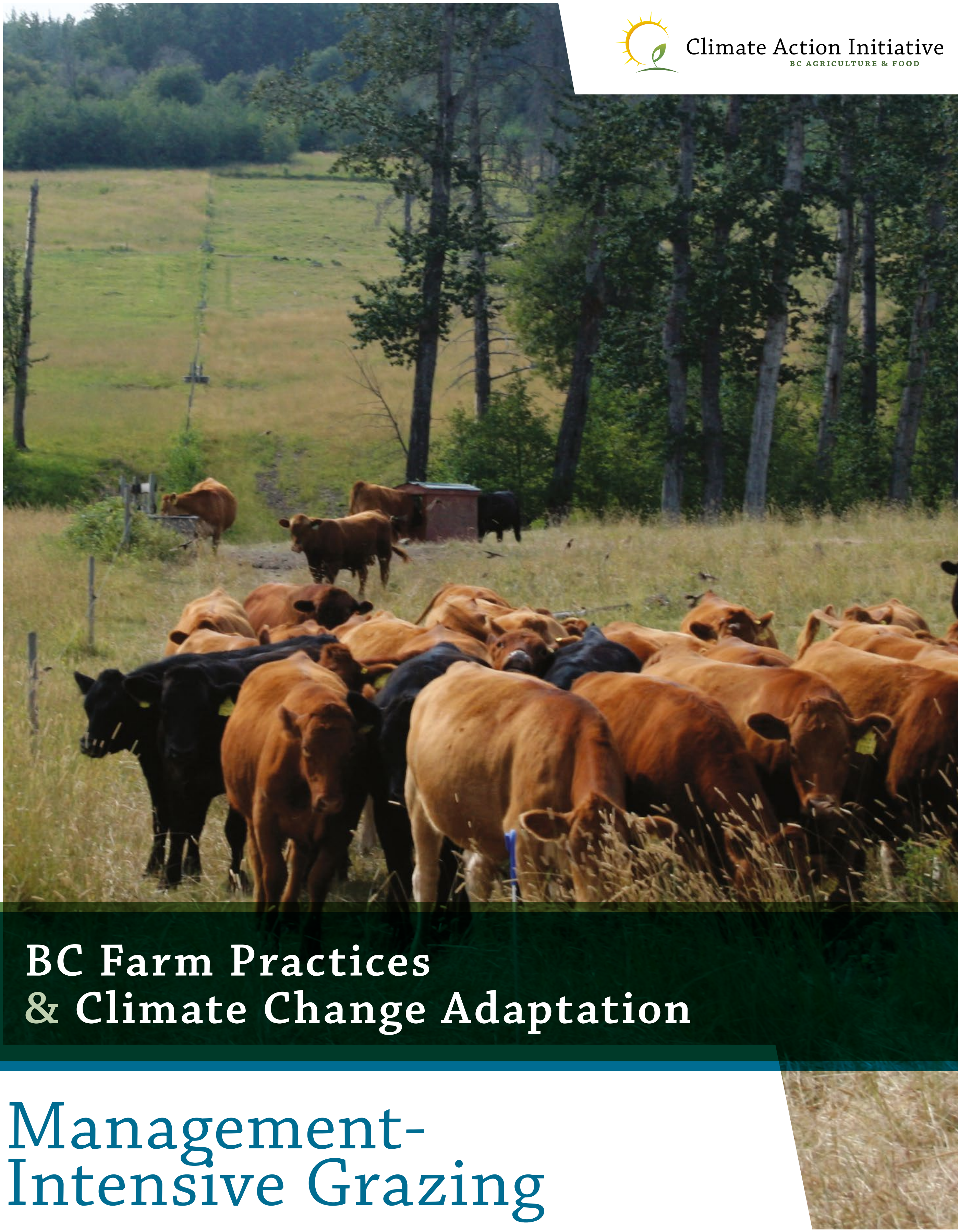

Climate Action Initiative
BC AGRICULTURE & FOOD

BC Farm Practices & Climate Change Adaptation

Management-Intensive Grazing

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Farm Practices & Climate Change Adaptation Series

This series of six reports evaluates selected farm practices for their potential to reduce risk or increase resilience in a changing climate.

The practices selected are well known in contemporary and conservation-based agriculture. While they are not new practices, better understanding of their potential relationship to climate change may expand or alter the roles these practices play in various farming systems.

Climate change will not only shift average temperatures across the province, it will alter precipitation and hydrology patterns and increase the frequency and intensity of extreme weather events. The projected changes and anticipated impacts for agricultural systems are considered in the practice evaluations. More details regarding climate change and impacts for various production systems in five BC regions may be found in the *BC Agriculture Risk & Opportunity Assessment* at: *www.bcagclimateaction.ca/adapt/risk-opportunity*

Farming systems are dynamic, complex, and specific to the local environments in which they operate. This makes the analysis of farm practices on a provincial level particularly challenging. The approach taken for this series, is to explore the application of practices regionally and across a range of cropping systems and farm-scales. While the ratings are subjective and may not reflect suitability for a particular farm, the ratings and associated discussion help to identify both the potential, and the limitations, of selected practices on a broader scale. In some cases, the numerical ratings are expressed as a range, to reflect variation in conditions across regions and cropping systems.

The practice evaluations are informed by background research and input from agriculture producers around the province about their current use of practices. Each document includes: a practice introduction, key findings, an evaluation of suitability to help to address climate change risks, and technical practice background related to adaptation. The documents conclude with practice application examples from various regions of the province. More detailed information about the overall project may be found at: *www.bcagclimateaction.ca/adapt/farm-practices*

Like farming systems, practice applications are location specific and change over time. Continued adaptation and holistic integrated practice implementation will be required as climate conditions change. The effectiveness of most practices for mitigating climate and weather related risks will vary over a range of conditions. Ultimately, if practice adoption can reduce vulnerability and risk overall, it has some effectiveness in supporting adaptation.

This document is not intended to serve as a stand-alone technical guide. Rather, it is hoped that this evaluation supports dialogue—among producers, agricultural organizations and key government agencies—about how these and other practices may apply in a changing climate, and how to address information or resource gaps to support further adoption and adaptation.

