbance does not appear to provide increased dry matter production. However mechanical disturbance with the use of manure, fertilizer or broadcasting seed may increase dry matter production.

Aeration operations should be carried out as early as possible in the spring in order to have the growing season to allow the stand to recover from the stress of tillage operation. There could be a negative effect on yield if the soil is too dry when the tillage operations are conducted. Some farmers have used land rollers to level the spiked land.

Research work conducted by Dr. Malhi at the Lacombe Research Station indicated there was no consistent beneficial effect of mechanical aeration on pasture or hay land. The treatments in this research project involved spring, fall and a combination of spring and fall operations. The project also considered various levels of nitrogen application. Work involved 5 different sites on grey and black soils. Using aerating equipment may be beneficial in preparing pasture lands for overseeding with legumes and grasses or in conjunction with fertilizer or manure application There are no long term benefits of aeration unless grazing management is improved along with fertility or the introduction of new species is considered.

5. *Over-Seeding Legumes*

In high precipitation areas the practice of broadcasting legumes and some of the smaller grasses on top of an existing forage stand has been reasonably successful. Using cattle or a light cultivation will help bring seed into contact with mineral soil. This practice can be used early spring or seeding just before freeze up. Again the results of this practice are very dependent upon weather conditions, grazing management and the management of the pasture following the seeding. Alsike and white Dutch clovers have been the most successful legumes using these methods. The practice of mixing legume seed with salt at a rate of approximately 5-10% of seed with loose salt can be fed to cow/calf units to spread seed.

Reseeding alfalfa into an existing stand without removing the old stand is generally not successful. Old alfalfa plants contain leachable toxins that are autotoxic and can effect germination and growth of newly seeded alfalfa. There should be at least a six-week break between the time all alfalfa plants have died and a new seeding occurs. The toxins are water-soluble and will break down and are leached through the soil.

6. *Brush Control*

Brush encroachment, particularly aspen and to some extent willow, is a problem in some of the higher precipitation areas. Proper grazing management should be used to help control any bush encroachment. Fencing and proper stock density will help reduce the competition from brush. Whatever treatment is used to control brush, treatment should be carried out between late June to the end of July.

Mowing early July and using proper grazing will help control regrowth. However mowing is expensive and depending upon mowing height can create problems with hoof damage of the grazing animals.

Bark scrapers have been manufactured from old Cat rails or grader blades and have been reasonably effective in controlling aspen and willow regrowth. The operation should be carried out early July.

Herbicides are another method of controlling regrowth The most commonly used herbicide is 2,4-D ester. It is applied at rates of 1 to 2 liters per acre and applied with ground equipment or aerial application. Ground equipment with higher rates of water applied per acre will generally provide better control than aerial application.
If aerial application is used, the regrowth should be no more than 8-10 feet for effective control. Any products used for brush control will in many cases remove legumes. Grass production begins more quickly with the bark scraping and mowing treatments.

Herbicide wipers are also available to be mounted on 3 point hitches or front-end loaders. Thirty percent solutions of glyphosate products have been used in the wipers for effective control of aspen and other woody weeds. The same treatment has also given effective control of Canada thistle.

Burning has also been used to control aspen and willow regrowth. Proper fireguards and burning permits should be obtained before any controlled burns. Combinations of the above treatments can also be considered for effective control of brush.

In summary, before any rejuvenation project is started determine and correct the problem particularly if the problem is grazing management. Without correcting the problem, another rejuvenation project will need to be considered in a few years. A cost-benefit study should be completed before starting a rejuvenation program.

Additional sources of information:

Rejuvenation of Tame Forages: Parklands, Saskatchewan Agriculture

Alberta Forage Manual: Alberta Agriculutre 120/20-4

Fertilizer Management for Forage Crops in Alberta: Agriculture Canada

Removing Forages from the Rotation in a Direct Seeding System FS 519-17

The Role of Fertilizers in Forage Management: Grazing Conference Red Deer, Dec. 2000: J. Lickacz, D. Cole, H. Yoder, S. Eliuk

Tame Forage Stand Rejuvenation: .University of Saskatchewan

Influence of Harvest Management & Fertilizers on Herbage Yields of Cool-Season Grasses Grown in the Aspen Parkland of northeastern Saskatchewan: Bittman etc. Canadian J. Plant Science 80:747-753

Reducing Usage of N Fertilizer for Optimizing Forage Yield of Bromegrass-Alfalfa Mixtures:
Malhi Lacombe Research Station

Grazing the Alfalfa Queen

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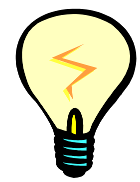
I. AN OPPORTUNITY

Alfalfa is the most productive, perennial forage in Western Canada. This does not mean that it is the exclusive forage in the field, or even that it is a prevalent choice for grazing. On the contrary, if graziers are willing to seed pastures with alfalfa at all, it is at low rates, in mixtures designed to limit alfalfa plant densities to less than 20% of the total in an established stand. Furthermore, stand management is not aimed at obtaining a maximum benefit from the alfalfa. The most common grazing strategy for alfalfa is the 'hay-and-graze' management system. Mixed stands of grass and alfalfa are usually cut for hay and stock graze the regrowth, or aftermath, in the fall. As the stands age, winter-kill and over-harvest take their toll, leaving too few alfalfa plants and too many weeds to justify haying. Fields that are still marginally productive as pasture are rendered bloat-safe by removing the remaining alfalfa with a herbicide. Otherwise these depreciated stands are renovated by cultivating and seeding to an annual cereal. Thus the most common grazing strategy is a strategy of using alfalfa, but not very much.



Minimal alfalfa grazing is a creditable management strategy aimed at reducing the incidence of bloat. Pasture bloat can be devastating; it occurs unpredictably, preventive measures are few and not always effective. Losing animals for any reason can be traumatic; a grazier will never consider the loss as just an operational hazard. Consequently, if the best strategy appears to be avoiding any situation in which bloat might occur, then the simplest strategy is to avoid grazing alfalfa altogether.

Operating at low risk, that is not grazing alfalfa to reduce the risk of bloat, means foregoing marginally better returns.

Unfortunately, bloat occurs anyway. Annual mortality due to bloat is as high as 1.5% of all grazing cattle and sheep. Each year rumours circulate about calamities, where bloat kills over 5% of an individual herd. These statistics vary little between surveys on several continents, and have not changed in spite of more than 30 years of alfalfa and bloat research. The annual loss in North America has been valued at $125 million.

Potential for Improvement

Operating at low risk, that is not grazing alfalfa to reduce the risk of bloat, means foregoing marginally better returns. Most economic models of grazing systems give a decided advantage to the use of more legumes. A review of North American grazing studies estimated that legumes in pasture increased the daily gains of calves by .15 kg. Over a typical Western Canadian grazing season (120 days) a calf could gain an extra 18 kg. An individual producer, with a breeding herd of 250 cows would gain an additional 9% in annual returns (Table 1.1). This is the production equivalent of weaning 19 more calves.

	Calf	Ranch	Alberta
1997 Statistics[z]			
Weaned weight (kg)	210		
Price ($/kg)	$2.42		
Grazing season (days)	120		
Breeding herd (cows)	1	250	1,952,000
Weaned calf crop	88%	220	1,717,760
Gross weight weaned (kg)	185	46,200	360,729,600
Gross return	$447.22	$111,804	$872,965,632
Potential Returns Grazing Alfalfa			
Additional ADG (kg)	0.15		
Seasonal weight gain/calf (kg)	18		
Gross weight gain/calf	16	3,960	30,919,680
Gross margin	$38.33	$9,583	$74,825,626
Marginal increase in returns	9%	9%	9%
Weaned calf equivalent	0.08	19	147,237

[z] Dunford and Jewison 1997

The performance and behaviour of grazing cattle are significantly affected by the amount of alfalfa in the pasture. At Kinsella, Alberta, cattle on pasture with a composition of 12% alfalfa (by dry weight), grazed longer (2.4 h d^{-1}) but gained less (0.14 kg d^{-1}) than animals on a stand containing 42% alfalfa. Dry matter digestibility on the light alfalfa stand averaged 8.3% lower over the grazing season. While the researchers attributed these differences to rotational grazing management subsequent studies in Brandon, Manitoba showed that the management system had little impact in any year. The reason for the improved gains was the amount of alfalfa in the field.

When bloat is controlled, stocking rates and rates of gain from alfalfa can be phenomenal. In Utah, more than 30 years ago, irrigated alfalfa pastures were stocked to extremes. Rates of gain ranged from 0.56 to 1.1 kg d^{-1} and stocking rates varied from 1488 to 2975 steer d ha^{-1}. Total live weight gains were 1506 to 1944 kg ha^{-1}. On dryland pastures at Brandon, containing 50% to 91% alfalfa, stocking rates ranged from 103 to 357 steer d ha^{-1} and rates of gain from .68 to 1.49 kg d^{-1}. These pastures were never stocked to obtain maximum gains but the total live weight gains were quite respectable, ranging from 107 to 462 kg ha^{-1}.

Clearly, the strategy of limiting alfalfa in pastures carries a significant opportunity cost. Western Canadian prairies have been stocked at or over their carrying capacity for much of the 20th Century and in some areas the demand is greater than the supply. Yet in most regions, alfalfa's high production potential has not been exploited except as a preserved feed; it does not contribute to the supply of pasture to any great extent. In Alberta, hay aftermath provides only 12% of the province's supply of pasture. Alone, alfalfa contributes less than 5% to the province's total carrying capacity. The wide economic gulf between grazing alfalfa and any other alternative strategy is an incentive to change and an opportunity for technological innovation. Also grazing alfalfa may be the only strategy with the potential to meet our growing demand for pasture.

II. BLOAT MANAGEMENT

Diagnosis

A rancher's normal response after a bloat incident is to examine the animals and the conditions they were in, including the plants they were eating, to see if something can be learned that will help predict and prevent another occurrence. If they can find a common factor responsible for bloat perhaps they will be able to diagnose the problem early, treat it before there is a death, or at least make its occurrence more predictable. Our current knowledge of bloat management has been directed by many of these discoveries.

CAUSES OF BLOAT. Bloat ensues as a chronic manifestation of disease, a dysfunction of the upper digestive tract, or from the consumption of a bloat-provoking feed (Cole et al. 1945; Johns 1954; Cole et al. 1960; Howarth et al. 1978a; Garry 1990a). The rumen becomes tympanitic when the rate of gaseous discharge is less than the rate of gas produced from fermentation. Bloat is symptomatic of many conditions that interfere with normal eructation and rumen motility including hypocalcaemia, vagal nerve damage, abomasal displacement, thoracic inflammation, ruminal stasis and obstructions of the cardia or reticulo-omasal orifices. Bloat is also a symptom of diseases like pneumonia, tetanus, and reticulo-peritonitis. Plant species known to cause bloat in grazing cattle include legumes such as alfalfa (*Medicago* spp.), red, alsike, and subterranean clovers (*Trifolium* spp.) and sweet clover (*Melilotus* spp.); and vegetative grass forages such as winter wheat, triticale, and the rye grasses (*Triticum* spp., *Triticosecale* spp., *Secale* spp., *Lolium* spp.). In confined feeding systems, cattle bloat when their diets contain processed cereal grains; preserved feeds such alfalfa or clover hays, pellets and even corn silage (often associated with increased digestibility from harvesting conditions or subsequent processing); and on poorly processed tubers and fruits (animals choke on potatoes, turnips, apples and kiwifruit) (Cole et al. 1945; Ayre-Smith 1971; Howarth 1975; Waghorn, G. 1997 pers. comm.).

TYPES OF BLOAT. A distinction is made between frothy bloat and free-gas bloat on the respective basis of the presence of a stable foam associated with amorphous, non-layered rumen contents or the absence of a stable foam and defined, normal layering of the rumen contents (Cole and Boda 1960; Howarth 1975; Garry 1990b). Both types of bloat can occur simultaneously (Boda et al. 1956). However they could arise from different pathological conditions that require different prophylaxes. For example, an animal that has been grazing legume pasture and has contracted pneumonia may bloat because the infection affects the animals ability to eructate. Retention of rumen gas may lead to a free-gas bloat at the same time that the digestion of the alfalfa forage may create a non-pathological froth. Other distinctions likely reflect differences in the feed or the by-products of digestion rather than the etiology of the condition. Frothy feedlot and pasture bloat differ in some rumen parameters; viscosity is greater and pH is often lower in feedlot bloats. Thus the differences between feedlot and alfalfa pasture bloat are primarily in degree of change and indicate that a range of feeds and rumen conditions can generate stable foams (Clarke and Reid 1974; Cheng et al. 1976). Similarly, the difference between sub-acute and acute bloat is also one of degree.

Sub-acute bloat - A state of sub-acute bloat exists when the animal has difficulty discharging gas from the rumen. The condition is asymptomatic, so the animal shows few signs of distress, but it can stimulate behavioural and physiological adaptations in the animal. Eructation and feeding behaviours are modified as the rumen's static pressure increases, to adjust to the new gas dynamics (Cole et al. 1945). Grazing bouts are shorter, rumination times are reduced and ruminal movements increase in frequency (Hancock 1954). Production losses are primarily a result of reduced feed intake (Johns 1954; Reid and Johns 1957; Alder et al. 1967; Hall et al. 1988). In cases of sub-acute, frothy bloat on legume pasture, the rumen has normal motility and low to moderate pressure but may be fully charged with a stable, amorphous foam, containing elevated chlorophyll levels, cation imbalances and an increased capacity to produce gas (Cole and Boda 1960; Reid 1960; Howarth et al. 1977, 1978b; Majak et al. 1980, 1985, 1986a, 1986b; Ledgard et al. 1990; Majak and Hall 1990). The danger for animals with sub-acute, frothy bloat is that they are predisposed to the onset of acute bloat (Majak et al. 1983; Hall et al. 1988).

<u>Acute bloat</u> - The development of an acute bloat can be rapid or protracted, with a sub-acute state remaining stable for extended periods (Lindahl et al. 1957). For acute bloat to occur, interactions between the animal and the feed source, the by-products of digestion or the microbial environment must escalate to a breakpoint beyond which fermentation gases begin to accumulate at a rate faster than the existing compensating mechanisms can expel them. If this point is not reached, the bloat may remain sub-acute and even abate without incident. Acute bloat often develops in conjunction with alterations in the forage quality, fluctuations in digestive conditions, when handling stress or a disease affects the animal's physiological status, or during changes in the ambient environment (Hall et al. 1984; Garry 1990b; Waghorn 1991; Hall and Majak 1991, 1995; MacAdam et al. 1995).

The additional gas held in the rumen during an acute bloat generates high pressure, leading to severe distension and distress. Therapeutics for the treatment of acute bloat are limited by time, especially if emergency medical intervention is required to prevent asphyxiation or internal haemorrhage and the death of the animal (Garry 1990a, 1990b). Proper diagnosis is a lesser concern when the difference between death and life is a matter of a few minutes. Consequently many experienced ranchers and veterinary practitioners use several remedies (chasing, tubing, drenching with oils, detergents, or pluronics, trocarization, and rumenotomy), chosen sequentially or at random, no matter the cause of the bloat, to relieve the distension. Ranchers need ways to control digestion or detect sub-acute bloats before acute bloats develop and generate serious economic losses (Clarke and Reid 1974; Howarth 1975).

Distension is the first clinical symptom used to detect bloat but it is generally insufficient to ascertain the severity of bloat or to verify the onset of acute bloat (Lindahl et al. 1957; Garry 1990b). Other visual symptoms of distress that show severity include panting, frequent urination, stamping the hind feet, kicking at the belly, or an abnormal stance, usually with forequarters and head elevated (Boda et al. 1956; Garry 1990b). However, animals vary in their physical ability to adapt to the pressure and in their individual response to discomfort. A change in girth is not linear with respect to changing ruminal pressure (Reid 1957; Waghorn 1991). As the rumen expands it fills the abdominal cavity, stretching the muscles and exerting pressure on the internal organs. Discomfort will be more severe in animals that have small body cavities, larger internal organs, or layers of non-elastic fat, connective tissue and muscle. Thus the only objective measure of severity is intra-ruminal pressure (Waghorn 1991) and for intact animals the recommended procedure is palpation of the left flank (Lippke et al. 1972). In ruminally cannulated animals the pressure released when the cannula is opened yields ample evidence of bloat severity.

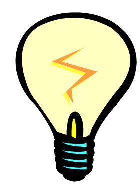
<u>Frothy and free-gas bloat</u> - Visually, the distension resulting from frothy bloat is indistinguishable from free-gas bloat. In the case of frothy bloat on pasture the clinical

symptom is the presence of a stable foam that sequesters the gas products of fermentation and retains them in the rumen (Reid 1960; Moate et al. 1997). Free-gas bloat may have a different etiology but on legume pasture, bloats may be a combination of free-gas and froth. Again, for intact animals, the only reliable, external, diagnostic procedure is palpation of the left flank to establish whether the rumen contents are abnormally uniform, due to the presence of foam, or stratified normally as is the case in free-gas bloat (Garry 1990b). A second, more invasive protocol, gastric intubation, can be used to expel gas and some rumen contents to confirm the diagnosis. Free-gas bloat may not be as prevalent in ruminally cannulated animals because gas can be expelled through the fistula. Thus, the severity and the incidence of bloat or the degree of distension may be underestimated by cannulated animals if pasture bloats are normally a mix of free gas and froth. However, the cannula provides a ready means of distinguishing between froth and a rumen distended with forage from a recent meal.

Theory and Practice of Bloat Prevention

Generally, correct diagnoses of the causes of bloat are made with the expectation that a reliable course of action can be taken to control or eliminate it. This is certainly true of bloat caused by a medical condition (Garry 1990a), but perhaps less so for frothy bloat (Howarth 1975). Popular recipes and rules of thumb on how to suppress frothy bloat on pasture or manage bloated animals, are quite variable although there are striking similarities in publications over a 250-year period (Beddows 1952; Anderson 1997). Turning animals out to pasture late in the day or onto mixtures containing grasses and trefoil were important management rules in 1716, while drenching with some special concoction is still a common remedy even today. The ingredients for the drench have changed considerably from ‘terpentine in beer’, but soaps, oils and other organic solvents are still recommended. All methods fail occasionally, which suggests that there are problems recognizing predisposing conditions that result in acute bloat, selecting an appropriate therapy or determining what caused a bloat (when treatment is given without diagnosis). On the other hand, the consistency of the prophylaxes demonstrates that some treatments have a high degree of efficacy.

Numerous theories have been proposed to explain bloat phenomena or the mode of action of preventative measures. Many are obsolete, but a few have maintained their currency for over fifty years. None could be called a unified theory which speaks to the obstinacy of the problem (Cole et al. 1945; Waghorn, G. pers. com. 1996).



Rates of consumption or gas production do not have to be extreme for gas to accumulate; the animal just needs to have a problem expelling the amount of gas produced.

THE EXCESSIVE CONSUMPTION HYPOTHESIS. Possibly the oldest hypothesis is the theory that excessive consumption causes bloat. It is supported by observations that fasted or hungry animals have high consumption rates during the first few hours after being turned out to pasture. Dougherty et al. (1987) reported that alfalfa consumption rates for the first hour of grazing by fasted beef heifers were 2.4 and 3.0 kg DM h^{-1} for low and high herbage allowances, respectively. This level of intake may produce gas at a rate exceeding 2 l min^{-1} or over 120 l h^{-1}. If eructation is suppressed, less than 60 l of gas may produce a serious bloat (Waghorn 1991). In contrast, the mean intake of beef steers continuously grazing alfalfa was much lower, 1.1 kg OM h^{-1} (Popp et al. 1997). Hence the old recommendation to keep animals well fed and move them cautiously, without interrupting their feeding regimen, may be well founded.

Rates of consumption or gas production do not have to be extreme for gas to accumulate; the animal just needs to have a problem expelling the amount of gas produced. The threshold level of gas necessary for bloat varies widely between animals. Waghorn (1991) reported that some animals needed to accumulate only 15 l of gas to obtain an intra-ruminal pressure of 10 cm water (Grade 1 level of bloat) while others required 50 l. Moate et al. (1997) found that non-bloated animals had rumen head-space gas volumes of 4 l while the volume in bloated animals exceeded 20 l. Lacking the evidence of foam or a high rate of gas production, Moate et al. (1997) were forced to conclude that a major cause of bloat is simply a failure to eructate. However, the reason for the failure may be far from simple (Garry 1990c) because it could include behavioural problems (eg. stress related suppression of rumen motility), biochemical disorders (eg. an impaired satiety function) or pathological conditions (eg. peritonitis).

Excessive consumption with an attendant high rate of gas production has not been confirmed as a cause of bloat but contrary to the opinion of some reviewers (Clark and Reid 1974; Howarth 1975), neither has it been ruled out. Only two studies looked at consumption patterns relative to bloat incidence (Hancock 1954; Johns 1954). Both studies used healthy, well-fed animals that were familiar with the feeding regimen. Consumption and bloat incidence in stressed, hungry or unhealthy animals has not been examined.

THEORY OF ANIMAL SUSCEPTIBILITY. Another old theory holds that bloat is a function of the animal's inherent level of susceptibility (Cole et al. 1945; Johns 1954). Cattle are more disposed to bloat than sheep and the susceptibility of individual animals varies widely (Ayre-Smith 1971; Clarke et al. 1974; Colvin and Backus 1988). Younger animals are more susceptible than older animals (Howarth 1975) suggesting that, with experience, individual animals can cope with bloat-provoking conditions. Learning grazing skills early in life from experienced mothers may have an impact on the off-spring's subsequent bloat susceptibility (Ramos and Tennessen 1992).

A corollary, the genetic predisposition hypothesis, has been examined in detail only in cattle. Reports of bloat in ruminants other than sheep or cattle are rare and usually cited in conjunction with a veterinary procedure or a confined feeding system (Clarke and Reid 1974). Bloat incidents in the commercial deer and bison industries in western Canada have not been documented although anecdotal accounts suggest it is extremely low for deer but may be a growing concern in commercial feedlots. Natural selection should eliminate the alleles of bloat-prone animals from herds that regularly encounter bloat-provoking conditions. However, divergent selection for high (HS) and low (LS) susceptibility to bloat in cattle found no specific traits other than that HS animals maintained comparatively high volumes of fluid in the rumen (Cockrem et al. 1987a, 1987b; Carruthers et al. 1988). The condition is heritable and a function of physiological or behavioural attributes, but identifying specific characters has been slow and unrewarding (Cockrem et al. 1983; Howarth et al. 1984). On the one hand high volumes of rumen fluid may restrict the head-space available for gas expansion implying that HS animals will reach stressful intra-ruminal gas pressures earlier than LS. On the other hand, if HS cattle retain more digesta in the rumen for longer periods then they must pass digesta through the rumen at a rate slower than LS non-bloaters (Okine et al. 1989).

Breeding a new class of livestock seems prohibitively expensive and inappropriate especially if bloat is an endemic trait. Comparisons between non-bloating and bloating ruminants to learn if there are specific traits associated with bloat have not been made and are unlikely, considering the expense needed to identify ruminant species that are truly non-bloating. And if these tests were ever conducted, the preferred outcome would be to exploit the non-bloating species rather than waste the time transferring its genetic capacity to sheep or cattle. Thus, management of the animals and their forage probably holds more promise than selecting non-bloating strains of livestock (Clarke and Reid 1974; Majak et al. 1995).

THE FOAM HYPOTHESIS. The most influential theory on bloat is not so much one of cause as effect. Combining a normal to excessive rate of gas formation with rumen liquor, foaming agents and foam stabilizers has the undesirable effect of turning the rumen contents into a stable froth (Johns 1954; Reid 1960). The theory explained a great deal of the phenomena that had been observed over the previous 30 years and spawned a 40 year search for foaming agents, foam stabilizers, destabilizers, the source of gas and an examination of the role taken by specific microbes in the development of bloat foams. Prior to the enunciation of this theory the prevailing philosophy was that an accumulation of gas, mostly in a free-form state (Cole et al. 1945), caused bloat. After, the study of free-gas bloat was virtually abandoned, perhaps to the detriment of our understanding of rumen function and the etiology of bloat (Howarth 1975; Moate et al. 1997).

Corollaries to the foam hypothesis include theories that protein, pectins, saponins, lipids, cations, polysaccharide slimes and cellular fragments of alfalfa stabilize the gas bubbles that are generated during digestion (Johns 1954; Mangan 1959; Pressey et al. 1963; McArthur and Miltmore 1964; Miltmore et al. 1970; Clarke and Hungate 1971; Gutek et al. 1974; Cheng et al. 1976; Howarth et al. 1977, 1978b; Majak et al. 1980; Majak and Hall 1990; MacAdam et al. 1995; Mathison et al. 1999). Axiomatically, lipids, in a dual role, and condensed tannins destabilize foam (Pressey et al. 1963; Cooper et al. 1966; Stifel et al. 1968). Howarth (1975) suggested that the distribution of surface active substances like proteins and lipids in the rumen liquor may affect their ability to stabilize or destabilize the rumen froth. Subsequent investigations (Howarth et al. 1978b) led to the suggestion that the lipid membranes of chloroplasts, fragmented from mastication and bacterial maceration, acted as nucleation sites for bubble formation. Obviously the creation and stabilization of rumen foam is a complicated and interactive process.

One major bloat management strategy has emerged as a consequence of the foam hypothesis, developing and evaluating the ability of novel prophylactics to prevent bloat. The strategy entails solving problems associated with the efficacy and administration of substances that affect the rate and stability of foam formation. The value of this strategy is that it is direct, with a history of traditionally applied remedies behind it, and it is an accepted means for ranchers to control the problem (Cole et al. 1945; Cole and Boda 1960; Howarth 1975). Complications arise in grazing or feeding systems when the efficacy of the substance is affected by dosage dependancy or microbial adaptation or if it suppresses digestive efficiency.

The prophylactic may have a plant origin. Condensed tannins (CT's), also known as proanthocyanidins, are polymeric compounds of flavan-3-ols or flavan-3, 4-diols found in many common forage plants (Jackson et al. 1996). They are produced by the plant as a chemical defence against herbivory since their protein-precipitating ability inhibits enzyme activity and cellulose digestion, and their astringent taste affects their palatability (McMahon et al. 2000). Extractable CT's were identified as foam destabilizers in the non-bloat-causing perennial forage legumes, sainfoin (*Onobrychis viciifolia*) and birdsfoot trefoil (*Lotus corniculatus*) (Jones et al. 1973; Gutek et al. 1974). Research teams in Canada and New Zealand are currently trying to reduce bloat incidence and increase protein digestibility by using these naturally occurring substances in grazing and feeding systems (Waghorn et al. 1989; McMahon et al. 1999, 2000; Barry and McNabb 1999).

A common management practice is to treat all animals and all conditions as if they are predisposed to bloat. Animals are provided with a daily dose of a specific prophylactic that the herdsman hopes will prevent bloat. Prophylactics are given in several ways including feeding them in a customized mineral supplement, dissolving them in drinking water, spraying them on pasture, 'drenching' animals before or after feeding or grazing, or by inserting a mechanical, time-release bolus containing the agent into the rumen. Invariably, the efficacy of an agent is dosage dependant so any reduction in the number of incidents and the severity of bloat is a function of the concentration of the agent in the rumen. Concentration, in turn, is dependant on the amount and frequency of administration of the agent, its rate of degradation and passage through the rumen. Thus the ability of an agent to control bloat may be strongly influenced by a stockman's herd management program, by the adaptation of the microbial populations to the agent or by a change in the rumen environment, and by extraneous confounding factors, like weather or palatability, that are beyond of the working range of the prophylactic's management protocol.

Many materials have been used to control the foam in bloat (Reid and Johns 1957; Ayre-Smith 1971; Clarke and Reid 1974). The apparent effectiveness of a specific product is directly related to its clinical efficacy weighted by its comparative expense and its ease of administration. Prohibitive costs, administrative difficulties or regulatory barriers for an effective bloat preventative often results in the substitution of less expensive products of low efficacy (Hall and Majak 1992; Hall et al. 1994b). Pluronic detergents such as poloxalene have been proven effective but are too expensive and difficult to administer for general use in North America (Bartley et al. 1965; Acord et al. 1968, 1969; Dougherty et al. 1992; Popp et al. 1997). Sodium bicarbonate and commercial laundry soaps are substituted in spite of their proven ineffectiveness (Reid and Johns 1957). Rumour supports the practice because ranchers report their subjective observations, attributing low bloat incidents to an unmeasured difference between using the product and not using it, when the effect could be equally attributed to livestock genetics, behaviour or management (Cole and Boda 1960; Acord et al. 1968; Dougherty et al. 1989a, 1989b; Warner 1997). Alcohol ethoxalates in a pluronic detergent carrier (AEPD), used in New Zealand and Australia for nearly 40 years, have recently been re-examined (Stanford et al. 2000). Yet regulatory restrictions may prevent their use in North America. Similarly, monensin, an ionophore, is currently registered for use in Canada, New Zealand and Australia, but not the United States (Bergen and Bates 1984). The situation with ionophores is not likely to improve because gaining approvals to use antibiotics to enhance feed digestibility or digestive characteristics will be increasingly problematic in the future.

Critically, in the context of the foam hypothesis, bloat cannot be eliminated. The causes of frothy bloat are so ubiquitous that therapies have had to focus on treating the symptoms, froth and distension, rather than the cause. Besides, any strategy that promises to eliminate bloat is antithetic because bloat originates from an outwardly normal digestive process; eliminating bloat will inhibit digestion. Regardless of its immediate outcome, eliminating froth will not eliminate bloat; free-gas bloats will still occur. Exclusive pursuit of the foam hypothesis has left us with strategies targeted at reducing the risk of frothy bloat as opposed to managing bloat in all conditions.

THE CELL RUPTURE HYPOTHESIS. A relatively new theory considers the development of bloat to be a consequence of the readiness of cells to rupture. The cell rupture theory of bloat proposed by Howarth et al. (1978a; 1982) was actually an advanced theory of forage digestion in the ruminant forestomach. Underlying the theory was the supposition that the initial rate of digestion was limited by the surface area and thickness of the plant cell wall. This was based on evidence that microbial digestion of intact leaf tissues proceeded in steps, each of which could be rate limiting. Bacterial colonization of the leaf surface (around stomata or lesions in the leaf) was followed by their subsequent penetration of the epidermal layer. Proliferation of microbial cells within the inter-cellular spaces macerated the tissues and allowed other bacteria to adhere to the cell walls. Eventual disruption of the cell wall resulted in an invasion of the intra-cellular space and the development of colonies of microbes within the cell wall fragments (Cheng et al. 1980; Howarth et al. 1984). Howarth et al. (1978a) derived their theory on bloat from the differences observed between the cell walls of different plant species, while Goplen et al. (1993) showed that thicker cell walls could affect the rate of digestion within a single species. Clearly the physiognomy of the cell wall had as much potential to influence the rate of digestion as any other rate limiting factor. Had they considered it they probably would have restated the cell rupture theory of bloat as a general theory of forage digestibility.

A cell rupture theory of digestibility introduces the idea that the rate of digestion is a function of cell size, shape, volume, surface area, arrangement and wall structure. The conceptual framework includes the supposition that initially, microbial degradation of plant tissues is regulated at the cellular level by a series of barriers. Once the barriers are removed or breached, microbial activity is regulated by competitive interactions and the demand for available nutrients or the accumulation of by-products of digestion and waste. Cells in one tissue type can also be barriers that restrict microbial access to cells in other tissues (Wilson and Mertens 1995).

Cell surface area, volume and the potential to rupture have been considered in a few models of digestibility (Fisher et al. 1989; Wilson and Mertens 1995). Ruminants evolved a system to capture some of the energy in the cell wall but this was likely a secondary effect that developed from a need to liberate the nutrients contained within the cell (Van Soest 1994). In the rumen, slower rates of cell lysis would reduce the digestibility of specific plant tissue types forcing the animal to eat less of that plant or develop a capability to break the cell wall.

The cell rupture theory also implies that equivalent rates of cell lysis will generate similar limits to digestibility in the ruminant and equivalent bloat potentials. As the plant tissues become macerated and the cell walls are broken apart in the rumen, many forages create a froth of cell constituents. Rumen foam is normal, a result of the mixing of gas and fluid during digestion. If the rate of cell lysis is limited then the volume, stability and rate of foam formation will also be constrained. For example on the plant side, some grass species (eg. perennial ryegrass, *Lolium perenne*) have leaf cell walls that are thinner than alfalfa but their respective cell sizes, shapes and arrangements constitute a greater barrier to bacterial adherence and invasion (Wilson 1993; Moghaddam and Wilman 1998). The bloating potential of these forages would be determined by the animals' susceptibility, not the plants' digestibility.

As plant cells mature their walls develop into a complex external matrix to protect the cell contents and support the structural integrity of the plant. Of all the factors affecting cell wall digestibility and the potential for rupture, the most important is maturity (Buxton 1993). In forages, the rate of maturity is a critical comparative index that is easily taken for granted. Comparing the extent and rates of dry matter disappearance, gas production, digestibility and nutrient contents will not be meaningful if all the plant material was collected on the same day. Such comparisons assume that all plants and all plant parts develop at the same rate and are equivalent in maturity on the day of collection. No two species of plants are that alike. Yet these type of comparisons are widely accepted as valid indications that one species is nutritionally superior to another (Hoffman et al. 1993).

Selecting a character in a bloat-provoking plant that affects the etiology of bloat in a herbivore is as esoteric a strategy as that of selecting non-susceptible strains of livestock, differing only in that breeding plants is less expensive. Picking a character for selection is just as difficult because its expression may not be universal, it may vary with the physiological status of the plant or the environment and, though the trait may be associated with bloat, it may not be directly responsible for the development of bloat in a grazing animal. Canadian researchers have looked at protein fractions, chloroplast membranes, leaf tissue disruption and leaf and stem digestibility (Miltmore et al. 1970; Howarth et al. 1977, 1978a, 1978b, 1979, 1982; Majak et al. 1995). They compared some of these traits with those found in bloat-safe forages and developed a procedure for breeding alfalfa plants to reduce the risk of bloat (Howarth et al. 1982, 1991).

III. ALFALFA FOR GRAZING

Since the turn of the 20th century, alfalfa has been bred to improve its quality, productivity and adaptation to the agronomic conditions in North America. It was primarily selected for its value in stored feed and most cultivars were selected under a mechanical harvest protocol. Alfalfa was rarely grazed in Canada, so it was never subjected to grazing pressure to induce grazing tolerance. The demand for grazing types or pasture alfalfas has risen with the demand for improved productivity and reduced cost of pastured forage.

Three criteria need to be met before an alfalfa strain can be called a grazing type. First, it must tolerate the environmental conditions. In western Canada, these conditions include harsh limitations like summer drought, severe winters, short growing seasons, and marginally productive soils. Second, it must tolerate grazing, including intermittent but severe defoliation and trampling. Third, and most important, it must possess a nutritional quality that enhances its suitability under grazing and reduces the incidence of bloat. The screening of genotypes for each criterion has been independent, the only area of crossover being that breeders of new strains have relied on previously screened genetic material.

Precursors of a Grazing Alfalfa

Canadian researchers have successfully met the first criterion, environmental tolerance, releasing several alfalfa cultivars for dryland pasture and rangeland seedings that are industry standards. Some early alfalfa cultivars are called grazing-types although they were never specifically bred for grazing (Heinrichs 1963). Recently released varieties are hardy plants with traits that include persistence, fall-dormancy, drought and winter-hardiness, low-set crowns, creeping roots, and disease and pest resistance. There were tradeoffs, yield in particular, for survival in cold regions (Lorenz et al. 1982; Berdahl et al. 1989; Caddel 1997).

Dryland alfalfa cultivars have a degree of grazing tolerance because a few traits, such as low-set crowns and creeping roots, enhance their survival in pasture. Although some cultivars have been tested in grazing trials (Berdahl et al. 1986), they were never selected for grazing tolerance. A grazing-tolerant alfalfa must persist under a regimen of severe defoliation and animal impact. Grazing-tolerant cultivars have decumbent growth habits, more crown buds and greater residual leaf cover after grazing, which may help maintain higher levels of total nonstructural carbohydrates in their root systems (Smith et al. 1989; Brummer and Bouton 1991, 1992).

The high feed quality of alfalfa may make it less than ideal for grazing because some factors responsible for its quality, such as digestibility and protein content, are implicated in bloat (Miltmore et al. 1970; Howarth et al. 1977). Breeding for lower quality is antithetical, alfalfa breeding programs rarely maintain lower quality lines except to evaluate traits for selecting lines of higher quality (Allinson et al. 1969; Shenk and Elliot 1970, 1971). However, species such as sainfoin or trefoil (*Lotus* spp.) seldom cause bloat. These differences were considered for developing a bloat resistant strain of alfalfa (Howarth et al. 1978a, 1979, 1982; Fay et al. 1980, 1981; Goplen et al. 1980, 1985; Kudo et al. 1985).

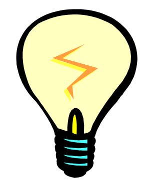
Thick plant cell walls are characteristic of bloat-free legumes. Rumen bacteria take more time to invade and rupture cells in these species than in alfalfa (Howarth et al. 1979;

Lees, 1984), so alfalfa strains selected for low leaf tissue disruption could be bloat resistant (Howarth et al. 1982). The breeding program, undertaken by Agriculture and Agri-Food Canada, selected individual alfalfa genotypes for dry matter disappearance (DMD) when fresh clippings from the tops (15 cm) of vegetative leaders were incubated in nylon bags in the rumen. Plants with a low initial rate of disappearance (LIRD) were screened and intercrossed through four cycles of selection. The final cultivar, LIRD-4, (released as AC Grazeland B^r) had a DMD 15% lower than a standard cultivar, Beaver (Goplen et al. 1993).

Evaluating Low Initial Rates of Digestion in Alfalfa

The new LIRD cultivar is unique. Almost all previous selection for quality in alfalfa has been carried out using *in vitro* techniques on dried samples, with long incubations, and where quality is assumed to be directly related to a few specific plant constituents (Hill et al. 1988). The argument could be made that broadly selecting a group of undefined plant constituents under the label 'digestibility' is risky, the outcome is less certain than the more traditional technique of narrowly selecting for one or two characters that are well correlated with digestibility. However neither a broad nor a narrow technique could be considered exclusively better when the outcome is as uncertain as the cultivar's ability to influence the behaviour or performance of grazing animals. If anything, the new cultivar is arguably closer to the ideal of breeding to influence animal performance.

The amount of dry matter disappearance hypothesized by Howarth et al. (1982) to bring bloat to an acceptable or nonexistent level was 25% lower than a standard cultivar, eight hours after ingestion. This goal was determined by comparing the DMD of alfalfa with non-bloating legumes. However, significant reductions in the risk of acute bloat may be accomplished earlier and with marginally smaller changes in digestibility. The major reduction of bloat incidence in sheep, in a feeding regimen designed to induce bloat, occurred after the mean apparent dry matter digestibility of the two alfalfa cultivars fell from 71.3% to 67.5 % (ie. 3.8%). Sheep are less prone to bloat than cattle (Colvin and Backus 1988) but if the principle is the same, the frequency of boat incidents will hinge on relatively minor changes in alfalfa digestibility.



Our current understanding of bloat points toward one conclusion: that it is an endemic trait of domestic ruminants and cannot be eliminated.

Our current understanding of bloat points toward one conclusion: that it is an endemic trait of domestic ruminants and cannot be eliminated. Consequently, there will be a continuing need to control it and reduce its severity. AC Grazeland may be an important tool in this respect: the multiple bloat incidents characteristic of 'bloat storms' were reduced in cattle grazing this cultivar during both low and moderate bloat challenges. This is probably a result of a maturity differential between AC Grazeland and the standard cultivar within comparative trials. A rancher trying desperately to prevent livestock deaths during a bloat storm would neither admit nor understand that AC Grazeland was helping in the situation. However if the decision has been made to graze alfalfa for the profit it can give the operation, a risk appraisal will rank the choice of AC Grazeland better than others.

Grazing Grass and Legume Mixtures

Bjorn Berg

Mixtures of grasses and legumes are more commonly seeded on tame pastures in western Canada than are monocultures of pure grass or a single legume. Grasses live longer and legumes produce more, so theoretically a grass-legume mixture should give us a long-lived, productive pasture. That's the pasture management goal for graziers: live long and prosper. I believe more legumes in our pastures will help us achieve this goal. So, in the following few paragraphs I will describe some of the complexity of grass and legume mixtures, define the grazing practices that we need to be aware of and point out where these practices may conflict with our grazing goals and the management of bloat risk. The inherent advantages of grazing legumes will be left for another article.

Mixture Theory

Grass-legume mixtures add new levels of complexity to our management. Before seeding, we choose the species carefully, selecting a group of plants that are adapted to the diversity we see in our soils or climate. We choose each species for its compatibility with other species in the mix and we choose individual cultivars for specific things such as improved productivity or creeping roots. We choose species for their seasonality, such as early spring or late fall growth, or their ability to regrow, so that we can harvest the field two or three times a year. To prevent bloat, we balance the seed mixture so that grasses dominate. A thumb-rule originating somewhere in history, limits the legume component to less than 20% of the total in the original seed mix with one exception: hayland seed mixes generally contain up to 50% legume.

Things really get complicated after seeding. Some species compete well in our pastures, maybe too well in some situations. Quackgrass, wheatgrasses, red fescue and smooth bromegrass can over-dominate a mixed stand and become a monoculture in less than two years. Species that are more palatable to livestock get overused, lose their competitive advantage and die out. And, where the risk of bloat is concerned, we may even do things to these mixed stands to limit the diversity we originally strived so hard to introduce, such as spraying them with herbicide. The pasture management practices used on these forage stands are limiting because not enough attention is paid to the response of mixtures to the management applied.

Standard Practices

In reality, only two management systems are used on pastures in western Canada, intensive and extensive systems. The difference between the two is an arbitrary one, generally involving the relative value of human, nutrient and structural inputs needed to set-up, maintain and operate the system. Intensive systems use more inputs, extensive systems use less. (Some authorities have argued that a controlled grazing or scheduled rest period is only used in intensive grazing systems, or that they use multi-paddock designs. However controlling grazing periods and creating multiple paddocks is not exclusive to intensive management systems. Humphreys (2001) felt that the essential character of intensive systems was their consistent failure to achieve any long-term increase productivity.)

Standard practices within the two systems vary across western Canada but are also one of only two types, Hay & Graze and Seasonal Grazing. The difference between these two practices is also somewhat arbitrary but generally divides by the period of time since the last cultivation, Hay & Graze being a relatively short period (less than 10 years), Seasonal Grazing being a long period, if at all.

The two grazing systems and two practices can be mixed and matched.

Hay & Graze

The most common management practice used on cultivated soils is Hay & Graze. The vigorous spring growth from new seedings is hayed during the summer and the regrowth is pastured in the fall. After 4 or 5 years, when the total productivity falls below a margin that would justify haying, the field is converted to seasonal grazing.

Variations exist that are more appropriately labeled Graze & Hay. For example, graziers may be forced to cut hay on the ungrazed paddocks in some multi-paddock, intensive management systems to control forage maturity and avoid waste. This happens when grazing periods in each paddock are too long, seasonal forage growth is too great or the stocking rate is too light. As another example, during extended droughts, the first-cut hay crop is often sacrificed for use as spring pasture and summer growth is conserved as hay or silage. Again, the practice combines two different harvest techniques in the same year, Graze & Hay.

Seasonal Grazing

Seasonal grazing practices are conventionally employed in extensive grazing systems on uncultivated native rangelands. Seasonal grazing occurs when paddocks or fields are grazed successively and exclusively, year-by-year during the same season. In the Peace River country, for example, open, south-facing slopes become spring pastures, while aspen-covered rangelands (bush pasture) and riparian bottomlands (meadows) are used primarily for summer pasture. However variations exist in this practice as well. Some intensive management systems rely on pastures seeded to plants with specific growth periods. For example, crested wheatgrass starts spring growth earlier than many other grasses, which has made it invaluable for early season graziers. Seasonal grazing of grass-legume mixes is primarily a summer or fall practice.

Response to Management

The original seed mix, which you spent so much time developing, will change from what was intended, sometimes quite radically and often within two years of seeding, depending on the management practice and the competitive ability of the species. For example, the proportion of smooth bromegrass in a mixed stand with alfalfa increases under either extensive Seasonal or intensive Hay & Graze management systems. These systems do not allow alfalfa a rest-regrowth period. Eventually the stands evolve into a classic 'sod-bound' monoculture of smooth bromegrass. However, under intensive seasonal grazing management systems (sometimes called rotational grazing), smooth bromegrass is less competitive because it cannot recover its lost leaf area as quickly as the alfalfa. The shift in production favors alfalfa and it is accompanied by an increasing risk of bloat. The solution is to switch from intensive seasonal grazing to an intensive hay and graze management system.

Competitive advantages

The response to a change in management depends entirely on the competitive advantage given to each species. If meadow bromegrass was substituted for smooth bromegrass in the previous example, the proportion of alfalfa would increase under all management systems. The critical issue for graziers is to time a change in management to force a compensatory response in the pasture mix to slow production declines and reduce bloat risk.

Competition for light is the most important factor determining the distribution of each species in the mix. The amount of leaf and its exposure to light directly regulates each plant's photosynthetic activity. During the spring, the leaf area of grasses expands more rapidly than legumes, resulting in competition for light between the species. Some legumes, such as white clover, cannot compete well at this time, because they are incapable of extending their stems above tall grass canopies. They perform better in mixtures with grasses such as creeping red fescue that have low canopy heights.

Both components, the legume and the grass, are at a competitive disadvantage in Hay & Graze systems. The off-take of photosynthetic leaf area is continuous in these systems. Tall legumes, such as alfalfa, are placed under significant pressure in this management system. Grasses are also under pressure but respond by hugging the soil surface to keep out of harm's way.

Bloat
Generally, the risk of bloat increases with the proportion of bloat-causing legumes in the stand. More accurately, the risk of bloat increases whenever the animals have a greater opportunity to eat bloat-causing legumes. Thus a pure stand of alfalfa is considered the highest risk because the animals have nothing else to eat except alfalfa.

Bloat risk is more difficult to manage in mixtures of grass and bloat-causing legumes than in pure stands of the same legume. The animals receive more attention when grazing pure stands because the situation is always treated as bloat-provocative and there is an expectation, often achieved, of improved animal performance. Mixed stands are considered to be more-or-less bloat-safe and to not require the increased level of management of a pure legume stand, which is a serious oversight. As I suggested before, they may need critically timed management adjustments to compensate for the dynamics of competition between species in the mix.

Animals vary the mix of plants in their diet, responding quickly to changes in plant palatability. On a crested wheatgrass-alfalfa pasture, the shift between a diet composed entirely of crested wheatgrass and one entirely of alfalfa can occur in a matter of one or two days. Often the diet switch will occur because the plant species differ significantly in maturity. The result is an increased risk of bloat if they move exclusively to a diet of bloat-causing forage.

