Grazing Management Guide

About the guide

The guide is comprised of this main document which is supported by factsheets and links or references to other information sources that may be of assistance. The operation's interests, objectives, opportunities and/or challenges will guide what supplemental resources will be used. This main document sets the context, outlines the approach and discusses the concepts – linkages between pasture and soil health, plant growth, response to grazing, grazing strategies, forage quality, their integration into a grazing plan – and introduces the idea of ongoing improvement or refinement via adaptive management and monitoring.

The *Grazing Management Guide* is laid out in three sections:

- Section 1 – Introduction
- Section 2 – Foundational Concepts of Grazing Management
- Section 3 – Applying the Concepts to Develop and Adjust your Grazing Management Plan

This document addresses the principles and foundational concepts and outlines the process. The details are supported by a series of factsheets. A comprehensive list and synopsis of the factsheets can be found in Appendix A at the end of this guide.

Section 1 - Introduction

This guidebook focuses on the needs of producers to economically graze livestock while ensuring the grazed areas can function naturally, supporting soil ecosystems, plant communities, and stand health. These functions are collectively termed Pasture, Range, and Riparian Health and form the basis for a Grazing Management Plan. Although this guide and its associated factsheets are designed to standalone, it can also be used in conjunction with the following resources:

- The Riparian Management Field Workbook of the Canada-British Columbia Environmental Farm Plan Series (See "Streams and Small Rivers" and "Lakes, Ponds and Wetlands")
- Agroforestry (silvopasture) information

This guide provides grazing management recommendations and monitoring strategies intended for use on private and deeded leased grazing lands. While the principles outlined are broadly applicable to similar sites and landscapes, it is important to recognize that some lands—such as provincial and federal lands—may have distinct objectives and requirements. They may require formal authorization to enable the use of grazing management systems and practices.

- **Pastures** include any vegetated land that is grazed or has the potential to be grazed. This includes areas that vary from intensively managed pastures to rangelands.
- **Rangelands** are lands on which the native vegetation (climax or natural potential) is predominantly grasses, grass-like plants, forbs, or shrubs and is managed as a natural ecosystem.
- **Pasture management** is the manipulation of the soil-plant-animal complex in pursuit of a desired result.

The health of pastures and rangelands can be maintained/sustained or improved by understanding and implementing the principles outlined in this guide.

The principles and management options provided in this management guide are intended for livestock producers who wish to increase their understanding of how they can assist in maintaining functional systems including:

- **Nutrient cycle -** the cycle of nutrients such as nitrogen and phosphorus through the physical and biotic components of the environment
- **Water cycle** - the capture, storage, and redistribution of precipitation
- **Energy flow** – conversion of sunlight to plant and animal matter on grazing lands
- **Soil carbon cycle** - plants take carbon from the atmosphere during photosynthesis, and through various processes like root exudates, decomposition, soil microbial action, ingestion and excretion by animals. Carbon can be stabilized and stored as organic matter in the soil.

In addition to the functional systems involved in maintaining grazing lands, ecological processes also provide other interactions and influences. These ecological processes refer to the ability of grazing lands to perform important natural functions like:

- Producing plant biomass, including forage for livestock and wildlife
- Maintaining the soil and its microbial ecosystem (fungus, bacteria, etc.)
- Protecting the site from erosion
- Capturing and beneficially releasing water
- Cycling nutrients and energy
- Maintaining biological diversity in natural systems
- Supporting pasture productivity and resilience
- Storing carbon

The concepts and options discussed or described are intended to assist livestock producers in preventing and decreasing environmental impacts or improving conditions on their farm, while maintaining or increasing profits. It is also a useful tool that may assist in achieving Grazing Management Plan objectives. The principles and guidance provided in this document will vary in applicability as well as the time and degree of pasture and soil health improvement across operations and landscapes. Finally, it is important to note that future revisions of the principles and concepts outlined in this guide will occur as science and experience provide additional information on indicators of rangeland and grazing land health and its assessment.

What we are managing for (vision)

Farm and Ranch Health are key to operational success, supporting the achievement of farm or ranch objectives, whether rooted in family or partnership goals, livestock and land stewardship, product quality and attribute marketing, or financial sustainability.

Pasture and Range Health is defined as the "*degree to which the integrity of the soil, vegetation, water, and air, as well as the ecological processes of the grazing land ecosystem, are balanced and sustained.*" (Society for Range Management, 1998).

Soil Health is the continued capacity of the soil to function as a vital living ecosystem. It is measured in pastures by the soil's ability to sustain plant and animal productivity, maintain or enhance the quality of water and air, and support human health and habitation.

Riparian Health or properly functioning riparian areas can reduce the impacts of flooding, trap sediments, and filter nutrients and pollutants. Healthy riparian areas also provide essential habitat for a wide range of plant and animal species, contribute to groundwater recharge, and are characterized by stable streambanks that help minimize erosion. Riparian areas attract livestock and wildlife by providing water, forage, and shelter. The degree of this attraction is dependent on the grazing season. For example, in the hot, dry summer months, the forage found in a riparian area may be the only lush, palatable, and nutrient rich vegetation available on a range or dry-land pasture. Combine this with water availability and shade, and it is easy to see why these areas are extremely attractive to livestock.

The **Riparian Management Field Workbook** publication of the **Canada-British Columbia Environmental Farm Plan Series** is designed to assist those interested in determining the health of their *riparian areas*.

Forest Health has been defined by the production of forest conditions that directly satisfy human needs and by resilience, recurrence, persistence, and biophysical processes which lead to sustainable ecological conditions. Livestock often graze in these areas, be they forest openings, cutblocks, silvopastures, or previously burned or disturbed areas. In the context of grazing, this guides us to ensure the natural processes and plant communities (vegetation) that support the forest ecosystem are not negatively affected. It is beneficial to include forest objectives specific to the site in the grazing plan and any subsequent monitoring. It is worth noting that while this *Grazing Management Guide* focuses on private and deeded leased land, in the context of Crown land and large private holdings, the majority of grazing in the province occurs on forested lands.

Why consider pasture and range health?

Healthy pasture and rangelands provide a wide array of goods and services that benefit both society and producers. For livestock producers, this includes economically and environmentally sustainable grazing opportunities, along with benefits such as improved water cycling, soil function, and overall landscape resilience. When managed well, these lands also support biodiversity, contribute to climate adaptation, and offer habitat for wildlife, all while sustaining long-term productivity and viability. Additional benefits may include:

- Reduced feed costs
- Maintenance and/or improvement of forage production and resilience to other disturbances such as extreme weather, fire, pests, etc.
- Increased livestock production per hectare or grazing land area
- Extended grazing season and increased flexibility around season of use
- Reduced weeds and associated control costs
- Reduced fertilizer costs
- Quality wildlife and fisheries habitat
- Prevention of soil erosion
- Enhanced silviculture and timber production
- Water quality and watershed protection
- Large soil carbon sinks — good grazing has been identified/proven to be a beneficial climate solution practice

Section 2 - Foundational concepts of grazing management

A **grazing management plan** that is designed for the operation's environment (land, weather, vegetation, livestock, personal, and management options) will help to alleviate environmental concerns, maintain or improve pasture, range, and soil health while improving forage and livestock production. In addition to these benefits, the approach should support the operation's profitability and resilience, while remaining practical, flexible, and achievable in terms of time, labour, and other resources.

What attributes should a grazing plan incorporate?