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Introduction

Grazing management is the practice of manipulating grazing to achieve an objective or a set of objectives. Often the aim is to balance livestock production with available forage resources at a sustainable level. As the technical disciplines of rangeland and pasture science have advanced, a number of approaches have been developed to help livestock producers implement grazing management on their farms and ranches. Management-intensive grazing (MiG) is one of those approaches.

MiG is a systems-based approach to grazing land utilization which emphasizes the manager's understanding of the plant-soil-animal-climate interface as the basis for management decision.[1] MiG may result in different levels of management depending on the goals and objectives of the production system, and the environmental constraints where it is being applied (see MiG Background Information, page 10). With its focus on the plant-soil-animal-climate relationship, MiG has potential to help farmers and ranchers improve ecosystem functioning, which should moderate some of the impacts associated with climate change. For example, producing more plant biomass and cover in pastures reduces runoff and makes precipitation more effective, while reducing the risk of erosion. In addition to a more resilient enviroment, the management and the adaptive capabilities of producers should also be increased with the adoption and practice of MiG.

Related Practices

- → Irrigation
- → Pasture mapping and GIS
- → Riparian area management
- → Shelterbelts and buffers
- → Nutrient management
- → Water development
- → Swath-grazing
- → Winter feeding

What Does Management-Intensive Grazing Involve?

MiG integrates grazing management parameters, including stocking density, stocking rate, stocking period, and rest period, into operational planning and application. Like holistic management—another adaptive grazing managment approach—it considers the entire resource base of a farm or ranch, including the human, sociocultural and economic dimensions, and is based on ecosystem building blocks like the water and nutrient cycles.[2]

MiG regulates grazing parameters of stock density and time (grazing or stocking period), by decreasing pasture size and reducing the grazing (stocking) period in any given pasture unit. Through careful monitoring and observation, over-grazing of individual plants is prevented, and growing season rest allows plant regrowth and recovery before being grazed a second time within the same grazing period. Where there is adequate growing season moisture, grasses can be kept in a vegetative stage for a longer time, increasing palatability and animal nutrition. Although more intensive grazing management can be accomplished with close herding, advances in electric fence technology have allowed livestock producers to intensify grazing practices in a cost-effective way.

MiG can be applied across a wide range of environments and landscapes, although it is most often associated with grazing under irrigation and in areas where growing season moisture allows plant regrowth. Examples of what are generally thought of as MiG systems are perhaps less common in extensive and semi-arid rangeland systems; however, MiG concepts are applied in these situations as well. Here herding may replace fencing to achieve the desired stock density and grazing period.

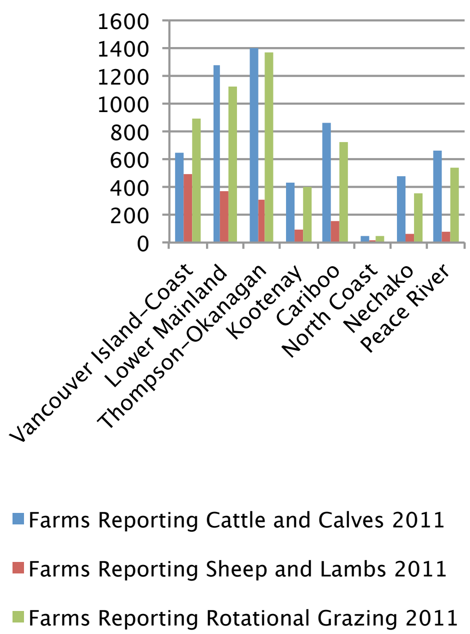


FIGURE 1 Farms reporting cattle and calves, farms reporting sheep and lambs, and farms reporting rotational grazing in 2011

Includes both dairy and beef. Source: Statistics Canada, 2011 Census of Agriculture, Farm and Farm Operator Data, catalogue no. 95-640-XWE.

Current Adoption in BC

Livestock grazing is a common practice in all regions of the the province. The Statistics Canada Census of Agriculture asks farmers whether they apply rotational grazing as a land use practice; however, this does not reveal how rotational grazing is being applied (Figure 1). Rotational grazing only means that a range or pasture unit is sub-divided, and that the sub-units are then grazed in succession. Simple rotational grazing can be accomplished with a single sub-division, yet this could potentially be an unbeneficial practice if the stocking density and the length of the grazing period are not properly adjusted to match forage production. Producers that practice MiG would likely report rotational grazing in the census, but rotational grazing in and of itself is not an indicator of management-intensive grazing.

There was a high level of knowledge and use of MiG among the particpants with livestock in this project; however, this group was purposely selected for that reason. Over the last decade, there has been program support for grazing management education for BC's livestock producers that has been delivered in a variety of ways. Proponents of Holistic Mangement, Ranching for Profit and MiG have all had contact with BC ranchers and livestock producers, some as far back as the mid 1980s. Producer organizations, like the Peace River Forage Association and the BC Cattleman's Association, with support from government, have helped to organize education efforts. Electric fence equipment manufacturers have also held field days and conducted demonstrations.

In the Cariboo region, there is a growing interest in grazing management and adaptation. The grass-fed beef collaborative of the Cariboo Cattlemen's Association is working to promote sustainable grassfed beef production, and more intensive grazing management. Poor livestock prices through much of the last decade, changing consumer preferences, and other environmental factors have led producers to re-examine how they manage grazing, and their overall operations. The management emphasis of MiG has encouraged livestock producers to put more focus on both the goals and profitability of their farms and ranches.

Key Findings

- MiG thus far has primarily been applied under conditions where there is normally adequate growing season moisture (i.e., on irrigated pasture, or in areas with moderate annual precipitation).
- There has been less application of intensive grazing management approaches on semi-arid rangelands, and timbered ranges in BC; effective and economically efficient strategies for more intensively managing rugged semi-arid rangelands in BC are not clearly established.
- MiG shows substantial promise as an adaptive practice for moderating the impacts of climate change mainly by maintaining and improving the function of ecosystem processes, and therefore ecosystem resilience, through an adaptive management framework.
- There is producer interest in having location-specific information about soil development and nutrient cycling processes under different grazing regimes.
- Successful implementation requires substantial knowledge base and mentorship support.
- Despite substantial apparent benefits, implementation of MiG is challenging and the current level of adoption is limited.
- The adoption of MiG usually produces a cascading adaptive effect through other aspects of an operation that enhance resilience (e.g., interest in more adaptive livestock breeding).
- The assessment of grazing management practices and their effectiveness is challenging because of the tremendous variability in grazing parameters and forage resources.
- New applied research approaches are needed to assess adaptively managed systems like MiG.
- Though considerable improvements in grazing management and production can be expected with MiG, environmental and physical constraints set the limits of production.