Grazing Mixtures
For grass-legume mixtures, we must observe change and skillfully apply our understanding of the effects of different grazing systems to vary the animal's diet and intake rate. The tools are readily at hand. Graziers can control the animal's diet by changing the species mix (using a herbicide), by varying the stock pressure, by switching between extensive and intensive systems (i.e. by putting up more cross-fencing and using smaller paddocks) or by haying and grazing. The technique used and the returns achieved will depend on the grazier's skill.

For all pastures, the level of input should increase over the life of the stand. In other words, as the stand ages we should be more intensive in our management and we should achieve better lifetime returns as a consequence.

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Pasture Species

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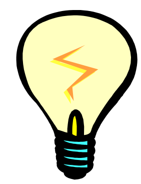
Grass for 4 Seasons

Grass for 4 seasons was an article written in 1996 about the Norm Ward ranch at Granum by Larry Thomas of the Cattlemen Magazine. When we think of pasture species we often wish for just that along with excellent growth, high intake and quality throughout the year. What is exciting is with proper grazing management most species of grass or grass/legume combination can come close to fulfilling those desires. That is why many of us get so excited about stockpiling or banking forages. With proper management for quality and quantity to extend the grazing season we get vigorous plants that create productive permanent pastures. The point to be made here is already known to many of you. Ideal pasture species is secondary to management and environment. When seeding pastures to meet the needs of the grazing system picking the right grass, legume or combination of grasses and legumes for a mixture can be confusing. But by picking the right species we can make our grazing management much easier and increase our opportunities to manage for greater success and with more flexibility in decision-making.



Ideal pasture species is secondary to management and environment.

Pasture Species and Management

We cannot talk about forage species for pastures in isolation of grazing management. The first question to ask yourself is why are you seeding or reseeding this stand? In Europe it is common to see pastures that are over 100 years old and are so productive they are regularly hayed as part of pasture management. High fertility now common in Europe was not practiced until the last few decades. Why do those pastures stay productive? The moist conditions do help and the common perennial rye grass species play a role but more so is the fact that the principles of good pasture management are applied. When planning to seed a stand look at personal goals for yourself and for your landscape. Look at the limitations of the land to seed. Look at the rest of your pastures and try to best address the weak link in your pastures overall if possible by what you do with this pasture. Finally what we need out of this pasture, its soil and climate limitations and how we plan to manage it are the keys to what are the best forage species to seed. Trying to decide whether to work up a pasture and to reseed it to a more productive pasture species or not to reseed and just to manage it back to a productive state is entirely a personal and situational decision. The pastures we have are reflections of species seeded, the management and environment impact on them. Working up, reseeding, establishment risk and waiting over time for a pasture to reach its full potential are costly financially. Calculations using custom rates for field operations show when a pasture is cultivated down to remove it after glyphosate application has shown total costs of around $130/acre for taking the pasture out and putting it back in at a later date. This cost should be amortized annually over the life of the future new stand to more clearly determine the economic soundness of the removal and reseeding operation. For those who cannot afford to reseed or are willing to take the time to bring the stand back to a healthy productive state you will learn a lot about good grazing management through the experiences of rejuvenating it. I also often wonder, will the end yield of forage be higher with the new species in one or five years later? Even if it is, does this mean I will be further ahead economically and the real difference, be getting more "beef "produced per acre? If planning to try to manage the stand back to productivity this also comes at cost in manager's and calendar time... be patient ... the damage to the stand did not happen over night and neither will the recovery. Your goals should be to manage the stand so the plants can regain their vigour, deepen their root systems and fill in bare spots as possible. Depending on the land's seasonal precipitation, species present, management or inputs used improvement may take a very little, a very long time or may not come back to the degree desired at all.

The quicker "fix" solution is to work down the stand, put it in cereals for a couple of years and then reseed it to new forage species. Depending on access to equipment, feasibility of waiting for rejuvenation to take place, or species and environment inability, weed problems, etc. this is often the best solution. Filling in bare spots may not be achievable in some pastures in dry areas for example Russian wild rye in 18 inch row spaces or crested wheat grass fields. Competition above ground (shoots) and below ground (roots) determines if space is available for bringing other species into the stand or increasing the tillering of the species that are there. Also in areas with high priced land and good moisture, reseeding and getting to a high level of productivity with a new stand is low risk and may give you favourable returns on this investment quite quickly compared to drier areas.

Once the decision has been made to break up and reseed in the future or rejuvenate a forage stand by adding species, now consider using species that have potential to be compatible with your soil, environment and management methods. Consider species that address your pasture "weak link", respond well to grazing and combinations of species that are compatible and together capture a high degree of solar energy for long periods of time throughout the growing season. Really ask yourself why you are seeding this stand. Wayne Burleson, in his 1998 Pasture Walk Workshop said to ask yourself ...Why? Now try to answer in depth. Do this again getting more precise each time until you have asked and answered the progressive questions five times. You now have the real specific reason to pick the species to best meet your needs and not just a general one that may be more suitable to others. I find this method works real well in getting past the symptoms and finding the "root" of any problem.

Key Grasses

When we think of pasture grasses we should look for specific grasses that respond well to grazing. In wetter parkland areas we have many choices for productive forage species and are not as limited as are grass farmers in drier areas. The best grazing grasses are ones that can physically regrow well when an animal grazes them. Species like (Russian wild-rye, orchard grass, quack grass, sedges and meadow brome grass) have multi-height growing points or ones like (Kentucky blue grass, creeping red fescue, tall fescue, meadow foxtail, crested wheat grass and Altai wild-rye) have low growing leaves called "short shoot" species. There is some overlap between species from one to the other category but I will not take time to discuss this here. After being bitten these species are left with either more intact growing points or sufficient leaf surface area to capture sunlight. As a result have the capability to regrow quicker than "long shoot" species like timothy, smooth brome grass, reed canary grass and the other wheat grasses that have to regrow from at or below ground once their growing points have been bitten off. They are called "long shoot species" because as these mature they also carry most of their leaves higher on the stem and elevate their growing points. This usually occurs quite early in the spring. Once these growing points are bitten off they take a longer time to regrow and recover from a grazing. Although these species are better suited for haying than grazing to simply not consider them as pasture options would be wrong. These species do remain more vegetative in older stands. They have better regrowth, and regrow more quickly with good species management and fertility. Production yields can be very high and often quite similar among species if managed properly with knowledge of the species strengths and weaknesses. For instance if timothy is grazed in the boot stage or the brome grasses in the stem elongation stage they will be set back quite severely. All this said, the growth potential any species have would be limited by genetic makeup, the environment and management on that stand.

Key grasses in the wetter areas are numerous. The majority of pastures are older hay fields of alfalfa and smooth brome or timothy invaded by Kentucky blue grass, quack grass and wild white clover. Species specifically chosen for pasture like orchard grass, meadow brome grass, creeping red fescue, tall fescue, Kentucky blue grass, reed canary grass, meadow and creeping foxtail all have various strengths for grazing. Orchard grass and meadow brome grass have very rapid regrowth with good moisture and management. Orchard grass can be overgrazed more easily as it stores its food reserves above the ground in the bases of its stems. Orchard grass and meadow brome grass grow late into the fall. Grazing severely at this time often causes higher winter kill in orchard grass. In the wetter, heavier soil areas of the Aspen Parkland or Boreal Forest orchard grass competes against invaders and has higher yields than does meadow bromegrass. In drier or more upland areas meadow brome has the advantage.

Meadow foxtail will be the earliest growing in the spring closely followed by meadow brome grass. Ungrazed seed heads of creeping or meadow foxtail are seed sources for their spreading across pastures. Both meadow and creeping foxtail need to be grazed early, severely and repeatedly with quite short rest intervals to prevent heading. Once they have headed they are very unpalatable. Unfortunately, because of this they limit a manager's flexibility in grazing management. The rest of the whole rotational grazing system revolves around these species use at the right times. They do not bank well for stockpiling either. The challenge with sedges, foxtails and other grasses in lowland areas is the ability to get on them when they are young, high in quality and the ground is not too wet for cattle traffic.

Kentucky blue grass and quack grass are invader's of all pastures in the wetter areas especially those that had a history of continuous grazing. Both species are of good quality and are excellent in protecting the soil surface from erosion or hoof damage in wet weather. Kentucky blue grass is often called "fescue". It's appearance and growth habit is much like creeping red fescue. Both are lower densely growing ground cover species that are very deceptive in yield because of these growth habits. Kentucky blue grass starts growth a lot earlier in the spring than creeping red fescue. Creeping red fescue grows a bit better in the summer heat, and in slightly drier areas, and both grow about equally in the fall. Both are excellent options for banking to graze in fall, winter or spring. In 1996-1999 we conducted simulated pasture research trials with several forage species on black or grey wooded soil in Central Alberta. We used good fertility and adequate rest between machine harvested clippings to allow for plant recovery. In fall, ½ meter squares of each plots growth was clipped to ground level to include all the low growing leaves and stems left below the cutting height (the 3" stubble) from the last harvest. If this was added to the yearly clipped pasture yield, all species yields were quite similar. In actual pasture situations Kentucky blue grass and creeping red fescue have total yields less than more productive species like orchard grass, meadow brome grass and reed canary grass but with good management they can yield more similarly to these more productive species. In a pasture estimating yield judged by height alone can be deceiving. Density is just as or even more important to the grazing animal. Skilled pasture managers and some research scientists have shown us that blue grass lack of production is more attributable to overgrazing than to lack of genetic potential to yield.

Smooth brome grass and timothy are often used because of cheaper seed cost or as older hayfields are converted to pastures. They elevate their growing points as does reed canary grass (but to a lesser degree) so regrow slowly, are less flexible for grazing options and do not give maximum yields in a typical grazing system. The best grazing management of these species is to graze similar to a hay harvest system with a quick and severe removal of forage growth. Thereafter give them a long rest period between grazings, allowing time for more forage mass to accumulate. This will give “long shoot species” more optimum yields when grazed.

Key grasses in the drier areas are the bunch grasses meadow brome and crested wheat grass. Crested wheat grass has a deeper root system but lacks palatability and quality as it matures when compared to meadow brome. For an early spring sacrifice pasture many people put cattle out on crested wheatgrass once it is in the three leaf stage. They graze it very aggressively to prevent it from heading out and until other native pastures are ready to graze. It seems to have its best fit managed like this as long as adequate rest is given thereafter. If moisture is adequate, it will be ready for grazing later in the season. Meadow brome responds exceptionally well to good management because of its quick regrowing ability and relatively deep roots. It should be about six inches high or more before grazing starts. If rainfall is adequate, by grazing the plant moderately in spring with a short duration grazing program it will respond with a good seasonal distribution of high quality growth. This is the reason it is becoming the grass to be seeded in some drier areas of Saskatchewan and Alberta.

If there is no concern of blue grasses invading a forage stand, Russian wildrye or Altai wildrye, although difficult and slow to establish are good options. Altai wildrye is the hardest of the two to establish. Both are very deep rooted with a good seasonal distribution of growth. The bunchgrass russian wildrye starts growth earlier in the spring than most grasses. Altai wildrye is also a bunchgrass but creeps slightly as well. Both are well known for their good quality when cured on the stem. This makes them excellent for dormant season grazing in dryland areas.

Other species grazed in drier areas are often because of lower seed costs or the “long shoot species” in old hay fields converted to pasture. Of these smooth brome is longer lived than intermediate or pubescent wheatgrass. Animals like it better especially at maturity than the wheat grasses. All three of these grasses have aggressive creeping root systems but intermediate or maybe more so pubescent has a deeper root system.

Why To Include Legumes

Under pasture situations where high nitrogen fertility is applied the need for legumes is questionable. As fertilizer prices go up, and as animal performance, and production per acre are known the use of legumes becomes a “clear cut” economic need. For those who use less nitrogen, legumes should be considered because if properly inoculated they have the potential to increase the total forage yield and spread out the season of pasture growth along with improving animal performance through higher forage quality and intake by animals. They harvest nitrogen present in the air in the soil and convert it into a plant usable form for themselves. There is still much to be learned in our grazing environment about how much nitrogen sharing occurs between what the legume produces and the grass uses. The legume is a high nitrogen user and is very aggressive about holding the nitrogen it produces. Data shows amounts of nitrogen transfer to grasses are in the 10-50% of grass nitrogen uptake. In Canada it has been found that more than 40 to 100 pounds of N/acre (nitrogen) must be applied to equal the contribution of a stand of 30-50% alfalfa (legume) grown with the grass. It is usually not economical to use nitrogen fertilizer on a 30% or greater legume/grass stand. Because of legume quality, animal daily gain is increased by 1/4-1/3 of a pound if a legume makes up a high percentage of the forage stand that the animal grazes. Also the length of the season of active forage growth is extended if legume is seeded with a grass.

When we think of highly productive and vigorous forage stands we normally think of them being ones with a legume in the mix. Legume leaves do not lose their quality as rapidly with maturity as do grasses. Legumes like alfalfa can have a longer season of growth than many grasses because of a deep tap root that harvests moisture below the grass root zone. The big disadvantage is many legumes can cause bloat, are short lived or do not stockpile well.

Legumes are often separated into two types, upright and trailing. Upright legumes (alfalfa, red, alsike and sweet clover, sainfoin and bird’s foot trefoil) have a true crown from which regrowth begins. With light grazing they often regrowth from axial buds, which is less efficient than regrowing from the crown. An exception is bird’s foot trefoil, which always regrows from axial buds, and grazing it lightly adds to its longevity. Trailing legumes (white and kura clovers, cicer milk vetch, and American vetch) are prone to overgrazing. The length of the remaining stem after grazing determines the rate of regrowth. Something to note is that once established the kura clovers immense creeping root system, white clovers creeping stolons and both having a low growth habit allows these plants to withstand quite severe grazing pressure and persist. Bloat can be caused by all the above legumes with the exceptions of cicer milk vetch, sainfoin and bird’s foot trefoil.

Key legumes used for pasture in moist areas are mainly alfalfa and wild white clover. As fertilizer prices rise or research is being done on legume cultivars, mixtures, bloat control methods and grass finishing animals more legume use in pastures will occur. Other key legumes to consider in wetter areas are white, alsike, red and kura clover, cicer milk vetch, bird’s foot trefoil and sainfoin. There are several new cultivars and other types of legumes that need further research on suitability to our grazing environment. Ones with potential appear to be low initial rate of digestion (LIRD) alfalfa AC Grazeland, producer harvested alfalfa seed being sold from old alfalfa stands may be one of the better potential pasture legumes for longevity, new cicer milk vetch cultivars, caucasian (kura) clover, and possibly other types of ladino and white dutch clover, and maybe bird’s foot trefoil. Specific management practices of these species is needed for stand establishment, longevity and/or a minimum of bloat. Allowing the species that lack winter hardiness or prone to diseases like crown bud rot (bird’s foot trefoil, white, alsike, and red clover) to mature and self seed with a banked forage rotation every two to three years is needed to maintain stands. Species like kura clover and cicer milk vetch are slow to establish so need excellent seedbed preparation, careful grazing or control of competing species canopy cover in the initial years of stand establishment. Alfalfa’s can last much longer in a stand if hardy species are chosen and thereafter applying manure or specifically phosphorus, potassium and sulphur fertility to replace harvested and exported nutrients. Couple this with two grazings which allows plants to reach the bloom stage at least once during the growing season aids in their productive longevity. New sunken crown grazing alfalfa’s do not have hardiness necessary for longevity in our environment although many new ones keep coming the result still is winterkill in the first few years.

Legume options in drier areas of the parkland fall back mainly to a deep rooted alfalfa plant. Creeping rooted species, Siberian types or old stand seed harvested alfalfa's are the hardiest, have a deeper crown, quite deep root systems but have the poorest regrowth potential. On the other hand Standard and Flemish alfalfa types have a potentially deeper tap root with better regrowth at the expense of stand longevity. The need for what alfalfa type or mixture will really differ based on management needs. Other legumes to consider are cicer milk vetch, sweet clover and maybe sainfoin.

Management Systems Dictate Seeding Monocultures or Mixtures

Monoculture? A grass and a legume? A more complex mix? This starts a heated discussion going between most people who are knowledgeable of forages on what is best. Knowledgeable from a scientific and/or practical understanding, very different opinions are held by many. In my opinion we do not have enough information about each particular situation to state if it is right or wrong because your inputs, management and environment determines what works best for you. Monoculture, one grass and a legume together or a complex-mix are not worth arguing over. Management is where energy should be placed first as long as species chosen are suitable to soil and environment conditions.

All that said I have to discuss this from one viewpoint and that is that Management-intensive Graziers (grazing management with consideration of the interactions of soil, plant, animal and climate) should consider well planned mixes and more continuous or simple rotation graziers a legume and a grass or just a grass. If you seed down a stand no matter which of the above systems you will use, the species you choose should be based on how you wish to "specifically" manage it, also the land and environment limitations placed on it.

Continuous or Basic Rotation Grazing

In a continuous, basic rotational grazing system a simpler mix or monoculture has many advantages over mixtures. As plants regrow and the animals remain on the stand they select for what they like best overgrazing new growth and under grazing older plants. Species, maturity of plant, plant physical form and animal behaviour effect grazing selection by animals. Succession will occur and in the end the plant species they like least or can stand being overgrazed the most will have an advantage. These tend to have the lowest growing points and are often least palatable. It is easier to keep one or two species in a stand than several. The ones you keep should be the ones that can optimize your management. Simple management should have only one or two species for easier management.

Including a legume with the grass will help feed the soil as well as the animal with nitrogen harvested from the air. In severely grazed pastures the legume soon disappears. One exception is wild white clover. Adding a legume is the most economically sound decision if phosphorus, potassium and sulphur fertility will be adequately maintained and some limited grazing management applied. Higher intakes and average daily gain(ADG) and a longer growing season occurs with 30% or more legume in grass pastures giving animal yields per acre equal to high nitrogen fertilized grasses. Total yield and seasonal distribution of yield vary between different grass species or within cultivars of species. In a test of four cultivars of perennial rye grass for hay herbage yield, grazed herbage yield and animal production yield (Munro et. al., 1992) the cultivars interchanged in performance rankings under each of the three treatments. Work done comparing hay herbage yield to total animal gain, and with Blaser ADG also from grazing (Blaser. 1969) (Mahli et. al., 1987) again showed herbage yield differences as well as ADG differences, but by season end total gain per acre was similar. Considering the above findings the higher forage production grass species or legume/grass combination may not create the most animal production per acre. Management of whatever species we have is often the most important factor.

In the monoculture or simple mix, species decisions should be made based on needs for: Early season of growth, late season of growth, summer growth, land characteristics like sandy or water logged or low pH soil, climate limitations like drought, plant physiological limitations and compatibility (For eg. Alfafa will not tolerate overgrazing or shading), concern with bloat, etc.

Management-intensive or Controlled Grazing

In a Management-intensive or controlled grazing system a more complex mix may be considered or is even advised. The choice of species is even more important and with less research information to draw on. The species should be matched as well as possible for palatability and growth form to minimize animal selectivity and make management decisions easier. One thought is to group later maturing species together for easier management. Seeding different mixtures in different paddocks to increase flexibility and target different management and soil limitations.

There are three areas to address in my mind when choosing species mixes for Management-intensive Grazing systems: 1) Legumes included for economic, quality, long season of growth and feeding the soil and grass as well as the animal reasons. 2) A creeping rooted grass to protect the soil surface and maintain or enhance soil structure. It should also create stability in the plant, soil and micro-fauna environment. 3) A "productive" fast regrowing and deeper-rooted grass should be considered. Now carefully consider reasons for adding other legumes as well as other grass species with different growing heights and timing of growth to get optimum solar capture during the growing season. High stock density, short duration grazing and proper rest periods allow for less selection pressure on forage species by animals and as a result succession will advance less quickly. Selection does occur even on daily animal moves but stand change in species composition in a pasture is more related to grazing severity and timing and length of rest periods in between grazings. I believe that a broad mix of forage species takes better advantage of niches in pastures, is more desirable to animals, can be more stable, a better solar collector and more productive forage stand in any given year or over the period of years. Depending on the soil and moisture for the area you are planning to reseed I believe it is ideal to consider a mixture of species that have different yet compatible strengths. A large bio-diversity of species in nature is considered to be succession at its climax. However our succession depends on economics also so this has to be also taken into account.

"Maverick" species that need severe grazing to prevent heading and unpalatability like crested wheat grass for early spring growth in drier areas and meadow or creeping foxtail providing the same in wetter areas are three species exceptions that should be considered for monoculture stands or with one legume and concerns to prevent spreading to other pastures taken no matter what the management system. Often their main use is as a valuable sacrifice pasture for calving on or early spring turn out.

Since "Mother Nature bats last" as the saying goes following her example seems logical. That said we have to remember we have modified the tools of nature like wide spread fires and cyclic nomadic herds of moving grazing animals that lived and died on the land. As we apply a controlled approach to nature, as Scott Wright, a Forage Researcher and staff member of Saskatchewan Agriculture says... "It's not more complicated than we think, it is more complicated than we can think...". A mixture in the hands of a willing grazier I believe gives us more options than a monoculture. I believe Mother Nature is very forgiving of the grazing mistakes we make. We should try to apply an equal and yet opposite in measure balancing act with different severity and /or biological timing of grazing to any one pasture from one grazing to the next. This should minimize negative effects of the succession we create. As a grazier form Swoope, Virginia said in the February 1998, Stockmen GrassFarmer publication..."Good enough is perfect.... Just do it". There will be no ideal species or mix but starting with the three components of a legume, a creeping rooted grass and a "potentially rapid regrowth" grass and building from there will be a good place to start.

It may be comforting to know that no matter what species we choose the stand will go through a succession process where species will express themselves to different degrees in different parts of the pasture. Invaders of native or naturalized origin will also come from seed or rhizomes to make up a part of the stand. Some seeded species will appear to be gone only to reappear with a change of management or climate. They were there all along but in a more depressed state or lacking in vigour to be notable in the stand. As you know you will not end up with the proportions of the mix you seed as you seeded them and in fact can expect to have areas of the field where one or a few species dominate over the others and this will vary from year to year based on climate and management. Whether you want it or not you and "mother nature" will fine tune your species choices. Through proper planned management of simple or complex forage mixes, making grazing decisions based on plant rest and recovery, rotating timing and severity of grazing from one grazing incident to the next, and excellent nutrient management you will come close to getting your "Grass for 4 Seasons".

Resources:

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Forages For Controlled Grazing

Grant Lastiwka, Jim Bauer and Myron Bjorge

LEGUMES

Alfalfa (Flemish, LIRD, Standard, Dryland, Siberian) (now most combined genetics)

- longevity and regrowth potential varies inversely with above listing left to right
- highest regrowth with Flemish and highest longevity with Siberian but newer genetics make this a bit more variable
- high protein, high yields
- pH 6.5-6.0 or higher best
- drought tolerant evader - deep root system whether creeping or tap
- as matures leaves remain high quality
- less palatable than grasses
- can cause bloat although AC Grazeland (LIRD) is much lower -"Rumensin bolus", Alfasure, and management for longer rest and more mature alfalfa
- graze in mixed stands with grass, with high stock density
- grazed more severely with long rests between grazings (2 times/year) and fertility for legume benefits alfalfa longevity in a legume or mixed legume grass stand
- orchard grass and meadow brome grass regrow quickly and keep pace with fast regrowth of alfalfa
- residual leaf doesn't mean much and will even inhibit with alfalfa as it regrows from crown buds
- does not bank overwinter well, looses leaves in fall after killing frosts
- animals prefer most other legumes and grasses over alfalfa so more severely graze companion legume or grasses in alfalfa-grass-legume mixes
- seedling vigor very good so can be used in sod seeding but preferred sod herbicide suppression
- wait two years for sod establishment evaluation – success or failure

Alsike Clover

- pH alsike 5.0, shallow, fibrous and roots
- bloat potential
- less palatable than grass
- lasts about 5 years but through reseeding in wetter areas can last a long time
- alsike will grow on peat and can withstand some flooding
- alsike left out clover does not have any "water marks" on leaves nor any pubescence
- by mistake white clover is often called alsike after alsike winterkills and white clover replaces it
- mixed results on how overwinters, you can find some plants that were protected by the grass, nice and green under the snow, very high quality but dry matter losses high especially if rains after snow gone

Red Clover

- high yields and high protein
- pH red clover 5.5, shallow crown and tap root with many side branches
- hollow stem and very succulent so does not dry well
- poor soil's alfalfa
- lives 2-3 years if not allowed to reseed
- red clover leaves and stems are very pubescent or "fuzzy" and some leaves will have the "V" shaped water mark (white on red)
- bloat potential
- single and double cut varieties
- less palatable than grass growing point is less high than alfalfa but is still better suited to silage or hay
- high dry matter losses if stockpiled to spring although it falls down after frosts and is better quality than alfalfa in the winter season of grazing
- most vigorous seedling of commonly used legumes or grasses so ideal for sod seeding

Cicer milk vetch
- high protein
- vigorous deep roots
- hard seeds and very slow to establish even if scarified are the real downfalls
- New varieties Windsor and Oxley II are better but still most graziers are disappointed with establishment
- does not cause bloat
- less palatable than grass
- regrowth is slow
- fairly good drought tolerance
- likes medium to high amounts of moisture
- does well on black soils but also more moist areas of thin black and dark brown
- very hardy and long lived
- starts 3 weeks after alfalfa in spring so grows well throughout rest of season into late fall
- 20% less yield than alfalfa
- best with bunch grasses
- banked overwinters much better than alfalfa but dry matter losses are quite high

White Clover (wild, white Dutch, ladino)
- grows by "stolons" or runners
- pH 5.5, shallow fibrous roots
- can withstand close grazing and needs the grass companion severely grazed at times to multiply
- very palatable, high protein
- often mistaken for alsike clover
- wild is commonly found in overgrazed pastures
- tame does not overwinter well
- doesn't tolerate a great deal of shading
- leaves will not have pubescence and may or may not have water marks (white)
- white Dutch and ladino lack hardiness
- ladino is high growing but used in Ontario for pasture

Bird's Foot Trefoil

- lacks hardiness - lasts two years and gone unless seed allowed to set and grass competition is low
- suffers when mixed with other competitive forage species
- does well on clay and water logged soil
- allowing to reseed every two years lengthens stand life as noted in ditches
- known for banked quality overwinter
- tannins like sainfoin except believed to be more variable between plant parts and cultivars
- hardiest may be Bull

Sainfoin
- high quality and animals like and regrowth is poor
- short lived and less hardy than alfalfa
- seedlings lack competitive ability and slow regrowing after cutting or grazing
- more drought tolerant than alfalfa
- best in brown, dark brown and black soil
- satisfactory in bunch grass mixtures like crested wheat grass and Russian wild rye
- tannins prevent bloat so promoted at 25% of stand with alfalfa lower bloat cases

Kura clover
- appears to be very hardy, tolerates severe grazing and high yielder in simulated pasture trials black and grey wooded soils near Lacombe
- bloat causer
- survived in Minnesota where alfalfa, red clover and bird's foot trefoil did not
- very slow to establish and poor seedling vigor so seedbed preparation needs to be excellent
- harvested sunlight energy in the establishment year is directed to developing an immense root system vs. shoot growth competition with companion grass species
- over three year trials at Lacombe and Bentley it was surprisingly good in establishment year but seedbed preparation was excellent
- it was the earliest legume to start growth in the spring compared to several other legumes
- seed hard to get although Proven Seed and Pick Seeds working with it
- originating in Caucasian Russia
- original spring growth upright stem and regrowth thereafter all leaves and petioles from crowns
- tolerates low fertility, soil acidity, wet soils and some flooding
- survives drought with poor yield and deep roots
- lower yielding than alfalfa and cicer milkvetch in Minnesota trials
- quality higher than bird's foot trefoil in those trials
- haying is difficult
- contact Grant Lastiwka 403-782-8028 for more info

Sweet Clover
- biennial that can last longer with self seeding
- coumarin content indirectly responsible for livestock bleeding disease in older varieties
- causes bloat but to lesser extent than alfalfa and other clovers
- grows from crown
- seeds need scarifying and if not some seed will grow years later

- white flowered taller and coarser stems and leaves than yellow blossom
- yellow is more drought tolerant and vigorous as seedling
- drought tolerance is equal to alfalfa or better
- common for one harvest and thereafter green manure plowdown

GRASSES
Smooth Brome Grass
- not as drought tolerant as pubescent and intermediate wheat grass
- more suited to hay than pasture
- pasture needs longer rest between grazings simulating hay system for optimum pasture production
- some consider it a better alfalfa companion for alfalfa longevity than meadow brome but there is some evident to support that it is not the species but the long rests between grazings that is the reason alfalfa can do well with smooth brome where rapid regorwth sooner regrazing of meadow brome puts alfalfa at a disadvantage
- high yielding and palatability better than intermediate and pubescent wheatgrass as matures
- quite early spring regrowth but slow regrowth after harvest
- root depth less deep at Lacombe than meadow although many others say the opposite

Timothy
- more suited to hay than pasture
- not quite as early as smooth brome but still early growth in spring
- shallow rooted and not drought tolerant
- does well on wetter, acid and poor soils
- slow regrowth but some cultivars are a bit better than others
- highly palatable
- stores food reserves in its corm (bulb like base just below soil surface)

Meadow Brome Grass
- excellent pasture grass for management flexibility in controlled or continuous grazing
- large seeds and expensive to seed because is not a good seed producer
- related to smooth brome
- semi-drought tolerant
- multi-height growing points make it an excellent pasture grass
- grows from basal leaves
- much better for pasture than smooth brome
- rapid regrowth, significantly less reproductive tillers than smooth brome
- stockpiles well
- one of first to start growth in spring
- palatability good but not most preferred

Crested Wheat grass
- a “maverick”
- best suited to dryland areas because of deep fibrous roots, drought and vigorous establishment
- high yielding Kirk for hay, Parkway and Fairway for pasture
- early growing and very aggressive
- common use in early spring as an alternative to too early grazing of native pastures

- forms seed head very early so needs to be grazed early and hard to prevent
- less beneficial to soil than native species
- not particularly palatable as matures
- escapes into native and expands in seeded pastures

Meadow Foxtail
- a “maverick” – works best when seeded alone and isolated from other pastures
- best suited to low areas with plenty of moisture, i.e. peat lands
- high yielding
- early growing and very aggressive so that planned grazing revolves around grazing it in the vegetative stage and grazing hard
- forms seed head very early sometimes before the end of May
- seed spreads and it slowly moves all over farm
- not particularly palatable and not at all when headed
- although quality good it stockpiles poorly as animals absolutely will not eat carryover in spring

Creeping Foxtail
- supposedly better than meadow foxtail for palatability
- more upright with higher leaves on stem
- not dormant in the summer and recovers faster from grazing
- very aggressive creeping roots
- high seed producer so once there “always there and spreads through farm”

Pubescent and Intermediate wheat grass
- some say both the same, others say pubescent longer lived, more drought tolerance and deeper strongly creeping roots
- higher leaves on stem than crested so best suited to hay
- palatability good when immature
- ”usually” short lived lasting about 5 years

Reed Canary Grass
- thought to need good moisture but work in U.S. shows does well in dry areas
- very tall with wide leaves
- creeping rooted but not vigorously creeping or establishing
- takes three years to come into its own but then can have high yields
- old (Castor) and yet older “native” (Frontier) varieties had alkaloid problems which lead to reduced intake and therefore animal gains
- new varieties have had the alkaloids bred to low levels and are much more palatable
- germination caution
- deserves looking at as grazing reports are more favourable all the time
- elevates growing point but slightly less than smooth brome or timothy

Tall fescue
- popular in US deep rooted bunch grass with tough coarse roots that dig deep in clay soils
- little is known here but thought short lived although 6 yrs at Grey Wooded Forage Assoc. (GWFA) and doing fine
- does well in US for dormant season grazing and animals prefer in GWFA banked palatability trials fall and spring

- wide range of adaptations
- deserves more looking at as its adaptations and growth habit are very grazing favourable
- drought resistant and grows well on dry soils
- low growing points and forage species are bunch grasses and do not creep
- slow to come in seedling stage and will leave spaces between plants in stand
- when young animals like
- looks coarse and unpalatable but not true in fall grazing GWFA
- watch for "real animal feed problems" with varieties containing endophytes but if a low endophyte variety, or 100% endophyte free clean seed on clean land and in mix no problem

Orchard Grass
- excellent pasture grass for controlled grazing particularly in wetter areas and grey wooded soil
- multi-height growing points so has very fast regrowth after cutting or grazing
- shallow roots so needs good moisture but doesn't like flooded areas, i.e. peat land
- requires good soil fertility to produce high yields
- extremely palatable and many basal leaves
- winterkill risk but more winter hardy than first expected; use "Kay, Arctic, Arctic 2, Nordic, AC Splendor or Glacier Brand"
- animals select for and can graze out of a stand quickly or cause very severe winter kill losses
- stores food reserves in fleshly stem just above ground
- in monocultures do not leave more than about 6" carryover through winter because snow mold may cause winter kill
- in mixed stands stockpiles well over winter
- heads rapidly when starts and animals do not prefer mature

Creeping Red Fescue
- excellent pasture grass, prefers moist conditions but thought more drought hardy than Kentucky blue grass
- high yields under good management
- slow start to growth in spring but grows late into fall
- forms a heavy sod and a dense solar panel
- often fooled by its lower growing habit thinking that it won't yield (clipping trials clip too high; i.e. 3" height and 3000# of material left behind)
- overwinters very well, holding its feed value (tightly rolled, waxy leaves close to the ground) and very little dry matter losses

Kentucky Blue Grass
- similar to fescue, most people call it fescue by mistake
- ecovar that is not native but is actually a serious invader of any pasture
- can withstand heavy overgrazing making it the most common grass in tame pastures in the wetter areas of western Canada
- sod forming and concerns with lack of production in older stands or is this a poor management issue?
- especially likes to grow on moist soils with good fertility, e.g. along water courses
- very palatable when young
- this is the grass that dominates most overgrazed pastures in this area and stressed plans often head out with few leaves

- usually found in association with white clover and dandelions
- can produce high yields and animal production per acre with controlled grazing
- very dense solar panel, i.e. at a 3" height there could be 3000# of material
- boat shaped leaves
- overwinters very well, holding its feed value (finer leaves and insulatively layered close to ground) and has low dry matter losses
- if vigorous or banked stands can be one of earliest to grow in spring and can be a high quality supplement in last year's banked forage

Russian Wild rye

- felt unique among grasses because of long season of growth and high digestibility so cattle like
- low growing points and leaves low to the ground make it a pasture grass with good regrowth if moisture is present
- very slow and harder to establish if blue grasses in area - don't bother trying
- dry part of the prairies
- bunch grass with deep and fibrous roots, can go to 10 feet deep and spread near the soil surface to capture much moisture and leaves bare soil around it
- cures on the stem so dormant season growth good
- heads rapidly once starts
- seed in 6 -10 inch row spaces or broadcast seed spacing at lower seeding rate as wide row spaces of 18 – 24 inches (don't) were proven experimental methodology error and allow huge soil erosion problems

Altai Wild rye

- very slow to establish and should seed set before grazing is recommended
- dry part of prairies - if blue grass in area do not try
- very long season of growth and regrows quickly if moisture is present
- low growing basal leaves
- deep rooted to depths of 10-13 feet bunch grass that slightly creeps
- permanent pasture
- seed in normal row spaces or broadcast seed spacing at a lower seed rate
- cures on the stem and makes excellent and palatable banked forage

Quack Grass

- "King of the Grasses"
- nutritive value highest next to ryegrass US graziers say
- in US really gaining in popularity by dairy farmers
- common invader of cultivated fields "grain farmers weed not a grass farmers weed"
- palatable, high yields especially around old barn yards or bale grazing where fertility is high or under high N
- forms dense sod, grows by rhizomes so will have have high carbon content and bind N
- can be abused/sacrifice pasture

Dandelion

- a calcium sink
- don't be afraid of some dandelions they are a symptom of bare ground and holes in a stand
- they are literally every where so don't worry about killing them, cows love them and they are highly nutritious although dry matter yield is low

- concentrate on improving your grazing management

LOWLAND

Spangle top, Red top, Manna grass, Slough Grass, etc.
- taller growing species
- grow around and in water body, course areas
- quality good if grazed immature but make sure sod not too wet for hoof damage

Sedges
- called “slough grass” by many - but sedges are not a grass
- many different - over 300 types
- fine to coarse basal leafed
- roots many rhizomotous, some fibrous and odd one stoloniferous
- finer upland - coarser wet land
- areas where standing water for prolonged periods or water logged soil
- raspy to slide between fingers - 3 sided stem - hard to I.D. type sedge especially if not headed
- palatability better after a frost
- vitamin A sink
- quality good - very good when young but watch for hoof damage to wet soil
- when only half of leaf mass removed regrows without tapping root reserves

Rushes
- wetter areas
- less palatable
- some can be good feed value especially when immature, i.e. Baltic rush

TREED AREAS
- some common Hairy Wild Rye, American Vetch, Pea Vine, Marsh Reed Grass
- latter 3 very palatable and vetch and pea vine are native legumes
- hairy wild rye not so palatable
- lack of sugars from sunlight harvested energy one reason for animal lack of preference

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Pasture Nutrient Cycling

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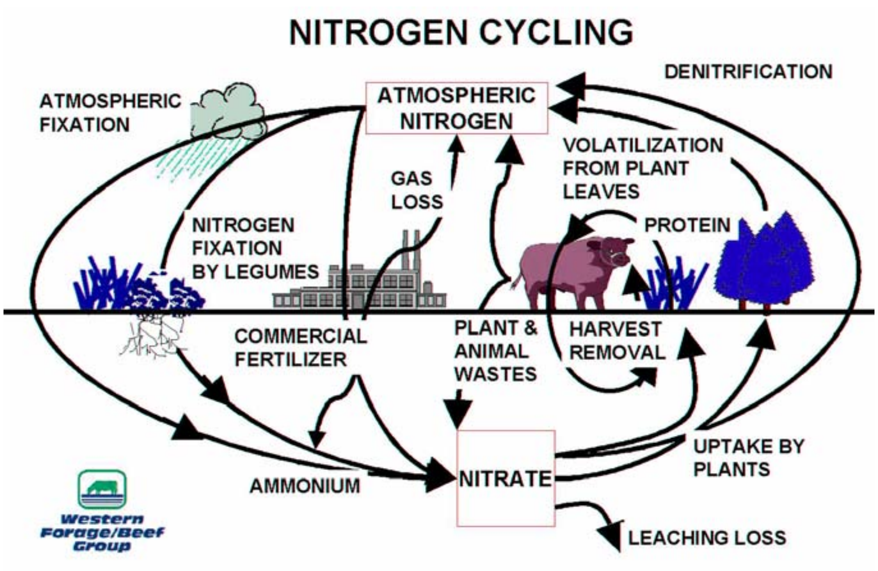
The cycling of nutrients in a pasture situation is the movement of nutrients from the atmosphere to the soil to the plant to the animal and back to the soil and atmosphere where the cycle begins again.

All the nutrients used by growing plants are cycled. The nutrients which the animal does not use are excreted. These nutrients may be cycled in the same form as they were ingested or they may be changed to a different form through the digestion process of the animal.

The nutrient which is the most limiting in pasture plant growth generally is nitrogen. This section will concentrate on the nitrogen cycle and the movement of nitrogen through this cycle.

Nitrogen is available in the soil in various forms and is released into the atmosphere in various forms. To simplify the process, nitrogen moving within this cycle will be called nitrogen rather than urea, ammonia, nitrous oxide, nitrous ammonia, nitrates, nitrites, etc.

The nitrogen cycle is a very complex cycle when looked at in its entirety, as shown in figure 1, but when broken down into events it can be very easy to understand.



Nitrogen makes up 78% of the earth's gases in the atmosphere. Ideally what we want to do is take this atmospheric nitrogen and put it into the soil in a form the plants can use. This happens in three of ways: through atmospheric fixation, through fixation by legumes and by using commercial fertilizers. Nitrogen is also lost from the soil and returned to the atmosphere.

Atmospheric Fixation

Atmospheric fixation is the movement of the nitrogen gases from the air into the soil. This form of nitrogen is brought into the soil primarily from rainfall. Rain picks up nitrogen in various forms. The majority of the nitrogen picked up can come from industrial gases released into the atmosphere in areas of heavy industrialization. Nitrogen levels released into the soil in this way have been measured from 1 - 50 pounds/acre. In areas of low industrialization and low rainfall, the levels of nitrogen released into the soil in this way would be expected to be low.

Soils also have the capacity to absorb ammonia gas from the atmosphere as well. The rate of absorption is dependent on ammonia levels in the atmosphere and the atmospheric temperature. The amount expected to be absorbed into the soils on the prairies is low.

Denitrification

Denitrification is the loss of soil nitrogen into the atmosphere. There are several things which contribute to the amount of denitrification which takes place:

1. high concentrations of nitrogen (nitrates or nitrites) in the soil
2. a readily available supply of organic matter
3. low availability of oxygen (high soil moisture content)
4. soil temperature
5. soil pH

The denitrification process generally occurs when the soil is waterlogged and there is low levels of oxygen present. Aerobic bacteria in the soil use the nitrogen (nitrates or nitrites) in the soil and break down the organic matter in the soil. During this process nitrogen is given off as nitrous oxide N_2O and elemental nitrogen N_2 and released back into the atmosphere. Waterlogged soils present an ideal environment for this to happen. It is more prevalent early in the spring or in the fall when plant growth is slowest.

As soil temperatures rise in the 2 - 250C range, denitrification increases rapidly. Denitrification will increase as soil temperatures rise up to 600C (not that we have to worry about that in Alberta). Spring conditions make for an ideal scenario for denitrification as soils warm in the spring, grass growth is slow and soils can be waterlogged.

Soil pH is important in the denitrification process as the pH range for the bacteria to be active is 3.6 - 8.6. As the soil pH falls below 4.8 or rises above 8.0 the bacterial activity slows. Denitrification losses are generally very low below a pH of 5.0.

Not only is the loss of nitrogen from the pasture a concern when denitrification occurs, but the form of nitrogen lost is mainly N_2O (nitrous oxide) which is a “greenhouse gas” that affects the ozone layer.

Nitrogen Fixation by Legumes

The atmosphere is made up of 78% elemental nitrogen gas. Nitrogen in this form is not available to plants as they are not capable of utilizing nitrogen in this form. When we look at the soil structure we can see that atmospheric gases are trapped in the soil between the soil particles. This nitrogen is converted by rhizobium bacteria which grow on the roots of legumes.

Legumes inoculated with the appropriate rhizobium bacteria are capable of "fixing" nitrogen and meeting most of the nitrogen needs of the plant. As the legume seed germinates and the plant begins to grow, the rhizobia invade the root hairs and form nodules. These nodules are "home" to the bacteria and they live in a symbiotic partnership with the legume. The bacteria receive energy in the form of carbohydrates from the host legume and in return, convert the atmospheric nitrogen in the soil into a nitrogen form which is useable by the plant. The fixation process follows the plant growth cycle as the amount of nitrogen fixed coincides with the demand by the plant through its growth cycle. The amount of nitrogen "fixed" by the legume is varied and is generally related to the dry matter production of the plant (Table 1).

Legumes require specific strains of rhizobia for each legume species. Alfalfa rhizobia will not be effective on clovers and clover rhizobia is not effective on alfalfa. There are many ways to inoculate the seed prior to seeding to ensure that there is sufficient numbers of viable rhizobia to invade the root hairs and form nodules. Industry has developed many different methods of applying inoculant to replace the standard method of applying a sticker and coating the seed with a peat based powder inoculant. All these methods are effective in supplying the seedling with sufficient numbers of rhizobia.

Table 1. Legume Nitrogen Fixation*

Alfalfa -	70 - 198 lbs/ac
cicer milkvetch	140 lbs/ac
Red Clover -	60 - 115 lbs/ac
White Clover -	115 - 180 lbs/ac
Bird'sfoot Trefoil -	44 - 100 lbs/ac
*source: Heichel (1987); Date & Brockwell (1978) - reprinted from Forage Legumes - University of Minnesota bulletin 597-1993	

We can do a rough calculation of the amount of nitrogen fixed by an alfalfa plant:

Assume: 2.5 tons/acre of alfalfa dry matter @ 18% crude protein
1 pound of nitrogen produces 6.25 pounds of crude protein
0.18 CP x 5000 lbs alfalfa ÷ 6.25 lbs of nitrogen = 144 lbs of nitrogen
if the alfalfa fixes 80% of it's nitrogen, then this field fixed 115.2 lbs of N/ac

There are many things which influence the amount of nitrogen which the legume is capable of fixing:

- soil pH - neutral soils having a pH of 6.5 - 7.5 provide the best conditions for nitrogen fixation. Alfalfa will grow and fix nitrogen in soils down to a pH of 5.8 but dry matter production is reduced as less nitrogen is fixed. Below a pH of 5.8 alfalfa production is substantially reduced. Alsike clover and bird'sfoot trefoil are more tolerant of lower pH's and tend not to lose production until the pH drops to 5.5. Soils too low in pH may be limed to reduce the acidity in the soil.

- soil temperature - legume rhizobia become more active as soils warm up in the spring and summer. Soil temperatures of 25^{0}C are the most favorable for nitrogen fixation by the rhizobia.

Table 2. Nitrogen Fixation in Inoculate Legumes Grown in Southern Alberta Under Irrigation

Legume	Plant-N Derived From the Atmosphere* (%)	N Fixed Symbiotically (lb/ac)
Alfalfa	80	267
Sweetclover	90	223
Fababean	90	267
Field Pea	80	178
Lentil	80	134
Soybean	50	134
Chickpea	70	108
Dry Bean	50	62

*determined by N_{15} isotope techniques
source: adapted from R.J. Rennie, formerly at Agriculture Canada, Lethbridge Research Centre

- soil fertility - Most plants will fix between 50% and 80% of their total nitrogen requirements (Table 2). Perennial legumes generally fix 75% - 90% of their nitrogen requirements. The availability of soil nitrogen will affect the amount of nitrogen fixed. Legumes will generally utilize the available soil nitrogen before the rhizobia begin to utilize the atmospheric nitrogen. The balance of the nitrogen requirements needed by the plants will be supplied by the breakdown of the stem and leaf material from the previous years production, the breakdown of the roots and nodules which have been sloughed off from the previous years production, the breakdown of other organic matter in the soil and from the cycling of nutrients by livestock.

  Adequate supplies of other nutrients will affect the nitrogen fixing capabilities of the rhizobia. Phosphorous, potassium and sulfur all affect the rate at which nitrogen is fixed. Micro-nutrients such as molybdomen also play a part in the fixation process and must be available in adequate supplies.

- soil moisture - The amount of nitrogen fixed under drought conditions is reduced, which is not a problem since the plant growth is reduced under these conditions as well. The plant demand for nitrogen is “fully synchronized” with the rate the rhizobia is capable of fixing the nitrogen. Excess soil moisture such as flooding greatly reduces nitrogen fixation because the amount of atmospheric nitrogen and oxygen is reduced.