This guide will focus on the use of the long established **FIO Principles** (frequency, intensity, opportunity). **Frequency** refers to the grazing duration of a grazing period – the time plants are exposed to grazing, which correlates to the possibility that plants regrow and are grazed during that same grazing event. **Intensity** refers to the amount of leaf area remaining after a grazing event – in general, leaving more than 50% of the leaf material ensures enough photosynthetic capacity to support plant growth both above and below ground (roots). **Opportunity** refers the amount of time plants have to grow before grazing or regrow after grazing (often called rest). Providing adequate rest between grazing events is critical to support vigourous plants and plant communities, winter survival, productivity, and soil health. A grazing plan that employs the FIO Principles in a manner that supports plant vigour is a critical step towards pasture and rangeland health and resilience.

There will be circumstances or situations where managing grazing **timing** (when grazing occurs during the season or plant development stage) will be beneficial. Paying attention to and managing **animal impact** and **stock density** may also be necessary to ensure positive grazing outcomes and to avoid negative effects such as soil compaction or pugging. For further information see *Factsheet #8 – Grazing Frequency and Utilization*.

There are different ways of expressing what these key attributes are; by way of example, here are three.

1. The BC Ministry of Forests (Range) refers to the Acronym DURT to reflect four basic principles of range management.
    - **D**istribute livestock over the range.
    - Graze to the right **U**se level.
    - Allow enough **R**est during the growing season.
    - Graze at the right **T**ime (and for the right duration).
2. The Canadian Forage and Grassland Association (CFGA) uses the acronym GRASS.
    - **G**razing period = time animals graze a paddock. Move animals prior to the “second bite” (removal of leaf regrowth). If not, adjust to enable regrowth and recovery.

- **R**est (regrowth) period = time plants need or are given to recover, i.e., grow after defoliation. Varies with season, species, plant vigour, utilization, and growing conditions.
- **A**nimal impact = physical effect animals have on the soil. E.G., "hoof action" and deposition of nutrients. *Caution is needed as negative effects can also occur.*
- **S**tock density = number of animals per unit of area. Typically expressed in terms of animal units per acre or hectare. Higher density equates to more plant species being grazed (less selectivity), better distribution of manure, and more uniform physical impacts.
- **S**oil armour – litter = plant residue covering the soil surface. Provides insulation, which mitigates soil temperatures (summer & winter). Reduces rain impacts, runoff, erosion, evaporation, and supports nutrient cycling, soil biology, and function.

3. The "Five Grazing Fundamentals"

1. **Timing:** When during the season or year grazing occurs.
2. **Frequency:** How often the plants are grazed.
3. **Intensity:** How heavily the plants are grazed.
4. **Duration:** How long the grazing event lasts.
5. **Rest:** Time during the growing season when the plants can recover from grazing.
    - ref: Noble Research Institute

Although expressed differently, when placed in the context of designing and implementing a grazing system, these fundamentals and attributes guide us to consider the impacts of grazing on plant and soil health. They encourage the use of rotational grazing systems. Utilizing them supports productive and resilient plant communities and pastures while providing good outcomes for livestock.

Pasture (plant vigour) and soil health are interdependent. For pasture plants to be vigorous and resilient, they greatly benefit from a healthy soil ecosystem. Properly functioning soils capture, store, and redistribute water, support plant growth, cycle nutrients and maintain or build soil carbon. For the soil ecosystem to be healthy, it relies on plants that are vigorous, providing energy (exudates) that support microbes (fungi, bacteria, etc.) and soil food webs. Active photosynthesis, root growth, and nutrient exchange are critical elements of healthy pastures and soils.

How does grazing influence pasture and soil health?

Livestock have tendencies and preferences when grazing. In general, livestock will select species and/or sites that they prefer. Subsequently, those areas and species may be grazed repeatedly and harder (more leaf area removed), resulting in less vigorous plants often described as being overgrazed, unless the livestock are removed, thereby reducing that possibility. Hence, the discussion turns to using rotational grazing strategies to maintain or improve plant vigour and soil health. The benefits of doing so include:

- Increased soil organic matter
- More availability of nutrients for plant growth
- Improved water infiltration and storage (aggregated soils)
- Increased plant or pasture production (more livestock, longer grazing season)
- Balancing production and conservation opportunities in silvopastures or riparian zones.
- More desirable plant species sustained in the pasture
- Better soil conditions that support germination, seedling establishment, vegetative reproduction, and root growth
- Increased ability of the soil to act as a filter, protecting water and air quality.
- Reduced water erosion (sheet, rill, gully)
- Sequestration of carbon from the air.

Editorial note

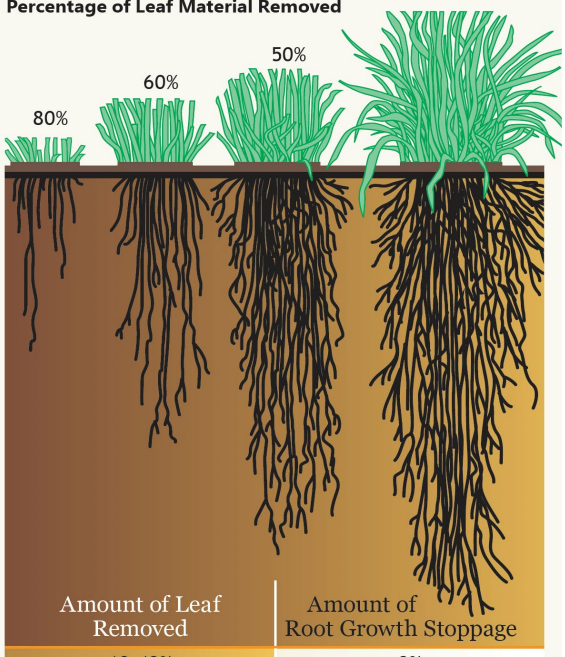
In the discussions that follow you will see *frequency, intensity, and opportunity* in italics to link the topics being discussed to the **FIO Principles** (Frequency, Intensity and Opportunity). In the FIO Principles *frequency* combines the duration and frequency of the Five Grazing Fundamentals on page 7 to address the risk of taking the "second bite" or multiple defoliations prior to a rest or regrowth period. *Intensity* refers to the degree of defoliation, and *opportunity* refers to the rest (growth or regrowth) period.

If livestock are allowed to graze and re-graze plants repeatedly, the effect on those plants can be quite negative. When grazed during the growing season, plants begin growing again almost immediately. As they begin to regrow, they place a significant amount of energy into leaf growth. If a large amount of leaf area is removed *(intensity),* then the energy supporting leaf growth is drawn from reserves as well as photosynthesis. Less leaf area equates to less photosynthesis, hence the need to use stored energy. Livestock tends to target this new growth due to its fresh, succulent, or highly palatable nature. Grazing the new leaf growth without a rest period is very detrimental to plants and can cause root growth to slow or stop and, if prolonged, greatly weaken the plants and ultimately lead to their death. Grazing plants without providing them the *opportunity* to regrow, rest, or recover is, by definition, overgrazing and is the primary reason for pasture conditions and production to deteriorate. To reduce that risk, management-intensive rotational grazing systems look to shorten the duration livestock stay in the same area (*frequency)*, set stocking rates so the leaf area removed (*intensity)* is appropriate (e.g., take half, leave half rule of thumb), and provide an adequate period of rest, recovery, or regrowth *(opportunity),* thereby supporting pasture productivity and plant health or vigour.