Areas for Further Adaptation Research & Support

- Research and monitoring of ecosystem processes, including nutrient cycling, soil organic carbon, microbial activity, and adaptive processes, economics and managerial development under MiG.
- Identification of management factors that increase profitability in various grazing systems, and linking these to ecosystem processes and use of specific grazing resources.
- Integration with other practices such as riparian area management, shelterbelts and buffers, nutrient management, drainage and on-farm water storage.
- Producer education, knowledge acquisition and mentorship for MiG adoption; this would include user friendly web-based GIS technology, planning, record keeping and monitoring.

- Support of existing producer organizations and collaborations that broaden acceptance of intensive grazing management approaches, like the grass-fed beef collaborative in the Cariboo region, and the Peace River Forage Association.

- Education, demonstration and research related to grazing management in various regions of the province with specific attention on local resources and adaptation, to increase resilience to the effects of climate change.

- Demonstration and research that help to establish the benefits of more intensive grazing management on various vegetation landscapes, including semi-arid ranges and Crown range.

Evaluation: Adaptation & Management-Intensive Grazing

Multi-Criteria Evaluation

Agricultural research is typically undertaken to establish the efficacy of a product or practice under specific conditions. Similarly, cost-benefit analysis is valuable for assessing whether an investment is economically efficient (whether it pays to invest in a particular practice or asset). An evaluation of adaptation options for climate change needs to consider more than just effectiveness and economic efficiency to be useful for both farmers and those interested in supporting climate change adaptation. Multi-criteria evaluation provides a framework for this evaluation—enabling a set of decision-making criteria to be examined simultaneously.

Multi-criteria evaluation (MCE) can be highly structured, or, as it is applied here, more subjective and exploratory. To have value, the evaluation has to have the decision makers it aims to serve in mind. Often when MCE is employed, considerable time is spent gathering input on decision-making criteria and the needs of users. Given the limited scope of this project, it was not possible to gather user-specific input, and instead the criteria were developed by looking at other studies in the field of adaptation to climate change.[3] However, producers did provide input on the relative importance of the selected decision making criteria in a ranking exercise (27 of 29 participants). Perhaps not surprisingly, economic efficiency and effectiveness were the top ranked criteria followed by adoptability, adaptability, flexibility and independent benefits. Institutional compatibility was ranked last by the majority of farmers.

Often MCE is used to select the most desirable option from various alternatives. Ratings for each criterion are determined, and then added together to provide a total score for each alternative. The relative importance, or weight, given to a single criterion can affect the overall suitability rating for a practice. However, for this evaluation, it is the scores for individual criteria that provide insight into how a practice might be suitable for adapting to climate change, and what might need to change to make it even more suitable. The purpose of the evaluation is not to aggregate ratings and compare practices, but rather to improve understanding of how the individual practices relate to adaptation to climate change.

The evaluation takes a broad view (coarse-scale) across areas and farming systems in the regions (and production systems) where the practice might be applied or considered. The ratings were determined under the assumption that there is some basis for the application of a practice within certain farm types.

For example, management-intensive grazing does not have application on a farm without livestock, and therefore it would be ineffective as an adaptive practice for that farm when compared to other alternatives.[4] If carried out at a fine-scale (individual farm level), the suitability rating of any practice could be quite different because the specific circumstances of the farm would be considered for each criterion. Likewise, ratings could vary depending on the purpose (e.g., policy formulation vs. farmer adoption), and the perspective of the individual(s) carrying out the evaluation. Even though, a broad view is taken in the evaluation, the criteria in this series are considered from an on-farm perspective.

The evaluation below assesses a farm practice through the following set of decision-making criteria: *Effectiveness*, *Economic Efficiency*, *Flexibility*, *Adaptability*, *Institutional Compatibility*, *Adoptability* and *Independent Benefits*. Each of the criteria are defined and a numerical rating (in some cases a range) has been assigned across a scale from 1–5 to reflect its potential value in adapting to climate change. The discussion that accompanies the rating captures some of the issues contemplated in determining the rating, as well as some of the variation and complexity of practice application across the province and farm systems.

Effectiveness

Whether the adaptation option reduces the risk or vulnerability, and/or enhances opportunity to respond to the effects of climate change.

RATING: 4–5
moderately effective to very effective

If MiG is appropriately implemented where grazing is currently practised, it should be moderately to very effective in reducing risk and enhancing the opportunity to respond to the effects of climate change. The reduction in risk will come mainly through better functioning ecosystem processes. Successful grazing management achieved through MiG will also improve the water cycle, by allowing better interception and infiltration due to increased plant and ground cover. Greater biodiversity should increase ecosystem resilience, while improved nutrient cycling and additions to soil organic carbon will also improve moisture retention. Stockpiled forage reserved for spring use in more exposed pastures could increase the amount of trapped snow, moderate freezing and thawing, and slow runoff. Effectiveness may be limited in some areas by environmental and physical constraints, and by available water resources. However, the feasibility of well-designed water storage for livestock water under climate change conditions is expected to be moderate to high in most areas of the province.

This summary takes the view that when MiG is used as a conceptual framework for grazing management and applied with adequate knowledge resources, it supports improved ecosystem functioning. Therefore, MiG reduces the risk or vulnerability, and enhances the opportunity to respond to the effects of climate change. There is some question about the appropriate level of management in various vegetation landscapes (i.e., extensive semi-arid range versus irrigated pasture), but again this evaluation is based on the notion that management-intensive grazing is adaptive and allows the necessary flexibility. A study of conventional graziers and those who had adopted Holistic Management (HM) in New South Wales concluded that HM grazing should be encouraged to help the industry adapt to climate change.[5] In this study, HM farmers demonstrated more adaptive behaviours in their day-to-day and longer term planning than did non-HM farmers. HM farmers also tended to recognize the value of bio-diversity across their entire farm landscape, rather than just thinking about specific management areas, (e.g., wooded buffers) set-aside to achieve identified environmental benefits.