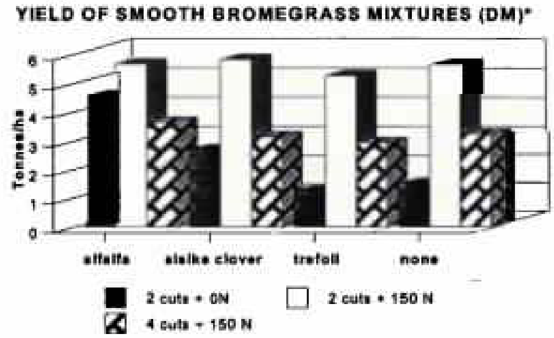
Nitrogen Transfer from Legumes to Grasses in the Nitrogen Cycle

There are three main pathways for the transfer of nitrogen from the legume plant to the grasses which may be in a pasture mixture:

1. Release of nitrogen into the soil and atmosphere

The legume releases nitrogen gases which may be taken in by the grasses or lost into the atmosphere. Nitrogen is "leaked" from the nodules and are taken up by the grasses in the mixture. These amounts are generally very low and do not play a significant part in the transfer of nitrogen to the grasses.

Figure 2



*N.A.Fairey. Effects of nitrogen fertilizer, cutting frequency and companion legume on herbage production and quality of grasses. Can.J.Pl.Sc. 71:717-725

2. Decomposition of plant residue in or on the soil

Stem and leaf decomposition release a large portion of the nitrogen from the legume plant to the neighboring grass plants. Cattle grazing legumes tend to leave the stems which may be stripped of leaves or trampled and broken. Legumes have high leaf losses from the bottom leaves which are not accessible to the cattle or have matured and dropped off. Ungrazed fall growth is left by the livestock the following year and decomposes. Nitrogen leached from the plant material is readily available but nitrogen from the decomposition may take several years to be available to the grasses.

In the fall most legumes "slough" root hairs and attached nodules. These are broken down the following year and release nitrogen into the cycle. Legume species vary in their sloughing of the nodules. If white clover is shaded or defoliated they tend to drop their nodules. New nodules are formed as the white clover sends out new stolons. Alfalfa nodules have indeterminate growth and stay attached to the root hairs through harvest, whereas bird'sfoot trefoil nodules are more determinate and readily die off after the legume is defoliated. The amount of nitrogen released by the nodules of the bird'sfoot trefoil may be higher than the alfalfa but the alfalfa tends to release more nitrogen through the decomposing roots.

N.A. Fairey at Beaverlodge showed that grasses benefit from the presence of legumes when grown in mixtures (Figure 2). When smooth brome grass was grown in mixtures with alfalfa, alsike clover and bird'sfoot trefoil and no fertilizer was added, the yields of the bromegrass in the mixtures was increased when grown with alfalfa or alsike clover. There was little response to the trefoil grown in the mixture and the most response when grown with alfalfa. When 150 kg/ha of nitrogen was added and there was only two cuts taken, there was no response to having the legume in the mixture. On a four cut scenario the bromegrass appeared to have some response to the alfalfa. In all three treatments the bird'sfoot trefoil mixture tended to produce less bromegrass than the check - bromegrass seeded alone.

3. Consumption and excretion of plant material by livestock

The amount of nitrogen recycled through the livestock to the grass in the pastures is variable. When the cattle graze a considerable amount of the grass is returned to the pasture as undigested fibre which must further breakdown before the nitrogen is available to the grass. The decomposition of the dung can have a significant increase in the nitrogen cycled back into the pasture, although there is a "lag" time between the animal depositing the dung and the nitrogen being available to the grass. Losses of nitrogen through the urine patches can exceed 50% as the ammonia in the urine is highly volatile and the nitrogen is released back into the atmosphere.

The transfer of nitrogen from legumes to grasses through livestock excrement can be substantial if the excrement is distributed evenly over the pasture. Livestock tend not to do this on a voluntary basis, but good grazing management practices will help in the distribution.

Commercial Fertilization Added to the Nitrogen Cycle

The nitrogen cycle is a very "leaky" system and in a grass pasture it is not possible to maintain grass production without adding some source of nitrogen. Cycling nitrogen through the livestock in the form of urine and manure will return nitrogen to the soil but over time will reduce yields because of the inefficiency of the process. Animals fed supplemental feeds while on pasture litter breakdown and spreading stored manure from feedlots, winter feeding grounds or other livestock facilities will all add nutrients to the system. Nitrogen urine losses are high in feedlot manures as the majority of the nitrogen has volatilized or leached into the feeding area. It is estimated that 50% of the nitrogen in slurry manure volatilizes once it is spread on the pasture.

The easiest method of ensuring that there is sufficient nitrogen in the soil for grass pasture production is to fertilize the pasture with commercial fertilizers. Even this system is not without its losses (Figure 3). Mahli et al found that there was an average of 7% (Lacombe) & 18% (Eckville) yield increase in forage yield using ammonium nitrate over urea when both were applied at the 80 kg/ha rate. These yield losses can be attributed to the loss through volatilization when using the urea fertilizer. Ammonium nitrate is more stable and the expected losses would be much less.

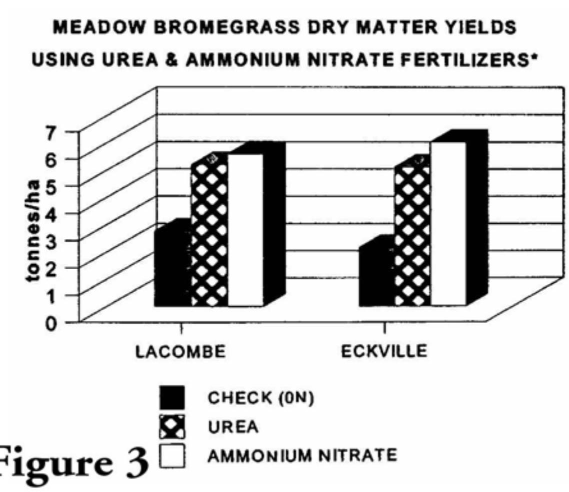


Figure 3

*** Average of Three Years**
S.S. Malhi et al. Fertilizer management for forages in central Alberta. AAFC technical bulletin 1993.

When fertilizing a legume/grass pasture, the addition of high rates of nitrogen fertilizer will reduce the nitrogen fixation of the legumes. The legumes will utilize the available nitrogen which is in the soil. The grasses will become more competitive and reduce the amount of legume in the stand. This is more likely to occur if the grasses in the mixture have a creeping attribute. A general rule is to treat a stand of 80% or more legume as a pure legume stand and a stand of 80% or more of grass as a pure stand of grass, and fertilize accordingly. Fertilizer should be added at the rate of 10 pounds of nitrogen/acre for every 10% of grass in the stand up to a 50/50 mix of grass and legume. When the ratio of legumes is greater than 50%, there should be no need to fertilize with nitrogen as the legume is capable of supplying sufficient nitrogen for the grass. Phosphorous, potassium and sulphur applied annually in sufficient quantities will help maintain the legume in the mixture. Mahli at Lacombe AAFC found that a 50% legume stand could be reduced to 25% in 3 - 4 years by adding only 50 - 100 lbs of N/ac. applied annually.

Nitrogen Uptake by Plants

Nitrogen is needed to promote plant growth. Low grass pasture yields in Alberta can generally be attributed to low nitrogen levels. Nitrogen is needed by the plant for growth and most plants normally contain 1 - 5% nitrogen. The nitrogen in the plant is used to make proteins as well it is an important part of the chlorophyll which absorbs light energy needed for photosynthesis. Plants deficient in nitrogen will appear stunted (some call it root bound) and the leaves will be pale green. The pale green to yellow leaves will first show in the lower leaves and older tillers.

High levels of nitrogen fertilizers will increase plant protein (Table 3). As nitrogen levels increase plant protein and plant yield increase. Yields and % protein can be influenced by good pasture management which will influence manure and urine distribution in the pasture.

The nitrogen cycle is not an efficient system and as plants grow nitrogen is volatilized from the plant leaves and released back into the atmosphere in a gaseous form.

Table 3. Dry matter and Protein Yields of Bromegrass Hay in Central Alberta (16 station yrs)

	Levels of nitrogen applied annually (kg of N/ha)					
	0	50	100	150	200	300
Dry matter yield(t/ha)	3.86	5.98	7.54	8.49	8.7	8.73
% protein content	11.2	11.6	13	14.4	15.2	15.8

S.S.MALHI et al. Fertilizer management for forage crops in central Alberta. AAFC technical bulletin 1993-3E

Nitrogen Harvest Removal, Usage and Excretions

Cattle on pasture harvest nitrogen as plant proteins and convert them to animal proteins as meat and milk. Calves and yearlings utilize 5 - 15% of the nitrogen whereas cows with calves or dairy cows will utilize 20 - 25%.

Table 4. Nutrients Harvested as Hay (per ton)

	alfalfa	grass
Nitrogen	58 lb	35 lb
Phosphorous	14 lb	10 lb
Potassium	60 lb	43 lb
Sulphur	6 lb	4 lb

Table 4 shows the nutrients removed by harvesting as hay. In a pasture situation the cattle will return the unused nitrogen and other nutrients to the pasture as feces and urine. If pasture is 12 - 15% protein then 50% of the unused nitrogen is excreted in the urine and 50% is excreted in the feces. As protein levels increase, the increased nitrogen is excreted in the urine (table 5). Phosphorous is 10% utilized and mainly excreted in the feces whereas 10% of the potassium is utilized and mainly excreted in the urine. Sulphur is mainly excreted in the urine as well.

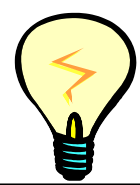
Manure and urine can cover $\geq$20% of the pasture area under good pasture management. Cattle will urinate 8 - 12 times/day depending on the temperature and access to water. Generally cattle defecate 11 - 16 times/day. A cow will urinate 1.6 - 2.2 litres of urine each time she urinates and the urine patch will cover 1.7 - 5.3 ft^2. The size of the urine patch will depend on the soil type, plant height and litter, which will affect the rate that it is absorbed. Urine will contain 0.42 - 2.16% nitrogen depending on the amount of water the animal has drank. Each urine patch may be like getting 100 inches of rain in one hour and adding up to 1100 lb of nitrogen/ac. The nitrogen in the urine is made of different nitrogen sources but the majority of it is made up of ammonia. Ammonia is very volatile and the amount which is volatilized can be 50% or greater.

Table 5. Fate of Consumed Nitrogen (lb/ac)[1]

GRAZING LEVEL	CONSUMED	EXCRETED			RETAINED
		urine & feces	urine	feces	
Heavy	165	145	104	41	19.8
Medium	144	127	86	41	17.2
Light	120	106	66	40	14.4

[1] V.S.Baron. Western Forage/Beef Group, Lacombe Research Centre. unpublished data

These losses can be reduced by maintaining a good litter cover and several inches of plant growth. The weather conditions greatly affect the evaporation of the urine. Hot dry windy conditions speed up the volatilization rate of the ammonia. Cool rainy weather reduces the amount of losses.



Dung piles and urine patches can affect plant growth FIVE times the size of the deposit area.

Cattle feces are 3.3 - 5.9 lb/defecation and the area of the dung patch is generally 0.5 - 1.0 ft^2, depending on the quality of the pasture. High quality pasture can result in very loose feces and the animal will spread it over a larger area. The dung contains 2.0 - 3.6% nitrogen and would be the equivalent of adding up to 930 lb of nitrogen/acre. The dung patches tend to decompose very slowly. A lot of the material in the dung patch is comprised of fibre which must be broken down over time. Losses are variable and depends on moisture content of the feces, size of the dung patch, amount of trampling taking place during the grazing period, weather conditions growth rate of the plants and the availability of birds, insects, worms etc.

Dung piles and urine patches can affect plant growth 5 times the size of the deposit area. This occurs through the lateral spread of the roots of the plants and the lateral wash of the nitrogen by rainfall.

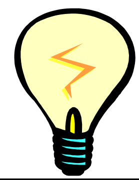
Nitrogen Leaching Losses

Leaching losses of nitrogen is the movement of the nitrogen down in the soil profile below the plants rooting depth. This nitrogen can end up in water aquifers which may affect drinking water. Nitrogen moves through the soil profile more readily than phosphorous or potassium which tends to bind to the clay particles in the soil much tighter. The rate and amount of leaching is dependent on the level of nitrogen in the soil, soil properties, soil moisture, rainfall and the evapotranspiration rate.

If soil nitrogen levels are higher than the plants are capable of utilizing, the excess nitrogen will move downward in the soil profile. These losses tend to be highest during the spring or fall when the plants are not actively growing and there may be periods of high rainfall. Sandy soils are more porous and the nitrogen can be carried downward much easier than in clay soils. If the rainfall exceeds the evapotranspiration rate, the moisture in the soil will move downward, taking nitrogen with it.

Pasture Management for Better Manure and Urine Distribution

The management of the pasture is directly related to the distribution of the urine and manure across the pasture. While it is impossible to manage the cow herd to even distribute the manure across the pasture, there are management tools which will provide better coverage of the pasture. Anything done to increase the pasture utilization will increase the manure and urine distribution. Just as cattle do not graze the pasture evenly, they do not distribute nutrients evenly.



Dung and urine distribution is affected by: stocking rates, water source, shade, topography and preferred grazing areas.

Dung and urine distribution is affected by: stocking rates, water source, shade, topography, and preferred grazing areas.

As much as 65% of the manure may be deposited within 30 metres of shade or water sources on a continuously grazed pasture. Jim Gerrish did some trials at Missouri where he used three pasture scenarios 3, 12 and 24 paddocks and counted dung piles within the paddocks.

Grazing Management Affects Manure Distribution by Beef Cattle[1]

. 3 pastures - ~32 acres in each pasture
. 3, 12 and 24 paddocks
. stocking rates: 3-, 12- & 24 paddocks averaged 2.7, 2.2 and 1.7 acres/AU respectively
. grazing period: 3 paddocks - 10-20 days, 12 paddocks - 2-6 days & 24 paddocks 1-2 days
. grazed April - November

[1] P.R. Peterson, McGill University & J.R. Gerrish, University of Missouri - Forage Systems Center

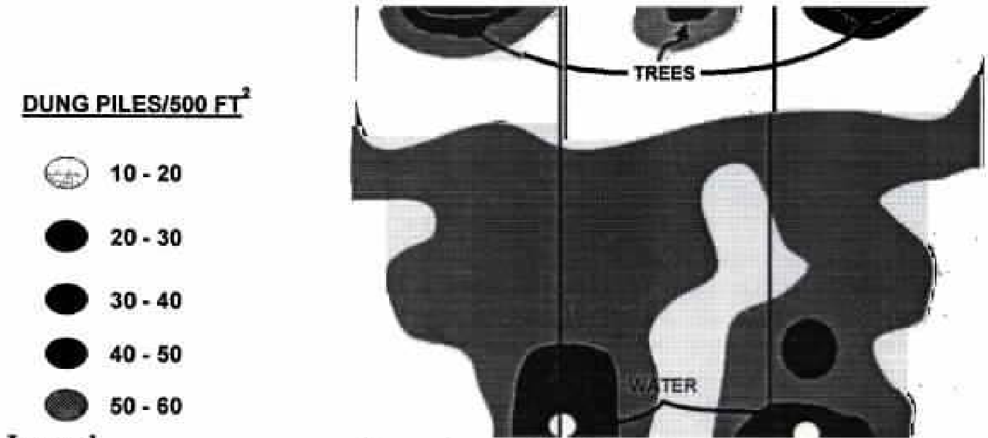


Figure 4. **3 Paddock System**

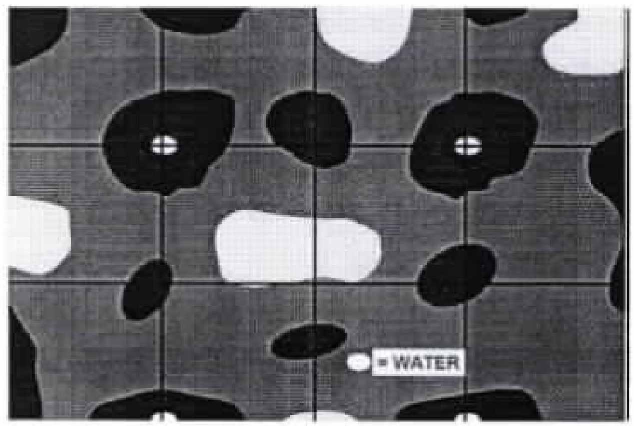


Figure 5. **12 Paddock System**

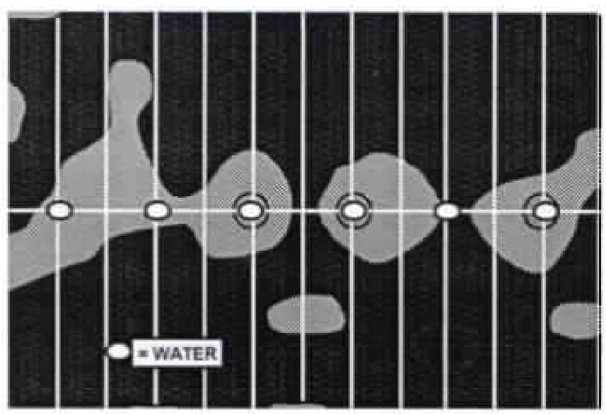


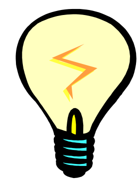
Figure 6. **24 Paddock System**

Figure 4 shows the three paddocks system with trees at one end of the paddocks and waterers at the other end of the paddock. There is heavy concentration of dung piles around the trees and the waterers. Approximately half of each of the paddocks received between 10 - 20 dung piles/500 ft^2 and the other half of the paddock received 20-30 dung piles/500 ft^2. Around the trees and the waterers the concentrations were 30 - 50 dung piles/500 ft^2 and increased closer to the trees and waterers.

In Figure 5 the pasture was divided into 12 smaller paddocks with no trees available for the cows to loiter under. There were fewer areas which received only 10 - 20 dung piles/500 ft^2. The majority of the paddocks were covered by 20 - 30 dung piles/500 ft^2 and there are areas throughout the paddocks where there are 30 - 40 dung piles/500 ft^2. There are still high concentrations of dung piles around the waterers.

When the pasture is divided up into 12 paddocks as in paddock 3 in Figure 6 and the cattle are moved every 1-3 days the manure distribution is increased. The majority of the smaller paddocks have 40 - 50 dung piles/500 ft^2, with some having as much as 40 - 60 dung piles/500 ft^2. There is still heavy concentration around the waterers but the distribution in relation to a 3 paddock system is much better.

For good dung and urine distribution, the stocking rates should be high enough or paddocks small enough that the cattle must be moved every 1 - 3 days. The elimination of the trees in the paddocks should be considered. There is conflicting research which shows that some shade is needed for the cattle. Unfortunately all of this research has been done in the southern States and Australia. Shade in Alberta may not be necessary, especially if the water source is close. If shade is important, consider portable winter windbreaks which can be pulled around in the summer for shade. They can also be placed in areas to promote better distribution of manure.



For good dung and urine distribution, the stocking rates should be high enough or paddocks small enough that the cattle must be moved every 1 to 3 days.

Figures 7 & 8 show two paddocks - one that has level topography and one that has a draw through the middle of the pasture which frequently held water. The paddock with level topography had fairly even distribution of manure with the exception of the influence of the waterer. The paddock with the draw through the middle had low distribution in the bottom of the draw and higher distribution in the higher areas on both sides of the draw where the cattle tended to loiter because it was drier and they had exposure to the cool winds. This may be reversed in colder weather as cattle may spend more time in the draw out of the cold winds. Topography does play a part in the distribution of the manure and urine.

The cattle should have access to water within 200 - 250 metres of the pasture. The farther that the animals have to walk the less manure and urine will be deposited on the pasture. When cattle drink or get up from laying down the tend to either urinate or defecate shortly thereafter. If they are doing this in a creek or under a tree, it has little or no effect on the pasture. Jim Gerrish in Missouri found that good water management reduced the manure concentrations around the water sources to less than 15%, and also found that cattle increased their water intake by 15%, resulting in lower nitrogen levels in the urine. Urine with lower nitrogen levels tend to have lower losses and the cattle will tend to urinate more frequently which will spread it around the pasture more evenly.

If the cattle must walk a great distance to water, build an alley way which is narrow and does not have areas where the cattle can loiter. At the watering area, have only water. Do not place mineral/salt blocks or oilers at the watering area, it only promotes loitering by the cattle. Ideally, the cattle should go to the water, drink and return to the pasture immediately to distribute as much manure and urine as possible on the pasture.

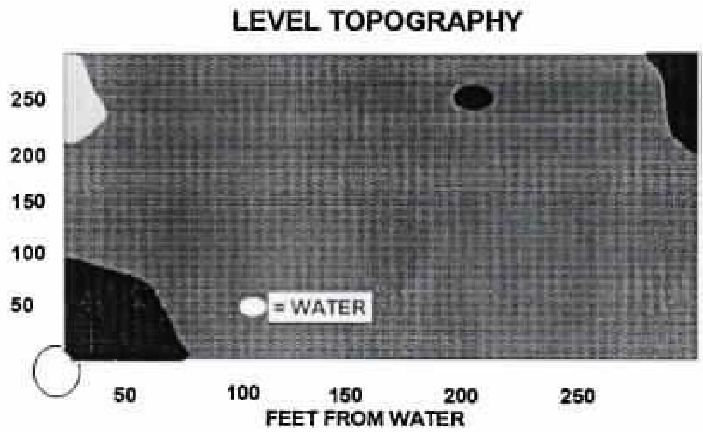
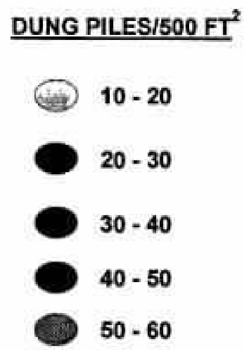


Figure 7 **Level Paddock**



Legend

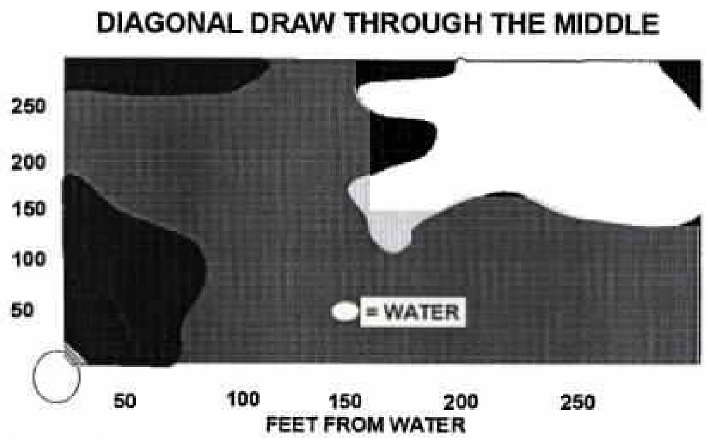


Figure 8. **Paddock With A Draw**

Summary

Nutrients can be cycled on pasture. There are many factors which play a part in how and how well this cycling takes place. Nutrient cycling is not a closed system and there are many areas where leaks from the system take place. The key to good pasture management is to recognize these areas and eliminate or reduce the amount that is leaked from the system.

Soil nutrients are like the gas tank of a car. The car will run as good on a ¼ tank of gas as it will on a full tank of gas, but it will not run as long. It is inconceivable to imagine that the level of soil nutrients be at the maximum levels, but they should be somewhere between ½ and ¾ to ensure good pasture production. Even with good pasture management and good manure distribution; like the gas tank on the car, it will need to be "topped up" sometime down the road.

As a grazier, it is your job to understand the nutrient requirements of the plants and the affect that grazing has on the soil nutrient levels. It is also your job to understand animal behavior and manage them to reduce nutrient losses from the pasture.

Common Forms of Nitrogen

Elemental nitrogen N_2
Ammonia NH_4^+
Nitrite NO_2^-
Nitrate NO_3^-
Nitrous oxide N_2O
Nitric oxide NO
Urea $CO(NH_2)_2$
Anhydrous ammonia NH_3
Ammonium nitrate NH_4NO_3
Ammonium nitrate-sulfate $(NH_4)_2SO_4$
Ammonium phosphate $NH_4H_2PO_4$
Ammonium chloride NH_4Cl

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The Role of Fertilizers in Forage Management

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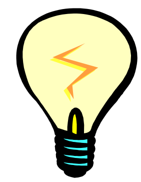
Introduction

Many farmers accept a gradual reduction in the percent legume in mixed forage or encroachment by undesirable species or weeds as a normal symptom of an aging stand. In the initial stages of stand degradation, legume growth becomes variable and eventually unproductive grasses dominate the stand. Depending on soil and climatic conditions, up to 100 pounds per acre of nitrogen may be required to maintain forage production on stands dominated by grasses. With mixed stands or stands where the objective is to increase the legume component other alternatives include aeration, sod-seeding and workdown of the existing stand and establishment of a new stand. Aeration and sod-seeding have had variable results. Working down the existing forage and establishing another stand is costly. In addition to the costs associated with re-establishment, the continuous supply of forage is disrupted which may necessitate purchasing a replacement supply of forage or temporarily altering livestock inventory on the farm. The purpose this paper is to provide an overview of forage management with a special emphasis of the role of fertilizers in forage management.



Depending on soil and climatic conditions, up to 100 lbs. per acre of nitrogen may be required to maintain forage production on stands dominated by grasses.

Objective of Forage Managers

The objective of any forage manager is the production of a continuous supply of high quality forage. This requires the manager to achieve a balance between the soil resource, forage species and management of the stand.

1. Soil Resource

Soil acidity or low soil pH influences the type of forage that can be successfully grown by reducing the rate of nitrogen fixation or the availability of other plant nutrients such as phosphorus and increasing the solubility of aluminum and manganese to the point where they become toxic. Low soil pH limits growth of alfalfa on approximately 4.8M acres of land in Alberta and the peace block of British Columbia. Agricultural lime or wood ash from forestry facilities can be used to increase soil pH (reduce soil acidity).

Areas characterized by knolls and depressions often result in variable forage growth. Knolls usually are very dry due to runoff during periods of intense rain, snow removal during winter storms and increased loss of water from the crop during the growing season. Depressions often are flooded for varying lengths of time making them unsuitable for most tame species. Knolls also tend to be lower in soil organic matter and plant available phosphorus.

Soils dominated by sand have excellent water absorption however their water holding capacity is relatively low compared to soils with more clay. Sandy soils are well adapted for alfalfa however growth of shallow rooted legumes such as the clovers often is reduced in these soils because of drought. Nitrogen fixation by legumes growing in heavy clay soils is often reduced because of poor soil aeration.

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2. Forage species
Individual forages have special adaptation to preferred soil types and use. Alsike and red clover are more tolerant of soil acidity than is alfalfa and the forage grasses are more tolerant than the legumes with timothy and creeping red fescue being the most tolerant. Meadow and smooth brome are more adapted to the drier areas while timothy and orchard grass are better adapted to higher precipitation areas. Bunch grasses such as timothy and meadow brome are more adapted to mixed stands than are strong sod-forming species such as smooth brome and creeping red fescue. Species with a predominance of basal leaves such as meadow brome and creeping red fescue are more adapted for grazing than for hay.

3. Stand Management
Timing of grazing or haying may have a significant effect on vigour and winter hardiness of legumes and in particular alfalfa. Harvesting or grazing in the last half of August or early September when plants would normally be storing carbohydrates in the root system may result in winterkill or reduced vigour in the stand the following spring. Soil testing assists in determining soil characteristics, which can be useful when selecting forage species or developing a fertilizer program.

Nutrient Requirements of Forage Crops
Sixteen nutrients are considered essential for plant growth. Carbon, hydrogen, oxygen and in the case of legumes, nitrogen are absorbed from the air and the remaining nutrients are mainly absorbed from the soil. The Canadian Fertilizer Institute reported nutrient removal by a 5 ton/ac crop of alfalfa averaged 290, 69, 300 and 30 lb/ac of N, P_2O_5, K_2O and S respectively. In 3 tons/ac of grass, 102, 30, 130 and 13 lb/ac of N, P_2O_5, K_2O and S are removed respectively. Nitrogen fixation will supply most of the nitrogen required by legumes provided the soil and other growing conditions are suitable for optimal plant growth. Legumes are dependent upon the soil for P, K, S and the remaining plant nutrients. The forage grasses absorb all nutrients from the soil.

Hay Land
The nitrogen (N) response by pure grass stands or stands dominated by grass species has been researched and most forage managers recognize the importance of N fertilization if optimal production is to be achieved. The response to N by pure legume stands or stands dominated by legumes is variable. Generally it is believed the N fixation process provides adequate N for crop growth. Research near Calmar has shown a small response to N in the yield of the first cut (Table 1). There was no increase in yield of the second cut. Research at the Agriculture and Agri-Food Canada Research Station at Beaverlodge has shown N fixation does not proceed at temperatures below 10°C. Although the response to N may not be economic, an application of 20 -30 lb/ac may be considered to stimulate early spring growth for early grazing or in years when cool and wet soil conditions limit growth in early spring.

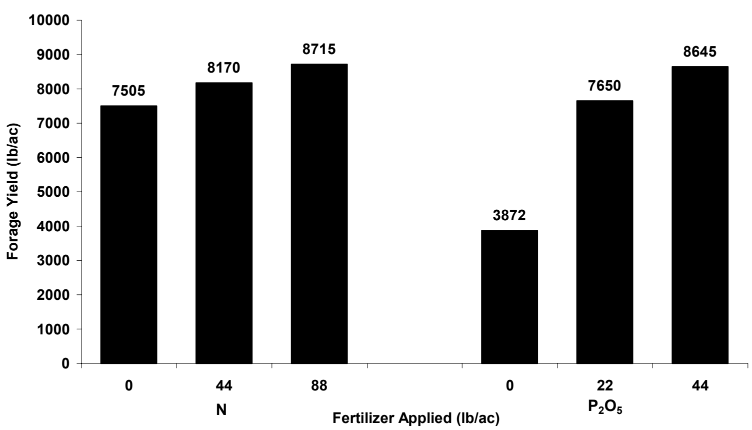
Table 1. Effect of Nitrogen on Yield of Mixed Forage

(Calmar 1995 - 2000)

N Rate	Cut 1	Cut 2	Total
0	3929	2555	5720
20	4361	2527	6080
40	4683	2518	6388
60	4851	2665	6704
80	5058	2690	6889

The response by grasses and legumes to P is variable. To assess the nutrient requirements of mixed forages, three experiments were established near Mayerthorpe on an existing stand that was in the early stages of deterioration. Experiment 1 was a nutrient screening trial to determine which plant nutrient(s) were limiting forage production. Experiments 2 and 3 were N and P rate trials. Results presented below are from the P rate experiment however interpretations from the other experiments are also contained in this discussion. Fertilizer was broadcast in early May in 1997 through 2000. A blanket application of 88, 77 and 26 lb/ac of N, K_2O and S respectively was also applied. In one of the companion experiments, N, K and S were found to be present in adequate amounts. The effect of N and P fertilizer on yield is shown in Figure 1. In this trial, there was a small increase in yield from the application of N however the increase in yield is not significant. P significantly increased yield. The greatest increase in yield was obtained from the first increment of P and there was a small increase in yield to the second increment, however the value of increased production is not likely to be economically viable. Fertilizer has significantly improved the vigour of the stand. Yield in 1999 was significantly higher than those of the previous years, despite 1999 being the driest year since initiation of the trial. These results suggest a properly fertilized crop is more resilient and can make more efficient use of moisture during periods of drought. It can also be speculated that a stand with improved vigour would also be more resistant to disease and winterkill.

Figure 1. Effect of Nitrogen and Phosphate on Yield of Mixed Forage (Mayerthorpe 1997 - 2000)

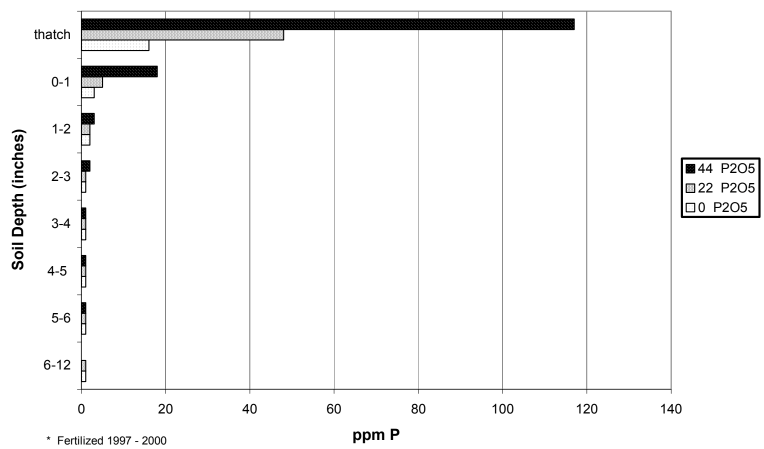


The value of the N, K and S applied in the P rate trial (Figure 1) was $42.78 per acre at current fertilizer prices (Nov. 2000) however, results from experiment 1 showed these nutrients were not limiting and therefore would not be applied by a farmer. These results show there is a significant response to P fertilizer. The value of the 22 and 44 lb/ac increments of P_2O_5 is $6.20 and 12.40 respectively and the cost of broadcasting is approximately $4 per acre. With an increase in yield from 3872 lb/ac at 0 P_2O_5 to 7650 lb/ac at 25 P_2O_5, the economic value of P fertilization on this soil type is obvious.

Soil samples were obtained from the P rate experiment to determine the P fertility status of this soil. Since P is relatively immobile in soil, the sampling procedure involved sampling the soil to 12 inches however the thatch was removed and analyzed as a separate sample. The soil was sampled in 1 inch increments to 6 inches and a 6-12 sample was also obtained and analyzed for plant available P. These results are presented in Figure 2. The results show the majority of fertilizer P remains in the thatch layer with a small amount moving into the 0 - 1 inch depth. The effect of rate of P is most pronounced in the thatch and to some extent in the 0-1 inch depth however there is little effect below the 0-1 inch depth. Caution must be exercised when this data is interpreted. The P distribution through the soil profile (Figure 2) is expressed in ppm (parts per million) which is an expression of concentration. Because thatch is relatively light in comparison to mineral soil, a direct comparison of the concentrations and extrapolation to available P can not be made. However, one may assume the higher concentration of P in the thatch may in part be responsible for the increased yield shown in Figure 1.

Results presented in Figure 2 suggest traditional soil sampling procedures involving sampling in 0-6, 6-12 and 12-24 inch increments may not provide an accurate assessment of the availability of plant nutrients and in particular P. In forage crops with a history of P fertilization or the application of manure, a 0-6 inch sampling depth results in mixing of P rich soil (thatch and 0-1 inch soil) with relatively P deficient soil from below. This mixing may lead to an incorrect assessment of the P status of the soil. The increase in yield from P presented in Figure 1 clearly shows the P distribution pattern presented in Figure 2 is effective in supplying adequate P for forages at this location.

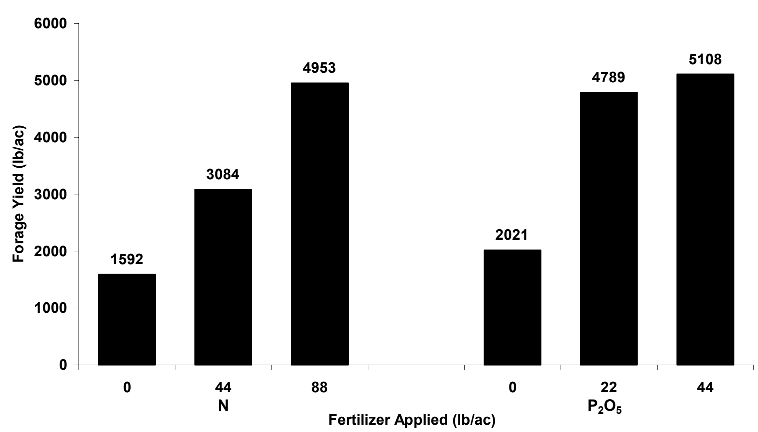
Figure 2. Phosphorus Distribution in Fertilized Mixed Forage (Mayerthorpe 2000)



Pasture

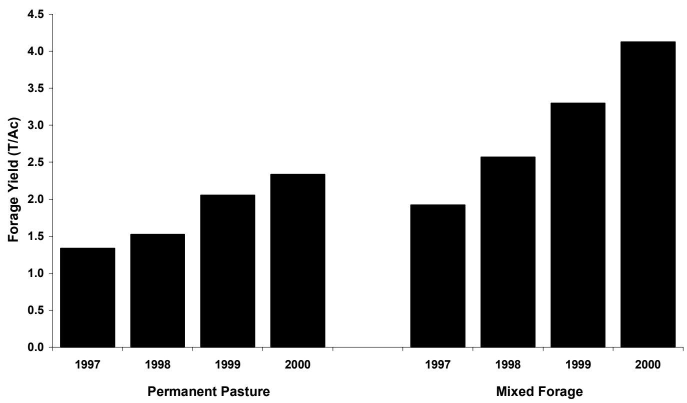
The same three experiments described above were also established on a permanent pasture site also near Mayerthorpe. This site had not been cultivated or fertilized for 20 to 30 years. Plant composition in the stand included wild strawberry and numerous native grass species. Experiment 1 showed N and P were limiting forage growth. Results from the N and P rate experiments are presented in Figure 3. N increased yield from 1592 lb/ac at 0 N to 4953 lb/ac at 88 N. In the 0 N treatment, legumes including alsike clover and vetch were the dominant species. It is speculated P in the blanket fertilizer stimulated growth of these legumes which, under the low input management system used in this pasture, were suppressed because of a deficiency of P. In the 44 N and 88 N treatments brome grass became the dominant species. In the P rate trial, yield increased from 2021 lb/ac at 0 P_2O_5 to 4789 and 5108 lb/ac at 22 and 44 lb/ac P_2O_5 respectively (Figure 3). These results are similar to those from the hay site in that there was a significant response to the first increment of P and no significant response to the second increment.

Figure 3. Effect of Nitrogen and Phosphate on Permanent Pasture (Mayerthorpe 1997 - 2000)



The response to N and P in the early years of the trial was relatively small in comparison to those obtained in recent years. In an impoverished soil such as this pasture site, species that are well adapted to nutrient poor soil systems become dominant while introduced species that have a higher nutritional requirement become suppressed. Since this stand was in an advanced stage of deterioration, time was required for the stand to respond to the new management system (fertilizer) and for the tame species to become dominant again. It can further be speculated that if nutrient inputs to the system were discontinued, tame species would decrease in their prominence in the stand and the native species would again become dominant. This trend is shown in Figure 4. At both locations (hay and pasture trials) there is an increase in yield with each succeeding year of the trial.

Figure 4. Annual Effect of P Fertilizer Application on Forage Yield Over the Four Year Period (1997 - 2000)



Nutrient Cycling in Forage Crops

From the perspective of our environment, complete cycling of nutrients always has been and always will be achieved. The laws of physics state matter can neither be created nor destroyed. If such were not the case, eventually all nutrients would be depleted from our environment. In soil a very small percentage of the total amount of nutrients are available to plants. In perennial forage crops, the amount of plant available N usually is less than 10 lb/ac at any given time. Larger amounts of plant available N suggest some other soil, climatic or management factors are limiting forage growth hence allowing N to accumulate in the soil. Total soil N may be as great as 10,000 lb/ac however most is present in the soil organic matter and must be decomposed before it can be utilized for plant growth. With legumes, N present in the atmosphere can also be considered plant available. Most of the P in soil is present in compounds of calcium, magnesium, iron and aluminum and are of limited availability to plants however as plants absorb P from the soil water, P contained in these compounds comes back into solution thereby providing a continuing supply of P for plant growth. Most of the K in soil is present as part of soil minerals or as attached to the surface of clay and organic matter particles and in most soils is not considered to limit forage growth. As with N, most of the S in soil is present in the soil organic matter. The objective of the forage manager is to have a working understanding of these relationships and to manage them in such a way to provide adequate nutrients for plant growth without resulting in mining of the soil and hence, achieve a sustainable production system.

The following discussion on nutrient cycling will concentrate on N however reference to other nutrients will also be made. Losses of N from the soil include N removed in meat, milk and harvested forage, leaching and gaseous losses to the atmosphere (volatilization and denitrification). The objective of the forage manager is to maximize production of livestock products or harvested forage. To achieve this objective, leaching and gaseous losses of N must be minimized. Leaching, which is the downward movement of nitrate nitrogen below the rooting depth of crops and eventually into groundwater, largely is an uncontrollable loss. Since leaching losses are economic and environmental concerns to forage managers and to society in general, management of the system to minimize the amount of nitrate present in the soil will minimize potential losses by this mechanism. This usually involves ensuring all other factors affecting crop growth are not limiting. Other conditions that contribute to increased risk of leaching are soil texture (percent sand) and precipitation. Leaching losses are greatest in sandy soils since these soils have a low water holding capacity and because pores spaces are relatively large, water moves very quickly through these soils. In the author's opinion, leaching losses are relatively small in most forage crops. The climate of western Canada is relatively dry and in most situations precipitation is quickly used by growing crops thereby eliminating the mechanism for leaching, namely, downward movement of water.

Volatilization losses refer to ammonia (NH_3) lost from surface applied urea fertilizer, composting manure and urine. Ammonia losses from broadcast urea may occur however the authors believe that if urea is applied early in spring when soil temperatures are less than 5-10^{o}C, this potential loss is minimized. Volatilization losses from manure, which is often piled to reduce volume handled, reduce weed seed content and to store it until land is available for spreading, can be significant.

Denitrification occurs when waterlogged conditions are present in soil or when intense microbial activity in soil reduces the supply of oxygen in the soil. Under these conditions, some soil organisms have the ability to obtain their oxygen supply from nitrate with the resulting release of nitrous oxide to the atmosphere. This loss may be greater in northern areas where a large accumulation of snow results in prolonged periods of flooding during spring break.

Losses of P from soil are relatively few in comparison to N. P from fertilizer or manure quickly reacts with other elements in soil to form compounds which are of low solubility and hence not subject to leaching. As previously stated, as plants absorb P from the soil solution, the P supply in the soil solution is quickly replenished from these previously insoluble compounds. There are no known losses of P to the atmosphere. Phosphorus absorbed by plant growth may be returned to the soil in the form of aftermath, roots and manure. P excreted by animals is largely contained in the feces. This P becomes part of the organic matter pool and will become available to plants when the organic matter decomposes. In addition to fertilizer P, inputs to the soil system include P contained in mineral supplements.

Removal of K is relatively small particularly under grazing systems. Most of the K in plant tissue is present in intercellular fluids and can quickly be returned to the soil when plants die. Most of the K excreted by animals is present in the urine.

Sulphur is similar to N in mechanisms for loss however it is generally believed the magnitude of the S losses are relatively small in comparison to N. Sulphur in the form of sulphur dioxide (SO_2) can be absorbed directly from the atmosphere by crops. Reductions in emissions from industrial facilities such as sour natural gas processing facilities and coal fired electrical generating stations have resulted in lower inputs from these fugitive sources.

In any forage management system, the soil and hence nutrient cycling will achieve a steady state or equilibrium with the environment. In this context, environment includes the soil (texture, topography and percent organic matter), the forage stand (grass, legume or mixed stands) and management of the stand (pasture, hay, continuous or rotational grazing system, fertilizer inputs).

From a soil fertility perspective, percent organic matter in a soil is a good indication of the nutrient supplying capacity of a soil. When a soil is in equilibrium or steady state with the environment, a reliable and continuing supply of plant nutrients from decomposing organic matter will be released to support plant growth. In most cases however, the supply of N is not likely to provide adequate nutrients for optimal grass growth. If management or forage stand is changed, the equilibrium is disrupted and over a period of time a new steady state is achieved. Whether the change is positive or negative will be dictated by the nature of the change. Positive changes are correlated with good management practices such as grazing management to achieve uniform distribution of urine and feces over the pasture. This may necessitate cross fencing, rotational grazing and development of additional water supplies to achieve uniform distribution of feces and urine over the entire pasture area. Rotational grazing may also result in more uniform hoof action over the entire pasture which also assists in nutrient release from organic matter and incorporation of seed into the soil. Increased use of fertilizer, providing periods of rest during periods that are critical for physiological plant functions and spreading manure also are positive changes that will contribute to sustainable production of forage crops. Negative changes are correlated with poor management practices which result in less uniform distribution of urine and feces over the pasture, lower fertilizer inputs etc. The time required to establish a new steady state likely is greater than five years. It is generally accepted that the carbon to nitrogen ratio of a soil at steady state is 10:1 meaning that for each 10 pounds of carbon in the organic matter, there is one pound of nitrogen also present. The relationship of these changes in management on soil organic matter is represented schematically in Figure 5a.

The effect of a positive change in management on nutrient cycling is represented in Figure 5b. Prior to a change in management, a steady state exists that results in a certain level of release of plant nutrients.

Figure 5a. The Effect of Forage Management on Soil Organic Matter.

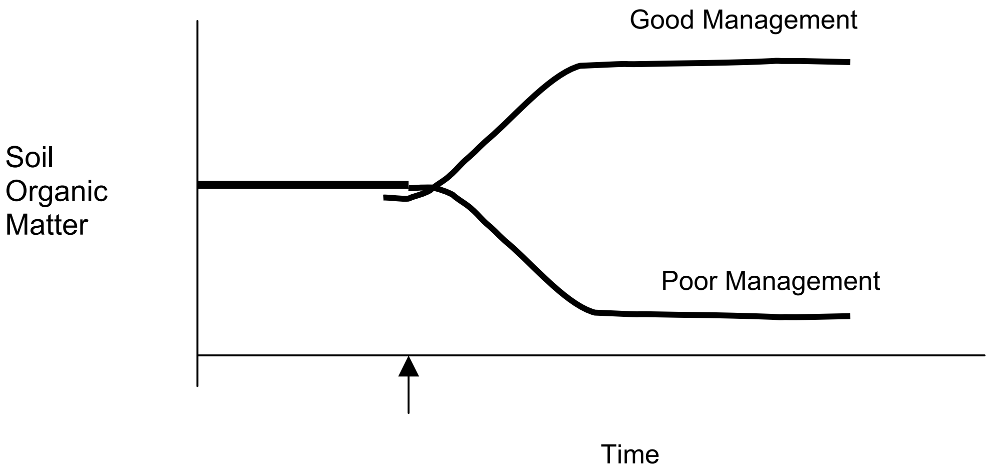


Figure 5b. The Effect of Good Forage Management on Soil Organic Matter.