Root growth, as well as soil ecosystem health, is largely dependent upon the plant's ability to photosynthesize and supply energy to the root and soil microbial environment. For photosynthesis to occur, growing conditions (water, nutrients, temperature) must be supportive; however, if there is little or no leaf area, photosynthesis is greatly reduced, and what energy is produced or drawn upon is used to reestablish the all-important leaf area. In those instances, root growth slows or stops depending upon the degree of leaf removal. The diagram below (Figure 1), based on Crider, 1955, shows the relationship between root growth and leaf removal.

As illustrated in this diagram, it is easy to see where the "take half, leave half" rule of thumb stems from. Of course, it is a guideline or concept, so has its exceptions. After grazing or defoliation, if there is enough leaf area (generally greater than four inches (approximately 10 cm)) to support photosynthesis, root growth is largely unaffected. Given the right circumstances, adequate leaf area (e.g., >4 inches (10 cm)) could remain to support growth when greater than one-half of the leaf area has been removed. Conversely, if there is little above-ground leaf area and one-half is removed, leaving less than four inches for example, then root growth will slow or be stopped for a period of time, potentially reducing plant vigour and production. A good root system that supports water and nutrient uptake is critical to pasture production and health. Leaving enough leaf area as well as time *(opportunity)* for regrowth is critical to enabling the plants to grow above and below the ground, providing healthy, productive pastures. See *Factsheet #8–Grazing Frequency and Utilization* for species-specific stubble height guidelines.

Figure 2. Plant Root Response to Grazing - Percentage of Leaf Material Removed



Amount of Leaf Removed	Amount of Root Growth Stoppage
10-40%	0%
50%	2-4%
60%	50%
70%	78%
80-90%	100%

If 80% of plant leaf material is removed, plant root growth can cease for 12 full days, which slows plant regrowth considerably (Dietz, 1989). If only 10% to 40% of plant leaf material is removed, plant root growth doesn't stop and the plant regrows faster and remains healthier.

Figure 1. Plant root response to grazing – percentage of leaf material removed

How forage plants grow

How forage plants grow and subsequently respond to grazing is another aspect that helps inform grazing management. Plant growth is a highly detailed area of study that is continually evolving. The intent here is to capture the highlights in an understandable and usable way. Feel free and welcome to dig deeper. The references have articles that may assist you in that endeavour.

In pasture systems we typically have and manage forages: grasses or grass-likes (e.g., sedges), forbs (broadleaves and flowers), and shrubs (woody stems). In all these plants, new leaf and stem growth comes from a part or parts of the plant that for simplicity's sake we will refer to as growing points. The crown (buds) is where the stem and the root meet on a plant; this is where the new growth occurs at the soil's surface. The most commonly referenced growing points are apical meristems and axillary or crown buds, which are the primary drivers of active growth. Apical meristems typically suppress the development of axillary or crown buds. When a growing point is removed, growth now must come from another growing point, typically an axillary or crown bud. The removal of the growing point causes the plant to shift resources (energy) to that new growing point so it can support plant growth. When that occurs, it results in energy being shifted from photosynthesis and/or energy reserves to the new growing point, often resulting in a slowdown in plant growth (above and below ground) for a period of time. This section will focus primarily on grasses and forbs (primarily legumes) that typically comprise pasture stands.

Grasses, forbs, and legumes provide above ground foliage via the production and growth of shoots. Tillering refers to the formation of new shoots that replace older and dead shoots also referred to as tillers in grasses and stems in forbs. Tillering increases the live shoot density of plants, thereby filling gaps in the pasture canopy, providing ground cover and vegetation available for grazing. Legumes are forbs with a difference; they have a symbiotic relationship with soil *Rhizobium* enabling them to fix nitrogen from the atmosphere. Reducing their need for additional nitrogen (fertilization) for their production and provide some nitrogen to other forage species in the plant community or pasture.

Forbs and legumes, although there are differences among species in their tolerance to grazing, all exhibit similar shoot growth. The growing points are elevated, at or near the top of the plant, with axillary buds and crown buds near or at ground level. These elevated growing points support active stem and leaf growth; however, as they move to their reproductive (flowering) phase, that growth slows significantly as the plant shifts its energy to seed production. Removal of growing points during the vegetative

phase results in the plant shifting its resources to new growing points from either axillary or crown buds. Depending upon the stage of growth and degree of defoliation, that can cause the plant's above ground growth to slow as energy shifts to support the new growing points. Ensuring that new growth is not grazed and providing adequate time for rest or regrowth is important, particularly as the growing season progresses. Fall and early winter management of defoliation can be critical to ensure legumes and other forbs have enough energy reserves to make it through the winter and initiate growth in the spring. In general, that means the last harvest should be made so that there are 8 – 12 inches (approximately 20-30cm) of foliage (regrowth) or 4 – 6 weeks of growth before the first killing frost. Leaving some above ground vegetative cover will also assist by providing insulation and an avenue for air to get into the soil to support plant respiration. That is especially important if you will be feeding livestock on the area or if there is snow compaction or melt followed by a freeze. For deep rooted legumes such as alfalfa, allowing the plants to reach the flowering stage at least once in the growing season (later in the season is seen to be slightly better) supports their vigour and survival.

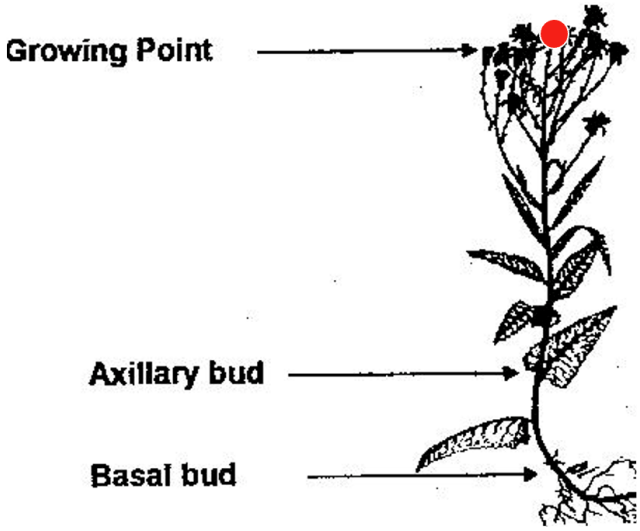


Figure 2. Growing point. Source: B.C. Range School

The meristems (buds) shown on this alfalfa plant are essential for regrowth. If the developing meristems are grazed too quickly, the stand will decline.

Figure 3. Purdue University, & Natural Resources Conservation Service (NRCS)

In most cool-season grasses (most common in B.C.), the axillary buds at the crown region of the parent tiller form new tillers. In many forbs or legumes, tillering can occur from axillary buds or crown buds. Grass species vary in the timing of shoot formation:

- In many perennial grass species, new shoots form axillary buds in spring and fall.

- Some species (e.g., Kentucky Bluegrass, Orchardgrass, Perennial Ryegrass, and Tall Fescue) form new shoots throughout the growing season.
- In other species (e.g., Timothy, Smooth Bromegrass, Intermediate Wheatgrass, Switchgrass, and in legumes such as alfalfa), new shoots form in pulses or waves as parent shoots reach maturity or are defoliated.

Key Points

- Cool-season grasses are often referred to as C3 grasses due to producing a 3-carbon acid as a product of photosynthesis. Their carbon dioxide (CO_2) pathways are more efficient in cooler temperatures.
- Warm-season grasses are often referred to as C4 grasses, as during the process of photosynthesis a four-carbon compound is created. The CO_2 pathway is efficient in hot, dry environments because the pathway that it utilizes allows plants to retain water by allowing the fixation of carbon when stomata are closed.