Economic Efficiency

The economic benefits relative to the economic costs that are assumed in implementing the adaptation option.

RATING: 4
moderately efficient

In order to be economically efficient, improved management must also accompany capital investments made to allow more intensive stocking rates.[6] Development of management capacity and the elimination of production inefficiency is a key aspect of the MiG approach, and so where there is successful adoption there should be moderate economic efficiency. The challenge of sustainable profitability in the BC beef sector remains, and additional sectoral adaptation and innovation (e.g., the development of a larger "natural" and grass-fed beef market) may be required. However, this evaluation assumes that the MiG will also support this type of adaptation.

For the most part, this assessment applies a conceptual, rather than a data based analysis. However, there is some support for the previous assumption, based on the experience of producers that have longer experience with adaptive grazing management models in BC. In a U.S. study, multivariate regression analysis showed dairies that had adopted MiG had more economic profit than conventionally managed dairies.[7] They captured this profit by being more efficient in operating practices, and in asset and labour use. More research on MiG adoption is needed to test assumptions related to economic efficiency under BC conditions.

Flexibility

The ability of an option to function under a wide range of climate change conditions. An option that reduces income loss under specific conditions, and has no effect under other conditions, would be considered inflexible.

RATING: 5
very flexible

Like other on-farm practices that are embodied in an adaptive management system, MiG is highly responsive to changing conditions. Continual monitoring of grazing conditions allows adjustment and planning. Adapted MiG systems consider all ecosystem processes, and are adjusted to meet conditions in a wide range of environments. In BC, more efficient forage production allows grazing of stockpiled forage to reduce winter feeding periods. There is some potential risk, in cases of continued heavy snowfall, or where rain falls and freezes on snow, that producers may be vulnerable if contingency plans for such events are not in place. However, variability in winter forage supply is also an issue under conventional management, and producers have considerable experience in dealing with this issue. Overall, MiG has the ability to function under a wide set of conditions and is considered very flexible.

Adaptability

Whether a practice can be built upon to suit future conditions and allows further adaptation.

RATING: 5
very adaptable

Since it is an adaptive management system (or model in the case HM), MiG is highly adaptable when successfully implemented.

Institutional compatibility

Compatibility of the adaptation option with existing institutional and legal structures.

RATING: 4
moderately compatible

Current institutional structures are generally supportive of MiG. It is highly compatible on private land. Maintenance and improvement of key ecosystem processes are goals of MiG, and these goals are foundational to all grazing management and are supported by the *Canada-BC Environmental Farm Plan Program*. These ecosystem goals are also explicit in the administration of Crown range. MiG objectives that include improved ecosystem functioning, are compatible with legislated requirements for use of Crown range (e.g., *Forest and Range Practices Act*, and the *Range Planning and Practices Regulation*). However, the non-exclusive nature of Crown range grazing tenures may require a cooperative management approach among range users in some areas. This adds another layer of complexity to MiG implementation that could limit adoption. The identification of MiG approaches that are compatible with more extensive and conventional grazing management models on Crown range would be helpful, and continued demonstration would likely be required to support adoption.

Adoptability

The ease with which farms can implement the practice under existing management practices, values and resource conditions.

RATING: 2
moderately low adoptability

Despite its potential benefits, MiG remains difficult for farmers and ranchers to adopt. A substantial knowledge base and operational experience is important for successful implementation. The nature and availability of labour remains a critical constraint to adoption for farms and ranches of all scales. Availability and involvement of family labour to help with frequent moving of livestock may be critical for implementation on some operations. In this study, family labour was a key part of implementation success for several operations. Labour shortages in the agriculture sector exist throughout the province, and in more remote ranching areas this is more acute. Competition for labour from the oil and gas sector is a particular problem in the Peace River region.

The willingness to use electric fence technology is also a factor limiting adoption. Producer's views on electric fencing vary widely, in spite of its cost effectiveness (approximately 20% of the cost of conventional barbed wire fence). Some have had animal breakouts with old or inferior technology. Electric fence is a psychological barrier, and an animal training period under controlled conditions is recommended when electric fencing is introduced on an operation. Proper grounding is necessary to achieve the necessary charge on the fence, especially over long distances, and this is sometimes overlooked when fence chargers are installed. Remote locations require battery or solar-battery installations. Some producers doubt its effectiveness, or do not like working with the high-tensile smooth wire used for permanent electric fence, and have no interest in trying it. In contrast, adopters—many of whom depend on it for MiG—swear by its use. Although MiG grazing objectives can also be achieved with close herding, MiG is unlikely to be efficient under current economic conditions without the use of electric fence technology.

There are cultural barriers limiting adoption as well—the overall approach of MiG is substantially different than existing conventional management that is highly dependent on the use of extensive summer ranges. Rancher initiatives, like the grass-fed beef collaborative in the Cariboo region, show promise for broadening the acceptance of MiG approaches, and helping to build acceptable strategies for the incorporation of more intensive grazing management on extensive semi-arid and timbered ranges. Overall, the adoptability of MiG is moderately low.

Independent Benefits

The potential for a practice to produce benefits independent of climate change. For example, a practice that reduces income loss regardless of climate change effects, would be rated high.

RATING: 4
moderate independent benefits

When successfully implemented, the independent benefits associated with MiG are very high. The practice takes a holistic view, and integrates all resources in a management approach that has an explicit production goal expressed in economic terms. Multiple benefits of the practice are recognized under current conditions, regardless of climate change effects.

TABLE 1 Management-intensive grazing evaluation summary

Evaluation Criteria	Rating	Meaning
Effectiveness	4–5	Moderately effective to very effective
Economic Efficiency	4	Moderately efficient
Flexibility	5	Very flexible
Adaptability	5	Very adaptable
Institutional Compatibility	4	Moderately compatible
Adoptability	2	Moderately low adoptability
Independent Benefits	4	Moderate independent benefits

Management-Intensive Grazing Background Information

Although grazing management is an age-old practice, the relationship between grazing animals and the plant communities they forage upon is complex, and not always fully appreciated. Accepted cultural norms, existing land use institutions and economics can all impact how the grazing of domestic livestock is managed, and its overall effectiveness.