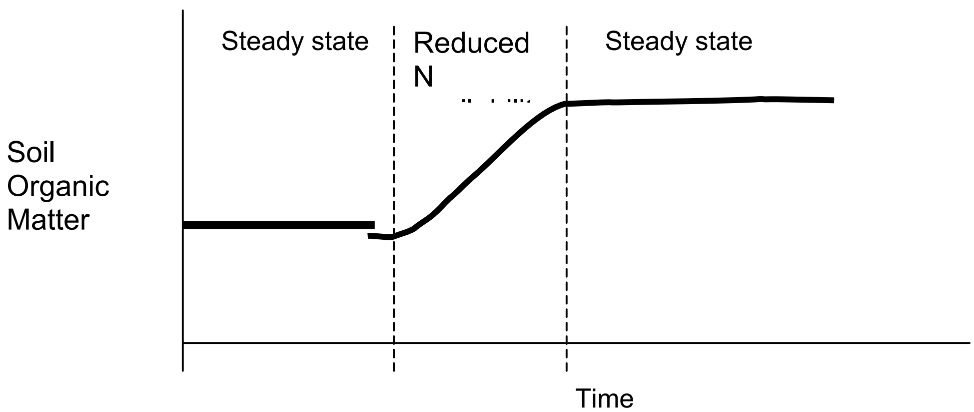
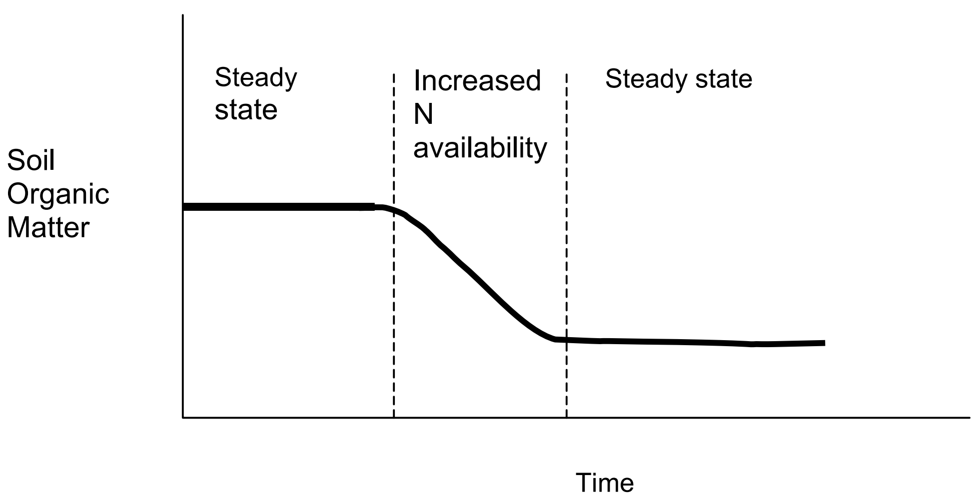


Figure 5c. The Effect of Poor Forage Management on Soil Organic Matter.



When a change occurs, the soil begins to respond to this change and soil organic begins to accumulate. Because of the C:N ratio, carbon and hence organic matter can not accumulate in isolation of N. During this period of adjustment, there is a reduction in availability of N and hence forage production will be reduced. When a new steady state is achieved, there will be no further accumulation of organic matter and nitrogen availability will increase. The release of nutrients will be at a higher level than that which occurred before the change in management.

When negative changes in management occur, soil organic matter will decrease until a new steady state is achieved. During this period of adjustment, there is increased release of nutrients because organic matter is decomposing. When a new steady state is achieved, a stable level of nutrient release occurs however, the rate of release will be less than that which occurred before the change. This is represented in Figure 5c.

Nutrient Cycling in Hay Land

Forages stands differ in the degree of nutrient cycling that occurs. Nutrient removal is maximized when hay or silage is removed and hence the opportunity for cycling of nutrients is reduced. The potential for nutrient cycling is limited to nutrients contained in the aftermath and the root system, leaves lost during raking and baling and nutrient leached from the forage before baling. With the exception of nitrogen, sustainable production of pure legume stands or stands where legumes are dominant will be dependent on input of P and S when these nutrient are deficient in the soil.

Nutrient Cycling in Pasture Land

The potential for cycling of nutrients in pastureland is significantly greater than in hay land. The degree to which nutrients in manure and urine can adequately meet the nutritional needs of growing forage will depend on the amount of manure deposited on the land and the uniformity over the field. Jim Gerish reported at the first grazing conference held in Red Deer in 1997 that P soil test results had increased in his intensively rotational grazed research trials. The source of phosphorus in this study was attributed to P in mineral supplements. In these situations, it is possible to achieve uniform distribution of the manure over the entire pasture and hence by-pass P may be an effective source of P for growth of forage crops.

N in urine is primarily present in the urea form and hence potential losses occur by the same pathway as the loss from broadcast urea fertilizer. N loss from urine may vary from less than 10% to over 50%. The extent of loss will be determined primarily by environmental conditions. The authors believe losses from urination in spring and fall when soil temperatures are relatively low are small however losses during summer may be significantly higher. The potential losses from urination on soils near saturation likely could be substantially higher than losses from soils containing less moisture. It has also been reported the area affected by urination may only account for 10% of total pasture area. This may result in higher losses since the ability of the soil to assimilate relatively large inputs of N by a relatively small volume of soil may be limited. This results in extreme spatial variability. Grass in one area may have adequate to excessive N fertility and in other areas, growth is limited by N deficiency.

It is highly unlikely manure could provide an adequate supply of nutrients under a continuous grazing system. In this system, manure will be concentrated around water supplies, salt and mineral feeders and around shade areas. Areas grazed less frequently are likely to have less manure and hence nutrients returned to the soil and therefore forage production will be limited by nutrient deficiency. A forage manager's approach should be to use stocking density and strategically locate water, salt and mineral supply in such areas to have uniform grazing over the entire pasture and hence uniform distribution of feces and urine.

Fertilizer Application

Forms

Forms of fertilizer and the method of application are the two key issues in fertilizer application on forage crops. With P, ammonium phosphate (12-51-0) fertilizer or fertilizers consisting of blends with ammonium phosphate are widely used. In some areas liquid fertilizers are used however their cost and availability limit their use. Ammonium sulphate (21-0-0, AS), ammonium nitrate (34-0-0, AN) and urea (46-0-0, U) are widely used in western Canada. Ammonium sulphate also contains 24% sulphur, which may be desirable, if legumes are grown or when forage grasses are grown under high nitrogen fertility conditions. AN and U contain no sulphur. Historically, AN has been the preferred N source for forage crops. The higher per unit cost of AN and fewer fertilizer dealers handling this N source has resulted in many farmers now using U on forage lands. Potential N loss from U can be minimized if U is broadcast in early spring before soil temperatures have increased above 5-10^{o}C. In central and northern Alberta, application in late April or very early May has shown U is an effective fertilizer material. AN is the preferred N source for mid-season application of N where the objective is to stimulate regrowth for late summer and fall pasture. U may also be used for this purpose however precipitation soon after application is required to minimize potential losses.

Sulphur is often deficient in medium to light textured soils. Sulphate-sulphur, as present in AS, has previously been used as a sulphur source however recently elemental sulphur (S^{o}) fertilizers have been widely used. Research has shown S^{o} fertilizers are effective sulphur sources however there is a delay in their availability to growing crops. A group of soil bacteria known as Thiobacillus convert S^{o} which is not available to crops to sulphate ($SO_4^{=}$) which is the form plants absorb S. When S^{o} is used for the first time, a blend of $SO_4^{=}$ and S^{o} should be used to ensure there is adequate plant available sulphur. In the second year of the fertilizer program, use of S^{o} alone will provide adequate sulphur.

Some forage managers speculate potassium (potash) deficiency is likely to occur when forage crops are grown since potassium is present in relatively large amounts in the vegetative component of plants. When grazed much of the potassium is returned to the soil since potassium is largely present in the intercellular fluids in plants and is released upon digestion. Potential mining of potassium from soil is greatest when hay or silage is harvested and manure is not returned to the land where the hay was harvested. Research has shown there are relatively few areas where response to potassium has been documented. Little work has been done on the micronutrient requirements of forage crops. There have been isolated reports of boron deficiency in alfalfa grown on sandy soils. Deficiency symptoms occur most frequently during periods of drought but may disappear quickly after rainfall.

Method of Application

Broadcasting is the most common method of fertilizing forage crops. Because of the different root system of forage crops and differences in moisture patterns under forage crops compared to annual crops, forages are able to efficiently utilize surface applied nutrients. After rainfall, forages absorb water from near the soil surface since there is little opportunity for reserve moisture to accumulate under forage crops. It is in this area that the nutrients are present after broadcasting hence their availability to growing forages is reasonably good. In contrast to annual crops which decrease their uptake of water by mid-August, water may accumulate in the subsoil in late fall, from snow melt water and from spring and early summer precipitation. During periods of drought, annual crops root deeper into the soil to access reserve moisture thereby stranding surface applied nutrients. Banding fertilizers in forage crops is more costly than broadcasting. Banding may also damage the root system of legumes. Weed growth may also be stimulated in these disturbed areas. Research in this area is contradictory however, research by the authors has shown broadcast N in grass stands and broadcast P in legumes was equally effective to banded N and P respectively.

Aeration of Unproductive Stands

Some forage managers believe loss in production from aging stands is caused by soil compaction from grazing livestock or harvesting equipment. Numerous models of aerators have been developed to improve water infiltration and soil aeration. Dr. S.S. Malhi, former research scientist at the Agriculture and Agri-Food Canada research station at Lacombe, evaluated four aeration treatments at three levels of N fertility. The Aer-Way was used to create fall, spring, fall+spring and check treatments. N rates were 0, 50 and 100 lb/ac and all plots received a blanket application of P, K and S. Four trials were established on pasture fields and the fifth was located on an alfalfa-bromegrass hayland. Malhi reported there was no consistent benefit from aeration however there was a consistent increase in yield from application of N. At one location, stand composition was determined. A bluegrass plant community was dominant in the 0 N treatments while bromegrass was dominant in the N fertilized treatments.

Weed Control by Fertilization

Weeds can be a problem in pastures and hay land. They can delay and jeopardize establishment of a new forage stand, as well as reduce yield, nutritional value, palatability and marketability of established stands. Poisonous weeds can be especially costly for a producer.

Any practices that encourage the growth of a healthy and competitive forage stand will assist in controlling, suppressing or managing weeds. The Agronomy Unit has conducted trials on the integrated control of problem perennial weeds in pastures and hay land. Results have shown a combination of herbicide and fertilizer can control ox-eye daisy, common tansy, wild caraway, dandelion and yellow toadflax in hay land. Broadcast applications of recommended rates of fertilizer for two years controlled ox-eye daisy in a forage stand however, fertilizer alone did not control tall buttercup. The difference in control is likely due to tall buttercup having large palmate leaves that grow above the canopy compared to the mainly small basal leaves and few bract-like stem leaves of ox-eye daisy. Increased forage growth from fertilizer suppressed ox-eye daisy likely because of competition for light but was not able to suppress tall buttercup.

Where used alone, herbicides controlled ox-eye daisy, however, the legumes and other broad-leaved plant growth were also eliminated from the stand. This provided an opportunity for ox-eye daisy seed present in the ground to germinate and establish new plants the following year. The herbicide had removed the competition for the ox-eye daisy. When fertilizer was used in conjunction with the herbicide, the increased grass growth provided competition to reduce ox-eye daisy numbers the year following herbicide application.

Results have shown fertilizer can be used as an effective tool in pasture and hay land management in not only increasing production but also rejuvenating weedy, unhealthy forage stands and maintaining competitive, healthy forage stands.

Presented at: Grassland Farming For The 21st. Century
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Red Deer AB

Annals for Grazing

The Lacombe Research Centre did extensive research in the late 1980's on the use of winter cereals for pasture. Fall rye, winter wheat and winter triticale all provide excellent pasture. These winter cereals can be seeded in late summer and grazed in the fall or, depending on location and weather conditions, they can be overwintered and grazed the following spring. Winter cereals may also be seeded in the spring and grazed later during the year.

Intercrop pasture also provided excellent forage at Lacombe. Spring and winter cereals can be seeded together and used for summer and fall pasture or as a silage/fall pasture system. The winter and spring cereals should be seeded at 3/4 of the normal rate of each crop depending on the moisture conditions. Winter wheat benefits more from mixing with spring cereals than fall rye for pasture grazing as cattle will graze the spring cereals until the winter cereals are ready. If the intercrop is grown for silage it should be seeded and harvested earlier than normal, approximately two to three weeks after heading, in order to allow the winter cereal enough time to regrow for fall pasture. At Lacombe fall rye and winter triticale are more productive than winter wheat for fall pasture regrowth. Winter wheat is also more susceptible to plant diseases when grown as an intercrop.

Annual ryegrass or Italian ryegrass can also be used to improve pasture productivity through extension of the grazing season. Research at the Agriculture and Agri-Food Canada Research Centre at Lacombe and Melfort have shown that weaned calf gain can be as high as 500 to 600 lb per acre when grazing annual ryegrass late in the fall.

There are two types of annual ryegrass - Italian and Westerwold. Italian ryegrass is a biennial originating from northern Italy where it is primarily used as winter hay and pasture. It does not set seed in western Canada. Westerwold ryegrass is an annual that was developed from Italian ryegrass plants that set seed in the year of seeding. Both types can be used as annual forage crops and as a result are collectively referred to as annual ryegrass. Annual ryegrasses are adapted to moist soil zones and do not survive the winter in western Canada. The Italian type is recommended for grazing in western Canada as it does not go stemmy and set seed.

Producers need to be aware that the Westerwold type will set seed and seed shatter can contaminate the field the next year if used for a grain crop. It will be necessary to heavily graze or silage the Westerwold rye grass in mid-summer and also heavily graze in late fall to reduce the seed shattering problem. Seeded early in the spring at a rate of 10 to 12 lb/acre, Italian ryegrass can be heavily grazed for a short period of time in late July, early August and in the late fall depending upon rainfall. Fertility and weed control is similar to an oat or barley silage crop.

A series of annual intercrop plot trials were conducted at Melfort and the following trends can be seen from the data. Oats or barley were seeded as a mono crop or as an intercrop with winter wheat, fall rye , winter triticale, and three different Italian or Westerwold rye grasses.The silage yields of oats intercrops exceeded that of the barley intercrop by 17%. The silage yield of the oat monocrop exceeded that of the barley monocrop by 120% at Melfort when averaged over three years. The Italian and Westerwold rye grasses can be used for silage BUT you need a rotary disc mower to swath the material as a grain type swather will not work. Also the rye grass silage should be mixed in with barley or oat silage in the bunker silo.

For fall pasture production at Melfort those plots that were planted for fall grazing only produced significantly more forage dry matter than the plots that were cut for silage and the regrowth used for fall grazing. Oats seeded alone for silage and fall grazing produced 85% more material for fall grazing than that of barley. The intercrop plots that were cut earlier for silage (when the barley was ready) produced more regrowth than the plots cut later (when the oats were ready for silage cutting.)

The Italian rye grass pasture yields seeded as a mono crop were 175% higher than winter wheat, fall rye, and winter triticale. The pasture yields of the Westerwolds, i.e. Aubade, did not differ significantly from the Italian type, Maris Ledger. Fall pasture yield of intercrops containing Italian rye grass exceeded the intercrop treatments containing other fall cereals by about 57%.

Calves weaned in late August at Melfort and Lacombe have gained from 1.5 to 2.5 lbs/day while grazing Italian ryegrass from late August to mid November. Due to the leafiness of annual ryegrass, it is highly recommended that the cattle strip graze the fields in order to reduce trampling and minimize wastage. Provided there is adequate shelter, weaned calves can successfully strip graze the Italian ryegrass in several inches of snow. Extra tillage for seeding will be required the following spring in order to handle the plant residue.

Swath grazing of late seeded oats or barley can provide an alternative way of wintering cows. The oats or barley should be seeded in late June and swathed at the soft dough stage in mid September just before of immediately after the major killing frost. Dry cows can then graze the material throughout the early part of the winter depending upon the depth of snow. The fields should be strip grazed using a portable electric fence in order to prevent wastage and the cows grazing all the grain heads first.

Natural bush or portable windbreak shelters should be provided for the swath grazing animals. Snow can be used as a water source but an alternative source of water needs to be provided if the snow source is unavailable.

Cows should be moved off the swath grazing to their winter calving area two to three weeks prior to calving. In the spring the cows plus calves can return to the swath area to clean up the residue. These cows should still have access to their post calving feed ration while cleaning up the swaths. Extra spring tillage may be required depending upon the amount of residue and soil compaction.

Currently the members of the Western Forage Beef Group are evaluating different methods of wintering beef cows: System 1 - Swath grazing mid-November to mid-February; System 2 - Traditional straw based ration free choice supplemented with barley silage; System 3 - Alternate day - straw based ration free choice where 2 days silage supplement is fed every other day.

In 1997 we swath grazed from November 19 to February 5 for a total of 78 days. Snow did not arrive until after Christmas. In 1998 we grazed from December 1 to February 17 for 79 days. Snow was on the ground throughout the trial and as deep as 20 inches. Snow arrived this past winter in early January and cows grazed from November 8, 1999 until March 2, 2000 for 115 days

The yields of available swath grazing material has been quite variable due to time of seeding and available moisture. In 1997 the average yield was 7280 lb/ac; 1998 - 5796 lb/ac and 1999 - 6428 lb/ac. The number of grazing days/ac was 297 (Nov. 20 to Jan. 30) in 1997; 167 (Dec. 1 to Feb. 17) in 1998; and 296 (Nov. 8 to March 2) in 1999. In 1999 and 1997 snow didn't arrive until after Christmas. It should be noted that part of the daily feed consumption came from our cows eating portions of their bedding. The cost of growing an acre of swath grazing crop as a silage crop is the same up until swathing. Here are the costs that we are using per acre based on the averages of the Alberta Custom Rates survey.

	Silage	Swath
Seeding	$ 12.00	$12.00
Seed	7.50	7.50
Fertilizer	44.00	44.00
Spray	7.25	7.25
Swathing	6.00	6.00
Harvesting	48.00	
Total/ac	**$124.75**	**$76.75**
Net DM Yield (tons)	**2.72**	
SilageCost/lb DM	**$ 0.023**	

In addition there are the costs of feeding the silage, hauling the straw used for feed and bedding to the cattle and hauling the manure back out to the field. At present we are still developing these costs.

Based on our actual grazing days/acre for 1999, 1998 and 1997 and the cost of growing a swath grazing crop of $76.75/acre, our daily swath grazing costs were 26 cents, 46 cents and 26 cents respectively. In addition we supplied bedding for the swath grazing cows at an estimated cost of $12/bale plus the cost of hauling them to the field for a total cost of 12 cents/cow/day.

The traditional treatment consisted of free choice barley plus 14 DM lbs of barley silage a day. The alternate day cattle received 28 DM lbs of barley silage every other day in 1999. The cost of silage for the 115 day period this past winter (115 days) was 32 cents/day based on a 2.3 cents/DM lb. The traditional and alternate day feeding groups consumed on average about 9 lbs/day of straw for a straw feed cost of 14 cents/cow/day. This figure does not cover the cost of hauling the straw to the pen which will be calculated at a later time. Bedding charges were 9.3 lb/day or 14 cents/day/cow. The main difference between traditional and alternate day feeding appears to be in labour savings.

Many producers ask about waste under swath grazing. During periods of snow we moved our electric fence for strip grazing every day. Residue left behind the cows during the winter period can be controlled by management of the moveable electric fence or animals can be brought back in the spring after calving to clean up all useable material. Spring calving cows will need to be supplemented with extra hay, silage or grain during the cleanup period. By using swath grazing in the spring, we are able to keep cows from grazing perennial pastures.

Remember, for each day one grazes a perennial pasture too early, we lose three days of grazing in the fall. As this is a preliminary summary of our results, we will obtain more information again next winter and present our findings at a later time.

During the past three winters all cows were successfully wintered under the three systems. In the winter of 1997-98 and this past winter snow did not accumulate until early January whereas this past winter, 1998-99, there was heavy snow accumulation. There was no significant differences in cow performance in the first year but there was a major cost benefit in swath grazing which required 30% less labor than traditional feeding and 14% less labor than alternate day feeding. When feed, bedding, manure removal and labor were considered, swath grazing cost $44.90 per cow less than traditional winter feeding $34.40 less than alternate day winter feeding. Alternate day winter feeding cost $10.50 per cow less than traditional winter feeding for spring calving cows.

Further information

Consult the following publications in your binder:

Winter Cereals for Pasture

An Introduction to Swath Grazing in Western Canada

Annual Ryegrass Production in Saskatchewan

Annual Ryegrass Management

Duane McCartney

Annual ryegrass is a cool season bunch grass that is mainly adapted to the moister areas of the grey and black soil zones and the irrigation areas of southern Alberta. In Alberta, ryegrass is used primarily for forage or seed production. Although there are a number of ryegrass species worldwide, in Alberta we only grow the species Lolium perenne (Perennial ryegrass), Lolium multiflorum (Italian types) and Lolium multiflorum var.westerwoldicum (Westerwold types).

Perennial ryegrass is primarily grown as a seed crop and rarely used for forage production. Italian and Westerwold ryegrass are primarily used for forage production with limited acres dedicated to seed production.

Unfortunately some confusion exists within the forage industry as to the term "annual ryegrass". This term is often used to describe both Italian and Westerwold types. There are significant differences between these two types of ryegrass in seasonal forage growth. It is important that seed purchasers understand these differences.

The first distinction between the two types of ryegrass is whether seed production will occur in the year of seeding. Westerwold ryegrass types are a early maturing type of Italian ryegrass. As a result, westerwolds function more like a annual crop, heading and setting seed in the year of seeding. These ryegrasses are induced to flower by exposure to long daylight periods. They only need 11 hours of continuous daylight to flower.

Italian types do not usually set seed in the year of seeding. They function more as a biennial. Seed set occurs in the second year if they successfully over winter.

The second distinction is the type of forage growth. Westerwold ryegrass has a high percentage of seed culm (stem) development during the year of seeding. Italian types, remain in a more vegetative (leafy) state during the seeding year. As result, Westerwolds are best suited to hay or silage production. Italian types are better suited to grazing systems.

Annual ryegrass cultivars can also be either be diploid or tretraploid. Tretraploid varieties produce fewer but larger tillers and leaves than diploid varieties. Tretraploid varieties also have a larger seed size and therefore require higher seeding rates.

Management Implications:

Both Westerwold and Italian ryegrasses offer livestock producers opportunities to enhance their forage production. But it is important ensure that the proper ryegrass is selected so that its growth pattern matches the intended end use.

Westerwolds: In the year of seeding westerwold ryegrass are best suited for use in hay or silage production. Westerwold ryegrass can be seeded either as a monoculture or interseeded with a spring cereal. For most areas of Alberta silage is the best option. Hay production is generally not recommended. Ryegrass is difficult to field cure for proper storage as hay. For grazing programs westerwold ryegrass can be used as silage/graze option or as annual pasture. If seeded as annual pasture, it is important to graze the ryegrass at either the vegetative stage or defer grazing until the boot stage.

One of the risks associated with growing Westerwold ryegrass is the potential for seed shatter during the growing season. Volunteer ryegrass can be a competitive weed in subsequent annual crops. To avoid seed development westerwold ryegrass should be harvested no later than the early heading stage for hay, silage or pasture. In grazing programs rotational grazing will provide the most uniform and frequent defoliation. Using cultural practices that will control seed development should be the first approach to managing westerwold ryegrass. If seed shatter does occur then future cropping programs should be planned to allow for either cultural control or in crop herbicide options.

Italian: In the year of seeding Italian ryegrass is best suited for grazing. Italian can be seeded as a monoculture or in a blend with a spring cereal for either pasture or for silage. To enhance pasture performance, grazing should start when the Italian ryegrass is approximately 8 to 10 inches tall. Grazing should stop when a stubble height of 2 to 3 inches has been reached. Under good growing conditions, rest periods of 3 to 4 weeks will be required in a rotational grazing program.

Seed shatter is not normally a concern in the year of seeding with Italian ryegrass. To set seed, Italian ryegrass must overwinter. If Italian ryegrass does over winter then it should be managed in a similar fashion as westerwolds with either cultural control options or selecting crops with herbicide options.

Volunteer Ryegrass Management:

Both winter survival and seed shatter can result in volunteer ryegrass in succeeding crops. The following guidelines can be used to help prevent volunteer ryegrass from long term field persistence.

Cultural Options:

- Use certified seed to confirm ryegrass type
- Prevent seed set through cutting and grazing management in the year of seeding
- Limit fall tillage in the ryegrass seeding year to avoid burying seed
- Monitor fields in the succeeding year for volunteer ryegrass plants
- Use Silage, Green feed, Annual Pasture or Tillage in succeeding years to address a volunteer ryegrass problem
- Other cultural options include delayed spring seeding in conjunction with shallow tillage and increased seeding rate of a competitive crop such as barley

Herbicide Options:

- Control spring germination of volunteer ryegrass with non-selective herbicides such as glyphosate or paraquat/diquat
- Avoid the use of Group 1 or Group 2 herbicides in crops following ryegrass
- Volunteer annual ryegrass has shown the propensity to rapidly develop resistance to herbicides such as Poast or Horizon
- Select crops in which Treflan or Edge can be used for volunteer ryegrass. Do not use these herbicides two years in a row

- If a Group 1 herbicide has to be used for volunteer annual ryegrass, field research has indicated that the herbicides Achieve, Select or Poast Ultra will provide suppression or control. Do not use these herbicides for two consecutive years to avoid the development of herbicide resistant ryegrass populations. Consult product labels for final detailed instructions before using any product

Annual Ryegrass Production:

The following are tips on using annual ryegrass effectively:

- Annual ryegrass needs good moisture conditions. Therefore it is best suited to the Black or Grey Wooded soil zones or Irrigation
- Seeding rates should aim to provide 10 lbs/acre (25 seeds/ square foot). The seed count (seeds/lb) does vary between diploid and tretraploid types due to seed size. Higher seeding rates are required for Tretraploid types.
- Companion cereals for greenfeed or silage can be seeded at 70 to 100 lbs per acre. Higher cereal seeding rates will decrease the ryegrass yield in the silage.
- Companion cereals in annual pasture programs can be seeded at 30 to 60 lbs per acre
- Ryegrass should be seeded in a separate operation from companion cereals. Cross seeding of the ryegrass will prevent in row competition and allow you to seed the ryegrass at the recommended depth of 1/2 to 3/4 inch
- Cereal/ryegrass blends should be seeded early as possible to allow for ryegrass regrowth in mid summer
- In irrigation areas apply water to the ryegrass immediately after the silage or greenfeed harvest. Ryegrass is a shallow rooted crop and requires good soil moisture conditions to initiate new regrowth
- Fertilize silage or greenfeed companion crops at your normal rate. Apply a second application of nitrogen after the silage or greenfeed harvest to enhance ryegrass regrowth. In non irrigated areas the second fertility treatment should be limited to 30 to 40 lbs of actual N. In irrigated areas 40 to 50 lbs of N could be applied to enhance ryegrass regrowth after each harvest.
- Fertilize cereal/ryegrass pastures at seeding and repeat N applications during the growing season to maintain ryegrass growth
- In cereal/ryegrass pastures, grazing should begin when the forage height has reached 8 to 10 inches in height. Annual ryegrasses are relatively tolerant of defoliation as long as a stubble height of 2 to 3 inches remains at the end of the grazing period. A rest period of 3 to 5 weeks will be required between grazing passes.
- If Westerwold ryegrass types are used for grazing it is important to note that some seed development may occur if plants are not grazed prior to the boot stage. Cultural control practices such as mowing or clipping may be required to removed non grazed plants
- Rye grass seedlings are not very competitive. Weed control during the seedling stage is extremely important
- Contributing authors and reviewers for this document include:

♦ *Dan Cole - Alberta Agriculture, Food and Rural Development*
♦ *Dr. Linda Hall - Alberta Agriculture, Food and Rural Development*
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♦ *Duane McCartney - Western Forage/ Beef Group*
♦ Gordon Hutton - Alberta Agriculture, Food and Rural Development

Leading Edge Graziers:Quality Pasture for Dairy Production

Jan Slomp and Grey Wooded Forage Association

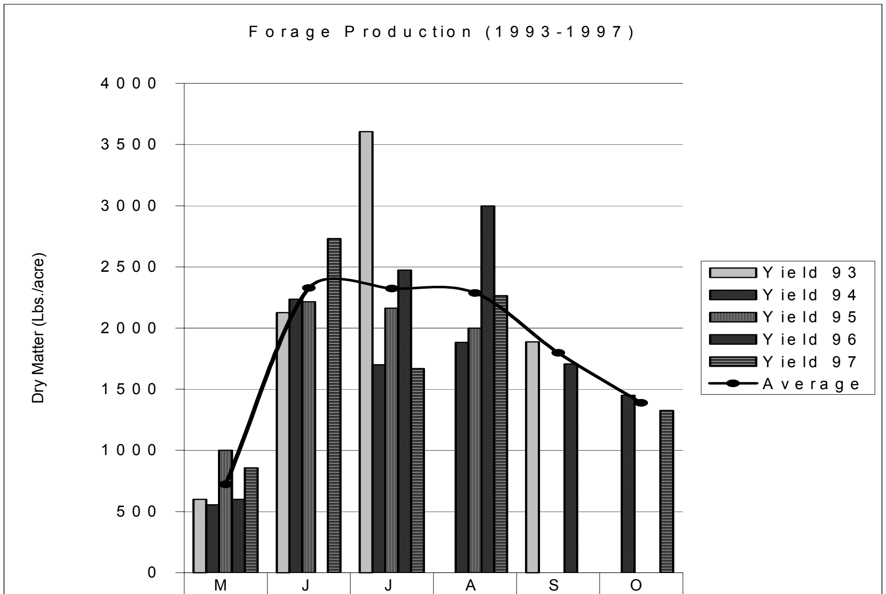
Objective: To gain practical information of controlled grazing management from a farm where it is being implemented. Information collected from this study is pasture yield, pasture quality and pasture economics.

Method: Pasture clips were done every 2 weeks from the start of the grazing season in May to the end of July; then weekly to the end of the grazing season to track the nutrition level throughout the grazing season.

Yield clips were done on a given paddock each time it is to be grazed to measure the level of pasture production in dry matter. The cooperator will keep records of grazing and any supplements fed in combination with grazing.

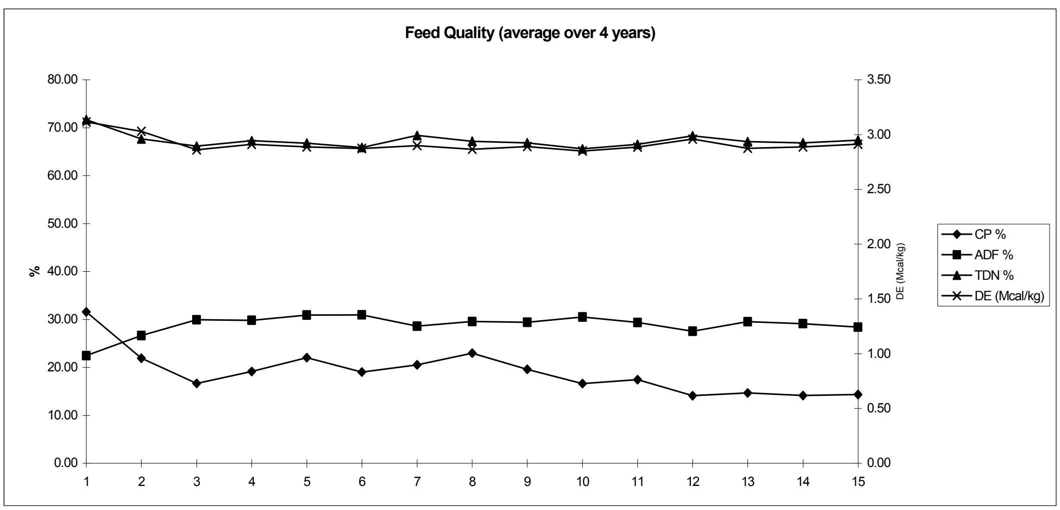
Results:

As you can see from the graph the greatest “blaze” of growth is in June. It is the management of this growth early in the spring that influences the yield in July, August September and October (or for fall and spring stockpiling). Notice that there is no severe drop in production in mid- to late summer. This is accomplished again by managing the pasture in June. Also, timely fertilizer applications after grazing or mechanical harvesting to smooth out the pasture production. However, fertilizer applications are limited to before July 31. Manure applications are used throughout the growing season. As the grazing progresses into the fall, production starts to fall, this is due to the lack or the slowing of vegetative regrowth. However, the plant is increasing in the production of non-structural carbohydrates (sugars) to allow the plant to overwinter. We also notice that the animals put on body condition (fat) at this time of the year (this is mentioned further in Body Condition Score).



	M	J	J	A	S	O
Yield 93	600	2127	3606		1888	
Yield 94	556	2236	1700	1883		1450
Yield 95	1000	2215	2162	2000		
Yield 96	600		2473	2999	1707	
Yield 97	856	2732	1669	2265		1325
Average	722	2327	2322	2287	1798	1388

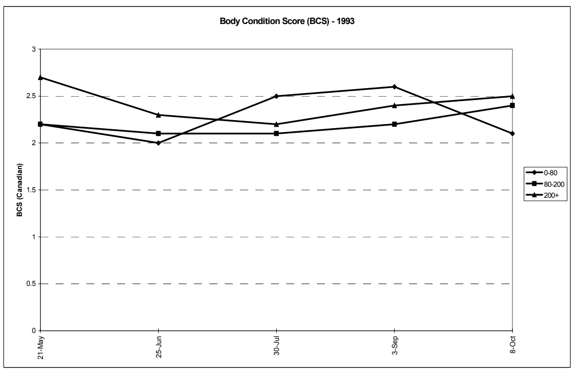
Forage Quality

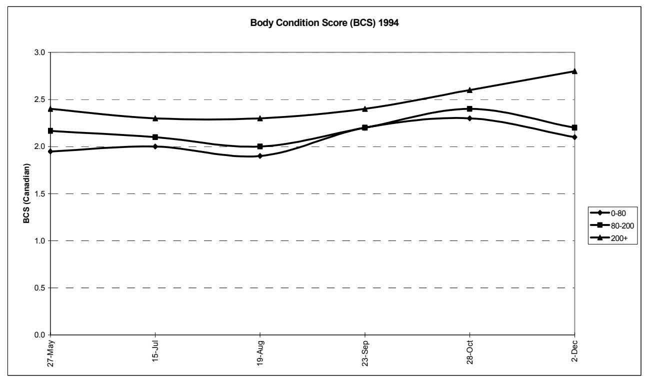


Samples 1-5 would be feed samples that were taken every two weeks at the beginning of the grazing season. Samples 6-15 are sampled weekly from the beginning of August to the middle of October (although they still grazing a large part of their diet is from silage, this is a transition period from summer milking to winter milking, and trying to reduce the effects that would be noticed in milk production). Notice by approximately the second week in June that Crude Protein and Acid Detergent Fiber intersect one another. It is at this point that Jan would like to maintain his pasture with an ADF of about 30%; any higher and Jan will see a decrease in the bulk tank. The average Crude Protein over the grazing season was 19.0%, and an average Acid Detergent Fiber (ADF) of 28.9%. The average Total Digestible Nutrients (TDN) are 67.3%, and the Digestible Energy (Mcal/kg) was 2.91.

Body Condition Score

Body Condition Scores (BCS) were taken on the milking herd in years 1993 and 1994. Trends were noticed from the analysis





of the data:

BCS increased going into the fall on all cows.
Cows over 200 days in milk are generally in higher BCS than the rest of the herd throughout the grazing season.

For the cow/calf producer this could lower feed costs by weaning the calf early, and dry off the cow (this lowers maintenance requirements) we can increase the Body Condition Score (BCS) of the cow and harvest “the fat off her back” during the winter feeding program.

Pasture Economics

With the pasture economics we looked at total feed savings of bunk feeding versus pasture. Animal health and manure handling savings were not included into the savings. Also not included was the quality of the winter feeds that were harvested due to the pasture management. In 1997 where Jan with his pasture production also harvested for stored feeds:

	85 loads of silage @ 4,2 ton/load @ 40% Dry Matter		= 142 ton of DM
also,	950 bales @ 25 kg @ 85% DM		= 22 ton of DM
		Total	164 ton of DM

The quality of this silage and hay was 17% CP with a 65% TDN.

1993 Production Period

Pasture period: May 13, 1993- October 1, 1993
Milk Yield: 197,732 Liters
Total grain concentrate fed: 55745 kg = $ 9839.00

Grain concentrate	55745 kg =	$ 4.98 / 100 Liters milk
Pasture rent	40 acres @ $60/acre	$ 1.21 / 100 Liters milk
Fertilizer	$ 1200.00	$ .61 / 100 Liters milk
Fence	$ 800.00	$ .40 / 100 Liters milk
Minerals	$ 800.00	$ .46 / 100 Liters milk
Additional Hay	500 sq. bales @ $2.25	$ .56 / 100 Liters milk
	Total Feed Costs	$ 8.16 / 100 Liters milk
Young Stock	4800 kg concentrate $912.00	$ .46 / 100 Liters milk
Pasture rent	35 acres pasture @ $40/acre	$ 70 / 100 Liters milk
Fertilizer	$700	$ .35 / 100 Liters milk
	Total Costs	$ 9.67 / 100 Liters milk

Dry Lot Feed costs are $ 14.85/ 100 Liters milk.
Savings: $ 5.18 x 1977.32 hL = $ 10,242.52

Pasturing Fall Rye in October saved:

12 ton hay equivalent @ $70/ton	= $ 840	
.75 ton fertilizer (34-0-0)	= $ 150	
Total	$ 690	$ 690
Savings manure hauling and bedding		$ 1400
Total Savings		$ 12,332.52

1994 Production Period

Pasture period: May 15, 1994- November 2, 1994
Milk Yield: 230,087 Liters
Total concentrate fed: 95,166 kg (end of October)

Savings: (approx.) $ 15,000
Note: pasture cost of $ 75/acre with rent at $45/acre and fertilizer at $30/acre.

1995 Production Period

Pasture Period: May 20, 1995- October 15, 1995
Milk Yield: 2000 Liters/day or 296,000 Liters
500 kg concentrate/ day

Concentrate	25 kg x $1.90/100 L	= $ 4.75 / 100 L milk
Fence		= $ .25 / 100 L milk
Fertilizer	$ 40/ac @ 100 acres	= $ 1.33 / 100 L milk
Rent	$ 40/ac @ 100 acres	= $ 1.33 / 100 L milk
Mineral	25 kg / day	= $ .58 / 100 L milk
Hay		= $ .55 / 100 L milk
	Total Costs	$ 8.79 / 100 L milk

Dry lot costs are: $ 13.93 / 100 L milk
Savings: (13.93-8.79) = $ 5.14 x 2960 hL = $ 15214.40

1996 Production Period

Pasture Period: May 20 1996- October 18, 1996

Milk Yield 314,103 Liters or 2080 L/day

Feed costs in January 1996		
Concentrate/minerals/supplement		$ 12.03 /100 L
Grass silage	@ $35/Tonne	$ 4.00 /100 L
Hay	@ $100/Tonne	$ .95 /100 L
	Total Cost	$ 16.95 /100 L
Feed Costs in March 1996		
Concentrate/minerals/supplement		$ 12.09 /100 L
Grass silage	@ $35/Tonne	$ 4.00 /100 L
Hay	@ $100/Tonne	$ .95 /100 L
	Total Cost	$ 17.04 /100 L
Feed Costs in June, July and August 1996		
Pasture	@ $40/acre	$ 2.08 /100 L
Fertilizer	@ $25/acre	$ 1.30 /100 L
Supplement		$ .52 /100 L
Concentrate		$ 5.72 /100 L
	Total Cost	$ 9.65 /100 L

Dry Lot Costs: $17.00/ 100 L (approx.)

Savings: $ 17.00- $ 9.65= $7.35 /100 L x 3,141 hL = $ 23,086.35

1997 Production Period

Pasture Period: May 18, 1997- October 10, 1997

Milk Yield: 303,923 Liters or 2125 L/day

Feed costs in January 1996		
Concentrate/minerals/supplement		$ 12.03 /100 L
Grass silage	@ $35/Tonne	$ 4.00 /100 L
Hay	@ $100/Tonne	$ .95 /100 L
	Total Cost	$ 16.95 /100 L
Feed Costs in March 1996		
Concentrate/minerals/supplement		$ 12.09 /100 L
Grass silage	@ $35/Tonne	$ 4.00 /100 L
Hay	@ $100/Tonne	$ .95 /100 L
	Total Cost	$ 17.04 /100 L
Feed Costs in June, July and August 1996		
Pasture	@ $40/acre	$ 1.31 /100 L
Fertilizer	@ $25/acre	$ 1.88 /100 L
Concentrate/ Supplement		$ 5.63 /100 L
	Total Cost	$ 8.82 /100 L

Dry Lot Costs: $17.00/ 100 L (approx.)

Savings: $ 17.00- $ 8.82= $8.18 /100 L x 3,039.23 hL = $ 24,861

Though the milk production declined a small amount compared to winter milking, the reduction of feeding concentrates (by less than half) by grazing high quality pasture resulted in considerable cost savings. This project shows that you can have consistently high producing and high quality pasture with management to use with any type of livestock production. Also, it shows that there is no differentiation between a hay field and a pasture, they can be one of the same depending on the management that you want to exercise on it.

Leading Edge Graziers:Pasture Management for Yearlings and Cow/Calf

Brian Luce

My wife Gail and I run a grass based cow/calf, yearling operation. We wanted to minimize our use and dependency on store bought inputs such as fertilizer and fuel and replace these inputs by using the livestock as a tool and by making more efficient use of the resources that we already had. These resources include soil, sunlight, microorganisms, rain and the grass.

We have always had a cow/calf operation and we always calved on the pastures, usually in the spring around April 1st. We now start on May 1st and wean in late January or February. These calves are backgrounded on hay and oats or pellets until grass is available and then they are sold in August or October. We also bring in custom yearlings for the grazing season. Our cows graze from the end of March to mid-December.

One of the most important management tools that we use is a pasture plan. This is important because when are stockpiling grass for spring grazing we need to know what we will need for quality and volume, what class of animal will be grazing it and what kind of grass we are stockpiling. Then we can plan the time to graze that paddock during the growing season in order to get the results that we need for the following year.

On the tour we will look at:

- old pastures
- stockpiling and extended grazing
- increasing yield
- planning, monitoring and assessing
- leader-follower system
- matching cow cycle to grass cycle, from calving to weaning
- maintaining legumes in a stand
- utilization and nutrient cycling

Pasture Economics

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Grazing economics is the final financial frontier on many farms and ranches. Just as the pasturelands have generally been the last to receive management attention, the grazing enterprise is often viewed as a subsidiary of a livestock enterprise. While this approach simplifies record keeping and reporting, it does little to assist with understanding the efficiency of forage production and use. Before we can manage, we must measure.

When grazing, the animal is the harvesting tool and each class of animal has a unique relationship with the pasture enterprise. This section deals with cow-calf grazing and grazing of yearlings or stockers. It is assumed that a cow herd is a long-term investment decision whereas grazing yearling cattle may be a regular part of the ranch business or undertaken only when forage supplies and market conditions make it attractive. A stocker enterprise could use home-raised cattle, purchased cattle, custom-grazed cattle or a combination of these.

This section is written primarily with the profit motive in mind, but sometimes environmental or livestock welfare issues take precedence over pasture profits. These kinds of decisions are sometimes based on belief and intuition due to lack of factual information, but knowing your pasture costs and returns can only make the decision easier.

Your attendance at this school indicates that you share our enthusiasm for the management of grasslands and their profitability. We will endeavor to give you some tools to increase your pasture management power.

Enterprise Analysis- The profit center approach

Few ranches are composed of a single profit center or enterprise. A pure custom grazing operation is a good example of a single enterprise ranch. Since no livestock are owned and no feed is mechanically harvested, all costs are attributed to the pasture enterprise. Revenue is only generated by pasture rent (or weight gain). If this custom grazier harvests some paddocks for hay in mid-summer, then a hay enterprise is born. When the harvesting is done by a custom operator, all of those costs are charged to the hay enterprise. However, if the grazier uses his own tractor, a share of the annual tractor and fuel costs are then allocated to the hay enterprise. When the hay is sold, the price received per ton can be compared to the calculated cost per ton to arrive at a profit figure.

For a cow-calf ranch to have only one enterprise, it would have to rent all pasture, sell all calves at weaning and buy all its winter feed. In fact this is a good way of viewing the cow enterprise, even when pasture, replacements and feeds are home-grown. By considering each of these products as purchased (transferred) the profitability of each profit center can be independently evaluated. All it takes is some effort in allocating costs.

The ultimate goal of profit center analysis is to report results in a format (Unit cost of production or UCOP) that is easily compared to some benchmark. For calf production, that benchmark is $ per pound weaned. For hay, it might be $ per ton. One unit that is useful when comparing pasture profitability to benchmarks is $ per Animal Unit month. This figure allows measurement of year-to-year progress on a single pasture or the entire ranch and can be compared to regional or industry standards. A pasture UCOP that is higher than local rental rates indicates that some management change is required; it might be cheaper to rent the neighbors pasture. For land use decisions within the business, a $ per acre UCOP allows comparison between annual crops and pasture or hay and pasture. In some cases this can be purely academic. For example a fragile riparian area could have more profit potential in the annual crops enterprise, but environmental considerations determine that permanent grasslands is the best use.

Fixed and Variable Costs

Accountants refer to variable costs, those that increase with each added unit of production, and fixed costs, those costs that remain constant over a range of units produced. Nitrogen fertilizer is a pasture variable cost. With each acre that is added to the grazing system, the total fertilizer cost rises. A large fence energizer is a good example of a fixed cost. The energizer may have the capacity to power paddocks covering 1000 acres, but if it is only used on 500 acres, the annual cost per acre will be double.

Reducing the burden of fixed costs is one of the motives behind the movement to grass farming. *Fixed cost items that rot and rust can be the biggest impediment to cow calf profitability*. A late model loader tractor selling for $75,000 will cost nearly $100 per cow per year for interest and depreciation if 50% of the annual use is feeding 100 cows. Extending the grazing season may reduce the variable costs invested in forages, but if the same complement of equipment is performing less work, the fixed cost per unit of output goes up.

Cows & calves

The challenge of the cow-calf pasture economics is the cost of shifting forage production from growing season surplus to dormant season use. In northern climates, feed & pasture are typically two thirds of the annual cost of keeping a cow and the winter feed portion is two thirds of that total. Methods of making summer forage surplus available in winter can be grouped into three categories and each has associated costs, benefits and risks.

The 20th century solution was to use fossil fuels and machinery to make a stack of hay or silage. Many of the costs in this process are obvious but a few hidden costs exist in the form of harvesting losses, storage losses, feeding costs and subsequent manure handling. In the worst scenarios, half of the nutrients present at the time of cutting never reach the cow's rumen. The earlier in the process that these losses occur, the less handling and interest lost. Harvest, storage and handling are often 50% of the value of hay or silage and this goes up as losses rise or productivity falls. Mechanically storing forages for winter use will generally double their cost. For example, when standing forage has a value of 1.5 cents per pound, similar quality baled hay is about 3 cents per pound. In our unpredictable climate this investment is justified as a hedge against risk. The question is how much? Before good roads and big snowplows a large feed pile was necessary. Today, the feed can nearly always be found and delivered, at a price.

The second method is to store surplus feed on the land in the form of stockpiled forage, annuals or perennials. Stockpiled perennials are the lowest cost but have the highest risk of use in areas where heavy snows or freezing rains are common. Annuals cost more to grow but are generally less prone to weather risk in the winter. The key to profitable stockpiling is adequate production (quantity and quality) and high grazing utilization.