Tillers recruited early in the growing season frequently become florally induced and terminate their life cycle during the same growing season, while tillers recruited later in the season frequently over-winter and resume growth the subsequent growing season. The longevity of these late tillers generally does not exceed two complete growing seasons. Fall tiller recruitment is especially critical.

Many cool season grasses form tillers late in the growing season that will overwinter and regrow the following spring. Pastures grazed heavily or trampled in the fall and winter have the potential to reduce grass density and production greatly the following year by reducing these late-stimulated tillers.

Managing stands to enter the fall and winter season in good health or vigour and managing that period to support tillering and tiller survival will enable a dense and productive stand for the upcoming growing season.

Grasses exhibit two growth strategies of stem elongation: "long shoots" (often referred to as jointed) and "short shoots." Long shoot grasses (e.g., Smooth Brome, Timothy, Reed Canary Grass, Big Bluestem, and Switchgrass) elevate their growing points (apical meristems) by internode elongation while in both the vegetative and reproductive phases. Many grass species with long shoots can be stimulated to increase tillers by moderate defoliation prior to flowering. Short shoot grasses (e.g., Meadow Brome, Orchardgrass, Perennial Ryegrass, Tall Fescue, Meadow Fescue, Kentucky Bluegrass, and Annual Ryegrass) do not produce significant internode elongation during vegetative growth with the growing point (apical meristem) near the surface until it changes to the reproductive phase and the flowering stalk elongates. These short-shoot grasses tend to be less affected by defoliation in the vegetative phase than long-shoot grasses because their growing points remain near ground level. At some point in the spring, short-shoot grasses shift from the vegetative phase to the reproductive phase, making the growing point susceptible to removal.

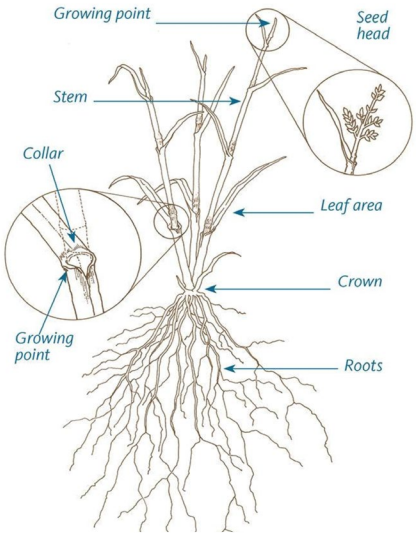


Figure 4. Grass plant parts, source Oregon State University.

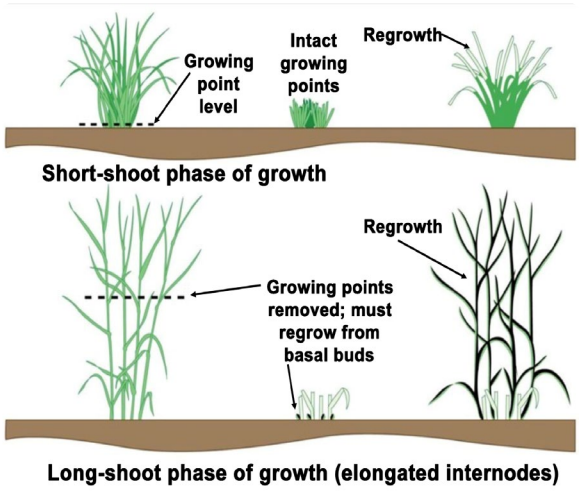


Figure 5. Short-shoot growth vs long-shoot growth. Source: Colorado State University.

The growth cycle is often discussed in terms of having three or four phases/stages. In the four-phase version, indicated by the growth rate diagram below (Figure 6), there is an emphasis on the early vegetative stage when growth is initiated. At this stage energy reserves are drawn upon to initiate growth and produce leaves. Leaf removal during this phase causes a further draw on energy reserves, slows growth, and reduces productivity, plant vigour, and viability.

As plant growth progresses, leaf area and photosynthesis increase, enabling the energy reserves to be replaced. Typically, by the 3 to 4-leaf stage, most grasses have replaced those energy reserves, and photosynthesis is able to support leaf and root growth.

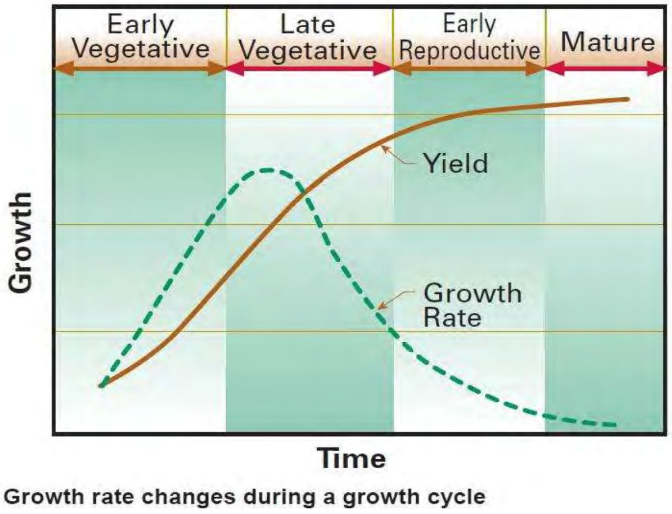


Figure 6. Growth rate changes. Source: Iowa State University

The three phases/stages of grasses growth and development, vegetative, transition, and reproductive are shown in the diagram below (Figure 7).

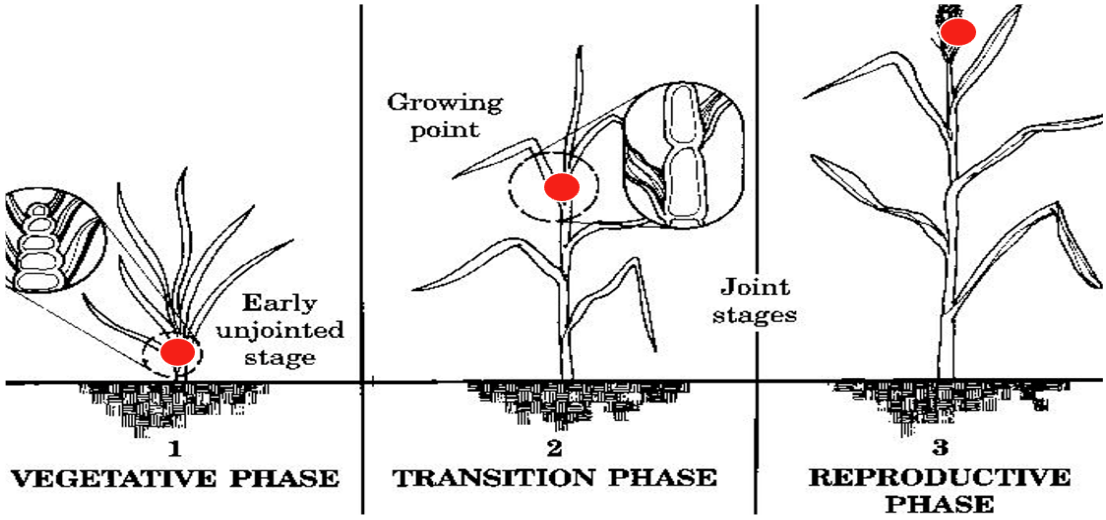


Figure 7. Movement of the growing point. Source: Ehlert and Lawrence 1999

The **vegetative phase** is characterized by rapid growth of shoots and roots. During this development phase, the shoot's growing points (apical meristem) are near or below the soil surface, except for long shoot species that begin to branch; hence, growing points elevate above the ground level. Only leaves are produced by plant tillers. Grasses are highly palatable and highly digestible during the vegetative phase.