Management-intensive grazing takes a holistic approach to grazing management and is not meant to be prescriptive. It uses grazing management tools, and applies them in an adaptive management framework. This approach has an advantage over prescriptive methods—especially in relation to climate change—because the application of various tools can be adjusted as conditions change.

To know the direction management should take, goals need to be established. The goals might be varied, but should include:[8]

- A production goal expressed in economic return per unit of land; and
- A goal for the improvement of the resource base (land, labour, human and financial capital).

A key part of MiG, and any adaptive management process, is an inventory of current resources to establish benchmarks and indicators of improvement and change. For example, on native range these indicators might include the amount of vegetative cover, bare ground, and species diversity. Continual monitoring provides information to make adjustments to practices in order to reach the established goals.

The Soil, Plant, Animal & Climate Relationships

Understanding the relationships between climate, soil, plants, and animals on rangelands and pastures is fundamental for successful management. The effects of grazing on individual plants and plant communities, and natural succession (as well as nutrient, water and energy cycles) have been the cornerstone of range and pasture science for decades. Increasingly, the effect of grazing on climate-change related factors like soil-carbon sequestration are being considered in research.[9] It is important to know and use this information for planning and improving grazing management. For example, increased soil organic matter from improved grazing practices should result in a more efficient water cycle. Likewise, increased vegetative cover and reduced bare ground should improve infiltration of precipitation and reduce runoff. More standing plant material left on pastures in the fall, could effectively trap and hold

Grazing Management Terminology

Establishing universally accepted terms to describe grazing management systems is challenging. Many practitioners carefully avoid using terms like "cell grazing" or "rotational grazing" because they often become prescriptions for grazing systems, and do not adequately reflect the critical knowledge and management inputs that might be required for successful grazing management. When used alone, these terms do not convey the grazing parameters that are required to meet different management objectives under varying conditions (see Grazing Parameters & Guidelines on following page).

> *"Rotational grazing is [the] wrong [term to use]. Because… if you tell people you do rotational grazing they think OK you just rotate your cattle. But you don't watch for the rest period. Therefore, I use the term management-intensive grazing. I am always rotating my cattle, but I make sure that I have 60 to mostly 90 days of rest in between. Where I am really [just] eating the top off I find out I don't need the 90 days anymore. I can come back in 45 days.*
>
> *— Rancher and MiG practitioner*

more snow. All these conditions could potentially help to moderate the impacts of climate change.

Creating the appropriate conditions for forage plant growth, while maintaining or improving functioning of ecosystem processes, is the key to sustained and improved production. The relative state of these conditions is referred to as range, or pasture health, and 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 maintained."*[10]

Ecological processes include the nutrient cycle, water cycle, and energy flow and thus 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 protect the site from erosion;
- Capturing and beneficially release water;
- Cycling nutrients and energy;
- Maintaining biological diversity; and
- Storing carbon.

Some landscapes may have been substantially modified, but can still be managed to perform these functions (e.g., irrigated pasture).

Human Resources & Economics

The scientific and technical knowledge exists to implement sustainable and productive grazing management systems. Still there are significant areas of rangeland and pasture that are managed at a sub-optimal level. However, grazing animals are predominantly controlled and influenced, either intentionally or unintentionally, by humans and their activities. This is the sphere of management, and it is shaped by the goals and knowledge of the individual manger, social institutions and economics.

Arguably, some of the human and social dimensions of grazing management have, until relatively recently, been a neglected part of range and pasture science. Increasingly, these important elements of grazing management are being incorporated into management approaches. Rancher schools and training (e.g., Ranching for Profit, Holistic Management and MiG) have all played a role in advancing more intensive grazing management. These models have provided information to ranchers in ways—often with a peer mentorship or collaborative component—that allow them to adopt better grazing practices at an operational level. Despite these advances in approach, intensive grazing management remains a complex and challenging practice to implement.

Grazing Management Continuum

In practice, the level of grazing management of any system varies along a continuum ranging from extensive, where land area per animal is greater and inputs are lower, to intensive, where labour inputs and stocking rates are higher. As a management approach, MiG is on the more intensive end of the grazing management continum. When MiG is applied on a farm or ranch, grazing practices will be adjusted to fit different landscapes and grazing resources. For example, grazing management may be intensified on irrigated pasture, and these modifications in turn may influence the nature of management on more extensive or semi-arid ranges.

Rotational Grazing, Continuous Grazing & Management

There has been considerable discussion in the literature regarding the lack of scientific evidence to support any superiority of rotational grazing over continuous grazing on rangeland.[11] In a recent review of grazing experiments, it was found that both plant production and animal production (per head and per acre), were equal or greater in continuous grazing compared to rotational grazing in a substantial number of the experiments (84–92%, depending on the variable examined).[12] This study also concluded that grazing experiments often conducted on a small scale, may not be extendable to ranch-scale operations. It also acknowledged that the objective of grazing research was to minimize managerial and ecological variability to test research hypotheses. Experimental grazing research is vitally important to help land managers and producers understand the soil-plant-animal relationship, but clearly new applied research approaches are needed to assess adaptively managed systems like MiG.

Grazing Parameters & Guidelines

There are a number of grazing parameters that can be manipulated to help achieve such grazing management objectives as balancing animal demand and nutritional requirements with forage supply, maintaining or modifying a plant community. Some key grazing parameters include:[13]

- Stocking density—the number of animals or animal units (AUs) per unit of area at any given time.
- Stocking rate—the number animals or animal units in one or more units over a specified time. It may be expressed as animal units or forage intake units per unit of land area over time (e.g. AUMs/acre).
- Grazing (or stocking) period—the length of time that grazing livestock occupy a specific pasture or paddock.
- Rest period—the length of time that a pasture or paddock is not grazed between stocking periods.