A common question asked is what is the opportunity cost of stockpiling forage? Opportunity cost is the benefit that can be gained from another use of the resource. In this case, an alternate use of stockpiled pasture lands could be grazing yearlings. When the value per acre of grazing yearlings exceeds the value per acre of stockpiling for dormant season cow feed, it seems logical to go with the yearlings. Other cow management factors also deserve consideration when making this decision. Grass that is stockpiled for spring calving provides health benefits to newborn calves that is not easily converted to dollars.

The third way is to store the surplus pasture as excess body fat to be harvested in winter. Initial results of research at the University of Alberta's Ellerslie research farm showed that feed costs for cows at body condition score (BCS) 4 in early November were reduced by 40% when compared to cows at BCS 2 and by 20% when compared to cows at BCS 3. *Body fat provides well-balanced nutrition without waste and little transportation cost*.

Early weaning is a strategy that can improve fall body condition of the mother cow. The cost of weaning in late summer or early fall is the net value of feed or pasture provided to calves and the net difference in weight gain. In order to match the weight gained by a nursing calf, high quality feed or pasture is needed. The dry cow will need less pasture quantity and lower quality than when nursing.

Yearlings

Pasturing yearlings has some unique economic characteristics. Making a profit from yearling grazing means that the value of the gain must be higher than the total cost of providing it.

The value of the gain is complicated by the fact that the livestock price per pound commonly falls as the animals gain weight. This negative price margin is cost to the gain just as is death loss or interest. For example when the animal is purchased for $1.20 per lb at 700lbs and sold for $1.10 per lb at 900 lbs, the original purchase weight is sold for $.10 less than it was bought for. The negative margin per head is $.10 x 700 = $70. It takes the first 58.3 lbs of gain to overcome the negative margin cost ($70 / $1.20).

One of the big decisions the pasture manager must make is how heavy to stock the pasture. This choice will determine the length of the season and also affect the rate of gain. As the stocking rate increases, the average daily gain falls. However, with intensive grazing management and a higher stocking rate, the gain per acre will generally increase. The combination of fixed costs per head and the negative margin means that giving up too much per head gain for per acre gain can quickly make for an unprofitable operation.

Every ranch has a unique set of resources available to the manager and therefore each management system will also be unique. There are no simple formulas for success in this business. Each manager has to be aware of the capability of the resources, understand the physical and economic relationships between land and livestock, and then choose the forage management techniques that satisfy the profit, environment and lifestyle goals of the business.

Pastoral Economics

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Grass Economics 101

Talking about the cost and money making potential of grass farming can be a dangerous exercise for both the presenter and the listener. As soon as any of us put the "numbers" for our operation up on an overhead for all to see, some one will invariably start to dispute your figures and calculations. As a speaker, this goes with the territory.

However the greater danger lies with the listener looking at the numbers presented for the speaker's example, and assuming that these costs will be the same for their own operations. Just as no two managers are alike, neither will their costs, production, or opportunities. Understanding 'which' costs are important is more valuable than the actual dollar value of the cost being presented. For instance; paid labor is a very important cost to identify, but what that labor will actually cost will depend more on local economies than the type of grazing enterprise being undertaken.

The purpose of this discussion is to highlight those costs and opportunities in a grazing operation that I feel a grazier should both understand and calculate out on their own. In this discussion, I will be presenting information from the perspective of a stocker cattle operation including cattle ownership and custom grazing.

Should I own the cattle or custom graze other people's cattle?

My answer to these questions is YES! While someone just getting into the grazing business might feel that custom grazing is a logical first step, I believe it is very important for prospective custom graziers to understand the stocker business from the cattle owner's perspective. This is best accomplished by stepping out and owning some cattle. Owning some cattle yourself will really help determine the value of your pastures, and appreciate all of the costs associated with grassing cattle.

Having some of your own cattle on grass also shows other cattle owners considering placing cattle with you, that you have confidence in your own ability as a grass manager and a vested interest in optimizing the growth on those calves under your control. Another reason for owning cattle is to develop a track record as to your ability to deliver good gain on grass. A cattle owner will be more willing to send cattle to you, if you can show him two or three years of production records demonstrating consistent results on pasture.

As far as whether custom grazing is more financially viable than cattle ownership, it really comes down to a question of what are your financial goals and constraints? Most years, owning the cattle is more profitable than custom grazing as the value added effect of turning grass into beef is realized. However, the monthly cash flow generated by a custom grazing venture may out weigh the potential profit for a young producer with typically limited cash reserves. In the case of our own operation, a strategy of 50:50 custom grazing and cattle ownership is the goal we are working towards.

Tables 1 to 4 compare the different scenarios of ownership vs. custom grazing on both grass and alfalfa pastures.

Table 1. - Stocker Enterprise on Grass Pasture						
Revenue:						
		Starting		*Finishing*		
	# of Head:	90		90		
	Weight:	650		850		
	Price/cwt:	$125.00		$115.00		
	Price / Head:	$812.50		$977.50		
	Total:	$73,125.00		$87,975.00		
		Total Revenue:		**$14,850.00**		
Expenses:						
	Feed Costs:		Total	Cost / Head	Cost / lb. Gain	
	- Hay & Roughage		$0.00	$0.00	$0.00	
	- Straw		$0.00	$0.00	$0.00	
	- Grain, Supplement		$0.00	$0.00	$0.00	
	- Pasture Costs:		$6,300.00	$70.00	$0.35	
	- Ionophores		$0.00	$0.00	$0.00	
	- Mineral, Salt, & Vitamins		$360.00	$4.00	$0.02	
	- Feed Trucking		$0.00	$0.00	$0.00	
	Total Feed:		**$6,660.00**	**$74.00**	**$0.37**	
	Herd Health Costs:					
	- Veterinary Services		$135.00	$1.50	$0.01	
	- Vaccinations / Antibiotics		$540.00	$6.00	$0.03	
	- Herd Health Supplies		$135.00	$1.50	$0.01	
		Total Herd Health:	**$810.00**	**$9.00**	**$0.05**	
	Marketing Costs:					
	- Livestock Hauling		$2,160.00	$24.00	$0.12	
	- Commissions		$1,350.00	$15.00	$0.08	
	- Brand Inspecting, ACC, Mics.		$270.00	$3.00	$0.02	
	- Insurance (Loan; Trucking)		$180.00	$2.00	$0.01	
		Total Marketing Costs:	**$3,960.00**	**$44.00**	**$0.22**	
	Other Expenses:					
	- Livestock Supplies		$135.00	$1.50	$0.01	
	- Custom Labour		$0.00	$0.00	$0.00	
	- Death Loss	2.0%	$297.00	$3.30	$0.02	
	- Interest	3.00%	$2,193.75	$24.38	$0.12	
		Total Misc. Expenses:	**$2,625.75**	**$29.18**	**$0.15**	
	Total Stocker Expenses:		**$14,055.75**	**$156.18**	**$0.78**	
	Gross Margin		$794.25	$8.83		

Table 2. - Stocker Enterprise on Alfalfa Pasture					
Revenue:					
		Starting		*Finishing*	
	# of Head:	90		90	
	Weight:	650		950	
	Price/cwt:	$125.00		$112.00	
	Price / Head:	$812.50		$1,064.00	
	Total:	$73,125.00		$95,760.00	
		Total Revenue:		**$22,635.00**	
Expenses:					
	Feed Costs:		Total	Cost / Head	Cost / lb. Gain
	- Hay & Roughage		$0.00	$0.00	$0.00
	- Straw		$0.00	$0.00	$0.00
	- Grain, Supplement		$0.00	$0.00	$0.00
	- Pasture Costs:		$9,450.00	$105.00	$0.35
	- Ionophores		$990.00	$11.00	$0.04
	- Mineral, Salt, & Vitamins		$360.00	$4.00	$0.01
	- Feed Trucking		$0.00	$0.00	$0.00
	Total Feed:		**$10,800.00**	**$120.00**	**$0.40**
	Herd Health Costs:				
	- Veterinary Services		$135.00	$1.50	$0.01
	- Vaccinations / Antibiotics		$540.00	$6.00	$0.02
	- Herd Health Supplies		$135.00	$1.50	$0.01
		Total Herd Health:	**$810.00**	**$9.00**	**$0.03**
	Marketing Costs:				
	- Livestock Hauling		$2,160.00	$24.00	$0.08
	- Commissions		$1,350.00	$15.00	$0.05
	- Brand Inspecting, ACC, Mics.		$270.00	$3.00	$0.01
	- Insurance (Loan; Trucking)		$90.00	$1.00	$0.00
		Total Marketing Costs:	**$3,870.00**	**$43.00**	**$0.14**
	Other Expenses:				
	- Livestock Supplies		$135.00	$1.50	$0.01
	- Custom Labour		$0.00	$0.00	$0.00
	- Death Loss	2.0%	$452.70	$5.03	$0.02
	- Interest	3.00%	$2,193.75	$24.38	$0.08
		Total Misc. Expenses:	**$2,781.45**	**$30.91**	**$0.10**
	Total Stocker Expenses:		**$18,261.45**	**$202.91**	**$0.68**
	Gross Margin		$4,373.55	$48.60	

Table 3. - Grazing Enterprise on Grass Pasture					
Revenue:					
	# of Head:	90			
	ADG:	2			
	Grazing Days:	100			
	Total Gain / Hd:	200			
	Price / lb. of Gain:	$0.35			
	Total:	$6,300.00			
		Total Revenue:		**$6,300.00**	
Expenses:					
	Feed Costs:		Total	Cost / Head	Cost / lb. Gain
	- Hay & Roughage		$0.00	$0.00	$0.00
	- Straw		$0.00	$0.00	$0.00
	- Grain, Supplement		$0.00	$0.00	$0.00
	- Pasture Costs:		$3,600.00	$40.00	$0.20
	- Ionophores		$0.00	$0.00	$0.00
	- Mineral, Salt, & Vitamins		$90.00	$1.00	$0.01
	- Feed Trucking		$0.00	$0.00	$0.00
	Total Feed:		**$3,690.00**	**$41.00**	**$0.21**
	Herd Health Costs:				
	- Veterinary Services		$0.00	$0.00	$0.00
	- Vaccinations / Antibiotics		$0.00	$0.00	$0.00
	- Herd Health Supplies		$90.00	$1.00	$0.01
		Total Herd Health:	**$90.00**	**$1.00**	**$0.01**
	Marketing Costs:				
	- Livestock Hauling		$0.00	$0.00	$0.00
	- Commissions		$0.00	$0.00	$0.00
	- Brand Inspecting, ACC, Mics.		$0.00	$0.00	$0.00
	- Insurance (Loan; Trucking)		$0.00	$0.00	$0.00
		Total Marketing Costs:	**$0.00**	**$0.00**	**$0.00**
	Other Expenses:				
	- Livestock Supplies		$90.00	$1.00	$0.01
	- Custom Labour		$1,080.00	$12.00	$0.06
	- Death Loss	1.0%	$63.00	$0.70	$0.00
	- Interest	1.0%	$63.00	$0.70	$0.00
		Total Misc. Expenses:	**$1,296.00**	**$14.40**	**$0.07**
	Total Stocker Expenses:		**$5,076.00**	**$56.40**	**$0.28**
	Gross Margin		$1,224.00	$13.60	$0.07

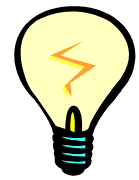
Table 4. - Grazing Enterprise on Alfalfa Pasture						
Revenue:						
	# of Head:	90				
	ADG:	2.75				
	Grazing Days:	100				
	Total Gain / Hd:	275				
	Price / lb. of Gain:	$0.35				
	Total:	$8,662.50				
		Total Revenue:		**$8,662.50**		
Expenses:						
	Feed Costs:		Total	Cost / Head	Cost / lb. Gain	
	- Hay & Roughage		$0.00	$0.00	$0.00	
	- Straw		$0.00	$0.00	$0.00	
	- Grain, Supplement		$0.00	$0.00	$0.00	
	- Pasture Costs:		$2,700.00	$30.00	$0.11	
	- Ionophores		$540.00	$6.00	$0.02	
	- Mineral, Salt, & Vitamins		$90.00	$1.00	$0.00	
	- Feed Trucking		$0.00	$0.00	$0.00	
		Total Feed:	**$3,330.00**	**$37.00**	**$0.13**	
	Herd Health Costs:					
	- Veterinary Services		$0.00	$0.00	$0.00	
	- Vaccinations / Antibiotics		$0.00	$0.00	$0.00	
	- Herd Health Supplies		$90.00	$1.00	$0.00	
		Total Herd Health:	**$90.00**	**$1.00**	**$0.00**	
	Marketing Costs:					
	- Livestock Hauling		$0.00	$0.00	$0.00	
	- Commissions		$0.00	$0.00	$0.00	
	- Brand Inspecting, ACC, Mics.		$0.00	$0.00	$0.00	
	- Insurance (Loan; Trucking)		$0.00	$0.00	$0.00	
		Total Marketing Costs:	**$0.00**	**$0.00**	**$0.00**	
	Other Expenses:					
	- Livestock Supplies		$90.00	$1.00	$0.00	
	- Custom Labour		$1,080.00	$12.00	$0.04	
	- Death Loss	1.0%	$86.63	$0.96	$0.00	
	- Interest	1.0%	$86.63	$0.96	$0.00	
		Total Misc. Expenses:	**$1,343.25**	**$14.93**	**$0.05**	
	Total Stocker Expenses:		**$4,763.25**	**$52.93**	**$0.19**	
	Gross Margin		$3,899.25	$43.33	$0.16	

What is my grass worth?

There are two different means of determining the value of the pasture; specifically tame improved pasture. If one is custom grazing, the value of the pasture is determined by the local price of standing hay. In the north Peace region, standing hay usually trades around $25 per acre for a young productive stand. Given a stocking rate of 2 acres per yearling, your grass cost per yearling for the summer would be approximately $50 dollars.

On the other hand if you are owning the cattle, a market value of 35 cents / pound of gain should be used as a comparative to custom grazing. Given the same stocking rate of 2 acres per head and a total gain of 200 pounds, the opportunity cost on your grass per yearling is approximately $70 dollars.

For the custom grazier, the $20/head difference is the margin that must cover labor, fencing, watering, and a return on investment & management.



The main difference between alfalfa and grass is the superior production that can be attained from alfalfa and the resulting higher stocking rate.

How does alfalfa compare to traditional grass pasture?

The main difference between alfalfa and grass is the superior production that can be attained from alfalfa and the resulting higher stocking rate. On average pure alfalfa stands are worth about $30 per acre as standing crop. A normal stocking rate on a straight pasture of alfalfa would be about 1.25 acres per head. This puts the cost of the pasture at $37.50 per yearling.

In the past, gains of 250 pounds over the grazing season on not unreasonable to expect. At a custom grazing rate of 35 cents per pound this results in an opportunity cost on the pasture of $87.50 per yearling.

However, the production advantage of the alfalfa is offset somewhat by higher death loss or supplement costs due to the hazard of bloat. In our operation, we utilize the CRC Rumensin boluses from Provel at a cost of $11.75 per head. When using this grazing tool, we have been able to maintain our death loss right around 1%. At $11.75 per head for bloat control on a 700 pound steer valued at $875 dollars; the comparable death loss that could be taken as an alternative to using the bolus would be 1.3%. Bloat is a very unpredictable problem, and many horror stories abound of producers that have lost as much as 10% of a group in a single bloat storm. To me $12 is pretty inexpensive peace of mind!

Why do cattle owners balk at $.35 /lb on pasture when feedlot gain is $.60 /lb?

As a rule of thumb, many graziers set their rate for pasture based on 50% of the cost of gain in the feedlot? Why the difference in price? Gain is gain; Right? This is where understanding all of the costs associated with grass cattle comes into play. Overhead costs and relative gain on pasture are the main factors necessitating the difference in charges. Pasture produces relatively low rates of gain compared to the feedlot and at a lot higher risk due to the effect of weather (i.e. drought) on pasture conditions. Cattle owners have fixed overhead costs going out onto grass, and when they only have 200 pounds of pasture gain to spread it out over; the total cost of gain can be quite high. In 1998 and 1999, the drought conditions across much of northern and central Alberta, resulted in poor gains on pasture. In many cases, total cost of gain exceeded $1 per pound. The following table illustrates the effect of gain combined with trucking and overhead charges on the total cost of gain:

Effect of weight gain and overhead costs on total cost of gain

Total Ibs. of Gain	Cost of Trucking / Head*		Other Costs	Pasture Costs $ .35 / lb.	Total Cost of Gain	Cost / lb. of Gain
	Spring	Fall				
50	$8.13	$17.50	$10.00	$17.50	$53.13	$1.06
75	$8.13	$18.13	$10.00	$26.25	$62.50	$0.83
100	$8.13	$18.75	$10.00	$35.00	$71.88	$0.72
150	$8.13	$20.00	$10.00	$52.50	$90.63	$0.60
200	$8.13	$21.25	$10.00	$70.00	$109.38	$0.55
250	$8.13	$22.50	$10.00	$87.50	$128.13	$0.51
300	$8.13	$23.75	$10.00	$105.00	$146.88	$0.49

* Trucking costs based on:
- $2.50 /cwt trucking in fall (full rate)
- $1.25 /cwt trucking in spring (back-haul)
- Freight from Clyde to and from Fairview

* Starting weight in the spring @ 650 lbs.
* Other costs: Vaccinations, Implants, Processing, Feeding, etc.
* Total cost of gain does not take into account any negative margin on original purchase price of calf

During the summer of 1999, feedlot gain hovered around the $57/cwt mark. When compared to the above table, a cattle owner had to be pretty confident that the custom grazier was going to put at least 200 pounds on the cattle in order to make things pencil out. Now as the cost of feedlot gains rise, so does the profitability and demand of grazing.

Can a grazier buy calves in the spring for fall marketing as yearlings, and make some money?

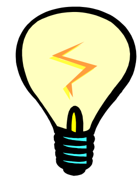
Many of us remember very fondly the spring of `96 when you could buy calves for 70 cents in the spring, and were then able to turn around and sell them as 800 lb. yearlings that fall for 84 cents. Unfortunately, this is a rare occurrence happening maybe once in a beef cycle. A lot depends on the numbers and quality that you want to put together. Trying to land large numbers of uniform good quality cattle in spring that will turn a profit is pretty tough. For this reason, most grass cattle owners slowly put their calves together over the winter as markets allow. By purchases the calves at a lighter weight, you are able to spread your fixed overhead costs over more pounds of gain.

Tables 1 and 5 can be used to compare the two different scenarios.

Table 5. - Backgrounding / Stocker Enterprise on Grass Pasture						
Revenue:						
		Starting		***Finishing***		
	# of Head:	***90***		***90***		
	Weight:	***450***		***850***		
	Price / cwt:	***$135.00***		***$115.00***		
	Price / Head:	***$607.50***		***$977.50***		
	Total:	***$54,675.00***		***$87,975.00***		
		Total Revenue:		***$33,300.00***		
Expenses:						
	Feed Costs:		***Total***	***Cost / Head***	***Cost / lb. Gain***	
	- Hay & Roughage		***$10,350.00***	***$115.00***	***$0.29***	
	- Straw		***$0.00***	***$0.00***	***$0.00***	
	- Grain, Supplement		***$0.00***	***$0.00***	***$0.00***	
	- Pasture Costs:		***$6,300.00***	***$70.00***	***$0.18***	
	- Ionophores		***$0.00***	***$0.00***	***$0.00***	
	- Mineral, Salt, & Vitamins		***$360.00***	***$4.00***	***$0.01***	
	- Feed Trucking		***$0.00***	***$0.00***	***$0.00***	
	Total Feed:		***$17,010.00***	***$189.00***	***$0.47***	
	Herd Health Costs:					
	- Veterinary Services		***$135.00***	***$1.50***	***$0.00***	
	- Vaccinations / Antibiotics		***$540.00***	***$6.00***	***$0.02***	
	- Herd Health Supplies		***$135.00***	***$1.50***	***$0.00***	
		Total Herd Health:	***$810.00***	***$9.00***	***$0.02***	
	Marketing Costs:					
	- Livestock Hauling		***$2,160.00***	***$24.00***	***$0.06***	
	- Commissions		***$1,350.00***	***$15.00***	***$0.04***	
	- Brand Inspecting, ACC, Mics.		***$270.00***	***$3.00***	***$0.01***	
	- Insurance (Loan; Trucking)		***$180.00***	***$2.00***	***$0.01***	
		Total Marketing Costs:	***$3,960.00***	***$44.00***	***$0.11***	
	Other Expenses:					
	- Livestock Supplies		***$135.00***	***$1.50***	***$0.00***	
	- Custom Labour		***$0.00***	***$0.00***	***$0.00***	
	- Death Loss	***2.0%***	***$666.00***	***$7.40***	***$0.02***	
	- Interest	***10.0%***	***$5,467.50***	***$60.75***	***$0.15***	
		Total Misc. Expenses:	***$6,268.50***	***$69.65***	***$0.17***	
	Total Stocker Expenses:		***$28,048.50***	***$311.65***	***$0.78***	
	Gross Margin		***$5,251.50***	***$58.35***		

Scales, Weighing Conditions, and Cattle Handling

A scale is an absolute must if you're going to make money in the grazing business. Waiting until the fall to find out how the cattle did is scary, and just "eye-balling" them over the summer doesn't tell a very accurate story. Continuous monitoring of weight gains will allow you to make timely management decisions that will help maintain profitability. This can be easily done by weighing as little as 10% of a group of cattle every 4 to 6 weeks. It is amazing how close the weight on that 10% is compared to the whole herd. The old saying of " If you can't measure it; you can't manage it" is so true.



But what does cattle handling have to do with economics? How you handle your grass cattle just prior to and during the weighing out process is probably one of the most critical factors effecting your bottom-line. The extra shrink on a load of cattle caused by poor planning or rough handling could easily be the difference between a break-even year or a profitable year. Ideally cattle should be brought in quietly off of pasture, weighed, and put back out on pasture or straight onto the truck. Avoid sorting on weighing day if at all possible.

How you handle your grass cattle just prior to and during the weighing out process is probably one of the most critical factors effecting your bottom line.

One group of cattle that we grazed for a fellow were being sold in Edmonton after leaving our place in the fall. The cattle were brought in and weighed; and the gains were pretty good given the year (*2.1 lbs. ADG, Shrunk weight*). The time was 1:00 p.m. The owner then decided he wanted to do a "little" sorting. Then the trucks arrived, and we had to do a "little more" sorting to make up loads. The last truck was loaded and pulled out of the yard at 10:30 p.m.! When those cattle went through the ring the next morning, they had shrunk out just shy of 10%!

Putting it all together!

If I could sum up the most important steps a grazier could do to increase the financial viability of their operations into a few points, they would probably be:

1) Know who your customers are
2) Know how much you are producing
3) Know what it's costing you to produce it

Once you can answer all of these questions, the final question of "Will I make some money" is pretty self-explanatory! Then you can concentrate on more important matters such as family and friends!

Matching the Cow to the Grass

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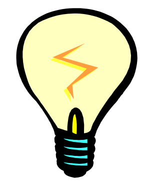
Profitability and long term sustainability are major concerns of astute cow-calf managers. However, attaining these goals are often difficult due to unforeseen economic conditions and confusing signs coming from different technological advances. There is an overwhelmed amount of information explaining the advantages of new product and management practices in the area of breeding, feeding and grazing. It becomes confusing as to which alternative management practice will improve profitability and maintain long term sustainability.



Feeding the beef cow is the single most important cost averaging 60 to 65% of the total cost of production.

Feeding the beef cow is the single most important cost, averaging 60 to 65% of the total cost of production. In Alberta, the cost for winter feed averaged $243/cow in 1996 and $273 in 1997 and ranged from $88 to $320/cow wintered. This range can be attributed to differences in cow type, body condition score (BCS), time of calving and management practices such as rotational grazing, fall and winter grazing programs, balancing winter rations and feeding trace minerals year-round. Most profitable cow-calf managers can be characterized as having a great understanding of how to match cow biological type to the available pasture, winter feed, land, labour and capital resources. This also includes optimizing management practices with climatic factors such as precipitation and photo period and economic factors such as feed cost and cattle seasonal prices. This presentation will focus on the keys factors influencing the profitability and sustainability of a cow-calf enterprise. They are:

1. Optimize economic traits
2. Match the cow type to the resource
3. Exploit individual cow variation
4. Calve on grass
5. Exploit cow body condition

1) Optimize economic traits or *"Sifting the grain from the chaff"*

Information collected by the Production Economics Branch of Alberta Agriculture, Food and Rural Development goes a long way in clarifying factors important to profitability. Data on production, cost and income were collected on over 200 cow-calf herds during the early 1990's. Twenty-eight production, 16 variable cost and four fixed costs traits were studied. Production traits included weaning weight, death loss of calves, culling rate, pregnancy rate, calving rate, weaning rate, pounds calf weaned per cow exposed to breeding, calving span and calving pattern. Fixed costs were insurance on building and machinery, property taxes, term loan interest and depreciation on buildings, machinery and equipment. These 48 variables or factors from each herd were placed into a "statistical black box" - a step-wise multiple regression for those stats gurus - designed to find those that have the largest affect on profitability. Figure 1 illustrates the results of this analysis.

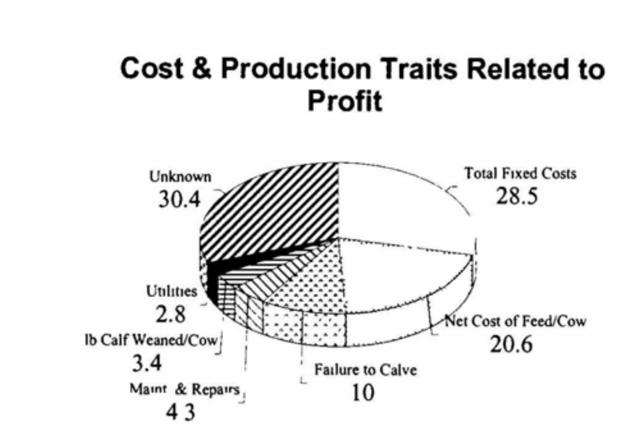
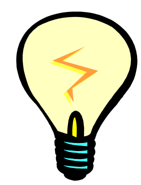


Figure 1. Cost and production traits related to profit.

Controlling fixed costs, winter feed costs and maintaining a high fertility herd are critical factors influencing the profitability of cow-calf production.

Fixed cost was the most important factor affecting profit, accounting for 28.5% of the variability in profit of Alberta cow-calf operations. Next came feed costs per cow wintered, accounting for 20.6% of the variability in profit. This result indicates that grazing and feeding strategies that reduce winter feeding cost are critical to the profitability of a cow-calf operation. Failure to calve was the third most important factor affecting profit, thus confirming the "10:2:1 rule of thumb" of cow-calf production. This "rule of thumb" states that fertility traits are 10 times more important than carcass traits and five time more important than growth traits for the profitability of a cow-calf operation. Cost of maintenance and repairs, pounds calf weaned per cow exposed and utility costs were of less importance, each only accounting for 3-4% of the variation in profit. The large unknown category is due to many factors which were inconsistent and unpredictable among herds, such as differences in weather, pasture productivity, winter feeding strategies and selling methods and price.

2) Match the Cow Type to the Resource



Reproductive rate has a major affect on cow efficiency and over-rides factors such as weaning weight and feed consumption.

Several comprehensive crossbreeding programs conducted in Canada and the United States have concluded that matching the genetic resource or brood cow's biological type to specific environmental and management conditions is critical to production efficiency (Fredeen et al. 1981, 1982; Smith et al. 1987a, 1987b; Cundiff et al. 1984; Montano-Bermudez and Nielson, 1990; Jenkins and Ferrell, 1992, 1994). Harlan Ritchie (Ritchie 1996) at Michigan State University conducted a review of the last 20 years of research on the "Optimum Cow" and concluded that:

- mature cow size is not related to biological efficiency
- acceptable market weight range be a major consideration when decisions are made on breed size and mating systems
- reproductive rate has a major affect on cow efficiency and over-rides factors such as weaning weight and feed consumption.
    - ☞ under restricted feed supply and/or a stressful environment, biological types having moderate size and moderate milk production tend to be better adapted than larger, heavier milking types.

☞ under a liberal feed supply there are no consistent differences in biological type, but there is a tendency for larger, heavier milking types to be more efficient than small to moderate types.

3) Exploit Individual Cow Variation

While these conclusions help cow-calf managers choose a biological type to fit an environment, they do not address the issue of how to select specific animals which optimizes a cow biological type for a given set of resources (feed, labor, capital). The variation that exists within biological types make this general recommendation impractical.

Many measures of biological efficiency have been applied under research conditions (Smith et al. 1987a, 1987b; Doornbos et al. 1987; Kattnig et al. 1993; Melton and Colette, 1993). All measures use the ratio calf weight or carcass weight outputs to feed energy or organic matter as inputs. Under commercial conditions measuring individual cow feed intake is not practical. Fortunately, feed intake for maintenance is proportional to metabolic body weight (NRC, 1996) and weaning weight is highly (R^2=.40) related to milk production (Butson et al. 1980).

Cow weight at weaning and milk production accounted for 90% (Manyberries) and 96% (Brandon) of the variation in total feed energy inputs (Mcal DE/cow/yr) of first-cross dams in the foreign cattle breed evaluation (FCBE) program initiated by Agriculture Canada (Smith et al. 1987a; 1987b). These data also showed a strong relationship between an indirect measure of biological efficiency (calf weaning weight/cow metabolic weight at weaning plus one-half calf metabolic weaning weight) and the ratio of calf weaning weight to total feed energy inputs (Brandon, R^2=.966; Manyberries, R^2=.906; P=.0001). Therefore, the following equation was developed to estimate individual cow biological efficiency (BE):

$BE = WWT_{adj} /(CWT^{0.75} + ((((WWT_{adj} - BWT)/AGE) \times (AGE/2)) + BWT)^{0.75})$;
where WWT_{adj} equals actual calf weaning weight (lb) adjusted for gender, CWT equals cow weight at weaning, BWT equals actual calf birth weight (lb), AGE equals calf age at weaning (d). Weaning weight was adjusted to a steer equivalent and constant weaning date, but not a constant weaning age (i.e., 200 day weaning weight). Weaning weights were not adjusted to a constant weaning age because this procedure would eliminate the effect of low weaning weights from cows which calved late due to poor fertility.

Across year BE for each cow were calculated by using a Most Probable Producing Ability (MPPA). The MPPA was calculated using the following equation:

MPPA = Herd Avg + (((N x R)/(1 + ((N - 1) x R))) x (Cow Avg - Herd Avg)),

where Herd Avg is the sum of the herd’s BE values across all years divided by the number of opportunities that all cows had to wean a calf, N equals the number of records for an individual cow, R equals the repeatability estimate or 0.40, Cow Avg is the sum of the BE indices for an individual cow divided by the number of opportunities that cow had to wean a calf .

These equations have been used to investigate the within herd variation in cow biological efficiency. For example, an intensively managed Black Angus herd located in central Alberta was studied over two years. Cow weight at weaning ranged from 1060 lb to 2060 lb and averaged 1498 lb. Cow-calf pairs rotationally grazed improved grass-legume (118 days) and annual pastures from May to September. The calves were weaned during the middle of September. The cows were held in a sheltered treed area and received grass hay and straw during the winter months. This diet was supplemented with barley grain during the last 65 days of pregnancy and during the first 70 days of lactation. Cow weight and body condition score were taken at weaning and biological efficiency on each cow was calculated (Figure 2).

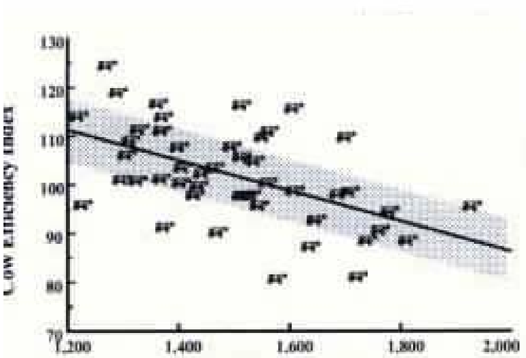
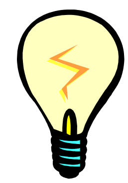


Figure 2. The relationship between cow biological efficiency index and cow weight at weaning. An index of 100 is herd average.

There are two key conclusions that can be drawn from this example. Firstly, there was considerable variation in biological efficiency among individual cows across all weights. This indicates that individual cow variation in biological efficiency can be exploited to improve profitability and long term sustainability. Research has shown that there is a 16-22% variation in energy requirements among breeds of cattle (Nielson 1995) and that within breed variation is at least as high (DiCostanzo et al. 1990). Thus within a herd or group of feeder cattle originating from several herds the individual animal variation in the energy cost of maintenance could vary by as much as 30-50%.



Individual cow variation in biological efficiency can be exploited to improve profitability and long term sustainability.

The second conclusion that can be taken from this example is that cow biological efficiency was negatively related to cow weight at weaning. Most cows over 1550 lb had below average biological efficiency indices. This result does not mean that small cows are more efficient than big cows. It means that, in this specific herd, cows over 1550 lb were too big and did not match the feed, labor, management and capital resources provided. Several other herd have been studied with similar results.

4) Calve on grass

Time of Calving

Dick Diven, a noted advocate of low cost cow-calf production systems, suggests that photo period has a significant impact on the anestrus period and thus on the best time of calving to optimize herd fertility. He quotes Dr. Jan Bonsma's observations "that sexual activity of cattle was greatest at or near the times of the vernal and autumnal equinoxes; around March 21 and September 22 (Fig. 3). In the southern hemisphere, the vernal equinox was recommended by Bonsma as the best time for breeding, whereas the autumnal equinox would be recommended in the northern hemisphere.

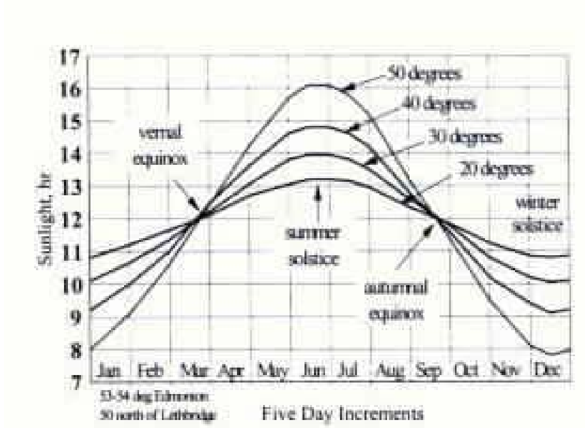


Figure 3. Daily photo periods for various degrees of north latitude (adapted from D. Diven, 1998).

Research conducted in the US by Hansen and Hauser (1983) also supports the influence of photo period on fertility (Fig. 4).

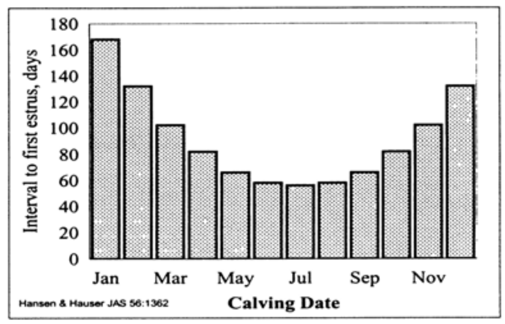


Figure 4. Relationship between calving date and port-partum interval.

Their data indicated that cows calving in May through September commenced cycling within 60 to 70 days of calving. Those calving from October to April commenced cycling within 80 to 160 days after calving.

Critics of photo period argue that cattle, unlike sheep, are not seasonal breeders and that photo period is not a primary regulator of reproductive activity in cattle. They also argue that temperature, nutrition and improving body condition at that time of year are more important factors than photo period. However, these arguments do not rule out time of calving being important from the point of availability and cost of feed supplies.

Fall versus spring calving

Numerous studies have reported lighter birth weights, less calving difficulty, less scours and pneumonia and less death loss in fall calving as compared to spring calving (McCarter et al. 1991a,b). In an Oklahoma study, McCarter and coworkers (McCarter et al. 1991a,b) reported that fall born replacement heifers calved first at an older age and had lower lifetime calving percentages. Feed requirements for fall and spring calving are approximately equal, however, total feed costs are about $35/cow higher for the fall calving system (Pang et al. 1999). This is because the higher feed input required for late gestation and early lactation coincide with winter when more expensive, stored feeds are being fed. Proponents of fall calving argue that the higher cull cow and calf prices in April and May more than compensate for higher feeding costs. However, higher calf prices in April and May was not the trend in Alberta during the years from 1994 to 1998. Figure 5 illustrates that June, July, August and September were the months with the highest prices for 500-600 lb calves sold in Central Alberta. Under this prices environment, fall calving did not have an advantage in higher prices for weaned calves. It can be concluded that while fall calving may be desirable under some circumstances it is not recommended from the point of optimizing fertility and minimizing costs.

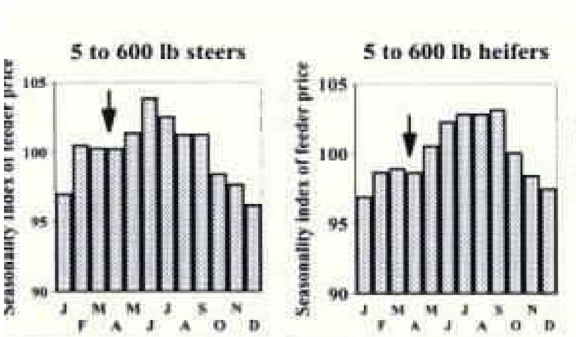
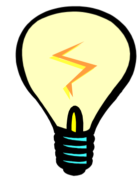


Figure 5. Seasonality of price in Alberta (central Alberta, 1994-1998; a 5 year average)



While spring calving may have advantages in optimizing fertility and lowering production costs, the exact months of calving is open to debate. To help us answer this question, lets look at the annual energy requirement pattern of a beef cow (Fig. 6).

Peak energy requirements for the beef cow occur about six weeks after calving at peak lactation …

Calving just before or just after the onset of lush forage would provide the best forage yield and quality to satisfy the cow's requirement.

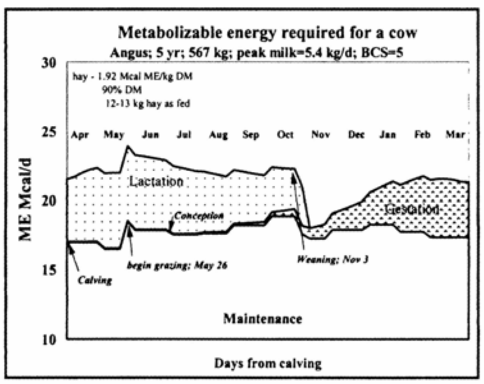


Figure 6. Annual energy requirement pattern for maintenance, gestation and lactation for a 1250 lb, mature beef cow.

These energy requirement patterns were generated by the Alberta Beef Production Simulation model developed by Pang et al. (1999). This figure illustrates that the maintenance requirements increase due to grazing activity from May to the end of October and again during the winter months due to colder temperatures. **Peak energy requirements for the beef cow occur about six weeks after calving at peak lactation** and when the cows and calves are placed on pasture. The lowest energy requirements for the cow occurs during the second trimester when the calves are weaned and the cows come off pasture. Thus, one could speculate that **calving just before or just after the onset of lush forage would provide the best forage yield and quality to satisfy the cow's requirements** for milk, maintenance and improving body condition. The time when forages will have best yield and quality will vary from farm to farm. However, data taken from the Lacombe Research Centre show that meadow brome, smooth brome and meadow foxtail reach yields of 1.5-2.0 tonne/hectare by mid to late May, whereas Orchard grass reach these same yields by mid June (Baron and King, 1992). Thus, calving in late May, early June (breeding in mid August) may be the optimum time of calving under these conditions.

A study was conducted at the University of Alberta Ranch at Kinsella to investigate the productivity of early (April) versus late (May - June) spring calving (Pang et al. 1998). Breeding in the early group began on June 21 to commence calving on April 1. Breeding in the late group began on August 4 to commence calving on May 15. The breeding season was 42 days long and calves in both groups were weaned at the same time. Records on 816 cows calving were taken from 1991 to 1993. The average calving span for the early group was longer than that for the late group (Table 1; 53 vs 47 days). The number of calves born in the first 21 days of the calving season was lower in the early group than in the late group (51.5 vs 61.8%). The tighter calving span and more calves born early are considered advantages for the late calving group. Pregnancy rates, calving rates and weaning rates were similar between early and late calving.

Table 1 .Effects of early vs late spring calving on cow-calf productivity

Trait	April	May/June
Calving span, d	**53**	**47 ***
Born in first 21 days, %	**51.5**	**61.8 ***
Pregnancy, %	**89.2**	**91.9 NS**
Birth weight, kg	**38.9**	**41.2*****
Preweaning ADG, kg/d	**1.17**	**1.12*****

Pang et al., 1998; University Of Alberta Ranch at Kinsella; 1991-1993; 816 cows

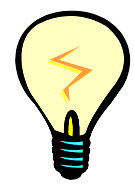
In this same study, birth weights of calves, adjusted for gender, were lower for the early calving group than for the late calving group (Table 1; 38.9 vs 41.2 kg). The authors attributed the heavier birth weights in the late calving group to more favorable nutrition from new growth pasture. This difference was more pronounced for heavier milking biological types. Calf preweaning average daily gain (ADG) was slightly higher for the early calving group, indicating that older calves are more able to utilize pasture and consume larger quantities of milk.

Table 2. Effects of early vs late spring calving on cow-calf productivity

Trait	April	May/June
Post-weaning ADG, kg/d	**1.57**	**1.56 NS**
Heifer wt at breeding, kg	**300**	**308 NS**
Cow BCS at calving	**2.5**	**2.6 NS**
Cow wt at weaning, kg	**576**	**564 NS**
Cow BCS at weaning	**3.1**	**2.8*****

Pang et al., 1998; University Of Alberta Ranch at Kinsella; 1991-1993; 816 cows

Early and late calving group were similar in post weaning ADG, heifer weight at breeding, cow BCS at weaning and cow weight at weaning (Table 2). These results indicate that late calving accompanied by a shorter lactation period is an advantage to the nutritional status of the cow. In addition, late calving allows peak lactation to be matched to peak pasture availability.

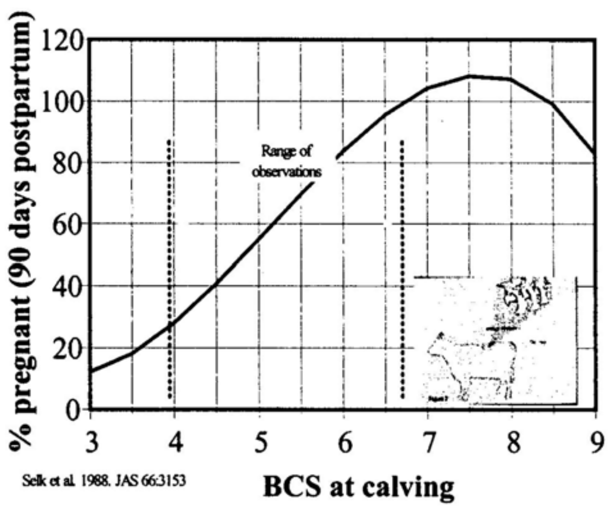


Determine calving date by matching peak nutrient requirements of the cow to the time when range forages have the highest level of crude protein.

Don Adams and his colleagues at the University of Nebraska are presently conducting a study comparing March to June calving (Adams et al. 1998). The cows are located in the Nebraska Sandhills where peak pasture quality occurs between June and July. Their hypothesis is to determine calving date by matching peak nutrient requirements of the cow to the time when range forages have the highest level of crude protein available in amounts adequate to meet the cows needs. They also wanted a short period of green grass before calving to ensure that cows would be in BCS 5 or 6 before calving. Preliminary data shows that matching the cow to the forage resource has saved more than enough costs to offset the lower weaning weights observed in their study. They emphasize that time of calving will vary for each set of range and pasture resources.

5. Exploiting cow body condition

The normal physiological function of an animal dictates a specific priority for the utilization of nutrients: body maintenance comes first, followed by lactation and growth and then reproduction. Thus, during nutritional deprivation, reproduction is the first to suffer and the last to recover. Since reproduction is the most important production trait influencing profitability of a cow-calf enterprise, it becomes essential to have an indicator of the cow's nutritional status.



Body condition score (BCS) is such an indicator and is a subjective measure of the amount of body weight that is fat. The relationship between BCS and reproductive performance is well documented (Selk et al. 1986). Researchers at Oklahoma State University (Selk et al. 1986) have clearly demonstrated the negative influence of poor body condition at calving on subsequent pregnancy rate (Fig. 7).

Figure 7. Effect of body condition score at calving on pregnancy rate.

Cows with a BCS of 6.5 to 7 have a much higher chance of conceiving within 85 days after calving. Having a cow conceive within 85 days after calving is critical for maintaining a yearly calving interval. A BCS of 6 is described as "ribs fully covered and not noticeable to the eye; plump and full hindquarters; noticeable sponginess over the foreribs and on each side of the tail head; and firm pressure required to feel the transverse processes". Ferrell and Jenkins (1996) suggest that maximum cow productivity and net return occur at a more moderate body condition, generally between 4.5 to 5.5. In conclusion, a BCS of 5 to 6 at calving (2.5 to 3.0 BCS in the East of Scotland College of Agriculture Canada system) appears to be optimum for cow reproduction and net return.
While a BCS at calving of 5 to 6 may be desirable, body condition can fluctuate throughout the year (Fig. 8).

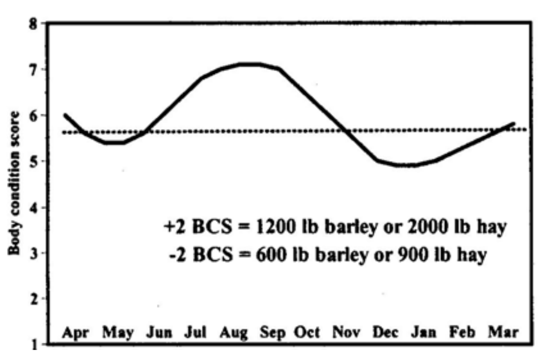
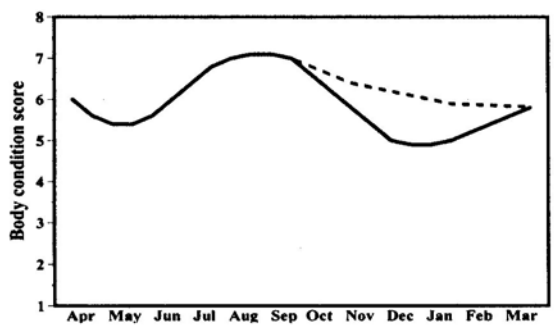


Figure 8. Typical seasonal pattern of cow body condition.

Body condition normally fluctuates between a high of 7.5 to 8 during August and September to a low of 4 to 5 in December and January. If cow BCS has to be increased from 4 to 6 at calving then an additional 1200 lb of barley or 2000 lb of hay are required during winter feeding (Rob Hand, pers. comm.). This is a very expensive way to add body condition to the cow herd.