During the **transition phase**, the shoot's growing point (apical meristem) begins to elongate in response to temperature and photoperiod signals from the environment. This growing point develops into a seedhead. As stems elongate, the apical meristems elevate, making them more vulnerable to removal. Ill-timed removal will slow grass regrowth since new growth will originate from axillary buds in the crown, which will develop into new tillers or shoots. These axillary buds are not fully formed until the seedhead is about to emerge from the flag leaf.

The **reproductive phase** is identified by an observable seedhead within the flowering stem (culm). Reproductive subphases are referred to as boot, early head emergence, late head emergence, full head emergence, flowering, anthesis, and seed maturity. Stem tissue has a high percentage of fibre, and lignification occurs at later periods of the reproductive phase. Thus, forage at this stage is less nutritious than the preceding stages, as well as lower in palatability and digestibility.

These phases can help us understand what to expect when livestock graze in those timeframes. As the plant goes through that growth cycle, forage energy and protein levels are dropping, and forage volume and height are increasing (phases 1 and 2).

In trees and shrubs**,** similar to many forbs, the growing points are elevated terminal buds, at or near the top of the plant, however, most of the axillary buds are positioned on lateral branches. Growth initiates from all buds from spring to early summer across most of BC. Research has demonstrated that browsing of woody material is most impactful to long-term tree and shrub productivity during the period of stem elongation to bud set in early summer.

Rotational grazing strategies

Rotational grazing strategies are intended to address the pasture and soil health considerations discussed in the preceding text. The majority, if not all, of the considerations can be addressed by employing the FIO (Frequency, Intensity, and Opportunity) Principles and incorporating grazing timing. The challenge with every situation is to develop a grazing plan that meets operational, landscape, environmental, pasture, and soil objectives and realities (these concepts are adapted from MaiaGrazing and Colorado State University).

Grazing systems are often categorized by descriptive names that reflect their level of management. Below is a summary of common grazing system types, presented in order of increasing management intensity.

Continuous Grazing is characterized as a single pasture with livestock not being moved or rotated through most, if not all, of the growing season. In the context of FIO, the *frequency* and *intensity* are all left up to the livestock and the stocking rate. Some management practices such as salting, herding, and water access management can distribute livestock over the landscape; however, nothing truly stops livestock from regrazing (taking the "second bite") areas or ensures there is an *opportunity* for rest (growth or regrowth).

Slow Rotational Grazing sees livestock moved through a few pastures every 2 to 10 weeks. *Frequency*, due to the long grazing durations per pasture, allows for the repeated grazing of plants to occur. *Intensity* is dependent upon stocking rate and livestock spatial and plant species preferences. *Opportunity* for rest (growth or regrowth) occurs to varying degrees depending upon the season. This system is quite common and is typical on rangelands, often incorporating a planned deferred or rest rotational approach, particularly for pastures used in the spring.

Planned Rotational Grazing has livestock moved from paddock to paddock every 3 to 10 days. In these instances, the shorter durations and *frequency* reduce the risk of plants being regrazed; obviously the shorter the duration, the lower the risk of a "second bite." The shorter duration also reduces the potential for the removal of more than the desired amount of forage, assuming the stocking rate reflects forage availability. The *opportunity* for plant rest (regrowth) is also enhanced, assuming there are enough paddocks or cells employed to provide a period without grazing that is appropriate for the geographic area, plant species, and season of use.

Management Intensive Grazing has livestock moved from paddock to paddock every one to four days. This approach requires numerous paddocks typically managed via a combination of permanent and temporary fences to create the smaller paddocks. Herd densities vary but are commonly in the three to 14 animal units per hectare, depending upon pasture production or carrying capacity. In this scenario the short grazing duration and *frequency* essentially reduce the probability of a "second bite" occurring. The smaller paddocks decrease spatial and plant species preferences by livestock; therefore, plant removal is typically more uniform, and *intensity* or forage removal is readily achieved unless stocking rates are too high. To enable meaningful rest or *opportunity* to occur, there will be a need for numerous paddocks, e.g., if 45 days of rest is needed and grazing duration is three days, then 16 paddocks would be needed. (45 days divided by three days plus one = 16 (note: the plus one is because the rest period starts after the first paddock is grazed)).

MOB Grazing involves significantly higher stock densities, with livestock stocked at 75 to 300+ Animal Units (AU) per hectare. This system requires multiple livestock moves per day, often between two to ten times daily. A combination of permanent and temporary fencing is typically needed to provide the number of paddocks required. Also, management time or labour will be higher to set up fences, rotate livestock, and monitor both livestock and pasture performance. This approach greatly decreases, if not eliminates, spatial and plant species preferences and utilizes animal impact effectively, distributing manure uniformly with hoof action pressing manure and plant materials to the ground, facilitating nutrient flow into the soil. With those features being managed well, *frequency, intensity and opportunity* are able to be managed to benefit pasture and soil health.

Adaptive High-Stock Density Grazing utilises many of the previously mentioned methods of grazing to allow graziers to adjust herd density to match conditions or meet nutritional needs of livestock. This approach typically sees livestock moved every three days to ten times daily. It necessitates the need for increased management and monitoring (pasture and livestock) to enable the operation to adapt to within-season growth patterns, livestock needs, or opportunities, e.g., marketing, enhanced growth, or production. It is a management approach or strategy that when adding the timing of grazing into the management considerations makes it very applicable to targeted grazing. Again, with these features — *frequency, intensity and opportunity* — being well managed, pasture and soil health will be maintained or improved.

As you can see in Figure 8, there are differences regarding how well the different rotational grazing strategies address various pasture and soil health as well as operational objectives. Certainly, from a pasture and soil health perspective, moving into the more intensive rotational systems, i.e., more intensive than "slow rotational grazing", the higher the likelihood of improving pasture and soil health becomes. Often, implementing the more intensive systems also results, after some time, in increased pasture productivity, a longer grazing season, and improved plant resilience, which may mean smaller swings in production year to year, including drought years.

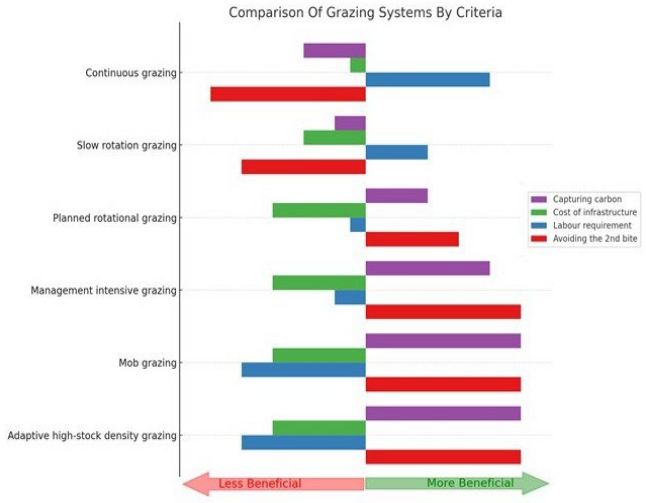


Figure 8. Please note that this diagram is simply conceptual, i.e., not derived from empirical data and will also vary depending upon site (irrigated, dryland, etc.), fertility and plant species or mixes.