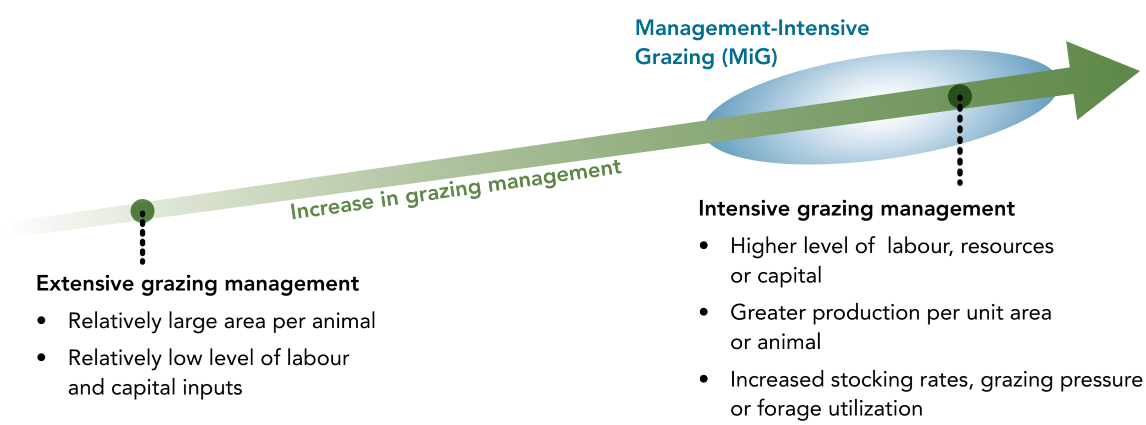
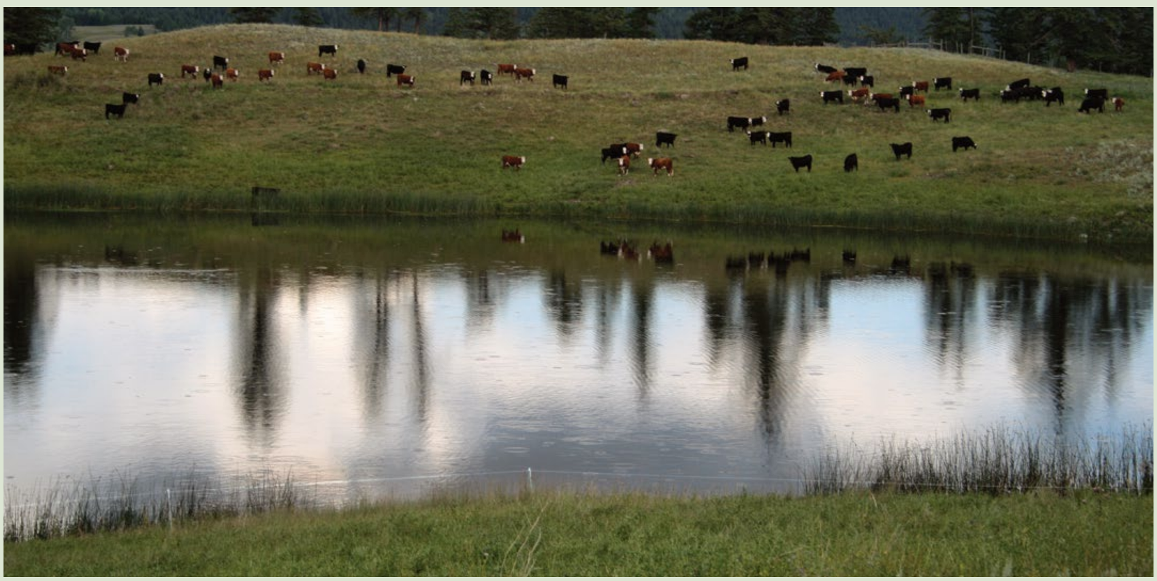


FIGURE 2 Graphic representation of the grazing management continuum

Temporary Electric Fencing

The development of temporary electric fencing has been an important technology allowing cost-effective controlled stocking in MiG systems. The fencing involves several components including: polywire – a polypropylene twine with strands of conductive wire; a reel so the polywire can be quickly rolled up and relocated; and portable fence posts to support the wire at the appropriate height (photo near right). The polywire is easily connected to a high-tensile main powered fence-line, and used to sub-divide pastures (photo far right) and to restrict animal access to sensitive areas (photo below).



- Grazing pressure—the relationship between animal live weight and forage mass per unit area of the specific unit of land being grazed at any one time; an instantaneous measurement of the animal-to-forage relationship (animal forage demand relative to forage supply).

With intensive grazing management, the level of forage utilization in any given grazing period can vary depending on the objectives. For example, to control aspen regrowth after logging or clearing, increased grazing pressure can be achieved with an increased stocking density over a specific time period. Once the desired utilization of aspen is achieved, there should be a rest period. In a pasture situation where forage production is being maximized, the stocking density may be high, but the grazing period may be shortened to reduce the level of forage utilization to allow quicker regrowth.

Management-Intensive Grazing & the Process of Adaptation

One of the more challenging aspects of MiG, is appreciating the adaptive process that supports development of site-specific and appropriate grazing systems for individual operations. Sound grazing management principles are required in all situations, but how practices are adapted and applied must fit with the land, plant, animal and human resources available. This is likely why mentorship and teaching, often associated with successful adoption, lead to practical advice like, "there is only one way to begin, and that is to get started."

The Cariboo region provides a useful example to illustrate the tremendous variation in the vegetation landscape, and why the adoption of MiG may take different forms depending on where it is applied. Figure 3 shows the general west-east precipitation gradient of the Chilcotin-Fraser Plateau, and some of the vegetation landscapes near the headquarters of four different ranches that are in various stages of MiG implementation. In the semi-arid landscapes in the west (Figure 3.1 and Figure 3.2), initial intensive grazing systems are being developed on irrigated land. On one of these ranches, the objective is to reduce irrigation costs under a centre pivot by intensifying grazing and reducing the amount of production taken off as harvested forage. Increased costs in this case are related to pumping water a considerable distance from the Fraser River to fields above. Increased river siltation caused by recent weather patterns reduces pump life and increases maintenance and repair. Intensive grazing is being initiated on irrigated hayfields on the other operation, with the objective of reducing winter feed costs. Both ranches are contemplating how more intensive grazing management might be applied to parts of their extensive semi-arid ranges.

The two operations east of the Fraser River (Figure 3.3 and Figure 3.4), have been applying MiG for a longer period of time and are successfully applying more intensive management across a greater percentage of their forage land bases. The longer involvement with MiG is definitely a factor in the more intensive application of MiG on these operations, but the nature of the grazing resources at this wetter end of the moisture gradient are also likely a factor.