A more profitable alternative would be to let the cow harvest forages and store excess energy as fat to be used during the more expensive winter months. In reality there is a very short window of time when the cow's nutrient requirements are low enough to allow her to gain body condition. In Alberta under a spring calving system, this period normally occurs during the cow's second trimester when the calf has been weaned and nutrient requirements are at their lowest. This period is the best time for the cow to consume forage energy in excess of other physiological functions. For example, no energy is required for lactation and minimal energy is required for gestation. Thus, the Figure 9. Seasonal pattern of body condition using fall grazing and stockpiled forages (--) cow can maintain or slightly reduce summer pasture body condition score by grazing fall pastures and stockpiled forages. For example, research conducted by the Western Forage Beef Group demonstrated that 78 days of swath grazing increased cow weights and body condition score. This was accomplished at feeding costs that were 32% less than a traditional feeding system. These costs included land, seed, fertilizer, herbicide, feed, bedding, manure removal, and equipment. Traditional feeding refers to cows in confinement fed free choice straw supplemented with silage, grain and a feedlot supplement formulated to NRC (1996) fed every day.



In conclusion, the profitability of a cow-calf enterprise can be improved by:

- optimizing fertility traits,
- matching cow type to the resources,
- exploiting individual cow variation,
- matching calving to forage growth, and
- exploiting body condition score.

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Extended Grazing: Fall/Winter/Spring

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Stockpiling Perennial Forages

The practice of stockpiling perennial forages to maximize grazing days can significantly lower the cost of production in a livestock operation. The harvesting, handling, and storage of feed is the cattle producers' single biggest expense. A study done by Alberta Agriculture on beef cow herds showed that winter feed costs averaged 40% of total cash costs. Grass farmers who have focused on lowering their costs through stockpiling perennial forages are now reaping the benefits during this low cattle market. This is not to say that stockpiling is only for beef cows. It doesn't matter what type of grazing livestock you have, beef cows, yearlings, sheep, dairy, horses, bison, elk, deer etc.; all can make use of stockpiled grass to extend grazing and lower costs.

Every day that a cow can harvest her own feed instead of you doing it for her is money in your pocket! Many ranchers use ball park figures of $1.00/day to feed a cow and $.50/day for grazing. These figures may not be the actual costs on your grass farm but for illustration purposes it is easy to see that is half price! As consumers we are usually thrilled when we can purchase something for 50% off, this is how we should look at the price relationship between grazing and feeding as well. I am sure no one in the beef business needs a reminder that they are price takers and a profit is produced by keeping production costs below sale revenues.

Plan to Stockpile Forage

In order to stockpile a deliberate plan is required. A producer needs a grazing plan that ensures there will be grass available to graze in the fall, winter or early spring. You need to match up your stocking rate with your pasture resources. The amount of stock that you carry and the productive capability of your pastures need to be realistic and achievable. Sometimes running fewer cattle and grazing them longer at lower cost leads to more profit. A chronic shortage of grass by early fall is usually caused by overgrazing and overstocking. In order to stockpile grass there needs to be a time in the late spring/early summer when your livestock can't possibly keep up with the pasture that is growing on your farm. We refer to this period as the "fast growth period". By setting aside pastures that were grazed during fast growth you can stockpile grass for later use.

If you make hay or silage on your farm, I suggest that stockpiling grass can be as simple as deciding to harvest less and graze more. Astute grass farmers use hay making as a pasture management tool rather than a means of obtaining winter feed. Their goal is to cut excess pasture to keep it from getting mature. Cutting the excess pasture keeps more acres of forage actively growing which allows you to stockpile high quality feed and maintain high quality pasture where the cattle are grazing. Winter feed then is the by-product of this type of harvesting - not the goal. The important point is that the emphasis is on the pasture - not the hay. Another benefit of hay making as a pasture management tool is that the hay or silage harvested from pastures is usually very high quality.

Whether you stockpile grass from pastures that are only grazed or use hay making as a tool to harvest excess pasture you need to graze or cut a pasture for the last time early enough in the growing season to allow plenty of time for regrowth. Timing of grazing or cutting can be anywhere from mid June to late July. Speed of regrowth can vary greatly from paddock to paddock within the same farm and is influenced by forage species, soil type and fertility, moisture availability, etc. The goal for banking forage should be to stockpile a high volume of good quality grass. High volume will give maximum animal days of grazing and is necessary if the livestock are expected to graze through much snow. High quality grass of course will give good animal performance. Ideally the grass should still be vegetative at the end of the growing season. Green vegetative forage is lower in fibre and higher in protein and energy than mature coarse forage. Vegetative grass is also more palatable and easier to digest than mature grass.

Nutritional Requirements of Livestock

The nutritional requirements of the livestock that are to graze the stockpiled forage need to be taken into consideration. For example a dry pregnant cow in early to mid gestation has relatively low requirements whereas a growing feeder calf has much higher nutritional requirements.

A Quick Reference to Protein and Energy Allowances for Beef Cattle and Sheep

	% Crude Protein		Mcal. DE/lb.				TDN
	----------------- (Dry Matter Basis) -----------------						
Cows							
Mid-preg	8			1.0			50
Late-preg	9			1.08			54
Lactation	10 - 12			1.12 - 1.25			56 - 63
Wintering Bulls	9			1.05 - 1.2			53 - 60
	Low	High	Low	High		Low	
	High ADG	ADG	ADG	ADG	ADG	ADG	
Growing Calves							
400 to 600 lb	11-12	12-14	1.2-1.3	1.35-1.5		60-	
65 68-75							
600 to 800 lb	10-11	12-13	1.2-1.3	1.35-1.5			
+800 lb	9-10	11-12	1.2-1.3	1.35-1.5			
Finishing Cattle							
900 to 1000 lb		10-11		1.35-1.5			68-75
+1000 lb		9-10					

	% Crude Protein		Mcal. DE/lb.	TDN
Ewes				
Maintenance	10		1.1	55
Flush/breed	10		1.2	60
Early preg	10		1.1	55
Late preg	12		1.3	65
Milk - 1 lamb	14		1.3	65
Milk - 2 lambs	15		1.3	65
Wintering Rams	10		1.15	58
	Early Weaned	Off Grass		
Growing Lambs				
40 - 60 lb	17	16	1.55	78
60 - 80 lb	16	15	1.55	78
+ 80 lb	15	12	1.55	78

Source: D. Engstrom, Nutrition Section, Alberta Agriculture, September 1991
Modified: G. Lastiwka, Crop Specialist - Forages, AAFRD, February 1996.

Forage Species for Stockpiling

A wide variety of forage species are suitable to stockpile. Generally grasses are superior to legumes. Legumes appear to deteriorate from weathering more rapidly than grasses. The later stockpiled pasture is kept before grazing the less suitable legumes appear to be. This is particularly true of alfalfa, leaf losses can be quite high. A practical guide-line would be to graze fields with a high percentage of legumes in the fall rather than carry them through the winter for spring grazing. Save your predominantly grass stands for grazing in winter and early spring. In the grey wooded and black soil zones Kentucky bluegrass and creeping red fescue are excellent grasses for stockpiling. These grasses are sod forming grasses with relatively narrow leaves that produce a dense mat of herbage. The dense mat of pasture formed by these grasses seems to be self insulating which appears to protect the forage from weathering. I have observed many times pastures of creeping red fescue and Kentucky bluegrass that still contain a large portion of green material through the winter and into the early spring following snow melt. Trials done by Grey Wooded Forage Association indicated very little quality or yield losses of these two grasses when overwintered. Taller growing grasses such as smooth bromegrass and timothy are also suitable for stockpiling. When vegetative these grasses are often higher in nutritional value than creeping red fescue or Kentucky bluegrass but seem to lose more quality and yield from overwintering. In the drier areas of Alberta many native species are stockpiled for winter grazing. Rough fescue is well known for its' ability to "cure on the stem" and provide winter grazing for dry cows. Russian and Altai wildrye are cultivated species that are useful for stockpiling in drier areas.

Table 2. Protein and Energy values of Stockpiled Forages*

Table 2-A Fall samples

Forage Type	% Protein	Digestible Energy(mcal/lb)
Alfalfa	15.5	1.30
K.bluegrass/timothy/clov	12.0	1.22
Red fescue	11.2	1.30
Red & Alsike clover	15.2	1.08
Orchardgrass/meadow foxtail	11.5	1.22
K. bluegrass/timothy/orcahard	12.6	1.19
Red fescue/clover	10.5	1.23
Sedge	11.0	1.23
Quackgrass/bluegrass	17.5	1.24

Table 2-B Early spring samples following snow melt

Forage Type	% Protein	Digestible Energy (mcal/lb)
Alfalfa	10.6	1.07
K bluegrass/timothy/clov	10.7	1.22
Red fescue	10.6	1.25
Red & Alsike clover	13.1	1.10
Orchardgrass/meadow foxtail	11.0	1.22
K. bluegrass/timothy/orchard	13.9	1.21
Red fescue/clover	8.9	1.19
Sedge	11.1	1.19
Quackgrass/bluegrass	20.8	1.25

Results are reported on a dry matter basis
Source: Lastiwka, Alberta Agriculture. Bauer, Grey Wooded Forage Association

*Table 2 contains examples of nutritional values of stockpiled forages. Use this information with caution as feed quality is dependent on stage of maturity of the plant and fertility of the soil it is grown on. These examples are not standardized and are not intended to be a comparison between species.

Grazing the Stockpiled Forage

It is important to ration stockpiled grass. Rationing is necessary to obtain optimum utilization of the forage. A good deal of forage can be wasted if livestock are allowed free access to a large area. Waste occurs from trampling and fouling with manure and urine. Higher volumes of forage are more at risk of losses from waste than lower yields. Yields of 1 to 2 tons/acre of dry matter or more is common in high forage producing areas. High yields of this nature should be rationed on a daily basis giving the stock access to only as much forage as they can consume in a day. Daily rationing should keep waste to a minimum and grazing utilization at an optimum.

When snow is on the ground it is important to continue rationing. Small amounts of snow (up to 3") do not affect grazing very much. After there is roughly 4" of snow grazing efficiency starts to decline, i.e. grazing is hampered somewhat and the cattle cannot graze a pasture as cleanly as if there was little or no snow on it. A high volume of stockpiled grass makes grazing through snow much easier. Snow in the fall often contains a fair bit of moisture and if cattle are allowed to roam freely, their act of walking packs the snow down and will "seal off" the pasture. If given a fresh break of grass every day a cow can graze through quite a bit of snow by brushing it aside with her muzzle. Of course there is a limit to how much snow a cow can graze through. Often snow depth is not as important as the condition of the snow, i.e. soft fluffy snow is easy to graze through, but hard icy snow is very difficult. The grazier has to use common sense and good judgement when determining if the livestock are able to meet their needs while grazing through snow.

Stockpiled grass is a valuable feed source in early spring after snow melt. If your herd is calving at this time stockpiled grass can make a clean dry bed for new calves while providing the feed for the cow herd. Yearling grass cattle can get an early start to the grazing season at this time. It is important to graze off this carry over grass as the old grass will block sunlight and inhibit new growth. Later in the spring it is important to back fence what has already been grazed. As new growth starts it needs to be protected; back fencing will keep the livestock from going back and grazing new green shoots.

It is my belief that maximizing grazing days by stockpiling perennial forages is one of the livestock producers' best tools to minimize production costs. Perennial forages are a wonderful resource and if managed well can provide a sustainable harvest of good quality grazing year after year.

Grazing Nutrition

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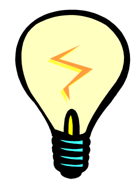
A well managed grazing system offers an opportunity to reduce the cost of producing forage and may contribute to savings in feed costs of about half to two-thirds of the decrease in total feed costs. However, there are nutritional and management challenges for grazing systems to reach the genetic potential of their animals. Therefore, there is increased interest in supplementing pastures to consistently achieve competitive gains and feed conversions. Producers have many choices including no supplements, trace mineral salt only, major minerals plus trace minerals with salt, primarily energy, primarily protein or a combination of energy and protein supplements. The choice within the protein supplements is further complicated by the portion of protein available in the rumen (DIP - degradable intake protein) or the small intestine (UIP - undegradable intake protein). But more on that later. First lets discuss dry matter intake on pasture.

DMI Is An Overriding Factor to Forage Quality



Dry matter intake is highly related to productivity and profitability depends largely on animals achieving as high an intake as possible.

Forage intake can only be measured when animals are allowed to eat as much as they desire. This implies that the amount of feed offered should be greater than the amount that the animal can consume. However selective grazing complicates the intake measurements. Table 1 illustrates the complexity of intake and the various factors influencing it.

Insert Table 1
Dry matter intake (DMI) is highly variable in even well managed pasture and is the major factor limiting animal performance. Maximum DMI occurs when grass or legume yields exceed 1800 pounds (820 kg) or 1400 pounds (635 kg) of fresh dry matter over the total grazing period. At forage utilization rates of 40% for grasses and 50%-60% of legumes, this implies that DMI will be limited when animals are grazing pasture with grass and legume dry matter yields of 3000 pounds (1360 kg) and 2650 pounds (1200 kg). Expect annual yield and its effect on DMI to be equivalent to legumes or better. Twice daily moves can increase utilization rates of pasture without sacrificing DMI.

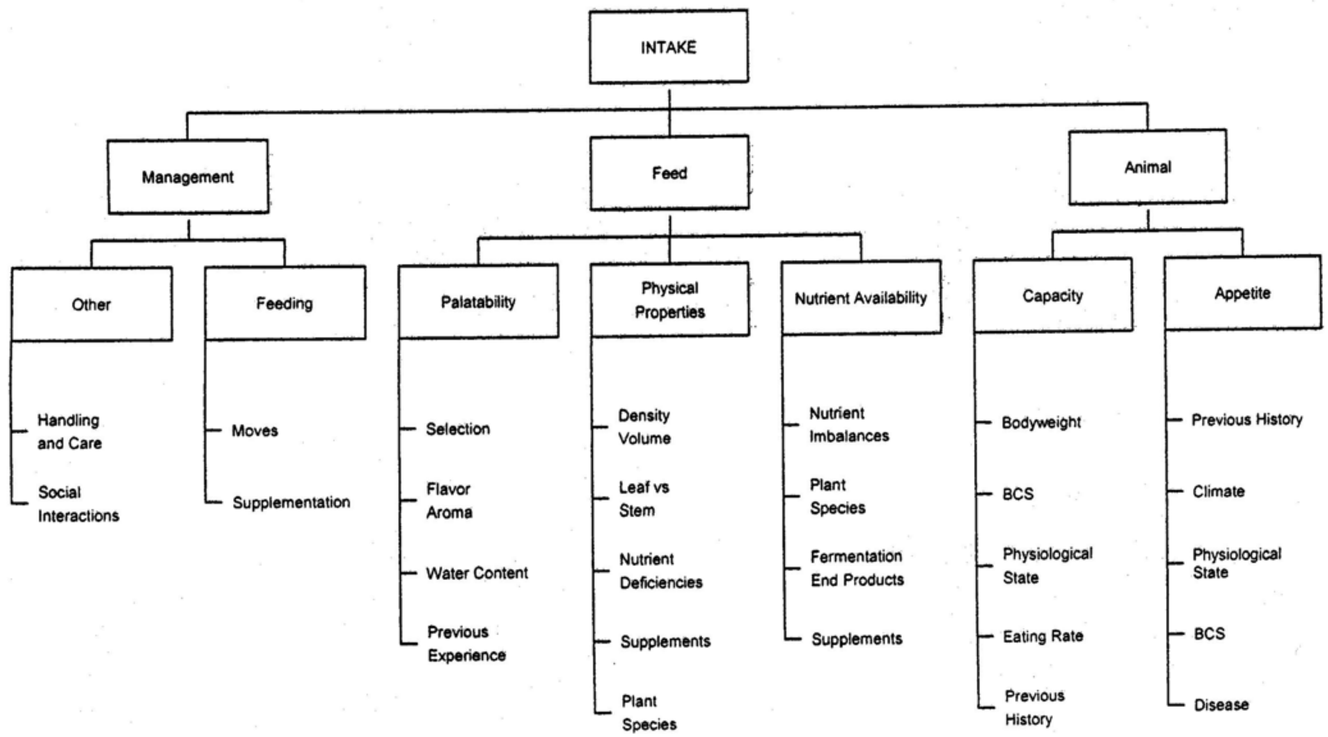
Dry matter intake is highly related to productivity and profitability depends largely on animals achieving as high an intake as possible.

Limitations to Dry Matter Intake on pasture

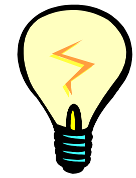
1. Forage mass in early spring or late fall are typically less than the critical yield to achieve maximum DMI.

Table 1: Some Factors Affecting Intake on Pasture

(Forage Quality, Evaluation, Utilization 1994)



2. Increased stocking rate tends to increase nutritional quality of the pasture. However DMI decreases as grazing period lengthens or stocking rate increases because yield of fresh unfouled forage diminishes below the critical yield levels for maximum DMI.
3. DMI is influenced by: sward density and height, forage quality (variable with plant maturity , species, previous grazing management, plant and animal mineral balances, drought - decline of protein and NDF (neutral detergent fiber), plant non-structural carbohydrate content, frost, insect problems, distance to water and quality, topography and forage palatability etc.



Animals consume less dry matter on pasture compared to nutritional balanced total mixed rations in confinement.

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Seasonal Supplement Considerations For Feeders On Tame pastures in West Central Alberta

This portion of our paper will focus on protein and energy considerations for pasture supplements for yearlings over a typical pasture season. Supplementation with major minerals such as phosphorus and trace minerals have been considered separately.

Our discussion points are based on using Cowbytes 3.0 (Windows), the Alberta Agriculture ration balancing software package. We tried to simulate the change in pasture quality with changing seasons, monitor nutrient requirements for a 700 lb yearling steer to grow at 2.5 lb/day and suggest supplemental feedstuffs to consider as the season progresses. The analysis was restricted to energy, crude protein, degradable intake protein (DIP) and undegradable intake protein (UIP).

Initial and final feeder value, pasture cost, feedlot cost of g ain or supplement costs were not considered within this analysis but must be included on a farm basis. Pasture and forage energy and nutrient composition data from NRC-Beef (1996), Alberta data (Kyle Greenwood, Grey Wooded Forage Association (1994-1996), Lastiwka (1994-1997), Vern Baron (1994-196) and Suileman (1995) were combined into four seasonal periods. Seasons and generalized nutrient analysis are listed in Table 2.

Table 2. Average Tame Pasture Nutrient Analysis for Four Periods Throughout the Season in West Central Alberta

	% DM	% TDN	% NDF	% eNDF	% CP	% DIP	% UIP
Stockpiled Spring	65	58	70	98	9	60	40
May to Early June	18	70	45	30	24	94	6
July, August and early September	18	67	54	41	15	85	15
Late September and fall	35	62	60	41	10	82	18

DM - dry matter, TDN - total digestible nutrients, NDF - neutral detergent fibre, eNDF - effective fibre as % of NDF, CP - crude protein, DIP - % degradable intake protein of CP, UIP - % undegradable intake protein of CP

It should be noted that the above values will vary greatly depending on forage species, fertility, grazing management, etc.. Representative values for your farm/client will be the most accurate. To sample, carefully watch how the animals graze and by hand grab sampling, collect those plants in the appropriate portions the cows were grazing.

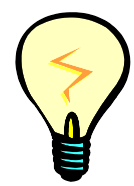
Seasonal Considerations

The analysis assumes forage availability is not restricting intake, that is dry matter availability is greater than 2 tons per acre. There can however, be times and grazing systems throughout the season when forage intake is restrictive. Managers will have different objectives depending on maximum gain or per acre yield, planned sale dates, whether cattle will be finished after the pasture period, pasture management systems and skills applied, varying weather conditions, etc. Feedlot managers may wish to use the pasture as a large feed pen while graziers want to optimize gains per animal or per acre and maximize forage digestibility and stand longevity.

There will be differences between protein and energy supplementation strategies and forage digestibility. A protein supplement can increase forage intake, especially for high fibre, low protein forages, typical in fall and stockpiled forages. As the forage protein content increases, the intake response to the protein supplementation decreases marginally. Protein supplements can enhance forage digestibility and generally do not result in substitution of supplement for forage intake. Research suggests that energy supplements (primarily grain) fed at 0.4 to 0.6% of body weight on a forage diet do not significantly reduce forage digestibility and forage intake. At higher energy supplement intakes, animals will substitute the supplement for available forage. An energy supplement has the least effect on forage intake when forage quality is low. Energy supplements work best when forage dry matter availability is restricted, for extending the pasture or when limit fed in small quantities. Feeding an ionophore on pasture is justified provided a supplemental energy or protein is required or the owner wishes to reduce the risk of bloat or coccidiosis.

Stockpiled Spring

In this time period a yearling's gain is restricted by low forage energy content, and usually crude protein and degradable intake protein (DIP). The DIP supplied is perhaps 50 to 80% of that required and may be the first limiting nutrient. This suggests reduced intakes due to slower degradation of fibre and rates of passage because of inadequate nitrogen for rumen activity.



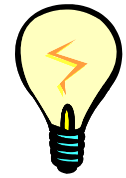
The maximum NDF intake is close to 1.2% of body weight of the animal.

The maximum NDF intake is close to 1.2% of body weight of the animal.

Preferred supplements are those that can supply DIP and thereby increase digestibility of fibre. They include molasses and urea protein supplements in liquid and block form or grain and urea supplements. A minimum DIP:TDN ratio of 12 to 13% (higher if forage quality especially low) in the supplement has been suggested by US researchers for cattle on low quality forages. About 25% of the DIP supplied can be from urea if dietary energy is adequate. Energy (grain or range pellets) supplements with urea are acceptable but should not be fed at levels that detract from potential compensatory gain which abundant spring forage growth will soon allow to occur. Natural energy/protein supplements such as hay are acceptable.

Energy and degradable intake protein (DIP) are limiting in stockpile forage.

May to Early June



Energy and degradable intake protein (DIP) are limiting in stockpile forage.

It is in this time period, that the transfer of cattle from winter feed to spring grazing may introduce an additional stress. A gradual shift from long fibre stored feeds, to lush pastures will allow a more gradual rumen adjustment.

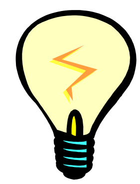
This time period is characterized by pasture that is low in effective fibre and supplies perhaps 2.5 times more DIP than required for rumen activity. The low effective fibre will result in less rumination, an acidic rumen pH and a decrease in microbial protein production. A compromised rumen due to a low rumen pH, excess ruminal ammonia and high forage moisture will likely result in low dry matter intakes and less than satisfactory gains. The excess rumen ammonia will be expensive to convert to urea. If rumen ammonia is too high, the yearling may be more worried about staying alive than trying to gain weight. Further factors affecting intake could be negative palatability factors associated with high moisture forages. This all occurs in a time period of potential large and cheap compensatory gains.

The amount of microbial protein (MP) produced in the rumen depends on both NDF and the effective-NDF. The MP produced decreases as the effective-NDF decreases from 20% and when it is higher than 56%.

Preferred supplements are those high in effective fibre and include limited amounts of feedstuffs such as stored grass hay or beet pulp. This is not a time to feed energy from grain since increased starch intake will aggravate an already acidic rumen.

A surplus of degradable intake protein (DIP) may account for losses in gain of about 0.5 to 1 pound a day.

July, August and Early September



A surplus of degradable intake protein (DIP) may account for losses in gain of about 0.5 to 1 lb. a day.

This period is more ideal for sustained gains than the earlier season pasture growth provided that adequate pasture dry matter is available and it is managed properly. The nutritional software program, Cowbytes indicates sufficient levels of effective fibre, DIP and UIP. The July to early September time period is extremely variable for forage quality and availability and is dependent on the grazer's skills in managing the forage to meet the growing animals needs.

Preferred supplements here will depend on owner objectives (daily gain versus gain per acre) and forage management (grazed continuously, grazed by controlled methods and grazing severity). Feed energy supplements if extending the pasture is a high objective. The substitution level between energy supplement and forage is thought to be between 0.3 to 0.8 pounds of forage for each pound of grain consumed. Energy supplements could be whole oats, processed barley, processed grain screenings, commercial range pellets and cubes. Supplement protein when pasture dry matter is available but pasture has been continuously or rotationally grazed at low stock intensities and much of the stand is mature. In this scenario, DIP in the pasture may be marginal. Intake of both energy and protein supplements must be restricted to optimize gain and feed efficiency response.

Late September and Fall

This is the period when some grazers report their highest daily gains. With cooler ambient temperatures, occasional frosts, shorter day lengths and lower soil moisture, the plant slows its growth and concentrates non structural carbohydrates (NSC) in stem bases, roots and rhizomes. In the fall period the NSC (15 -22% on DM basis) levels in regrowth often exceed spring levels. Non structural carbohydrates are soluble carbohydrates like sugars that are not associated with fibre. Each NSC percentage point is equal to one percentage point of organic matter digestibility. Maintaining high gains will be related to abundant dry matter available, high NSC, fresh feed daily and fresh water which allows for high dry matter intakes, perhaps as high as 3.1% of body weight. Effective fibre, DIP and UIP appear adequate without supplementation but in reality will be variable from year to year depending on weather (frost), soil moisture, plant regrowth and pasture management skills.

The synchronized availability of degradable intake protein (DIP) and non structural carbohydrates (NSC) leads to improved animal performance.

The preferred supplements will be similar to the July, August, early September period. Supplement energy in the form of whole oats, processed barley, grain screenings, or range cubes and pellets. Include an ionophore and trace and macro minerals in the supplement. An energy supplement fed at 0.4 to 0.6 % of body weight will give minimal reduction in fibre digestibility since effective fibre is still greater than 20%. This implies a very healthy rumen with a pH well above 6.2. Feeding energy supplements in late afternoon may reduce any adverse effect on fibre digestion. Supplement protein when pasture dry matter is available but pasture has been continuously or rotationally grazed at low stock intensities and much of the stand is mature. In this scenario, DIP may be marginal and is the protein type of choice to supplement. Feed conversions calculated as pounds dry matter per pound of additional gain will only be competitive if the energy or protein supplement is limit fed.

In this period, feedlots or those grazers that are retaining ownership of cattle to slaughter will want to increase grain or grain/silage combinations to extend available pasture, get cattle accustomed to feedlot diets and to reduce the time in the feedlot.

Pasture Considerations that Modify Recommendations

1. High nitrogen fertilizer, high percent legume stands and good grazing management increase crude protein and energy in fall and spring stockpiled forages.
2. Degradable intake protein as percent of CP in the late summer and fall periods increases as grazing management increases.
3. Forage dry matter levels remain low for vegetatively managed stands throughout the season but increase with increased percent of mature reproductive tillers in all pasture.
4. Dry matter intake can be influenced with rotational versus continuous grazed pastures, frequency of moves, sward height, sward structure, species mix, rumination time, bite size and eating time.

The following questions arise from this exercise:

1. There is a need to more accurately quantify changes in pasture acid detergent fibre, neutral detergent fibre (NDF), effective NDF, crude protein, degradable intake protein and undegradable intake protein as the season progresses, under rotational and continuous grazing systems.
2. Pasture management can be an overriding factor in determining animal performance.
3. The difference in net energy for activity on continuous and rotational pastures needs to be determined. Delivering water to the pasture and frequent moves will influence the net energy for activity, pasture productivity and stand longevity.
4. High quality fall pasture probably is not economical to use with yearlings if ownership is not kept in the finishing phase. A better use may be in banking the forage for early spring turnout of high value animals.

Trace Mineral Supplementation

There is a very high probability of deficiencies in cobalt, iodine, manganese, selenium and zinc in our pastures. Based on requirement for copper of 10 mg/kg, there is an 80 to 100% chance of being deficient. Similarly, requirements for manganese at 40, selenium at 0.2 and zinc at 50 mg/kg of body weight, may result in a probability of 60 to greater than 90% of being deficient for legumes, grasses and cereal pastures. The supplementation cost is about $3.00 for a cow on pasture 100 days. Given the high probability of being deficient and the low cost of supplementation, it is advisable to feed trace minerals.

Mineral feeding can be regulated as in force fed or self fed. Alberta grazing trials show that cows, yearlings and calves visits to mineral feeders is variable. Some cows visit the feeder on a frequent basis and others rarely visit the feeder. Most cows visit the mineral feeder once every two to five days. Yearling and calf visits are variable as well and are more dependant on feeder location. Free choice feeding via a mineral feeder is not an acceptable mode of providing a nutrient or feed additive on a daily basis. In summer cattle activity at the feeder peaks in late afternoon.

Are We Getting Value From Year Round Phosphorus Supplementation?

High phosphorus minerals are expensive. A commercial mineral supplement fortified with all trace minerals and containing 18% phosphorus but without salt might cost $22.00 per bag. A similar mineral but with 12% phosphorus and 30% salt would perhaps cost $18.00 per bag. That compares to a salt fortified with all trace minerals costing $8.00 per bag. Mineral costs for a cow consuming either 50 or 80 grams of minerals daily for an entire year will be either $12.50 or $21.00. Expressed as a cost per pound of gain at weaning for a 580-lb calf, the value is either 2.2 or 3.6 cents per pound of gain to weaning.

Phosphorus is considered a necessary mineral for good reproduction and growth. Reproduction is considerably higher than either growth or carcass traits in determining cow-calf profitability. The question is then, Can phosphorus supplementation be fine tuned without being a detriment to reproductive or growth rates? To answer that question, we need to look at cow requirements in relation to the productive cycle and the phosphorus content of our feedstuffs.

Table 3 shows two periods of higher phosphorus requirement and one period of low requirement throughout the production cycle. The higher requirement periods are from the first month until 4 to six months after calving and the last three months of pregnancy. These times would be from mid March (calving) to mid August or till the end of the breeding season for a herd starting to calve in mid March. The second higher requirement period would be from mid December to mid March. In our March calving example, the period from mid August (end of breeding) to mid December will be the low requirement period.

Table 3: Typical Calcium and Phosphorus Requirements Throughout the Year

	Month Since Calving							
	1	2	3	4	5	6	789	101112
	Calving - Milking - Breeding						Mid-Pregnancy	Last Trimester
Mature Cow, 1320 lb, 18 lb milk at peak								
Ca, lbs	0.1	0.1	0.08	0.07	0.06	0.06	0.04	0.07
P, lbs	0.1	0.1	0.06	0.05	0.04	0.04	0.031	0.044
First Calf Heifer, 1150 lb, 18 lb milk at peak								
Ca, lbs	0.1	0.1	0.07	0.06	0.06	0.05	0.04	0.066
P, lbs	0	0	0.04	0.04	0.04	0.03	0.026	0.04
Source: NRC Beef, 1996.								

We also need to know how much phosphorus is in our feeds. Table 4 shows calcium and phosphorus ranges of some of our common feedstuffs. Pasture phosphorus analysis will be higher than these values since the growing plants have higher leaf to stem ratios and are more vegetative. Animal selection for the more vegetative plant components such as leaves results in a diet higher in phosphorus (and other minerals) than that analysed.

Table 4: Calcium and Phosphorus Content of Some Common Stored Alberta Feedstuffs

	# Samples	Calcium %	Phosphorus %
Grains			
Barley	2689	0.07 ± 0.02	0.38 ± 0.05
Oats	1064	0.08 ± 0.02	0.34 ± 0.04
Field Peas	78	0.10 ± 0.03	0.40 ± 0.07
Roughages			
Alfalfa	2480	1.71± 0.43	0.21 ± 0.05
Legume-Grass	4928	1.13 ± 0.53	0.19 ± 0.05
Brome	392	0.46 ± 0.19	0.17 ± 0.08
Timothy	384	0.49 ± 0.20	0.16 ± 0.07
Creeping Red Fescue	49	0.52 ± 0.19	0.18 ± 0.07
Native	178	0.44 ± 0.19	0.12 ± 0.06
Barley Silage	699	0.46 ± 0.21	0.26 ± 0.06
Barley Straw	424	0.35 ± 0.13	0.10 ± 0.07
Barley Chaff	12	0.50 ± 0.22	0.13 ± 0.06

± Standard deviation. (Two thirds of the samples analysed fall within this range).
Source: Average Analysis of Alberta Feeds, Alberta Agriculture.

Table 5 shows the phosphorus intake based on either 28 or 25 pounds of feed for either a mature cow or first calf heifer. These classes of cattle will probably eat more feed than this value so our phosphorus intake value will likely be conservative. The three boxes show where phosphorus intake would be met or exceeded for the three production periods. Feeds must contain at least 0.2% phosphorus (Box 3) to meet requirements from the first month to 4 to six months after calving. Feeds must contain 0.16% phosphorus (Box 2) when fed in the last trimester of pregnancy and contain at least 0.12% (Box 1) after the breeding season thru mid pregnancy.

Table 5: Phosphorus Intake at Various % Phosphorus in Feed								
		% Phosphorus in Feed						
	Intake (lb)	0.10%	0.12%	0.14%	0.16%	0.18%	0.20%
Mature Cow	28 lbs	0.028	0.034	0.039	0.045	0.5	0.056
First Calf Heifer	25 lbs	0.025	0.032	0.035	0.04	0.045	0.05
			Box 1		Box 2		Box 3

We can now take advantage of this information to develop phosphorus feeding strategies for the cow herd. Our strategies might be:

Box 1	Months 7, 8, 9 after calving (mid pregnancy)	Most feeds contain greater than 0.12% phosphorus. Cattle are bred by now and calves are weaned. Free choice a trace mineral salt without phosphorus. Feed savings could be $3.25 per cow for a 3 month period.
Box 2	Months 10, 11, 12 after calving (last trimester)	A number of feeds contain greater than 0.16% phosphorus but risks must be assessed. Phosphorus is needed for prevention of retained placentas. Be safe, include phosphorus in a mineral supplement unless feed testing indicates otherwise. Minerals can be fed free choice until six weeks before calving when force feeding is desirable.
Box 3	Months 1 thru 6 after calving (calving to end of breeding)	Few feeds contain 0.20% phosphorus or greater. High milk production and need for high fertility indicates need for phosphorus supplementation. Force feeding is desirable especially before pasture turnout. Continue supplementation until the end of breeding.

This information suggests that phosphorus supplementation is likely not required throughout the year. Key times to supplement are from three months before calving until the end of the breeding season. Force feeding phosphorus (in silage, grain) is preferable to free choice feeding.

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Pasture Assessment/Walk

Grant Lastiwka
Pasture Specialist

Pasture walks or assessments are great for determining pasture condition. In 1998 Harvey Yoder, myself and many others were fortunate enough to attend a two day Pasture Walk workshop put on by the Wayne and Connie Burleson of Range Management Services in Absarokee, Montana. We asked Wayne and Connie if we could include three of their articles and a laminated chart of grass and land phases in this section. They gladly gave us permission to do. We thank them for their openness and support. Their 9th annual in depth workshop, was held this spring; we highly recommend this excellent workshop and have included some of these articles, so please take time to read them. We will be incorporating several of Wayne Burleson's ideas along with other key educators and our own in this afternoon's classroom and field session.

Overview

In such a busy world we do not take the time to properly understand what the land, plants and animals are actually telling us. In reality their performance or lack of performance are often only symptoms of how more basic systems are functioning. A basic Holistic Management concept is that in order to really get to the root of a problem, spend time on the problem itself, and not the symptom of it. Dealing with symptoms is addictive and costly as we find ourselves doing it over and over again without a long term solution. If we deal with the problem, we can solve it effectively. Wayne Burleson showed us another way to approach this. He taught us that by asking and answering the question we asked five times, each question and answer in this series more in depth looking for the reason why something is the way it is, will get you to the root of the issue by about the fifth answer. Only then can real and cost effective change be made. Here is an example: Why is it costing so much to raise a calf? Feeding the cow all winter is the biggest cost. Why so long a winter feeding period? We run out of grass. Why do you run out of grass? The pastures do not produce enough or long enough. Why are the pastures not producing? They do not regrow well and get sod bound too quickly. Why are the pastures sod bound? They are over grazed. Now instead of just working up the sod bound pasture (symptom of a problem) we realize that we need to prevent overgrazing (the problem).

Now take this concept back to the pasture assessment and the more elemental level, the root of the problem. By monitoring the land, plants and animals we can see how effectively the energy, mineral and water cycles are functioning. These six key components interact with your management in pastures to create a dynamic system or community and to give us the results we receive. They are the background for the pasture walks or assessments we make so we need to have a good understanding. The better detective you become in your pasture evaluation, assessing the pasture condition accurately and discovering what problem is greatest or most easily improved, is exciting and the key to an excellent pasture in the future. To look at something in a different light than ever before is the goal achieved by Pasture Walk expert Wayne Burleson and many other excellent pasture managers, and will be our attempt in this session today.

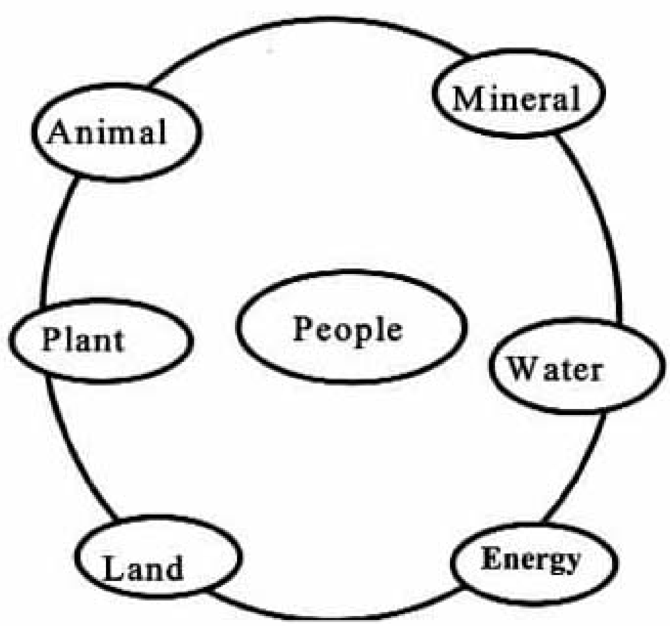
The six components are: land, plants, animals, energy, mineral and water and we **will** add two, people or how we manage, and dynamic systems (Smith, 1998) or community dynamics (Savory with Butterfield, 1999) . These were discussed to various degrees and different ways in the other seminar articles in this Pasture School binder. Harvey Yoder in Pasture Rejuvenation talks about dealing with symptoms of problems which is what the land, plants and animals can show us. Arvid Aasen, in Nutrient Cycling and Vern Baron, in Understanding Grass and Legume Growth and Pasture Production, talked about the mineral, energy, water cycles and community dynamics in various ways. For further clarity I will briefly define the three cycles, and give some background detail.

Energy flow - green plants capture sun light energy in a usable energy form for ruminents

Mineral cycle - nutrient turnover in soils, on soils, of soils and from the air (also plants and animals)

Water cycle - falling moisture, surface water standing, runoff, evaporation of water from soil and water bodies, plant respiration, deep percolation and underground flow and soil held water

Community Dynamics or Dynamic Systems - interrelationships within and between the systems or communities make ever changing optimums of each of the cycles



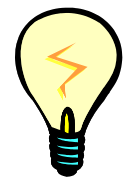
These cycles make up a system that tries to optimize not maximize (Smith, 1998). Interactions with themselves and the land, plant, animal and people components make up the ever changing ecosystems we live and profit by.

Community Dynamics or Dynamic Systems (Savory with Butterfield, 1999; Smith, 1998; modified Lastiwka and Scott, 1999). Each item has interactions with each other attempting to optimize themselves and creating complex community dynamics, or dynamic systems.

What to Look For

A healthy pasture will have an active mineral cycle. As plants are grazed, through normal plant life cycles (root production and death) or through frost action (sloughed off), roots are turned onto the organic matter pool in the soil. Healthy plant roots will penetrate deep into the soil pulling up minerals deeper in the soil to be eaten in the plant form by animals and deposited as manure or urine on the soil surface. Plants will be bright green in color, leaves will be broad, plants will look like they are vigorous and are actively growing.

Parts of the plant that are not eaten mostly fall to the soil surface as litter or residue. Litter reduces the loss of soil to wind and water erosion. It keeps the plants and soil cooler and reduces wind speed at the soil surface reducing evaporation. The cushioning effect of plant litter or fibrous root systems between the soil and animal hooves protects the soil from compaction. Litter or animal waste becomes a part of the shallow, rapid turnover, nutrient pool plants use and reuse quite quickly. Litter provides a stable habitat for larger soil organisms such as insects and earth worms. The soil is teeming with organisms feeding off and breaking down plant parts in various degrees of decay creating an excellent nutrient cycle. There are about six groups of soil organisms: bacteria fungi, protozoa, nematodes, arthropods and earth worms. Within each group and between each group these organisms play an important role in soil quality (Lewandowski & Tugel, 2000). Most noticeable will be earthworms and beetles but there are billions of organisms in a square inch of soil. Many have not even been named or discovered as of yet.



Litter provides a stable habitat for larger soil organisms such as insects and earth worms.

A good litter cover will enhance water infiltration.

A good litter cover will enhance water infiltration into the soil with less runoff and help hold moisture through keeping the soil cooler preventing evaporation losses. Bare soil reflects sunlight creating higher heat levels than normal air temperatures for plants. A high organic matter soil holds water and oxygen more effectively than a lower organic matter one. Deep rooted plants draw water from the soil and continue growth when shallow rooted ones stop growing. As the roots penetrate, then die, they create an ideal soil crum structure for oxygen movement, water holding capacity and water penetration. The result of this is a very effective water cycle.

Capture of sunlight energy by the sward can only be done with green plant growth. It is highest with green growth from plants that are functioning at a high level: Rapid growing, deep rooted, vigorous, dense, varying canopy layers, varying plant structures, a diversity of well adapted species and a long seasonal distribution of growth. As you can see a good energy cycle goes hand in hand with good mineral and water cycles.

Community dynamics or dynamic systems; these cycles interact together with your management to determine the optimum production from a forage stand, the animals and the land in both the short and long term. These may be synergistic and/or antagonistic but are always in flux as the ecosytem we operate within tries to optimize all the sum of the parts. The more diverse and complex the community, the more stable the whole. More stable but in never-ending development. As Allan Savory with Jody Butterfield says in their 2nd edition book on Holistic Management, “Change begets change as the organisms interact with one another and their micro environment (their environment immediately surrounding them)”.

The best way to try to understand, evaluate and give an assessment to something this complex is to break it into categories that are specific, understandable and hopefully as simple as you wish to take the time for. That is what we will do in this exercise and Wayne Burleson also does this very well in his pasture workshop. With the Pasture Assessment/Trend form and Pasture Meter/Forage Height Yield form included after this article we know you will be able to do your own pasture evaluation quite effectively.

Now take the time to walk a pasture with animals preferably in it and make an assessment of what is happening. By evaluating the pasture for the various categories on the Assessment/Trend form a clear overall pasture condition or trend can be determined. Steps to improve this pasture and your bottom line can then be put in place.

Types of Pasture Walks/Assessments

There are about four different types of pasture walks or assessments. The one most used is when we proceed to move cattle from one paddock to another. This may occur twice daily or once a week or maybe longer depending on how long we leave cattle in a paddock. Depending on frequency of moves , this may be a very quick evaluation looking only at the paddock they were in and the one they are going into. Quickly note the weather conditions, rainfall, animal numbers, performance, herd effect on the land and plants, manure quality and distribution, forage utilization, litter, animal grazing patterns on plants or area they selected most. In the new paddock determine the amount of available forage, and plant growth rate of species and maturity stage. Maybe the manager will take time for a few notes to be made in a log book or written on the grazing plan or just note the day animals moved and to where.

The second is on a weekly, biweekly or monthly basis; most of the paddocks are walked in the same way as the first but more time is spent evaluating them. More serious mental or written notes are made and our written grazing plan should be consulted to see what adjustments have to be made for plant rest and recovery.

The third type of assessment is an annual pasture assessment to see the trends in how our management is changing the landscape and to make seasonal plans. This should occur at the same time each year so that trends can be more noticeable. Our biological plan and control chart, or grazing plan and record sheet, should be analyzed for paddock performance in animal units/acre prior to going out to the field. By using a biological plan sheet it is clear on paper which are the higher or lower productivity paddocks and now we need to visually appraise and record why this is the case. It may also be the time to bring in a consultant to give us some more ideas of what is happening and help us decide what changes will give the best results to meeting our landscape goals (ideal vision we have for the land we manage). The full Pasture Assessment/Trend form we use in the field session is designed for this annual assessment. A copy of this form is following this article.

The fourth and final assessment is probably every five to ten years. We again need to do the Pasture Assessment/Trend form and also do fixed point photographs of historic benchmark areas. Again it is best to carry this out each time at the same time of year. Compare soil tests and written notes to previous notes and pictures. Are we really making a positive difference? Are we reaching our landscape goal we have desired? What new changes do we wish to make to better obtain our goals or do we wish to change our long term landscape goal? These questions should be discussed with members of the operation along with sharing what assessments or trends have been found. On a mid summer or weekly walk we monitor and adjust our grazing plans to reflect short term grazing goals.

Various Tools Used in Pasture Assessments

A good assessment of the pasture comes in several forms and assists in making these evaluations easy and essential. There are several different and effective ways to evaluate, record, and plan management strategies placed on the pastures. Fencing off a small area of a pasture for no animal access, taking pictures, evaluating and recording pasture condition on monitoring sheets, noting plant phases on land maps and making yield estimates with a pasture disk meter all provide valuable information to make management decisions.

Livestock Exclosure

Try to fence out a small piece of all paddocks so no livestock can graze it. Although it may be a hassle to do this it is an excellent reference point to what is happening to areas without your effect. Species, density, plant vigor, litter, bare soil and yield differences within this exclosure versus outside tell an interesting story of management trends.

Pictures

A picture is worth a thousand words. It is hard to see changes happening when you are seeing a paddock often. A picture if properly taken will show you trends easily missed. It is best to use a camera with the date on it. Pick a spot that you will be able to find again even in several years time. It is best to take a broad shot with landscape in the background that will be there in the future for reference points. Although time consuming, make detailed notes about the picture site location as you take the picture. You will need this when trying to find this spot next time. Trees grow and pasture stands are always changing. With the better management you place on this pasture, it will be harder to tell if this was the same site. Get one or two reference points in the picture. When you get the pictures back transfer this information onto a sticky label on the back of the picture. A local copy store can blow up this color picture for a nice record if you wish. Try to put an object with height increments in the picture to give a two dimensional record of the site. Then take a second shot above the plants looking down into them. Finally dig up a "clump" of grass and soil and with your hand in the picture hold it in front of the camera for a closeup shot. Mark the specific site so you will find it again, i.e. place a few rocks for the corners or one large one. A small yellow or green wire flag can last several years but if brightly colored may attract animals. You may wish to paint a post top and write distances and other details from reference points on the assessment form. Remember that years go by quickly, scenery changes and one's memory will fade. I emphasize that you take pictures. It is exciting to see changes happening. The best way to learn is to know the progress you are making. If the progress is not what you wished, the sooner you know that, the sooner you can make adjustments to reach your landscape goal for that piece of land.