There are many tools and strategies other than just fences that can be employed to distribute and/or rotate livestock over large pasture or rangeland areas, (see *Factsheet #3 – Improving Livestock Distribution*).

Integrating plant growth and seasonal factors when developing a grazing plan

1. The plant growth curve. Figure 9 shows typical production levels throughout the growing season. Some points to note are that with cool-season species (dominant in BC), forage production is higher in the spring, tapers off in summer, and rebounds modestly in the fall or autumn. That may mean

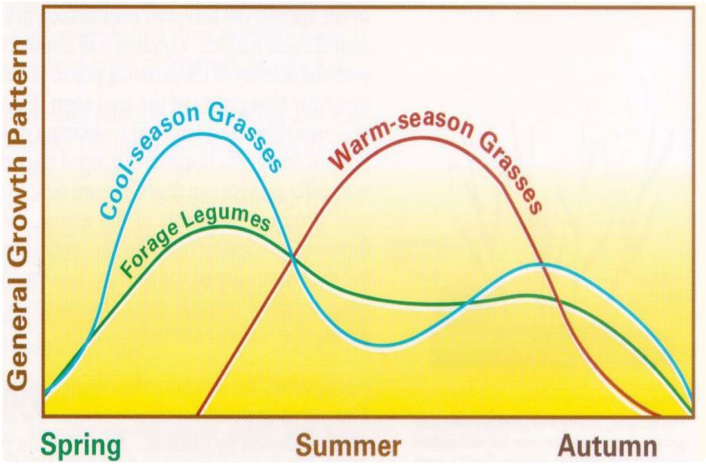


Figure 9. Reference: Iowa State University. 2018. Pasture Management Guide for Livestock Producers.

addressing that reality by shifting livestock numbers, adjusting paddock sizes, stockpiling forage, or harvesting, for example.

2. Would using cover crops (annual species) assist in addressing seasonal forage needs? For example, provide high-quality forage to meet the needs of higher-producing or growing livestock, provide increased forage during the summer or extend the grazing season, i.e., later into the fall or winter and/or provide earlier spring grazing.

3. Rangeland and forested native species systems in particular can have species, primarily forbs, that grow in pulses or over a short span of time. Timing of grazing will be an important aspect to address to ensure their vigour and keep them in the pasture. That may mean ensuring that the pasture is not grazed at the same time each year. Very short duration systems may well address that aspect but monitor or observe to ensure the desired species are sustained. Below is a diagrammatic example of those short growth periods.

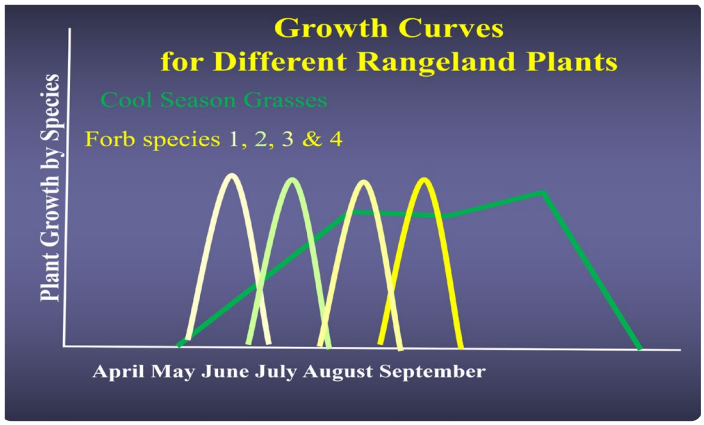


Figure 10. Note: each of the yellow forb curves refers to a different species, i.e. they grow in a very short window of time. Source: B.C. Range School.

4. Grazing grasses stimulate the replacement of leaf area by activating meristematic tissue (growing points) and enhancing photosynthetic activity. Under favorable growing conditions, this can lead to an incremental gain in forage production and often results in improved forage quality compared to ungrazed plants.

5. Seasonal inundation or soil saturation in pastures, silvopastures, and riparian areas may also dictate changes in grazing rotations to avoid livestock use when soils are at an elevated risk of compaction or pugging.

6. Cool-season forage species grow rapidly during spring and early summer, but their growth rate slows as the season progresses—especially in grasses, more so than in legumes and forbs. Consider rotating livestock quickly through the paddocks, consuming 25% - 33% of the forage. During periods of rapid growth, rest intervals between grazing events can be shortened—for example, allowing a quicker return to paddocks after the initial grazing pass. Figure 11 is a diagram showing rest or recovery periods in an irrigated pasture; please only use this as an example.

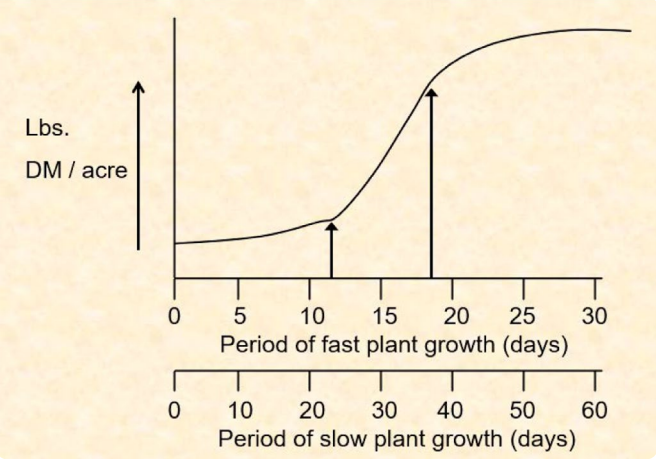


Figure 11. Craig Saxe, Univ. Wisconsin. Rest period is indicated by the long vertical line/arrow on the right (plus/minus a few days) for fast and slow growth periods

7. Roots and root growth are vital to plant health and productivity; since they are not easily monitored, we rely on some basic principles. Root growth is slowed or stopped when leaf removal is greater than 50% by frequent regrazing ("second bite" or more), which keeps leaf area low reducing photosynthesis, and when growing conditions do not support growth. Pasture plants do not support all their root area all the time; this is often expressed as grasses shedding 30% to 40% of their roots yearly. Maintaining sufficient leaf area when growing conditions are favorable supports the energy needed for root growth, replacement of sloughed roots, and the establishment of deep and robust root systems.

8. Fall management is key to enabling grasses to set up for next spring's growth through the regeneration of roots and the formation of growing points. Root rebuilding can be seen by checking for new white roots developing from the crown. Dig the plants and wash them free of soil with water. Allowing plants to store carbohydrates in the fall is essential to long-term forage production and pasture health. Strive to have stubble heights be above the guidelines found in *Factsheet #8 – Grazing Frequency and Utilization*, or in a general sense, greater than 4 inches (10 cm). Grazing lower reduces energy reserves, as carbohydrate

reserves are stored in this lower portion of the plant. Leaving that stubble height will also provide soil armour and cover, which will insulate plants against sudden temperature drops.

9. Fall rest periods are essential for restoring energy reserves, especially in cool season grasses and legumes. During the fall plants shift energy toward root regeneration and carbohydrate (energy) storage. Managed well—ensuring adequate rest and sufficient leaf material—plants can maintain the physiological processes needed to prepare for winter survival and support vigorous regrowth during spring green-up. For these reasons, fall is often seen as the critical time of year for cool season plant health.