Water Development Under Management-Intensive Grazing

Livestock require daily access to water, so when stocking rates and stock densities are intensified, additional water points may be required. In this pasture layout, a series of six water troughs with floats were established along a dividing centre fence so the two main units could be subdivided into 5 acre paddocks using temporary fencing (see photo top). Using above-ground polyethylene pipe, the troughs are gravity fed from a dugout on the crest of the hill (see photo bottom).

FIGURE 3.1 Mixed native grassland, elevation approximately 840 metres

FIGURE 3.4 Aspen, spruce and mixed grass-legume pasture, elevation approximately 840 metres

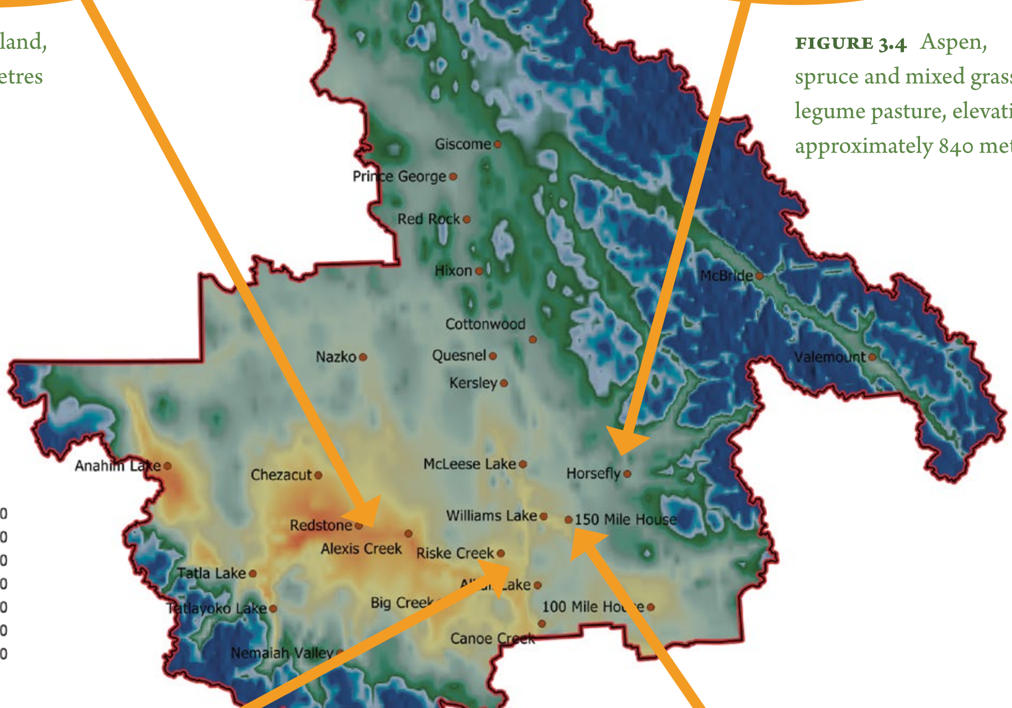


FIGURE 3.2 Bluebunch, wheatgrass and cacti in the Fraser River Valley, elevation approximately 685 metres

FIGURE 3.3 Rolling grassland and wet-meadow complex, elevation approximately 710 metres

FIGURE 3 West-to-east moisture gradient and vegetation landscapes on the Chilcotin-Fraser Plateau in the Cariboo-Fraser-Fort George Region

Notes: Photos taken August 2012. Map showing 1961–1990 Average Annual Precipitation from: The BC Rangeland Seeding Manual.[14]

Private Land & Crown Range Resources

The location and type of land ownership can influence how grazing is managed. Private land, whether owned or leased, is located near settlement areas in most regions of the province and this means human (management) resources are typically closer to forage resources on private land. With the increased labour requirements needed for intensive grazing management, proximity and travel distance are important factors affecting the level of implementation.

There are two types of Crown land grazing administered in the province. Grazing licences and permits administered under the *Range Act* are non-exclusive, forage-volume based tenures that cover a defined, but often extensive, land area. Often on-going timber harvest and silviculture operations in these areas can make management more complex. Grazing leases created under the *Land Act* are exclusive and area based, and were created to help provide critical fall and spring range. In many cases, these areas are relatively close to private ranch lands. Of the two types of Crown land grazing, *Land Act* grazing leases may represent the best opportunity for more intensive grazing management because of their close proximity to private lands. Where range use stewardship and management competency are demonstrated on grazing licence and permit areas, there is sufficient flexibility in Crown range tenure administration to allow more intensive grazing management. There is at least one example in the Chilcotin Forest District where electric fence is being applied on a Crown range grazing license area. Wider use of this cost-effective technology could potentially improve management on these extensive areas.

Among the ranches discussed in the previous section (Figure 3), the two in the west (Figure 3.1 and Figure 3.2) have Crown range tenures, but currently are using more intensive grazing management on their private lands. Of the two ranches in the east one is using private lands exclusively (Figure 3.4), and the other has a Crown range grazing licence where the required *Range Use Plan* has been adjusted to allow the same volume of forage harvest, but over a shorter stocking period (Figure 3.3).

Winter Forage & MiG

Stored winter forage is typically the greatest annual operating expense for livestock operations in BC (see Figure 4). When more management attention is focused on grazing and other resources, new forage opportunities are often created. Some producers have substantially shortened their winter feeding periods and reduced feed costs, by extending the grazing season and using stockpiled forage created through more intensive management. Greater emphasis on gross profit and less on maximizing individual per animal production has improved the economics of these operations. Some producers have gone so far as selling all their haying equipment and buying their entire winter feed supplies. The shift to forage and grass leads to further adaptations, including a move to smaller frame cattle and cattle that are able to forage better through snow.

FIGURE 4 Hay stored for winter in fenced stackyard

High fencing, or innovative 3-dimensional electric fence installation, is necessary to protect forage from use and damage by wildlife, in this case elk. High concentrations of wild ungulates limit the use of other winter feeding options like swath-grazing.

FIGURE 5 Permanent electric fence is much less expensive to install than conventional four-wire barbed wire fence

Electric fence uses fewer resources (posts and wire) and ranges from $1200-$1800 per km, while conventional barbed wire ranges from $7,000-$10,000 per km. This photo shows the wide post spacing for a permanent two-wire electric fence

FIGURE 6 Electric fence charger installation

Effective use of electric fence technology is critical for the implementation of management-intensive grazing, but its use can be a barrier to adoption for some producers. Proper installation and sufficient grounding ensures effectiveness over 70 km or more of fence. Technical information and knowledge are required for effective installation.