In Depth and Timely Assessments with Pasture Condition Sheets

To do an in depth annual or semi-annual pasture walk, it is best to pick a consistent time of year during the high growth period. Start with the poorest paddocks in need of the most attention in case you run short of time to assess all of the pastures. By carefully going over each paddock you can see the results of your management and make changes as needed. The more time you are willing to spend evaluating a pasture, the better the knowledge you will have; as a result the more successful grazing plans you will make.

A record on paper of plant species present, percentages of each, their condition, bare soil, weeds present, litter, what you broadly see happening and specific solutions for improvement goes nicely with a picture taken showing trends to your management. There are different forms out there and each have many good points. The

Assessment/Trend form we included in this article is a United States Districts of Agriculture (USDA) form that was modified by Frank Gazdag of Public Lands, Jim Bauer of Grassland Agriculture Consulting, and some other members of Alberta Agriculture Food and Rural Development. Wayne and Connie Burleson have a new form for dryland areas that has many practical and excellent concepts. We have included their ideas on “Phases” of plant vigor (Phase I - over grazed plants lacking vigor, Phase II - vigorous plants given time for rest and recovery and Phase III - old plants not grazed losing vigor), cycles (Energy, Mineral and Water) and solutions or comments. Phases of plants can be assessed or recorded very quickly on a pasture map when the grazier is short of time especially during pasture moves. For those who take the time, answering the in depth questions and recording pro-active solutions for improvements will really help.

Because no paddock is the same and neither is the year quick assessments are needed throughout the year as the cattle are moved through the pasture rotation. There should be green grass stains on the knees of your jeans from any assessment. It is surprising how much can be missed from a truck window, a quad, the back of a horse or walking looking down. The rancher, whose operation we attended at Wayne and Connie Burleson’s 1998 Pasture Walk workshop, records the three Phases of plant vigor and the dates animals are in each paddock on a pasture map of all paddocks. This is the “fast and dirty” approach best used when trying to do quick assessments for planning the next few paddock moves. For those who are not the type to do further recording try to find a pasture walk system that works best for you. Shading in pasture areas on xeroxed copies of paddocks with different colored ink that are in Phase I, II or III works well also.

Making assessments and recording what you see are the best ways to see trends over time and to take into account the effect of yearly climate differences. The greatest knowledge comes from learning as you go.

Physical Tools

To record pasture conditions each year or more often as needed, it is nice to have a tool to use for yield clips or plot site recording. Pick a site you feel is representative. It may be the site of your photograph for the annual assessment or of a problem area if you wish to specifically address it with management changes. You may consider picking several if a pasture is quite different and record these separately. Even on good land forage species and land condition vary significantly especially if the pasture is older or a mixture was seeded. Soil type, micro-climates and management create ecological niches that vary pasture conditions and species quite significantly over short distances within a paddock, at different times of the year and from year to year. You will be surprised at what you’ll find when you do your own pasture assessment at home.

Wayne Burleson used a loop of rope about 93 inches around with tape on it to mark each quarter. A normal hand was about 5% of its area. A thumb is .3% of the area inside it. This helps when trying to carry out the in depth assessment for calculating the amount of ground a species, bare soil, litter, etc. covers on the site you have chosen to record.
A pasture stick is a good tool to train the eye of the grazier to visually estimate yield. This is helpful when planning for turnout dates, desired removal at certain residue levels and also for any general pasture allotment decisions. A pasture stick will not be needed for long if a concerted effort is made into checking the accuracy of your stick yield/acre-inch and calibrating it to your eye estimate of yield. The pasture stick measures height and “to some degree” density of forage growth. Measure height from point where 90% of forage mass is below it, i.e. Press mass with palm of hand until slight resistance is felt

and measure height at this point.

Accuracy is however quite variable depending on the stand height, density and forage species maturity.. Take height measurements from as many sites as you feel you need until you have an idea what is representative of the pasture. The stick is calibrated for a forage species that is 6 inches in height. To calculate yield/acre-inch pick the most common species for the sites. Visually estimate the stand condition to fair, good or excellent. Since forage density also varies with height when the stand is < 6 inches high consider using the (excellent) higher lb/acre-inch range and if > 6 inches high consider using the (fair) lower lb/acre-inch range.

Cut a 13 inch circle of forage as close to the ground as reasonable. Dry it in a microwave oven on a paper plate. Also place a cup of cold water with some ice in it. This will prevent a fire if the forage becomes too dry. Keep rotating the cold cup for a hot one whenever the water starts to boil. The water may overflow so I recommend you take the forage out of the bag you collected it in and place it onto a paper plate before starting to dry it. Drying is complete when the weight of the dried forage stays constant between the last two microwave dry down attempts. Take the final dried weight in grams. Multiply the dried gram weight by 100 to get pounds per acre. For example: Wet weight 120 grams dried to 24 grams. Dried weight of 24 grams x 100=2400 pounds/acre of dry matter forage. To calculate moisture content 24/120=0.20 x100=20% dry matter therefore moisture was 80%. Clip, dry and calculate yield periodically along with guessing the forage yield. Do this on various paddocks and species at different times of year until you feel you can accurately guess yield without the pasture stick. The accuracy of estimating yield through this system is not perfect but in my opinion and as grazier Joel Salatin from Swoope, Virginia says..."good enough is perfect".

Conclusion

By actually knowing what condition your pasture is and the trend of where it is going is sound information needed for making good pasture management decisions. Once the pastures are assessed for several key category areas, plans can now be put in place knowing what specific needs for that pasture and which parts of that pasture are going to be worked with to meet your landscape goal. Managing for these improvements with confidence will get you more optimum yields and sustaining or improving a pasture stand makes sense. By using the tools we discussed above it is hoped you can best fit your style of doing things with the information needed to make good pasture decisions in the short and long term. Keeping and comparing good records from year to year is an excellent way of monitoring and learning at an accelerated rate as you go. Sustaining and improving pastures is easiest when the right things are monitored and correct actions taken. Using the right tools makes the task easier even if once and awhile the knees of your jeans get a bit green.

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Cycles' Crib Sheet
Western Forage/Beef Group
Pasture School 2003

Energy Cycle

Excellent ... Good	Fair ... Poor
- excellent regrowth	-slow regrowth after being grazed
-dense stand	-bare soil
-vigorous spring growth	-sparse spring growth
-desirable species	-non-desirable species
-good seasonal distribution of growth	-poor seasonal distribution of growth
-desirable grazing behavior	-undesirable grazing behavior

Mineral Cycle

Excellent ... Good	Fair ... Poor
-dark green patches well distributed >60% field	-dark green poorly distributed <40% field
-manure decaying	-old manure intact
-thatch 1-2" thick	-thatch <1" or >2"

Water Cycle

Excellent ... Good	Fair ... Poor
-no erosion	-erosion channels
-little ponding after rains	-Puddles of water or run off after rains
-well protected soil	-bare soil

Community Dynamics Cycle

Excellent ... Good	Fair ... Poor

Do your findings meet your expectations? Why or why not? Brainstorm or consult others as required.

Source: Savory with Butterfield, 1999; Smith, 1998; Bjorge, Lastiwka and Scott, 1999.

Criteria

This job sheet was designed for use by persons with different levels of technical ability. It can be used quickly and without tools, to visually estimate the condition and trend on grassland. For example, when it asks for a % the user should make their best visual estimate. With experience, condition/trend surveys will be quite consistent between users.

Acres can be the total acres in the field or the acres represented by the evaluation. The month and year should be recorded at Mo __ and Yr __.

Category

1. *Plant Population* - Visually estimate the % composition by weight of each plant grouping and assign a weighted value. Desirable, intermediate and undesirable will vary with site, kind of grazing animal and intended use.
1. *Plant Diversity* - Is the number of different kinds of plants that are well represented on the site. If only two kinds of plants occur, diversity is narrow; if 7 or more kinds are present, diversity is broad.
2. *Plant Density* - Ignore undesirables and visually estimate density of living desirable and intermediate species that would be present at a two inch stubble. Is there room for more desirable and intermediate plants?
3. *Plant Vigor* - Are the desirable and intermediate species healthy and growing at their potential? Some things to look for are: color, leaf area index, reproduction, presence of weeds, rate of growth and regrowth, etc.
4. *Legumes in Stand* - Visually estimate the % composition by weight of the legumes present in the stand for the area being evaluated.
5. *Severity of Use* - Close and frequent use causes loss of vigor, reduces desirable species, promotes erosion and run-off. Light use allows excessive residue buildup, blocks sunlight, reduced palatability and production.
6. *Uniformity of Use* - Uniform grazing has all plants grazed to a moderate, uniform height throughout the field. Spotty grazing appears uneven, with some plants or parts of the field grazed heavily and others lightly.
7. *Soil Erosion* - Visually observe and collectively evaluate all types of erosion and determine the severity for the area being surveyed.
8. *Weeds and Brush* - Estimate the % ground covered by undesirables.
9. *Plant Residue* - Appropriate residues provides adequate ground cover to retard run-off, improve water intake, return nutrients to the soil surface and provide a favorable microclimate for biological activity.

Where needed, use weighted values and interpolate. For example, if you can't decide between a value of 2 or 3 use a value of 2.5.

Pasture Assessment/Trend

Paddock Name: ______________________

1. Rainfall: Above Avg. ___ Avg. ___Below Avg. ___

2. Temperature: Above Avg. ___ Avg. ___Below Avg. ___

3. Soil Type: Brown ___ Dk. Brown ___ Black ___ Thin Black ___ Grey Wooded ___

4. Grazing System: Continuous ___ Rotational ___ Management - intensive or controlled ___

5. Pasture Type: Tame grass ___ Grass/legume ___ Legume ____ Tame/native mix ___ Lowland ___ Bush ___ Native parkland ___ Native prairie ___ Pasture/irrigated ___

6. Acres: ______

Seeded Pasture Assessment/Trend

Category	(Pick Best Choice) Parameter - Value	Mo___ Yr____ Value	Solutions to Improve (*Comments*)
1) Plant Population - The estimated % by weight is mostly:	Desirable 5 Intermediate 3 Undesirable 1		
2) Plant Diversity - The diversity of plant species is: (If diversity undesirable reverse parameter order but not values)	Broad 7+ 5 Medium 3-6 3 Narrow 2 1		
3) Plant Density - Desirables and intermediates (% ground cover) are:	Dense > 95% 5 Med. 75-85% 3 Sparse < 65% 1		
4) Plant Vigor - desirables and intermediates are:	Phase II 5 Phase III3 Phase I 1		
5) Legumes in Stand - % of legumes by wt. or number makeup:	> 40% 5 20-29% 3 <10% 1		
6) Severity of Use - the degree and frequency is:	Light 2 Medium 5 Heavy 1		
7) Uniformity of Use - The uniformity of grazing use is:	Uniform 5 Intermediate 3 Spotty 1		
8) Soil Erosion - Sheet, rill, gully and stream bank is:	Slight 5 Moderate 3 Severe 1		
9) Weeds and Brush:	< 10% 5 > 10% 1		
10) Plant Residues - Dead and decaying plant material is:	Excessive 1 Appropriate 5 Deficient 1		
11) Manure Cycling - manure appears to be:	<u>Decomposition</u>: Rapid 5 Medium 3 Slow 1		
12) Manure Distribution - manure is:	<u>Spread:</u> uniformly 5 somewhat uniformly 3 Concentrated in small areas 1		
Totals			

Yield Estimate: ________

Overall pasture condition/trend
0-12 = very poor; 13-33 poor; 34-45 = good; 45-60 = very good
(Please circle one above)

Mineral Cycle: _____ Water Cycle: _____ Energy Cycle: _____ Community Dynamics: _____

Please indicate Poor (P); Average (A); Good (G); Excellent (E)

Sources: USDA/SCS/MO. Modified by: Frank Gazdag, Public Lands; Myron Bjorge and Grant Lastiwka, AAFRD, 1999 and Jim Bauer, Grassland Agriculture Consulting. JS-Agron-24-6/23

Pasture Type/Height/Yield
Estimating dry matter in pounds/inch/acre
Stand Condition

Forage Ground cover	Fair 60 - 75%	Good 75 - 90%	Excellent > 90%
	lb/acre-inch		
Mixed Pasture	150-250	250-350	350-450
Orchardgrass & Legumes	100-200	200-300	300-400
Bluegrass & white clover	150-250	300-400	500-700
Smooth Bromegrass & Legumes	150-250	250-350	350-450
Red Clover Or Alfalfa	150-200	200-250	250-300
Tall Fescue & Legumes	200-300	300-400	400-500

Note 1: Measure height from point where 90% of forage mass is below it; i.e. Press mass with palm of hand until slight resistance is felt and measure height at this point.

Note 2: Since forage density also varies with height when the stand is < 6 inches high consider using the (excellent) higher lb/acre-inch range and if > 6 inches high consider using the (fair) lower lb/acre-inch range.

Note 3: As this is just a means to estimate average forage yield monitor animal consumption and forage residual after grazing and adjust this approach through practical experiences learned from applying height/yield estimates to personalize it to your pasture.

Source: Missouri University Extension, 1999. Missouri Grazing Manual. M-157. Editors Jim Gerrish and Craig Roberts. Forage Systems Research. Linneus, Missouri. (Bluegrass/whiteclover modified Lastiwka, 2002.)

DYLAN BIGGS

Livestock Handling Clinic

An Argument for Giving Stress Management Top Priority in Herd Health Programs

Cattle handling is now one of the most enjoyable jobs on our ranch. In the past it used to be anticipated with anxiety. When I was growing up it was inevitable that somebody, whether it was my mother, us kids, or the dog would get yelled at. You could never quite be in the right place at the right time. Feelings were hurt and tears often the result. I venture to guess that most farm families who own livestock have experienced this to some degree.

It is not only human relationships that suffer when faced with these stressful experiences. The financial costs of these scenarios also add up. Technology has lead many cattlemen to embrace a vast array of new and expensive equipment. A lot of producers in our area have installed curved metal chutes and crowding tubs. Unfortunately this has done little to reduce the amount of stress that livestock are exposed to.

The U.S. 1991 "National Beef Quality Audit" reported that the # 7 concern of retailers, purveyors, and restaurateurs and the # 10 concern of packers was too many dark cutters. The packers believe that these dark cutters are increasing and pose a real problem. A dark cutter carcass results in $146 loss per carcass. The Canadian Beef Quality Audit reported that 17% of virgin bulls graded as dark cutters. In February and March of 1997 we slaughtered and collected carcass data on 133 head of our own ranch raised virgin bulls. We had one dark cutter, this translates into less than 1%. Compared to the Canadian average we saved $7,161 on this set of bulls alone. In the 1996 Canadian Audit dark cutting resulted in an annual loss to the industry of $4,097,189. Dark cutting is a result of stress, either weather or handling induced. Also included in the packers number 10 concern was the fact that one in every twenty cattle on the kill floor and in the cooler was bruised. In the Canadian Audit only 22% were free of bruises resulting in an annual loss of $10,537,629 to the industry. Bruising is something that could be virtually eliminated with a concerted effort from all segments of the industry.

The cost of shrink, especially to producers that run yearlings on grass, can be substantial. Compare these two scenarios. One hundred yearling steers are to be gathered, corralled and loaded onto trucks to be shipped to the local auction market. The pasture is 640 acres and the loading facilities are in one corner. Producer #1, alone on horseback, is able to gather and walk the steers into the corrals for loading. Nor running, milling, chasing or shouting. They load without incidence. Producer #2, with the help of four willing hands and horses, spends hours getting all 100 head corralled. The steers backsides are covered with manure, they have their tongues stuck out panting and are all sweated up. A couple of the steers are on the fight and break through the corrals while being loaded. First group, zero to half a percent shrink prior to being loaded. Second group, 3% shrink prior to loading. Assume they average 1000 pounds and they sell for 75 cents per pound. The #2 producer would have lost $2250 to shrink before they even left the yard. In addition to this, there is the labor and materials to fix the corrals and gathering two runaway steers.

The cost of medications is also significant. The stress cattle experience while being handled acts as an immune system suppressant. This leaves them more vulnerable to viral and bacterial diseases. Reducing stress by employing LSLH(Low Stress Livestock Handling) Shipwheel Feeders of Taber, Alberta saw a dramatic drop in their drug costs, $89,000 in their first year alone. Their second year of practice resulted in a reduction of $110,000.

There are many valid reasons for giving stress management top priority in your herd health program.

Making the Shift to Low Stress Livestock Handling

Nine years ago Don Halladay and I met Bud Williams at the annual HRM meeting in Albuquerque, New Mexico. We were impressed with what we saw and heard and decided to organize an Alberta tour for him and his wife Eunice. In the summer of 1990 Bud spent three days on our ranch introducing his livestock handling concepts to us. I've also attended his Stockmanship School in Lloydminster, Alberta. What I have learned from Bud combined with previous exposure to Ray Hunt and John Lyons, has totally transformed my family's ranching operation.

The behavior of an animal while it is being handled is determined almost entirely by the handler. The cattle can be calm and quiet or nervous and frightened. The mistake that I used to make while handling cattle was to blame them for any and all difficulties we had. This justified all the yelling, cussing and inappropriate use of canes, stock prods and ropes. There is the perception that unless a handler is aggressive he or she won't be effective moving cattle. People in this mind set believe that the only way you can get cattle to cooperate is by scaring them. Understanding the power of correct positioning and movement offers an effective alternative to handling/herding methods that are fear based.

Our herd fluctuates from 350 to 400 cows. We background all of our calves and run them as yearlings. We also AI. about 300 females a year and run a number of single sire herds during our breeding season. All of our herds are moved quite frequently for grass management purposes.
Traditionally we never perceived the difficulties we had, for instance moving custom grazed yearling steers, as unusual. The problem being that we had no other experience to compare it to - nobody we knew did it any differently. After working with Bud Williams for a couple of days, it quickly became apparent that we had some things to learn.

An essential attitude in making this technique effective is to take responsibility for how our cattle react to being handled. To understand that if our cows are wrong, we were wrong first. For people who have spent their lives working cattle this can be a very difficult notion to accept.

We all have been at the tail end of a herd of cattle when a single cow will try to quit the bunch. In the past I would have seen this cow as an ornery miserable thing that was bent on making my life difficult. The unfortunate result of this interpretation is that the handler assumes what is required is more pressure to prevent her from escaping. This in turn causes her to try escape even more vigorously. I now realize that I was crowding her too much and as a result she couldn't find a safe place to be and felt she had to run to escape my pressure. By interpreting the situation incorrectly and blaming the cow, a vicious cycle can result and on occasion the whole herd will take.

Cattle communicate primarily through body language. You have probably observed cattle at a water trough. Do you recall the reaction of other cattle when a cow with horns comes in with her head down? Automatically any cow that sees her coming will scramble out of her way. They don't need to speak to each other to communicate effectively. Cattle can also read our body language. You may have experienced the change in your cattle when a high strung friend or neighbor shows up to help you with your cattle handling job. Cattle pick up on nervousness, anger, and frustration and will in turn feel more apprehensive themselves. If we desire cattle handling to be an enjoyable job that doesn't turn into a make work project, ie: fences and corrals to repair, spousal relationships to heal, or bodily injuries to mend, then we must remain calm and confident while working our cattle.

Like you and I, cattle have their own personal space. A flight zone can be defined as the space surrounding an individual or a herd that when penetrated will cause an attempt to re-establish a comfortable distance from the handler. Flight zones are not static, they will vary due to a number of environmental conditions and circumstances. Low stress livestock handling is based upon strategic infringement of the flight zone of individual animals or a herd. Ideally a handler will never penetrate the flight zone to the point where the animal(s) panic and take flight. Rather it is a process of applying and releasing pressure on the flight zone and finding the balance point that causes, not forces the animal(s) to travel calmly in the direction wanted.

Cattle have herd instinct. Bunch quitters are made, not born. If we are adequate with the pressure we apply and precise with our movements and position, cattle are very happy to be in a herd. In fact they would rather join and follow the herd than leave it. If you have ever observed how quickly a bunch of cows will leave a pasture through a gate that was accidentally left open you have seen how powerful herd movement can be. It starts with one cow finding the open gate and rapidly progresses to the point where the pasture is empty. "Emptied" without the help of any cowboys. Yet if it was our intent to move them out the gate quite often it would be a lot more difficult. Why is the gate more difficult to find and get through when people are added to the equation?

In this article I have discussed what I believe to be some basic principles to successfully apply low stress livestock handling.

Mastering the Basics:

All contact people have with their cattle trains them. Even just walking through the pen to check the waterer. Training them to be more at ease or less at ease with people. Knowingly or unknowingly we are reinforcing a pattern of interaction. If the reinforcement is positive (non stress inducing), most of the time cattle handling will be easier and more efficient.

Moving a herd of cattle is a process of initiating movement, controlling direction and speed, and stopping the movement. Once these basics are mastered with a herd of cattle the end result will be a ***manageable*** herd. It will then be possible to complete all your moves and processing tasks with relative ease. Initiating movement is the first step. Most often movement and direction are initiated together. There are times though when asking for movement and the desired direction simultaneously will prove counterproductive. In these cases be prepared to accept movement in any direction initially. Many of you have driven tractors or vehicles without power assisted steering. Do you recall how much easier it is to turn the steering wheel once the vehicle is moving? This is also the case with a herd of cattle that insist on going in a direction opposite to where you want them to go. Once good herd movement is initiated then ask for direction.

Initiating movement is the first step in herding and possibly the most important from the standpoint of the influence that it will have over the entire move. The move will go much smoother if proper herd movement is initiated and also the cattle will handle a lot better once corralled. So often we look at troubles we have during the move and at wrecks in the corral as isolated incidents. Quite often they are a result of cumulative stress built up over the entire move. There is most likely residual stress from previous moves also. Successful low stress handling is a good investment and should always be perceived and approached as such. We so often make the mistake in our fast paced world of defining success as a function of time. Everybody is in a rush. We end up valuing time more than the well being of our cattle. Make your first priority the well being of your animals. The paradox is that once you give-up time as your first priority you will actually save time and man power. Before I made the change, more often than not working cattle turned into a make work project: “Bunchquitters” to collect, fences and corrals to repair. Poor handling inevitably comes back to haunt us. Don’t be afraid to invest the time to get proper herd movement initiated. It will definitely pay off.

The type of herd movement you want is a relaxed walk. The “relaxed “ or calm state of mind being indicated by the position of the head relative to the top line. The top of the head should be level with or below the level of the top line. If the head is up the animal is on alert and not in the state of mind needed for a manageable herd. Until this type of movement is achieved though, this process should not be furthered. For example, 140 yearling steers have just been placed in a pasture off of cattleliners from the auction market. Ideally they will have been settled by horse and rider when they were unloaded. This would have made sure they were calm and grazing and had been given the opportunity to water. Settling them would also have prevented any milling or unnecessary pacing of the pasture perimeter. For now we will assume that this is the first time we have worked these steers. The plan is to move them to fresh grass in an adjacent pasture to the east. A single horse and rider are going to move them. They may not have seen a horse and rider before. The steers are all together at the dugout. You approach them at a walk. They see you approach and being curious by nature they run up to you and stop. You take one or two steps toward them and they spook and run off. **Let them run off**. Do not chase after them. Chasing after them will only reinforce that they are justified in fleeing from you. That would definitely be a bad start. Quite often when they react this way they are just feeling good. At other times though they are panic stricken. Regardless, do not chase them. Let them come to a stop on their own. If they run quite a distance just follow them at a walk. Once they are stopped walk up to them again. Repeat this process if necessary until the point is reached where they will allow you to approach them without running off. An approach at an angle that would take you past them will help you get closer also as opposed to walking directly at the herd. Often with fresh cattle you will have to go through this process a few times.

Herd movement is initiated by tracking a back and forth path across the face of the herd. It is done perpendicular to the intended direction of travel. If you have seen border collies work a herd of sheep or cattle you have seen this zig zagging being done. If you want the cattle to go east, your zig zag will be done on the west side of the herd on a north south path. Your passes on a bunched herd such as this should be across the entire face of the herd completely from one side to the other. In fact it is important that you go right out past the edges. This prevents the yearlings on the outside edges from hooking around behind you. What this line of travel creates once close enough to the herd is a collective infringement or pressuring of individual flight zones. The cattle will tell you when you are close enough by turning around and walking away from you. It will start with a few animals and sometimes very quickly engage the whole herd. Our yearlings that are used to being handled this way only require two or three passes to get them moving. Sometimes less depending on the situation.

Something that is very important when working a herd is whole herd focus. It is very easy to become fixated on the cattle directly in front of you and lose track of what is happening in the rest of the herd. One needs to focus on both. This is because the herd always communicates what its next move is before it actually occurs. The lag time between the initial indications and the completion of the change in movement, speed and direction depends a lot on the size of the herd. It only takes one animal to start any change and they are quite often, but not always, at the front. Once the critical mass point is reached you've missed your opportunity to prevent undesired changes. When initiating herd movement, especially with fresh yearlings that are already bunched as in our example, if you become fixated on the rear critters only you could easily miss movement beginning up front. This movement up front may be indicating a need to release or reduce the pressure you are applying at the rear. Before you know it they take off running again. Herd movement is magnetic. In other words, movement draws movement. It also has a lot of inertia at times, especially with fresh yearlings. Let's say our yearlings run off and appear to come to a stop in a corner. So often even though they are physically stopped, mentally they are not. Then all it takes is a little nudge and off they go again. You need to be able to observe the entire herd when you are working them. The herder and the herd form a continual feedback loop. If you can read the feedback you can save yourself and your animals a lot of time and effort. The problem is not being able to see the forest (the herd) for the trees (individual animals). Being able to alternate your focus between individuals and the herd will allow you to make adjustments and prevent undesired movement before the critical mass point is reached.

The other extreme are cattle that are so quiet and docile that they will hardly move when approached. In this case the same approach and pattern apply but one needs to bring more speed into your passes. In this situation you will probably have to get very close and be traveling at a good trot. Watch the herd and observe what they are telling you. Being able to take directions from the cattle will reliably tell you what you should be doing. Are they needing more or less pressure? Pressure is a composite of proximity, speed and body language. Don't confuse speed and body language . Remember body language reflects your emotional state. You can be moving very quickly and yet still be calm and confident and you will have a totally different effect on your cattle than someone else moving at the same speed who is frustrated and angry. If you are getting no reaction from the herd speed up and get closer. Continue your passes until you get the entire herd moving at a calm, orderly walk. Once the herd is accustomed to this type of handling it takes very little to initiate herd movement. People who are really good at handling horses or cattle have developed the ability to observe the slightest changes in behavior of the animals they work. Not only that, they are aware that these changes are due to their presence, speed, proximity and body language . I never used to make that connection. I always assumed the cattle were at fault. When you can develop this observational skill you can adjust accordingly and prevent all sorts of mishaps.

Getting Herd Movement to Work For You

Once proper herd movement is achieved , step one in developing a manageable herd has been achieved. Then comes the task of maintaining the movement and controlling speed and direction. The thing that I still find amazing is how willing cattle are to stay in the herd and what little effort is required to keep the herd moving.

The majority of the time we are horseback when we are moving our cattle. These methods work equally well on foot, with a four wheeler, or whatever your personal preference might be as long as the same principles and methods are used.

So lets pick up our herd of steers where we left off with them in the last article. We had achieved herd movement using the back and forth zig-zag motion. The next thing we must do is get out from behind the cattle to what we will refer to as the outrider position. This is imperative if we want to maintain our direction in an open pasture. Unfortunately it is the last thing that people want to do once the cattle are moving. Being behind the cattle just seems like the natural place to stay since that is where we started.

What makes this position behind the cattle counterproductive if maintained, is that the leaders, especially with fresh yearlings, want to be able to see you at all times. Cattle have binocular panoramic vision which allows them to see almost 360 degrees without turning their heads. But they do have a major blind spot directly behind them. So when they can't see you, they will circle around attempting to get you in their view. Unless you are in a fenced road allowance, staying behind the herd is the worst thing you can do. Get positioned out to the side of the herd far enough so that the leaders can see you.

With most herds, being out to the side from between 30 to 75 feet will be sufficient. The ideal is to let the cows tell you when you out to the side far enough. If you hesitate in behind the herd and the front end starts to hook that is your cue to get out to the side. Go straight out until the front end straightens out. The distance out from the side of the herd where you can walk along with them without affecting your herd movement is where you need to be. A good rule of thumb is that if you can see the leader's eye, they can see you. Believe it or not, most people will have to work very hard to break the habit of being behind the cattle they are moving. Once out to the side, I usually position myself about one third of the way up from the back of the herd. Any position out to the side will work, don't be afraid to ride along right at the back or up at the front. If you maintain proper distance it won't affect herd movement.

Once out to the side, with good movement going, the only thing you need to do is ride along with the cattle and pay attention to the herd. Proper herd movement has its own inertia. So you can just let them go on their own. There is nothing better for a herd of stressed cattle than to get them started properly and just walk along with them. As they calm down you will be able to gain on the herd to the front as if you were going to pass them with out them speeding up and as soon as you get ahead of them they will stop and look at you. Then you will be able to walk back toward the tail end of the herd and they will start up again. If you can't gain on the herd without them speeding up either you are to close or they are telling you they are still to nervous to take that, and you need to spend more time just walking with them. A manageable herd by definition is a herd that you are able to gain on without starting a race so you can get to the front to pressure it, whether to control direction or to feed a gate, without losing control. With enough speed you can get to the front but if you can't control them at a walk you won't be able to control them at a run.

From the outrider position you can monitor the entire herd much more effectively than from behind them. This will allow you to respond if you need to re-direct the herd, speed them up, or slow them down.

Lets assume we are riding along with the herd and they are going just where we want them to. Then we notice that something has attracted their attention, possibly the neighbor's cattle, and the lead steers start to veer off course. Controlling direction can be done with a couple of different maneuvers. The first one is simply an extension of your zig zag, directly out to the side of the herd (see Figure 1). It is most often employed when you're herd has just started and you are just contemplating picking up your outrider position. You notice a couple of steers up at the front just starting to veer off to the left. What you then want to do is to walk straight out, away from the herd to the left, as if you were walking away from them but keeping an eye on the animals you want to redirect. Most of the time this alone will straighten your cattle out. This works especially well with a herd that has just gone through a gate with an open pasture on their one side that they drift out into. When you follow them through the gate, if you just walk straight out into the pasture to their right or left (depending on the position of the open pasture), the cattle will straighten out and you can pick up your outrider position.

There are times when this maneuver won't work. Having gone out to the side puts the rider in a good position to go up the side of the herd to the front to re-direct the cattle. This is because when going up the side it is imperative to be far enough out so you do not interfere or stop herd movement. Once you get to the front to straighten it out, you will want to be careful to just get even with the leaders and not ahead of them. Getting ahead of them will either stop them or turn them right around. Once you are even with them you want to turn and ride straight at their heads. Keep riding at them until they turn away and then turn back and travel against the flow to keep the movement going (see Figure 2). Be looking back to see if they need more straightening. If they haven't straightened out, go out to the side again and then up to the front and repeat the process. The reason for riding back against the flow is to maintain your herd movement. If you just pushed the leaders over, and didn't go back against the flow, there is a good chance that the cattle behind the leaders will stop and you'll lose your movement. When riding back against the flow, the cattle should be speeding up. If they aren't, you are not close enough. The trick in this whole process is to re-direct your movement without stopping it. Keep doing this until they are traveling the direction that you want. Then pick up your outrider position again.

This is also the same basic pattern if you want to speed up the whole herd or a portion of it. Lets say the back one third of the herd is dragging and you want to catch them up to the others. Position yourself on the side so that you are at the front of the pack that is dragging. Then, ride directly into the side of the leader at a right angle traveling at a trot. Ride into them until they speed up and then turn and travel against the flow of the herd at a trot (see Figure 3). When you are doing your first pass to speed up the stragglers, you have to continue to watch the first ones that you pressured. If they start to slow down, this signals the need to repeat the procedure. Continue to repeat this until they have enough speed or momentum to catch up with the other animals. Be careful not to get too much speed, or you may get the whole herd running. This has happened to me on more than one occasion. Practice makes perfect, don't be afraid to get out an try these techniques. They've become invaluable to our operation.

Making Gates Easier

There are times when getting cattle through a gate can be quite a challenge. Be it yearlings, bulls, or cow-calf pairs out of or into a pasture or corral, the gate can often be a sticking point.

In this article, I would like to share some things we have learned that have made gates much less problematic, for us and our cattle.

Cattle see the same world that we do, but they see it differently. This is due to structural and placement differences in the eye itself. Our eyes have round pupils and are placed on the front of our heads. Cattle have almond shaped pupils and their eyes are placed on the sides of their heads. Comparatively, this gives cattle much greater peripheral vision, but much poorer depth perception. This makes it much more difficult for them to judge distances. Their poor depth perception can add to the challenge of getting through a gate. Especially in corrals, feedlots and auction marts. A typical example is a gate that leads into an alley in a T intersection arrangement. Unless the cattle are standing right in the gate, they may not see any distance between the gated fence and the back fence of the alley. To them it appears as one solid fence. In a situation such as this to get them to see the gate they will need to be very close and, given the time, to stop and look to be able to accurately perceive the distance between the gate and the back fence. Another thing that will help the cattle to see the gate is having them approach at an angle so that they can see down the alley.

In general, it isn't safe to assume that your cattle automatically see or can see the gate even when they may be looking right at it.

Having your cattle in a relaxed responsive frame of mind will make it much easier for them to find the gate. If in the process of getting them to the gate, they get all worked up, chances are they will be too preoccupied keeping an eye on the person chasing them to even think about finding the gate. Take your time to get calm orderly herd movement - it will make getting to and through the gate much easier.

Six years ago, if someone had told me that the best place to be to put your cows through the gate was at the gate, I would have had trouble believing it. Like most everyone, I had always been in front leading with feed or behind pushing.

Now, more often than not, I am at the gate executing a gate feeding maneuver. In fact we hardly ever have anyone at the back pushing anymore or leading with feed or a combination of both. Feeding the gate is a minor variation of the maneuvers I described in previous articles to turn or speed up a herd. The position you will need to be in is right even with the front of the herd when they get to the gate. If you are advancing to this position from farther back, you must be out far enough to the side of the herd so as not to disturb herd movement. You will know if you're too close if the cows you are passing start stopping. Timing in this is very important. Ideally you want to start pressuring the herd just as they hit the gate.

From this position turn and travel directly into the herd. This places you at a right angle to the direction the cattle are moving. Move directly towards them at a good rate of speed, such as a trot on a horse, until the critter in front of you starts to speed up. To be effective as possible focus on a single cow. Pressure directly into her ribs. The instant this animal speeds up you turn sharply towards the back of the herd and ride parallel close enough and fast enough to cause the cattle you are passing to speed up. As you are doing this back draft pass continually glance back towards the gate to monitor the progress of the cattle and your effect on them. The instant you notice that the cattle going through the gate are slowing down this is your cue to turn away from the herd and return to your initial starting position up at the gate (see Figure 4). The pattern you have just completed is a basic triangle. When returning back to the position at the gate make sure you are getting out and away from the herd. Three years ago I was in southern

Wyoming we were in the high desert moving about 1100 cow/calf pairs to the west side of a 60 section pasture. We had gathered the entire herd at a water point and two cowboys were working at drifting the cows west away from the water . The one young rider was riding back against the movement doing the back draft pass to speed them up and it was working. Unfortunately when he would finish a pass and return back up to the front he was to close to the cows and all the movement he had generated was stopping. It was like clockwork. So ride out away from the herd at an angle when you return to the starting position. You then repeat this maneuver again and continue to do so until all of the cattle are through the gate. Like anything that is unfamiliar, it will take some practice. At my hands-on clinics people trying to do this for the first time usually aren't traveling fast enough and aren't close enough on the back draft to get the cattle to speed up. If you are going back against the cattle and they aren't speeding up - get closer and go a bit faster. You will know when you're too close when you start to peel cows off from the herd.

Depending on the situation, it may be best to position yourself on a particular side of the gate. If they are passing and continuing straight through then either side will work. In the situation where the cattle are being fed out onto a road allowance and turning right down the road, it will be best to position yourself on the right side of the cattle (see Figure 5). This is so that you are in the position to prevent cattle from turning prematurely to follow the herd movement and thereby missing the gate (see Figure 6). To prevent this it is very important that your back draft pass be very well executed - it's this that keeps the movement going out the gate before turning. This is especially the case with cow calf pairs where the calves are still learning about the meaning and existence of gates.

There are times when you may lose all of your herd movement at the gate, even if they do see it. In this case you cannot utilize the gate feeding maneuver as easily. This is because it relies almost entirely on herd movement to be effective. Unless your cows are very well trained and you are very precise, attempting this with no herd movement will likely drive your cows away from the gate. Most often gates are in corners and the herd will be stopped in somewhat of a circular formation. When doing your zig zag to get movement started again, it is very important to keep your line straight. If your passes curve to follow the shape of the herd, you will be getting ahead of the cows in the back and likely send them back into the pasture. First and foremost, be patient. If they started once, they'll start again.

I may be giving the impression that we never lead our cattle with feed. That is not true. On occasion leading with feed is the easiest way to get the job done. There are numerous situations though in which a sufficient bribe doesn't exist. Without any other tactics you may find yourself in a bind. Quite often one is then forced to resort to scare tactics and brute force.

Learning to herd our cows the way Bud Williams taught us has never let us down. It has given us the ability to get all sorts of jobs done that we would not even attempted in the past.

Hopefully this information will help make gates less troublesome for you and your cattle.

One on One: Working an Individual Animal

Sorting an individual from a herd and trailing it away to a separate location can be difficult. Pulling a bull at the end of breeding season, sorting a sick animal to be treated or a cull to be shipped are only a few of the jobs one is faced with as a livestock owner.

Accomplishing these tasks in a calm and controlled manner is an essential aspect of good animal husbandry.

Getting an animal to “voluntarily” comply with your intentions is the name of the game. Your task is to work on the animal to get it to choose to go along with you. It’s the same principal used to train a horse or a dog. You don’t force them to go along with you. What you do is set it up so that their life is made easier by going along with you. That means making anything they do contrary to your plan difficult but not impossible. You make it difficult by infringing upon their personal space, or comfort zone, with your physical presence. In the words of Ray Hunt, “you wanna make the right thing easy (our idea) and the wrong thing difficult (their idea)”. A cow’s comfort zone is like a bubble surrounding her. You know when you are invading it when the cow starts moving away. It’s at this balance point that you strategically apply and release pressure using your position to get the cow where you want her.

To get this process to work effectively there are certain attitudes that are necessary. It is best to be calm and confident and to approach the job as an observer - as a patient observer. How much patience will be required will vary with every animal and situation. As Bud Williams told me all you need is just a tiny bit more than the cow. Patience is a relative thing, but if you have ever seen 300 thirsty cows all wanting water at the same time from a trough with room for 20, you know how impatient they can be. One thing that makes me more patient when working cattle is understanding the cumulative nature of the cows experience. A negative experience will linger in a cow’s mind. The nice thing is that it goes both ways. If you get the cow moved without a fight the first time, your patience will be rewarded with greater co-operation from the cow the next time. If you get into a fight, chances are that the cow won’t be as co-operative the next time, and the job will take more time and effort.

I would like to relate what I consider a good example of the “trainability” of cattle. We bought a yearling bull last spring. During A.I. we naturally mated him to a few cows before turning him out to do cleanup. I hauled him from a pasture at home to our A.I. facility seven or eight times. The first time I walked him into the corrals and loaded him out of a chute. The second and third time I loaded him out of a large pen at the gate. The rest of the time I parked beside him in the pasture and walked him onto the trailer. We then turned him out with his own cleanup herd. When I pulled him 3 weeks later, it was out of a half section pasture. I parked about 30 ft from him and walked him on - it took about 3 minutes. Late in the fall he got in a fight and broke his back left leg - a compound fracture just above the hock. It had been four months since he was on the trailer and we wanted to salvage him. This bull had great difficulty walking and I was wondering if he was going to be able to get on the trailer. He was in a pen and I parked in a bit of a hole about 100 ft from him. He reluctantly walked over to the trailer and hopped right on. My point, if we are willing to invest the time required to get the job done without a fight the first time, our patience will be rewarded.

To get a cow to go where we want, we need to be able to control her speed and direction. This is a progressive process. You can’t go on to grade two until grade one is complete. Grade one is initiating proper movement. A calm natural walk is the best speed to work at. If you don’t have control at a walk, chances are you won’t at a run. If you pressure her up and she runs off let her come to a stop on her own before starting again. Don’t chase after animals that spook. That will only substantiate their need to escape. How threatened the cow feels by your presence will determine the best approach. A slow zig zag approach at 50 yards might be all it takes. Or if she’s complacent, you may need a fast approach right into her hip. The more observant you are, relative to how the cow is responding to you, the more accurately you will be able to adjust. You can always rely on the cow to tell you when and how to adjust, but it requires your attention to pick up on what she telling you. Say she continues lying down and chewing her cud as you approach - she is telling you to keep coming.

Once you have good movement to work with the next thing needed is direction. This is usually where the fun starts. It's one thing to have a cow going, it's an entirely different thing to have her going the way you want - especially if you are taking them away from the safety of the herd. The usual situation, if there is such a thing, is you have the cow going just right until you reach a certain distance from the herd. She starts getting uncomfortable and wants to turn to go back. This is usually when most fights begin. Accordingly, it's the phase that will require that bit more patience. The crucial thing in avoiding a fight in this step is being willing to listen to the cow when she is telling you that you need to give ground. If you don't listen and you try to block her, she'll just start running and hook around you. When that cow is determined to go back, you have to learn to fade back with her like a good defense man playing hockey or guard playing basketball. Bud Williams has a video of two border collies helping him pen some reindeer. The reindeer got up close to the corral with the dogs bringing them - at this point they decided they weren't going any further and turned back. The dogs knew they couldn't stop them and faded back with them until the reindeer stopped. The one comment that I remember Bud making was "if I could only teach people to give ground like those dogs". For some reason it's contrary to human nature - giving ground just doesn't seem like progress. It seems more like losing the game. The game isn't lost until you run out of patience. In my experience, you may have to fade back into the herd several times. Just pick her up and bring her out again until the light goes on and your idea becomes her idea. You will know when it does because the cows body language and expression will change. She will become pliable and yield to pressure from both sides. When she yields or bends away from pressure from both sides you will be able to walk her anywhere you like.

Combining the above principles with proper positioning will substantially improve your effectiveness working individual cattle in all situations. The most common problems working single critters are a result of being out of position. Accordingly it is imperative to learn where not to be which will go along way to teaching you where to be. The worst place to position yourself is directly behind the critter (see Figure 7- Incorrect). This will inevitably cause them to turn to try to keep an eye on you. When you are close to a cow and directly behind her she can't see you. Accordingly she turns left or right depending on the situation to regain sight of you. I refer to this as hooking around. The common response to the cows natural reaction is for us to go directly to her head/shoulder area, what is referred to as pinching in, in an attempt to straighten her out or redirect her (see Figure 8 - Incorrect). This is our second mistake in response to our first mistake. The reason going directly to her head/shoulder is a mistake is because usually by the time you get close enough to exert the pressure you need she is ahead of you enough that you end up pressuring her shoulder/rib area and this speeds her up instead of turning her. More speed does not help an out of control situation. The best way to straighten her out is by stepping directly out away from the cow in the same direction she is turning (see Figure 8 - Correct). If this in itself doesn't straighten her out it will usually stop her and put you in position to turn her without the unwanted behavior of speeding her up. Once she is stopped then you can pressure directly into her head to turn her (Figure 9). So staying out to the side of the cow will dramatically improve your chances of keeping her going straight (Figure 7 - Correct). If she does turn even of her own accord stepping out away from her will either straighten her out or stop her putting you in position to turn her and improve your chances of starting the unwanted foot race.

Like anything else proficiency comes with practice. More than anything always be aware of your position and the effect it is having on the cattle.

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Why Controlling Stress is Important in Beef Cattle

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Animal Physiology
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6000 C & E Trail
Lacombe, AB T4L 1W1
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The word "stress" (or "distress" or "stressor") has been with us for several decades. This term is generally thought to have been coined originally by a very accomplished Canadian researcher by the name of Hans Selye when he was working at McGill University. In brief, the term "stress" refers to any conditions that result in an increase in the hormone product cortisol. Cortisol is a steroid produced in the adrenal glands close to the kidneys. When an animal experiences a stress such as pain, visual impact such as the sighting of a predator, a loud noise, etc., one part of the brain (pituitary) communicates with the adrenal glands via the blood stream and tells the adrenal glands to produce cortisol. This is a necessary event in order for the animal to cope with a stressful situation because the cortisol causes the body to do many useful things such as breakdown fat and muscle for energy.

However, it is important to understand that stress and cortisol can also cause a host of events to occur in a beef animal, all of which may not be helpful to health and production. It is interesting for example that cortisol levels are reported to rise to four times resting levels in a calf simply from the handling and management associated with a 2-hour transport. Furthermore, once elevated, these levels can remain high for over 24 hours. Animals experiencing such stress and elevated cortisol usually display the following symptoms:

1. Catabolism: An animal under stress usually breaks down muscle and fat for energy. This process is generally called catabolism.

2. Reduced Immune Competence: Stress will cause the immune system to change the production or circulating level of specific white blood cells. For example, one cell called a neutrophile, will increase in numbers and another, called a lymphocyte, will decrease. Neutrophiles generally help destroy bacteria and viruses, and lymphocytes are largely responsible for one type of immunity to foreign particles. The neutrophiles and lymphocytes are normally kept in a constant balance but under stress this balance is upset and the animal is more susceptible to infections.

3. Electrolyte Imbalance: The balance of electrolytes such as sodium, potassium and chloride in the body is normally within a specific range. Stress can cause this balance to change and a tremendous amount of energy is spent to correct this balance.

4. Dehydration: An excited and stressed animal usually displays an increased respiration rate which will cause a lot of water to be lost from the breath. These animals usually urinate and sweat more profusely. Collectively these events deplete the animal of moisture and dehydration can occur.

5. Hypoglycemia: All of above events can use up a tremendous amount of the animal's stored energy called glycogen or glucose. This causes the energy levels to be very low or a condition called hypoglycemia.

Practically speaking, the above events will cause an animal to display a host of undesirable reactions including weight loss, reduced quality grades, increased dark cutting beef, reduced immune competence and therefore higher health and treatment costs, an increased feed per gain ratio, more days on feed and so forth. In other words, stress causes reduced production and higher costs of production plus reduced welfare standards.

Effect of Transport and Handling Stress on Pasture Cattle

The movement of cattle from pastures is often a novel experience for the animals and can be stressful. It is common to see cattle lose weight and productivity during such situations. Previous research at Lacombe Research Centre (see reference Schaefer et al. 1993) has shown that it is common for cattle to lose up to 7% of their weight when moved off of pastures. In this earlier work, 62 head of yearling steers and heifers were raised on improved annual pastures of barley/triticale. To simulate a typical auction sale scenario, half of these animals (31) were moved off of pasture, given a 1h transport and held overnight on water. These animals lost 6.7% of their live weight. By comparison, the other half of the animals, when offered a liquid nutritional therapy drink both before and after transport lost only 4.9% ($P<0.01$) or retained an additional 7.2 kg of live weight under the same transport and handling regime. Another way of thinking about this situation is that this difference in weight loss represents about two to three weeks of grazing time simply lost due to animal stress.