10. Forb and legume growing points are elevated or near the top of the plant. Grazing will therefore remove some of these growing points and require the plant to support growth from axillary buds or crown buds. This results in a bit more of a slowdown in growth than a grass plant whose growing point is at or near the ground's surface. This also happens with long-shoot grass species. For legumes such as alfalfa to stay in the stand, it may be necessary to extend rest periods to approximately 40 days or more at least once during the growing season, allowing the alfalfa to have significant bloom. There is some additional benefit to having this bloom occur later in the season. If it is grazed lightly, not all of the elevated growing points are removed. Shorter rest periods are fine so long as the plant goes into the winter with good root reserves. Monitor the forbs and adjust rotations to facilitate plant recovery as needed.

11. Grass growing points are near the soil surface until the transition stage (short-shoot grasses) or, in the case of long-shoot grasses, when the stems elongate, or jointing is evident. When a growing point is removed, a new growing point needs to be initiated to provide leaf growth. That process often draws on energy reserves, and leaf growth is slower from that tiller or new growing point compared to leaf growth from tillers whose growing point was not removed. In spring, grass growth is primarily reproductive, progressing

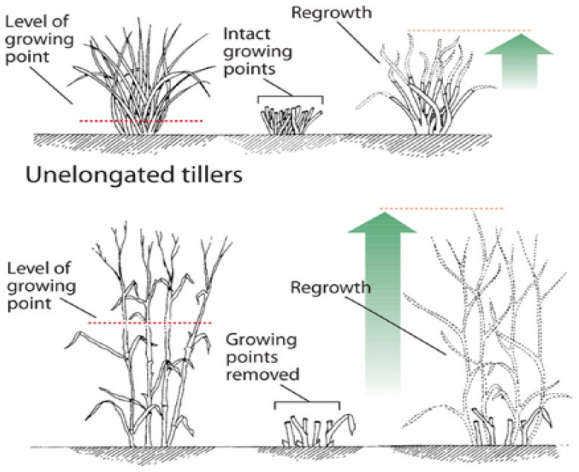


Figure 12. Colorado State Univ. Growing points of grasses and regrowth after defoliation — regrowth of unelongated tillers is from the existing leaves, while the elongated tillers are from new growing points at the plant's crown.

through vegetative, transitional, and reproductive phases. After harvest or removal of the growing points responsible for seed head formation, subsequent regrowth is generally vegetative. Figure 12 shows that response to grazing.

12. Weather and precipitation patterns, as well as fertility, play an important role in plant health and productivity, particularly in dryland situations. If plant growth is stopped (e.g., by drought), and particularly if the above-ground portion dies back, then those plants will likely draw on energy reserves to reinitiate leaf production, very similar to what occurs in the spring. That means allowing time for those plants to grow to a point where photosynthesis has replaced those reserves and can support above- and below-ground growth. Yes, that means although it is greening up, some patience will be beneficial to the plants. As Figure 13 shows, it is important to wait until energy reserves are very close to being restored, if not fully restored, prior to grazing.

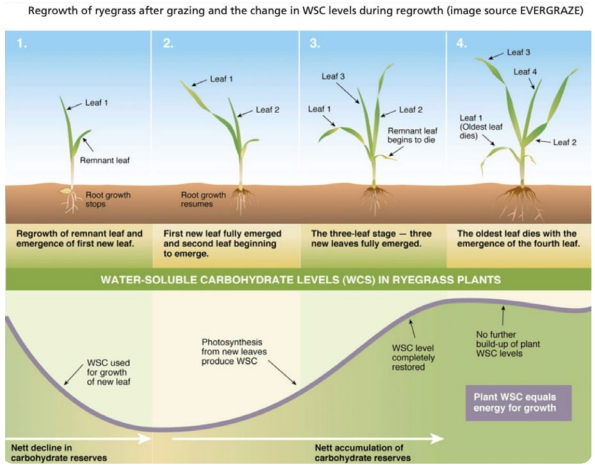


Figure 13. Colorado State Univ. Growing points of grasses and regrowth after defoliation

13. From a plant's perspective, it does not matter whether defoliation occurs due to insects, wildlife, harvesters, trampling, fire, or whatever. That defoliation will cause the plants to adjust their growth in accordance with the associated loss of leaf area and/or growing points. This should be considered when pasture conditions are influenced by factors beyond livestock management, as these can affect plant growth phases and recovery potential. That may well require adjustments such as decreasing grazing duration in some paddocks (*frequency*), reducing the amount of forage livestock remove (*intensity*), increasing rest periods (*opportunity*), or some combination of the three.

14. **Forage quality or nutrients decline as plant maturity progresses through the vegetative, transition, and reproductive stages.** Although legumes and grasses both lose quality as they mature, there are some notable differences. Grasses typically have lower crude protein values, which drop faster than legumes as they mature. Energy levels in grasses are typically higher and drop off slower than legumes as they mature. Figure 14 and Figure 15use digestibility to demonstrate the change in forage quality.

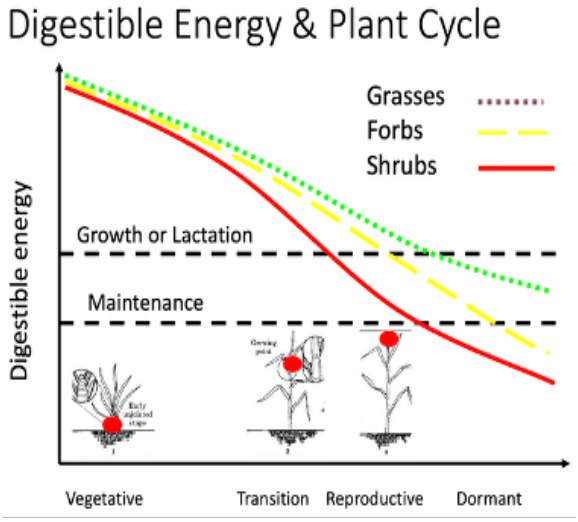


Figure 14. Link between plant cycles and digestible energy. B.C. Range School.

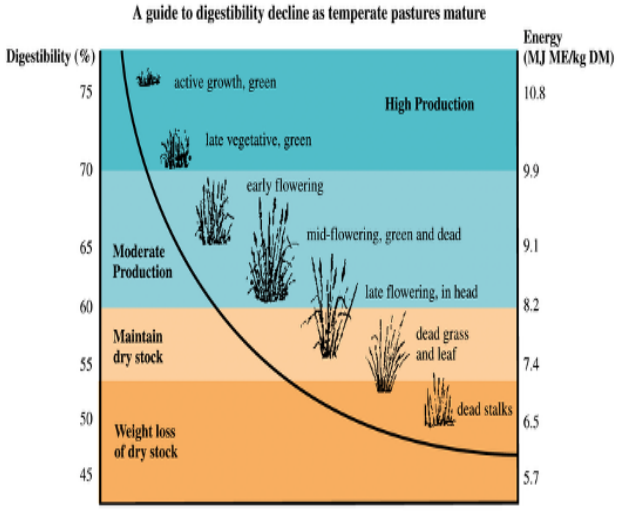


Figure 15. Digestibility and plant stage. Meat and Livestock Australia

15. **Silvopasture and riparian pastures with an overstory of trees and shrubs can delay the development and maturation of forages in their understory.** This can also be the case with changing elevation, aspect (e.g. north versus south facing slope) and vegetation or plant community types. These microclimates or areas can be used strategically to extend the period of forage availability at phases/stages with high palatability and forage quality.