Some Benefits & Payoffs of Management-Intensive Grazing

The primary benefits associated with MiG are:

- Greater productivity of plants and animals
- Reduced winter feeding costs; increased flexibility
- Electric fencing costs lower than conventional fencing (see Figure 5)
- Potential for increased soil organic carbon
- Reduced potential for soil erosion
- Improved watershed characteristics for water quality and quantity
- Improved bio-diversity
- Cattle breeding better adapted to local grazing conditions

Costs & Trade-Offs of Management-Intensive Grazing

Some of the costs and trade-offs associated with MiG:

- Increased labour inputs
- Capital investment in infrastructure, including water development and fencing
- Other alternatives for achieving control of stocking density and other objectives can be costly (i.e., herding)
- Can be challenging to apply on extensive rangelands and rough terrain
- Effective and efficient strategies for more intensively managing semi-arid rangelands in BC are not established
- Willingness to accept electric fence technology; knowledge acquisition required for effective installation (Figure 5 and Figure 6)
- Potential for reduction in livestock nutrition and reproductive rates in the early stages of adoption

Climate Considerations & Management-Intensive Grazing

Operators that shift successfully from conventional management to MiG, or another intensive management model, liken it to a paradigm shift in how they think about their land base and other resources. This may be one of the most beneficial aspects of MiG as a practice for adapting to impacts related to climate change. The adoption of MiG often produces a cascading effect through all of the related aspects of an operation. One of the strongest examples of this is the renewed interest in more adapted livestock breeding. Once the decision is made to intensively manage forage resources, attention is drawn to the efficiency of the animals doing the grazing. There is a general movement among these producers toward smaller frame-sizes, and animals that are known for their winter foraging ability and superior production under a wide variety of grazing conditions. Attention to local adaptability should help build resilience to the impacts of climate change.

Also as observation skills develop and changes in the plant communities take place, ranchers become interested in other aspects of their production environment, like the amount of micro-biota and organic matter developing in their soils. Producers involved in MiG also recognize that when they buy hay from off-farm, they are also importing additional nutrients that can be used to supplement their forage production (see *Nutrient Management* in this series). This interest in a healthy nutrient cycle (also called the mineral cycle) is also likely to help build resilience.

Management-Intensive Grazing Examples

Management-Intensive Grazing *(Cariboo region)*

The last decade has been an economically challenging period for BC's beef producers. Poor beef prices combined with rising operating costs have put some producers out of business, and led others to drastically reduce cattle numbers. Those signals have also stimulated adaptation. A number of producers in the Cariboo region have adopted MiG as a way to improve their livelihoods and stay in business. When asked about adoption, this rancher, who has been practicing MiG for four years, offered:

> *The primary reason would be economics. We were going broke with traditional agriculture… The second one would be ecological and environmental… According to the banker we have halved our expenses, compared to our income. Last year we cut our expenses in half, and this year we are still improving.*

The transition to more intensive management requires the development of observation skills, to assess utilization and monitor change in plant communities. These abilities are a critical part of adaptive grazing approaches like MiG.

> *And we are just noticing changes that we never used to notice before. We never used to have alfalfa or clover in our hayfields because we would mow it to 2 inches in the hottest months of the year, and it would burn right off. Unless we got a wet fall we never got much regrowth. Now we are taking a third or half of what's there and there is more and more growing and the legumes are coming in and starting.*
>
> *We can see the benefit and we're continuing on. We are getting better as time goes on.*

Highlights

- → Adoption of MiG
- → Improved economics
- → Improved water and nutrient cycling
- → Greater biodiversity
- → Continued adaptation

On this historic ranch, MiG has been practiced for nearly five years. A log barn houses an electric fence charger that powers several kilometres of fence that is necessary to achieve the desired stocking densities (photo left). Substantial forage is left behind after grazing in a flood irrigated pasture once used for hay production (photo above). This allows for more rapid regrowth, and provides stock-piled forage for either late- or early-season grazing. With a much shorter winter feeding period, the ranch's haying equipment was sold and hay is now purchased, improving overall profitability.

Management-Intensive Grazing *(Peace River region)*

More intensive grazing mangement provides an opportunity to set goals for the vegetation landscape. In the Peace River Region, and other parts of the province, the regrowth of woody species after clearing and logging often interferes with forage production objectives. On this ranch, intensively managed grazing was used to control aspen regrowth following logging, slash piling, and the establishment of agronomic forage species with aerial broadcast seeding. Water troughs and a powered centre dividing fence was installed, and this allowed 2 hectare (5 acre) paddocks to be created with temporary electric fence (20 in total). Once the aspen control objective was met, the grazing intensity and management inputs were reduced.

> *So as we started we had more paddocks, more portable fencing, and now that we've got control on the poplar and willow species coming in, we can do less portable fencing*

This producer also understands the importance of aspen retention for its influence in the watershed, and the positive effects of MiG for moderating the effects of drought (see panel). Here the desire to improve total production on a limited land base has resulted in an estimated 50% increase in stocking over that of conventional management.

> *There [aren't]many places with the land base that we have that would run this number of cattle. Quite often they'll have more land base, or they'll have community pasture and the cows will go out there…We would have less cows today… we wouldn't be able to feed what we are feeding [if we hadn't] managed for grazing. We wouldn't have got regrowth, wouldn't have enough hay production, because we would have let them get old [speaking of hayfields].*

Highlights

- Vegetation objectives met with MiG
- Increased production
- Improved economics
- Opportunities for livestock management and breed improvement
- Resilience under dry conditions

The top photo shows a pasture 13 years after establishment, where aspen regrowth has been controlled with intensively managed grazing. The centre photo shows results of another approach to improve forage production and control aspen regrowth, where winter feed is used to control animal distribution, add nutrients and provide a seed source for desirable forage species. This aspen stand (bottom photo) is also incorporated into the grazing plan, and demonstrates the importance of tree retention and a late-season green-forage effect in the understory. All three photos were taken on the same day (August 13, 2012), when measured precipitation was around 60% of normal for the time of year.

Endnotes

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