Profit margins in the cattle industry are often very tight so there is a need to reduce costs of production. Also, as a beef exporting nation, such factors as the welfare demands will increasingly affect our trading practices of our partners. Both factors suggest that finding less stressful ways of managing our animals will be advisable. Such things as the nutritional management of animals during periods of handling and management stress, i.e., with electrolyte replacement programs can accomplish some of this. Other practices such as proper loading densities and humane livestock handling practices are also a very important part of reducing stress in cattle.

Reference

Schaefer, A.L., V.S. Baron, R.W. Stanley, S.D.M. Jones and A.K.W. Tong. 1993. The effect of pre and post transport electrolyte therapy on live weight loss in heifers and steers raised on pasture. World Conference on Animal Production. Proceedings. Vol 3. P275.

Suggested reading:

A.L. Schaefer, S.D.M., Jones and R.W. Stanley, 1997. The use of electrolyte solutions for reducing transport stress. J. Anim. Sci. 75: 258-365.

High Performance Electric Fences

Jim Stone, *Olds College*
Telephone: 403-556-7420

Energizer Selection
Energizers are usually identified in one of two ways: Joules or Miles of fence you will energize.

Joules
Joules = Watts x seconds. A watt is volt x amps with volts being pressure and amps being volume of electricity. High voltage is important, yet safe, if at low amperage. If you were to use water to help explain it, just visualize spraying your leg with a garden hose compared to a pressure washer. The higher pressure of the pressure washer would be felt more as would electricity from a fence wire at higher voltage. The larger volume of water from the hose or higher amperage would only make your leg wetter faster but wouldn't feel a lot different. Therefore, with electric fence we must have 2000+ voltage to be effective. High performance would be in 4000+ volt range for cattle.

Miles of Fence
Wire is like a long hose and as the electricity flows through the wire, voltage (pressure) is lost as is (water) pressure in a hose. A weak energizer will only supply 3000 volts and as you go further away, the voltage drops thus making the far end of a fence less effective due to low voltage. Usually Mi refers to one wire fence for x miles.

Take time to compare one way or the other and always consider the price/Joule or price/mile. Purchase the one that matches your budget and your long term needs. Most often one energizer would deal with the total needs of a large operation if chosen properly. The Make is not as big an issue as price, performance and service.

Solar energizers are an alternative to plug in ones. They are more expensive if you want them properly set up. You require a 12-volt energizer and a RV deep cycle battery and a panel large enough to keep the battery charged. To small a battery or solar panel will usually end up being inefficient. If you can use a plug in energizer and take the power along an existing fence to another section of electric fence, it is best. Even if it required one mile of offset fence, it would be much less expensive in the long run. Another option is to plug in at a neighbour's place and pay him for power. Average energizer would require less than 10 watts of 110 volt power.

Grounding
This is where most people fall down on in the installation of a system. Old pieces of rebar are used and are very ineffective because they rust which insulates the rod from the ground. They only make a good contact with soil on the rings which is less than 10% of the surface area. You must have large surface area in contact with the soil and it is best to use galvanized rod or pipe in order to prevent the rust problem.

What works best for me is 2 to 4 pieces of 3/4" galvanized pipe about 4 feet long, as you will have a problem getting 8 feet pounded in most areas. Pound these pipes in 10 feet apart, if possible, in a moist area like under the eaves of a building. The drier the area, the more rods you should pound. These rods will cost about $10 each. All connecting bolts and washers should also be plated and use 12.5 gauge HT wire without breaks to connect these directly to the energizer.

Testing

To check your ground system, you must short out the fence with some steel bars some 300 yards from the energizer. Lean a couple of steel bars on the wire and on the ground itself and with your voltmeter connected to the ground wire and to the ground as far away from the wire as leads will reach. No voltage should be read here at best or no more than 400 volts.

A must for testing is a digital voltmeter which reads in 100 volt increments. Using one, you check your fence occasionally and if low voltage is found, start at the energizer and check as you drive along the wire to locate where the voltage is the lowest and you will find your fault near there.

The Fence

With the proper energizer installed properly and well grounded, you must now build the fence that doesn't lose the voltage you have.

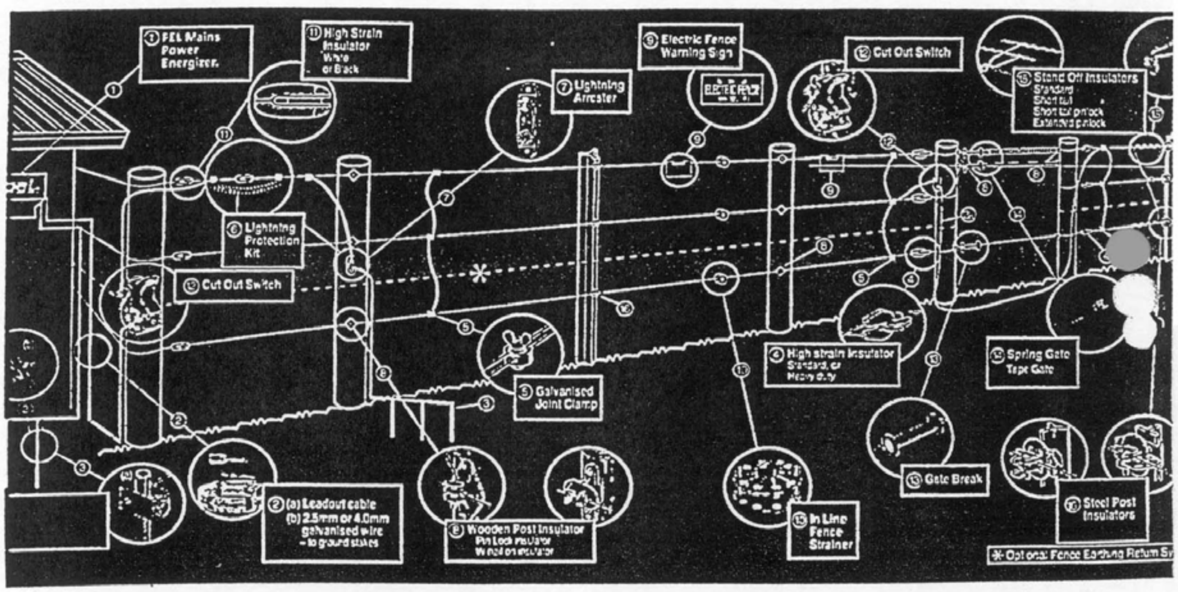
- Wire must be totally insulated from posts to be most effective. If you want to test this, just touch an energized wire to an old fence wire and measure the voltage before and after it is touching the uninsulated wire. Voltage will drop dramatically as it leaks through an uninsulated fence.
- The simplest and strongest end insulators are fiberglass using knots to tie to posts. Plastic will pull through and short out.
- Post insulators are either 4" long tubes which must all be installed at one end and pushed along the wire as you staple or wrap around insulators that are split and wrap around wire and staple holds them together. Either one works well and is not expensive. At a higher price, a pilar insulator is available or a pin lock insulator can be used. These are best in very high voltage fences (9000+ volts) or where side pressure is felt on a post such as a curved fence. Pin insulators work well for gate tape on gates and where it may be useful to raise or lower a wire for harrowing or moving cattle.
- Voltage loss in the fence will occur through plant growth (grass) and also if posts were not insulated where it touches old fence wire. Your goal is to eliminate all of these losses for more output. Don't place the bottom wire too close to the ground, i.e. 18 inches plus is best. You may need to weed-whip or mow under some fences and then spray fence lines with Round-up. Grass on a wire is like holes in a garden hose - the more holes the less pressure at the end.
- Small 3/8 diameter fiberglass posts work well for single or double wire fences. No insulator is needed and 60 foot spacing is O.K. Cost is relatively low. They last as well as any of the plastic posts available.
- Use offsets on old fence rather than add an electric wire between barbed wires. It keeps wire further away to eliminate shorts. Up to 100 feet spacing is O.K. on offsets. This will eliminate fence repairs and constant rubbing on it.
- Don't over tension wire; just tighten enough to take out the sag between posts - about 250 pounds of pull. Wheel type in-line tensioners that slip on the wire work well, but you can over tighten with them.
- I recommend a 3-wire perimeter fence, all hot with standard "H" end braces with 8 to 10 foot landscape ties as a brace between two 7 foot posts. Use high tensile

wire with a wheel type tensioner for the brace wire. Tie wires together to eliminate hot wire from touching it.

. All cross fences use 1 wire about 30 inches off the ground with 6 foot posts pounded in the ground about 3 feet and no brace unless in soft soil conditions. Use 3/8 inch fiberglass posts at 60 foot spacing.

. Do not use gate tape to transmit power to a fence across a gate. Always use buried cable under gate with special clamps to secure aluminum under the gate to galvanized wire.

Electric Fence Systems



Expected Fencing Costs

Now we all know that there is no free lunch, so I would like you to understand that there are some fixed costs as follows.

To develop a 1/4 section existing pasture material only:

Energizer complete 110 volt with lightning system in arrestor $400
2 miles of offset wire on barbed wire fence $450
(This will end fence repair for a long time even on an old fence)
Divide into 6 to 12 pastures $800 to 1,600
Water system from house well and buried water line, gravel, tensor and mesh troughs $1,300
Labor $800

Total$4,550

Amortized over 10 years + maintenance $500/yr
If a perimeter is required use 3 wire hot 40 feet post space material $500/1/2 mile

If you compare rotational grazing on an existing farm to buying more land, if available, the increased revenue is more like a gift. The biggest advantage of this is you will not only produce more beef, but your grass stand will be healthier.

Electric Fencing for Winter Grazing

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Telephone: 403-556-7420

Winter and electric fences are not usually a real good combination. You have several factors against you before you start:

- The soil is generally quite dry on top even with the snow on it so your ground does not conduct as it does in summer when soil is moist. The reason for this is that dry soil acts almost as an insulator rather than a conductor because of its resistance to the flow of electricity.

- Animal winter coats are much thicker and longer so if they do not get a shock on their nose, electricity once again finds there is a problem to conduct through the resistance caused by the long thick hair.

- The atmosphere is also generally quite dry in winter so the air itself is also much more resistant to electrical flow.

All of these factors together add up to a problem in controlling animals in winter with an electric fence.

There are several things that can be done to improve your fence performance in winter:

- Ground becomes very critical, therefore you must pay special attention to detail in this area.

- Use galvanized large surface area ground rods (e.g. galvanized pipe + 1 ¼" tubing used to frame link fence gates).

- Use more than one ground rod at energizer end and if you are using a half mile or more of main electric wire to supply your cross fence. Consider running a second wire below this wire and ground it to energizer and to several ground rods along the fence every 1/8 mile. This reduces the distance from animals to ground connection of energizer.

- Be sure to use all galvanized connections, wire, rods, etc.

- Pour water on ground rods in fall and in winter occasionally to improve ground connection

The conductor used for cross fencing seems to make a difference as well.

- First choice would be to use high tensile for all fences needed and install all fences in the fall for winter use. This means you need some method of winding up cross fences as they need to be taken out. (e.g. ATV with reel on wheel or an electric or hydrostatic reel).

. If you like plastic wire, use the wire rather than the tape for movable fence. It seems to conduct to the animal better in these conditions.

Training of animals is very important as it seems people who have cattle on electric fence year round have much better success in winter. If you just turn the cows you got last week into a fall grazing program, train them or expect trouble.

. Training means 24-48 hours in a regular fenced area either barbed wire or board fence with offset wire at about 1 metre height energized with high performance energizer (high voltage)

. If you start to have trouble, install both a hot and ground wire about 6 inches apart for a move or two, this may help train them again.

Voltage is your ace in the hole

. Use your voltage meter to be sure voltage is, and remains high. Be sure to insulate fence well to reduce voltage loss.

. Be sure your energizer produces 4000+ volts and it matches your load (length of fence).

. Unless your main system is in good condition, you may want to disconnect much of the main system if not in use for winter months.

. If you use a battery operated energizer, pay special attention to keeping the voltage up. Batteries do not like cold weather, so charge them often. A plug-in energizer is much more dependable.

. Some energizers are low in Joule (watts per second) rating but quite high voltage output so consider this. The higher voltage may help.

Mechanical construction ideas:

. Pound in posts in fall to facilitate use of high tensile wire for cross fences

. If you need to install cross fence posts, use a cordless drill to drill holes in the frozen ground and install 3/8" diameter fiberglass posts or step-ins.

. Another option is to pour concrete in car tires with a steel post in the centre. Make it so the concrete does not contact the ground in the center and a small bump with a loader will break and loosen it for moving.

Lowland Forages: Recycling Plant Nutrients - Prolonging the Wetlands

Lowland forages species provide excellent hay when harvested at the peak of quality, in early July. Feed value drops quickly to what is commonly called "slough grass" as the season progresses. Change your lowland waste areas into a source of nutritious feed for your livestock.

Agriculture - "*The Recycler*"
Only agriculture has the ability to take large quantities of pollutants out of water, and use them as plant nutrients, thereby providing quality forage for local area cattle.

Because of hay production on back flood areas, purer water flows on downstream.

One ton of hay removes:

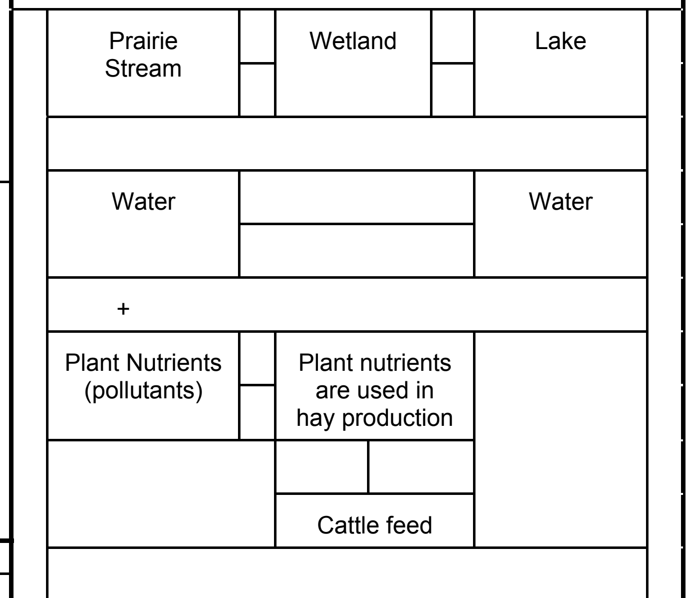
Nitrogen	**29 pounds**
Calcium	**5.8 pounds**
Phosphorus	**1.8 pounds**

Why annual backfloods are important to:
Agriculture
* Inexpensive source of quality forage
* Can provide winter feed for many cows

The Environment
* Improved water quality
* Can improve fish spawning and other wildlife habitat
* Increased useful lifetime of managed wetland area
* Areas of native vegetation are not being plowed up
* Fertilizers are not needed for forage production

Agricultural concerns in backflood areas
* Without proper water level management, i.e. depth, duration and time of flooding, backflood areas will not provide adequate forage quality in perpetuity.
* Prolonged flooding over time will shift vegetation to less desirable forage species of grasses, sedges and other aquatic plants.
* Weed control is a concern to surrounding farmers and counties. Idle land is often a source of weed problems.

Agriculture - Recycling the Nutrients
Prolonging the Wetlands



Forage plants of backflood areas - Alberta parkland

Lowland forages

Sedges	**Grasses**
Awned sedge	Narrow reed grass
Water sedge	Quackgrass
Woolly sedge	Tufted hair grass
Beaked sedge	Reed canary grass
	Timothy
	Spangletop grass
	Wood blue grass
	Kentucky blue grass

Press Release, November 28, 1994
Prepared by:

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Wetlands and Agriculture Should Co-exist

Agriculture should not think of wetlands as unusable land. Wetlands are a valuable farm resource. Wetlands are often described as lowland, wet areas where the water is retained for purposes of groundwater recharge, water cleansing, and wildlife habitat retention. For agriculture these purposes are very important.

We rely on groundwater recharge to provide us with well water for domestic and livestock use. Wetlands have the ability to take pollutants out of the water before allowing the water to recharge into the soil. This is done by the native wetland plants, such as rushes, cattails, sedges, and grasses.

Wetlands are an important part of the hydrologic cycle. Water evaporates from the wetlands, forms clouds, and returns to us as rain for our crops.

There is one other aspect of wetlands where agriculture plays a very important role. Agriculture is the only one that is able to recycle nutrients out of the water. It uses them to produce high quality forage. This forage can be hauled away from the wetland and used to feed cattle. One ton of hay contains approximately 29 pounds of nitrogen, 6 pounds of calcium, and 2 pounds of phosphorus. This may not sound like very much, but multiplied by three to four ton of forage per acre per year, haying can utilize a lot of elements otherwise considered pollutants. By recycling we can increase the useful life of the wetland. Everyone benefits.

Forage harvested off of the lowlands when it is just coming into head is a high quality "lowland forage". It is equal in protein and fibre to many of the upland species. Harvested at maturity it is no better than straw and deserves to be called "sloughgrass". Harvest management is very important.

Native lowland meadows are composed mainly of a mixture of sedges, grasses, rushes, and other forbes. Some of our meadows have been consistently hayed for over one hundred years, and are still producing three to four ton of forage per acre per year. This has bee done without the addition of fertilizer, simply by recycling the nutrients out of their soil and water environment .

Water control, through a backflood irrigation project, is the way in which this recycling can be accomplished. In early spring water is allowed to flood the wetland area. In late spring the water is drawn down to where it only covers a portion of the wetland. The remainder is allowed to dry down for hay production. The hay is harvested in early July. In some years a second cut can be taken in late August.

In a proposal such as this agriculture is not the only one that benefits. Permanent or long term water is maintained for wildlife habitat protection, fish like to spawn on the areas that have been hayed, water can be purified before being recharged into the ground, and the hydrologic cycle continues

In a well planned wetland, agriculture plays an important role in recycling the nutrients. Agriculture should be a partner in wetland protection.

Lowland Forage, Grazing Issues, Water Quality and Wildlife Habitat

Grant Lastiwka
Alberta Agriculture, Food & Rural Development, Lacombe

Lowland forage areas often called the riparian or green zone surrounds water bodies or intermittent water bodies (University of Montana). It is the link between the extensive upland ecosystems and much smaller wetland ecosytems. Lowlands serve very important functions for water quality, water quantity, stream stability, wildlife and fisheries. Their key components of water, forage, and habitat attract use. At the same time they are vital to the livestock grazing industry and mining. They often have timber on them, are homes to many wildlife and fish species, provide people with recreation opportunities and are desired subdivisions for urban settings. With so many potential uses it is no surprise that conflicts with use would develop.

The concern over environmental issues and the limited world supply of fresh, clean water has made the use by non agriculture and agriculture producers of lowlands and the uplands adjacent to them an issue. This has been broadened to the watershed by the many public and government groups involved in these issues. If land, whether it be a lot in town owned by an individual or business, an acreage in the country, agriculture holding, or used for industrial purposes, has water movement down into the groundwater or water that runs off the property this means that this land is a part of that watershed. It is not surprising to know that all these land areas are part of a watershed! In these watersheds developing of roads or creation of bare soil through harvest of timber, mining, oil and gas development, a cattle wintering site or human wastes all create problems to a clean water supply. Are you part of the solution or part of the problem? There is no sitting on the fence! It is a scary issue to think that runoff of phosphorus or nitrates, or other forms of pollutants often go into a tributary of a creek, a stream, river or groundwater recharge area and will be the source of pollutants that can be carried many miles to contaminate someone else's water supply. The right to have clean water is one that the urban public demands and industry and the agriculture community also desires.

If most of the forage residue is grazed or even worse, soil is left bare, erosion of soil into the water occurs and there is an inability to filter nutrients entering the water.

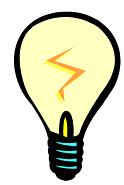
Grazing of wetland or riparian areas means that some of the lowland forage that filters runoff going into the water body is removed. Trees, shrubs, forbes and deeper rooted forage species may be damaged, killed or replaced with less functional, grazing resistant shallow rooted forage species. If cattle have continual access to the water body banks may be eroded and bare soil result. If most of the forage residue is grazed, or even worse soil is left bare, erosion of soil into the water occurs and there is an inability to filter nutrients entering the water. The ability to slow water speed and increase infiltration or deep percolation into the soil on uplands or in the riparian buffer before getting to the water body is also reduced. If soil particles enter the water body they become pollutants downstream. We in agriculture also realize summer watering of livestock form these water bodies can contribute animal pollutants directly in the form of manure and urine into the water.

The biodiversity of life in wetland areas, in particular wildlife and fish, whose habitats are closely tied to the water is another source of public concern. Our society feels that wild native species need to have a place to live and thrive. Concern over extinction of species is another issue tied strongly to wetlands as riparian areas have such a diverse habitat they contain many species of plants, animals, birds and sometimes fish. The public wonders as wetlands are drained or managed are the rights of these species preserved? These species are one of the reasons agriculture producers and urbanites enjoy living or recreating in the country.

The urban public is getting openly vocal through the many groups that have sprung up to address these environmental and water quality issues. But it is important to remember that industry and the farming or ranching community is part of the public as well on many of the above issues. Also the urban public is part of the user groups that enjoy recreation activities in these areas and should also be held responsible for leaving areas in a good state of health. So how do fish, wildlife, water quality, recreation, industry and agriculture use of wetlands in a non damaging and preserving manner get accomplished? In the rest of this article I will address the agriculture side of lowland area management by sharing information on what helps preserve the lowland resource and still keeps the agriculture industry in the business of producing food for the public.

First a Riparian Health Assessment on your property should be conducted to determine the health and successional stage of the riparian or lowland areas. Health is the ability of these areas to function in sediment filtering, streambank building, storing water, aquifer recharge, providing fish and wildlife habitat and dissipating stream energy (Riparian and Wetland Research Program-Frequently Asked Questions, University of Montana). Once the assessment is done a system is in place to chart our improvements. Specific actions can be taken to address the areas that are in need of improvement. Also a better understanding will be gained of what are the key components making up the riparian system and reasons for them. Informed decision making is the result.

A winter and summer water development in upland areas can prevent the direct and indirect site contamination problem by preventing or discouraging animals from spending time in these lowland areas. The result is less defecating and urinating near or in the water. In winter if the shelter of the trees is taken advantage of to bed the cattle in this area nutrients can become very concentrated. Wintering sites in, or adjacent to lowland areas is the biggest problem agriculture faces as a source of phosphorus and nitrate pollutants. This is a real issue for contamination of water. In early spring with no new forage growth and frozen ground the spring melt water can move the nutrients from a wintering ground quite a distance and often they end up in a water body. Most farm building sites were built near water by homesteaders. Therefore, wintering cattle at home means that water contamination in early spring is likely. Keeping cattle out of the yardsite as long as possible grazing banked forages or swath grazing lowers winter feed costs, manure removal costs and reduces the amount of feeding and resulting manure created near water bodies. A win-win situation for both agriculture and the public.

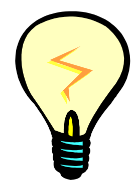


A winter and summer water development in upland areas can prevent the direct and indirect site contamination problem by preventing or discouraging animals from spending time in these lowland areas.

In summer riparian areas, although usually only a minor part of a pasture system are very productive. In drier regions especially, these areas are counted on as a major portion of the forage needed for grazing animals. These areas are often the places animals loiter to remain cool or because they do not want to walk elsewhere to forage. As a result trees, shrubs, and deep rooted grasses, sedges and rushes that anchor banks are often replaced with shallow rooted grazing tolerant grasses and in some spots bare soil is all that may remain. Banks are eroded more easily in high water times as they are less stable to remain intact without the deeper roots “rebar” forming a resistant structure to erosion.

Water development in uplands or limiting water access to the riparian area are excellent remedies for these problems. By using fenced accesses with a gravel base and tensar polygrid for stability or solar pumps, nose pumps, windmills, electricity or gas powered water pumps to move water to an upland storage place and/or a gravity feed system or a water truck, there are many options for getting water to the animals. This is easier to solve in parkland grazing systems than in the open grass prairie. On extensive grazing areas salting in uplands or supplemental feeding away from the water source also limits the time animals spend in these lowland areas. Culling cows that tend to spend most of their time grazing in lowlands although once thought an option does not appear to work. Work done by B. Ross MacDonald of Montana State University showed that the most dominant and highest producing cows were typically grazing the lowland areas with highest quality and quantity of forage. When these animals were removed from the research group to see if that would solve the lowland "camping of cow problem" less dominant cows took advantage of the situation and moved into the lowland areas. It is important to remember that these water developments have some cost recovery capabilities for many cash strapped cattle enterprises. Water development often leads to less herd health problems like foot rot and improved animal daily gains. Less maintenance on water sites; i.e. cleaning out of dugout sediment periodically, and in drought a greater availability of use when water supplies are low. Personal fulfillment and enjoyment of wildlife and scenery are other less tangible benefits that most producers enjoy.

Fencing the immediate riparian area into a separate paddock for greater grazing control is the preferred method of riparian health restoration**.** This can be very costly and difficult with meandering streams, many potholes or extensive land holdings. That is why water development accesses and enticers like salt in uplands are preferred to fencing. If fencing is decided on, once fenced in a separate paddock, grazing severity can be managed for light, moderate or deferred forage removal and can allow time for recovery of riparian health. In some cases exclusion of grazing for a year two or more may be the fastest way to start recovery. Disadvantages to total exclusion with the riparian area fenced off permanently, are a loss of land use for grazing, and there may be problems with tree growth over fences and a poorer nutrient filtering system from the future mass of dead non growing material. Which level of grazing management that is taken should be based on the amount of damage to the riparian area and the ability to forego profit from limited use of these areas. Electric fencing with one stand of high tensile wire is the most cost effective fencing method. However, many producers are not familiar with electric fence nor do they have a perimeter framework of electric fence to power up key areas. But there are ways around this to the inventive producer.



Grazing should be timed to minimize damage and allow for the harvest of high quality nutrients.

Grazing should be timed to minimize damage and allow for the harvest of high quality nutrients from lowland areas. The filtering function of a riparian zone means that nutrients are captured by vegetation before going into the water. If this nutrient sink is not harvested it may become overloaded and be the source of pollutants that leach into the water system. Harvest and recycling of nutrients through grazing (or even better haying) and stimulating regrowth of plant material is an excellent way to "clean the filter system" of the riparian area and allow for highly effective riparian functioning. If grazing is used it should start with a planned system that has a predecided rest and recovery period in it. The grazing method used should be a planned short duration grazing system so time in any one area will be brief and monitored to produce the desired outcome previously planned. It is not the fact that grazing is bad for riparian systems just that continual grazing and loitering of animals in these lowland forage areas does not allow plants time to recover. All plant species are part of the riparian functions so harvest of and health of all needs to be considered. Management for timing of rests and length of rests needed for recovery has to be balanced with your knowledge of the wetland system and its needs, with forage quality, grazing severity and duration. Forage

quality is best in spring at a time when soil may be water logged and very prone to pugging damage. Soil should not be bared if possible as it is then very prone to erosion into the water body. Trees, shrubs, forbs, sedges and grasses need biological time to rest after the grazing period to recover and have residual for next year to trap the sediment in spring runoff from reaching the water. Balancing these variables it is best to graze in the earlier part of the year (Neil Miller, Paul Hansen, Wayne Elmore). Mid to late June to mid July and if grazed later leave residue for faster regrowth thereafter.
Residual forage material left after grazing needs also to be decided. Clayton B. Marlow, Montana State University, looked at six riparian residual studies. They had determined varying stubble heights from 1-8 inches effectively trapping sediment. Some were observations and some did not involve actual grazing. In his subsequent grazing residual study he found that on a upland area adjacent to a riparian zone a grazed 6 inch stubble height on a 2-4 % slope had sediment trapping no different than a non grazed control. At 2 inches of stubble height their was a definite bank impact indicating a decline in vigor of vegetation on the bank. Depending on varying high rainfall events, degree of slope, and soil type every riparian area needs individual assessment for deciding on the best residue height to trap sediment. Other studies had noted that stubble height on the streambank needed slightly more residual than the upper slope or high water level areas which also needed certain residual levels to not overload the lowland areas with sediment.

Knowing that we are all part of a watershed makes all of us accountable for managing our own land for healthy functioning lowland forage areas. Changes to management to improve these areas often comes with their costs partly or mostly covered through increased forage production, animal performance and the enjoyment producers get out of the seeing and understanding nature at its best. As Neil Miller says, “By wisely harvesting the sediments as nutrients, through grazing or haying, allows for viable agriculture use of this resource, maintains the useful life of the wetland, cleaner water and adequate habitat will also be available for fish, wildlife and people”.

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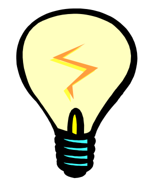
Surviving a Drought

Grant Lastiwka, Pasture Specialist
AAFRD, Lacombe

"Drought is any time forage growth is slowed or stops, when it is not normal to do so"(Smith, Leung and Love, 1986). In wet-dry environments droughts are normal and a plan should be in place to deal with these dry times. The authors also note, that plant growth stops for almost the opposite reasons such as excessively cool, wet, or cloudy weather. No one can truly understand what a drought is but the people that experience them. They can take their toll in terms of impact on economies, people(mental as well as physical hardship), plants, land and animals.

Droughts can be more minor and affect part of the growing season, the whole growing season or be prolonged from year to year. If we live in a wet-dry climate we know we will have some form of drought to deal with each year so we should always plan for them. Droughts do not just happen overnight, they are cumulative. That is why managers who plan and monitor those plans can see drought effects coming and take action steps quickly. In this article I will emphasize drought preventative measures, advance planning and possible actions to be taken early in the drought.



Plan to maintain a forage stand that can withstand short and medium term periods of drought through:
✦Seeding drought adapted plants
✦Maintaining sufficient residue levels on pasture
✦Keeping high plant vigor by not overgrazing and
✦Using a good fertility program.

Plan to maintain a forage stand that can withstand short and medium term periods of drought through: Seed drought adapted plants; maintain sufficient residue levels on pasture; keep high plant vigor and deep plant roots by not overgrazing and using a good fertility program and keep plant density high to prevent bare, hot soil. Stands with the above features will allow for the most effective water infiltration and use, keep the soil cooler and slow windspeed at soil surface to lower soil evaporation and plant transpiration. Finally be a forage stockpiler when green forage is short plus keep plant growth stable and allow for a quicker regrowth when moisture does arrive.

Having a grazing plan in place and by monitoring and updating it regularly provides a great benefit in budgeting forage production and animal needs. By monitoring the plan, animal needs and plant growth, the manager knows he is running short of forage in advance of the drought effects fully occurring. Controls can be put in place, replanning done and actions taken (slowing grazing rotation speed, destocking or supplemental feeding) before overgrazing takes place and before serious or long term damage is done to the pasture or the pocket book. Regrowth in a drought cannot be predicted in days and, as Burt Smith said at the 1999, Edmonton, Western Canadian Grazing Conference "Life uses a biological time that cycles around, but never quite comes back to the same position." The biological time for recovery will be increased if drought stressed plants have been over grazed and plant residual removed.

Having drought plans in place are especially important for people who experience droughts commonly or cannot afford to make costly mistakes. In these areas where droughts regularly happen maintaining higher financial equity levels and stocking at a rate in line with long term productivity allows for times when drought occurs for significant periods. Better decisions can be made and human stress lowered if contingency plans are in place before a drought occurs and with a cool head, than during the drought, with a hot one. A procedure of management steps for degrees of drought and corresponding actions to be taken are a good idea because no one can predict when a drought will end. By acting quickly with tactical steps previously decided as each planned drought level occurs, the operator is in better control of the situation and reduces losses in the short and long term. Steps such as: Water supplies/options for livestock explored in advance is crucial (prevents cattle direct access so water is clean and lasts as long as possible); fertilize, find pasture elsewhere, seed annuals or graze crops; placing cattle on pasture later; sacrifice certain pastures with greater vigor or carryover forage; feed on areas in need of nutrients; group herds and have flexible herd numbers and selling or putting in a feedlot portions of the animals as predecided drought points are reached, i.e. Yearling steers, next heifers, early wean calves, then cull cows and finally put out on shares or sell portions of the core cow herd.

In conclusion, the preventative planning steps and by having grazing and drought management plans in place the effects of droughts are less detrimental in the short and long term. Monitoring those plans and taking quick remedial action as each tactical point is reached with a predecided step to offset the shortfall makes good management sense and is less stressful to the manager than not doing anything until it is too late. As the old saying goes "you cannot graze your way out of a drought". Grazing everything off as it regrows slowly may be a short term solution but will leave you with a long term negative result.

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Integrated Control of Problem Perennial Weeds in Pastures and Hay Land

Dan Cole
Weed Specialist, AAFRD

[1]Weeds can be a problem in pastures and hay land. Weeds not only reduce forage yields and carrying capacity, they can also reduce the quality of the forage. Some weeds, such as Canada thistle, reduce yields by out-competing the forage as well as creating a barrier effect to discourage livestock form grazing the forage in the immediate vicinity. Unpalatable weeds, like ox-eye daisy, cause cattle to selectively graze around the weed, reducing forage competition. Some weeds are poisonous and directly affect livestock well-being. Weeds may render specialty forage crops, such as timothy compressed hay and forage seed crops, unmarketable. They not only affect the esthetic value of pastures and hay land, but may also attract the attention of the weed inspector and incur the costs of meeting the requirements of the Weed Control Act.

In most instances, the control of weeds in pastures and hay land is not perceived to be economical. So nothing is done and the weed spreads in the pasture or hay land and onto the neighbor's land.

Weeds are often indicators of an unhealthy pasture or hay land. As weeds are often abundant and are adapted to spread by wind, water, equipment, birds, mammals and man, weeds move into new areas and gain a foothold where there has been a disturbance in the plant sward. This disturbance may be from a pocket gopher or from cattle grazing too early in the spring. Even native plants, such as pasture sage and prickly rose, can become weed problems in overgrazed and less well maintained forage stands. The weedy plants that have been introduced into Canada from Europe seem to have been able to take advantage of the new environment and the different plant sward. For example, Canada thistle and yellow toadflax have spread extensively throughout the prairies and are very difficult to remove. They especially thrive in less competitive and disturbed forage stands, on low fertility soil.

Producers take advantage of forages for their natural competitive ability against weeds and assist them in being more competitive with the use of fertilizer and/or manure.

Forage stands adjoining heavily infested fields may never have a weed problem if the stand remains healthy and competitive. In fact, a properly maintained forage stand is a method used by producers to reduce weed problems. They take advantage of forages for their natural competitive ability against weeds and assist them in being more competitive with the use of fertilizer and/or manure.

With this in mind, an approach to improving the health of the forage stand may not only increase the quantity and quality of the forage but may also assist in addressing the weed problems.

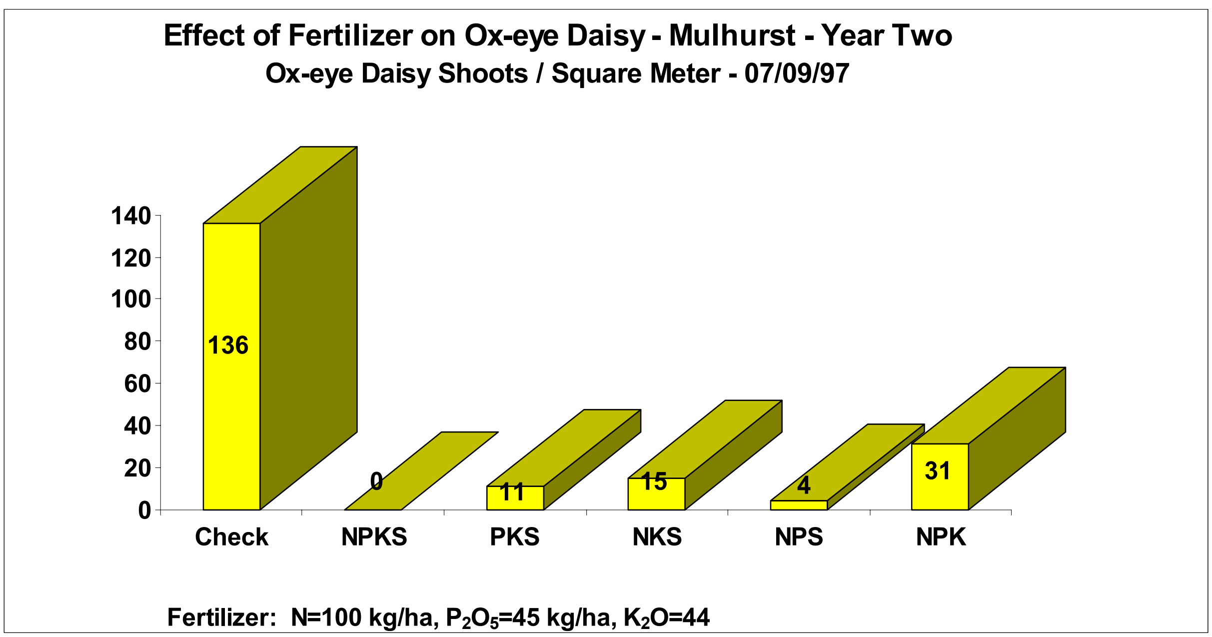
Problem perennial weed control trials using herbicides and fertilizers and their interactions were conducted on fenced-off pasture in west-central and central Alberta. This integrated approach was used to address the difficult to control weeds, yellow toadflax, common tansy, ox-eye daisy, wild caraway and dandelion, with a project just starting on the integrated control of Canada thistle. The purpose of the research was to determine a cost effective means of providing long term control of these problem perennial weeds.

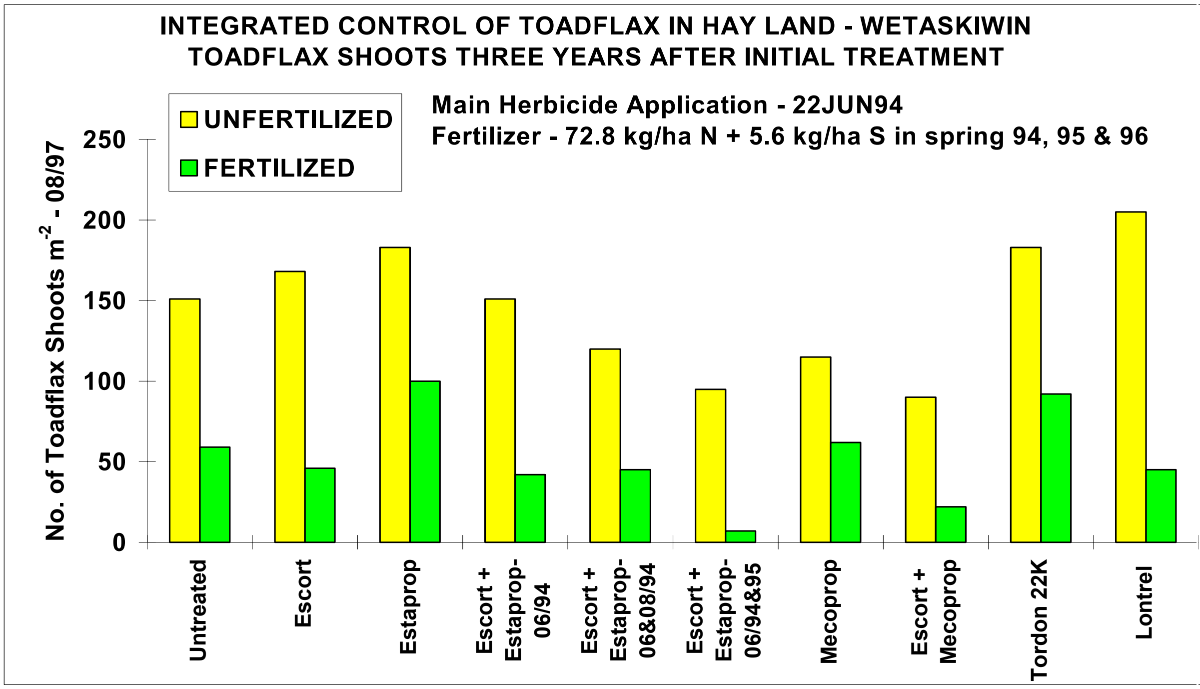
The results from these trials show that the addition of fertilizer can enhance the control of these five weeds provided by the herbicides. There was improved control whether the herbicides were effective or not. For one weed species, ox-eye daisy, herbicides were not even needed. Fertilizer alone was adequate to remove the weed from the forage stand. Two years of spring surface application of fertilizer to soil test recommendation rates increased the forage growth to cause the forage to out-compete and remove ox-eye daisy from hay stands in four separate trials conducted across central and west-central Alberta.

Escort provided good suppression or control of all five weedy species when applied in combination with early spring surface application of fertilizer.

Using the yield increase obtained in the research trials on ox-eye daisy from the fertilizer application, and not considering the increase in quality and other beneficial aspects of weed control, fertilizer application resulted in a $89.00/ac increase in forage yield. The fertilizer not only paid for itself but also resulted in weed control and a cleaner field.

Increasing and maintaining the competitive ability of a forage stand can provide a long-term and cost-effective means of suppressing weeds in pastures and hay land.




INTEGRATED CONTROL OF TOADFLAX IN HAY LAND - WETASKIWIN
TOADFLAX SHOOTS THREE YEARS AFTER INITIAL TREATMENT
UNFERTILIZED
FERTILIZED
Main Herbicide Application - 22JUN94
Fertilizer - 72.8 kg/ha N + 5.6 kg/ha S in spring 94, 95 & 96
No. of Toadflax Shoots m-2 - 08/97
0
50
100
150
200
250
Untreated
Escort
Estaprop
Escort + Estaprop- 06/94
Escort + Estaprop- 06&08/94
Escort + Estaprop- 06/94&95
Mecoprop
Escort + Mecoprop
Tordon 22K
Lontrel

Other Resources

Here are some other general resources you may find helpful in trying to find assistance in pasture management or different parts of the grazing industry. My apology in advance to those I missed.

Agriculture and Agri-Food Canada: Contact your closest office of AAFC for scientific information on specific soil, plant and animal areas.

Bud Williams Stockmanship School: Call Bud or Eunice at 308-423-5624

Cattlemen Publication: 1-800-665-1362

Ducks Unlimited: 1-800-665-DUCK (3852), Website: www.ducks.ca/conserv/wbf/index.html

Interesting internet sites and links at http://

AgriLaunch: www.agrilaunch.com
American Farmland Trust: www.grassfarmer.com
Farm Home Page: www.loughries.demon.co.uk
Graze-L WWW Site: grazel.taranaki.ac.nz
grassfarmer.comhomepage.html
grassfarmer.com/cmf/welco1.html
grassfarmer.com/Links.html
Roping the Web: www.agric.gov.ab.ca
pss.uvm.edu/vtcrops/forages.html
www.stat/ab.iastate.edu/survey/SQI/sqihomes.html
http://aes.missouri.edu/fsrc/news.html
www.ag.ndsu.nodak.edu/cow
www.oznet.ksu.edu/forage
forages.orst.edu
www.ag.ndsu.nodak.edu/dickinso
www.holisticmanagement.org
www.caf.wvu.edu/~forage
www.its.uidaho.edu/range
www.grandin.com
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ansi.okstate.edu/library
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aes.missouri.edu/fsrc/index.stm
www.uidaho.edu/cfwr/range
www.wvu.edu/~agexten
extftp.agric.gov.ab.ca
www.agric.gov.ab.ca/ministry/pid/agronomy_unit/index.html
www.asas.org/bulletin/April2000.html
www.ars.usda.gov/is/np/ha
www.asas.org/JAS

www.ext.nodak.edu/extpubs/beef.htm
www.ag.ndsu.nodak.edu/dickinso/grassland/range.htm
www.statlab.iastate.edu/survey/SQI
www.pasturemanagement.com
www.ag.ndsu.nodak.edu/cow/lsmanews/archives.htm
osu.orst.edu/dept/range/index.htm
www.or.blm.gov/Prineville
www.cnr.colostate.edu/RES
www.agro.agri.umn.edu/mfn
www.Cowdoc.net
www.agnic.org
www.gov.on.ca/OMAFRA/english/crops/field/forages.html
www.gov.on.ca/OMAFRA/english/ag.html
www.afac.ab.ca
www.meatingplace.com/meatingplace/Index.asp?nocache=10%2F2%2F00+11%3A26%
3 A41+AM
www.agr.ca/pfra/pfintroe.htm
www.agric.gov.ab.ca/agdex/400/400_27-2a.pdf
www.msue.msu.edu/jackson/GLGC.htm
www.agr.ca/policy/winn/biweekly/English/index2e.htm
www.uwex.edu/ces/forage/articles.htm
www.cattle.ca/Acc/default.htm
www.agric.gov.ab.ca/navigation/links/economics/index.html
cattlefeeder.ab.ca
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www.farmwest.com/forage/afm/index.cfm
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Agricultural Research and Extension Council of Alberta (Formerly Alberta Forage Council): Call Richard DeBruijn, Manager, 403-782-0772 or email: abforgco@telusplanet.net.

Forage Systems Research Center in Missouri for courses and newsletter: Call 660-895-5121

Grainews Publication: 1-800-665-0502

Grassland Agriculture Consulting for courses: Call Jim Bauer at 403-546-2427.

Holistic Management, bimonthly newsletter: 505-842-5252

Holistic Management Courses: Call Len Pigott at 306-463-6236 or Don and Randee Halladay at 403-729-2472.

Low Cost Cow Calf Production courses: Call Dick Diven at 800-575-0864

Low Stress Cattle Handling Workshop/Marketing Natural Products: Call Dylan Biggs or Colleen Biggs at 888-857-2624 or grassfeed@telusplanet.net

Prairie Farm Rehabilitation Administration: In British Columbia call: 604-782-3116; Alberta call 403-340-4290; Saskatchewan call 306-773-7255 and Manitoba call 204-726-7584 for water system, shelter belt and some pasture management needs.

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In Alberta call Ag-Info Centre at 1-866-882-7677.

Ranch Management Consultants & Ranching for Profit Programs: Call Dave Pratt at 707-429-2292.
Internet Site: www.ranchmanagement.com

Range Management Services/Courses and consulting on range, goals and people issues: Wayne and Connie Burleson at 406-328-6808.
Internet Site: www.pasturemanagement.com

Society of Range Management, Rangelands Periodical and conferences: 303-355-7070

The Stockman GrassFarmer Publication: Call Jane Walsh or Linda Brister at 1-800-748-9808

Western Beef Development Centre: 306-966-4151

Western Forage/Beef Group Newsletter: 403-782-8030

Journal's: Refer to University or Government libraries for access:

- Agronomy Journal
- Canadian Journal of Animal Science
- Canadian Journal of Plant Science
- Canadian Journal of Soil Science
- Grass and Forage Science
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Field Guide: Identification of Common Seeded Forage Plants of Saskatchewan

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