Key takeaways

What does this all lead to or mean? In short, for a grazing plan to be successful it will have considered the aspects discussed above in context with the grazing area's (pasture's) characteristics and the operation's realities and objectives — climate, growing period, pasture composition, labour or time, finances and objectives. That will inform some key information that can be used to start developing a suitable grazing plan. Elements to consider include:

- Length of the growing season
- Precipitation available to support growth (irrigated, sub-irrigated, wet meadow, etc.)
- Estimate of pasture productivity and/or carrying capacity
- Length of rest (growth and regrowth) periods *(opportunity)*
- Nutritional needs of livestock at key growth or production stages
- Pasture composition and health (refer to pasture assessment)
- Integrated production areas (e.g. silvopastures) and conservation zones (e.g. riparian, wildlife habitat) requiring differing timing of grazing or length of rest *(opportunity)*
- Grazing duration per paddock and number of paddocks
- Stocking rate and/or livestock density
- Paddock size
- Water source for each paddock
- Grazing plan map indicating paddocks and rotational sequence

Once the key grazing principles are understood, the next step is putting them into action. That means thinking about how water will be supplied, what kind of fencing is practical and affordable, and who will be responsible for setting it up. Choosing infrastructure that allows flexibility—like adjustable paddock sizes, easy water access, and adaptable grazing schedules —will make it easier to fine-tune your plan as conditions or goals change.

Once a grazing plan has been developed and its implementation begins, remember that conditions and operational objectives are not static, which means refinements or adjustments to the grazing plan should be anticipated, both within the grazing season and year to year. In some regards we could describe this as having a plan or system, including key infrastructure, that is flexible. Flexibility is valuable but knowing when and why to adjust is what makes a grazing plan truly effective. This topic area can be described as “adaptive grazing management” which in this context asks us to candidly observe our pastures and rangelands and their response to grazing, weather, plant growth, livestock needs and operational objectives. The approach is to “monitor – adjust – repeat”, i.e. repeat the cycle of candid observations or monitoring and adjust

as appropriate. See *Factsheets 11 and 12* for monitoring options and techniques.

As the *Grazing Management Guide* and its text has inferred, the ultimate goal of grazing management is to improve animal performance, boost plant productivity, and enhance soil health. When done well, it can also reduce the need for winter feeding and other inputs— potentially leading to a more efficient, resilient, and profitable operation. There are many methods to improve grazing management. The key is to **find a suitable method that works for you** and improves the quality of life for you and/or your family. So, take stock of your situation, including operational objectives, interests, resources, time, etc. and select the approach that is your best fit.

Section 3 – Using the concepts to develop and adjust your Grazing Management Plan

A Grazing Management Plan is not a static document. Putting it into practice should be an iterative process of observing the results and adjusting to the current circumstances. The approach for the initial drafting is a three-step process:

1. **Assessment of your pasture and range sites** – these provide a snapshot of the current condition and trends in the pasture or rangeland being addressed. See *Factsheet #1 – Pasture and Range Assessment*; the assessment questions used are:
    a. *Do desirable plants make up more than one-half of the vegetation?*
    b. *Are desirable plants abundant in all age and size classes?*
    c. *Does leaf length, seed production, colour, and overall productivity of desirable plants indicate strong vigour?*
    d. *Is there any evidence of overuse (hedging caused by livestock browsing) on shrubs and trees?*
    e. *Is litter and plant residue fairly abundant and partly composed of desirable plants?*
    f. *Is the area free of evidence indicating soil compaction or soil movement, including its loss?*
    g. *Are plant roots exposed or are there other signs of pedestalling?*

2. **Identify any opportunities and concerns from the assessment** and select revised management practices where desired or required. *(see Factsheet #2 - Addressing Pasture and Range Assessment Concerns)*

3. **Develop a Grazing Management Plan** based upon the use of the principles and concepts outlined in the *Grazing Management Guide*, with more specific guidance provided by the associated factsheets. At a minimum, use *Factsheets #4, #5 (and/or Factsheet #6 if appropriate).* Monitor results *(Factsheet #11 & #12)* and adjust practices as appropriate – otherwise known as adaptive management. Utilize other factsheets relevant to your operation as appropriate /required. Conducting your own cost-benefit analysis *(Factsheet #7)* can be useful in determining which practices are more beneficial for your operation's profitability.

Appendix A – grazing guide factsheet synopsis

Factsheet #1 – Pasture and Range Assessment. This factsheet describes how to assess pasture and range sites by walking you through the process, offering examples to assist and scoring the results.

Factsheet #2 – Addressing Pasture and Range Assessment Concerns. Provides guidance and insights into what aspects could benefit from adjustments to current management practices, ideas on options and where to seek additional information.

Factsheet #3 – Improving Livestock Distribution. Discusses tools and strategies that can improve livestock distribution and patterns of use on pasture and range areas.

Factsheet #4 – Components of a Grazing Management Plan. Discusses and describes what elements or topics should comprise a grazing plan and offers some tools to assist in that process.

Factsheet # 5 – Pasture Design. Discusses and describes aspects to consider when designing a grazing management plan or system, (includes stocking rate calculation). Offers some examples, both conceptual and actual, of grazing systems and approaches including a checklist.

Factsheet #6 – Riparian Pasture Design. Discusses and describes aspects to consider and steps to take in designing a grazing plan for riparian areas. Offers some examples, both conceptual and actual, of grazing systems and approaches.

Factsheet # 7 – Cost-benefit Analysis of Various Grazing Systems. Discusses and provides analytical guidance and tools with regards to evaluating the costs, benefits and returns associated with investing in rotational grazing practices.

Factsheet # 8 – Grazing Frequency and Utilization. Provides further insights into the FIO Principles and timing of grazing as well as some plant species leaf or stubble height guidance to use in conjunction with FIO to quickly monitor grazing impacts and the effectiveness of the rest periods.

Factsheet # 9 –Different Livestock Species – Grazing Considerations. Outlines the general characteristics of livestock species as they pertain to grazing management as well as an Animal Unit chart. Species included are: sheep, goats, hogs/pigs, poultry, and horses.

Factsheet # 10 –Multi-Species Livestock Grazing. Looks at the basics of multi-species grazing from a pasture and livestock performance perspective. Compliments factsheet # 9.

Factsheet #11 – Monitoring Grazing Lands. Discusses monitoring in general, photo-point use and methodology, stubble height rules of thumb, relative use levels, forage production and browse species utilization and trend. Sheets to print for in-field monitoring.

Factsheet # 12 – Monitoring Strategies for Extensive and Intensive Grazing Systems. Provides information on various monitoring tools and approaches. Including the Grazing Response Index, Pasture Walks (with silvopasture and cutblock section), soil moisture, record keeping, and a link to the Grassland Monitoring Manual for British Columbia.

Factsheet # 13 – Pasture Renovation and Management. Outlines considerations and options associated with forage pasture renovation, species selection and management linked to operational objectives, forage productivity, soil and pasture health and carbon considerations.

Factsheet #14 – Seasonal Considerations for Grazing Management. Discusses grazing management and use aspects and consideration points in relation to the seasons of the year.

Factsheet # 15 – Managing Grazing Lands During Drought. Discusses some options for herd, forage, and grazing management in times of drought.

Find more information:

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