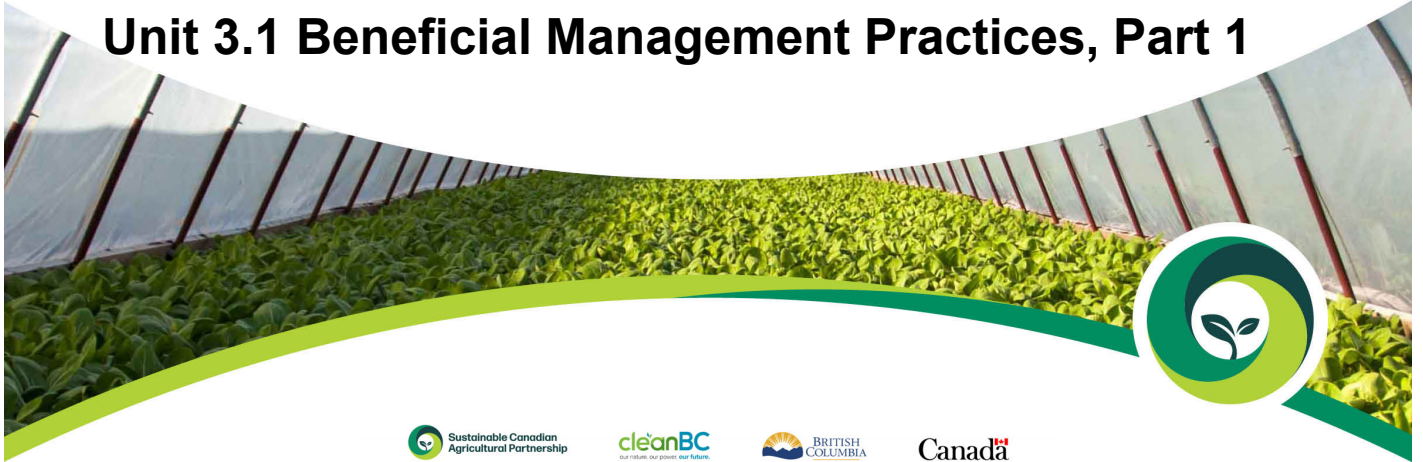


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Silvopasture In British Columbia Information Series

Unit 3.1 Beneficial Management Practices, Part 1





Acknowledgment

This work has been funded by the Governments of Canada and British Columbia under the Sustainable Canadian Agricultural Partnership, a federal-provincial-territorial initiative.

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2

Insert local indigenous territorial acknowledgment.

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Silvopasture in BC Information Series Content Guide



Core Units	Case Studies	Supplemental Units
0. Series Overview		
1. Introduction		1.s. History of SP in BC
2. Science Behind SP	2.c.1 Production Synergies: Kootenay Tree Farms	2.s.1. Light & Microclimate
	2.c.2 Riparian Silvopasture: Silver Hills Ranch	2.s.2. Hydrology
3.1. SP BMPs - part 1	3.c.1 Small-lot SP: Just Another Weed Patch Farm	3.s. Managing Damage
3.2. SP BMPs - part 2	3.c.2 Mature Forest to SP: Indian Gardens Ranch	
4. SP Planning	4.c.1 Planning on Crown Land: SP Pilot Project	
	4.c.2 Adaptive Management at Aveley Ranch	

This is the first part of the third core unit in the information series on silvopasture in BC and is intended to provide basic education on the use of silvopasture as an option to complement pasture and range management in BC.

Unit 3.1 Beneficial Management Practices, Part 1



Goal

Learn beneficial practices that will maximize resource use separation and facilitation, or minimize negative interactions in silvopastures.

Suggested Prerequisites

Unit 2: Science behind silvopasture.

Introductory pasture and range management concepts.

Content

1. Review: Resource Sharing, Interactions, Development Phases
2. Herbaceous Phase Focus: tree-forage and livestock-tree interactions

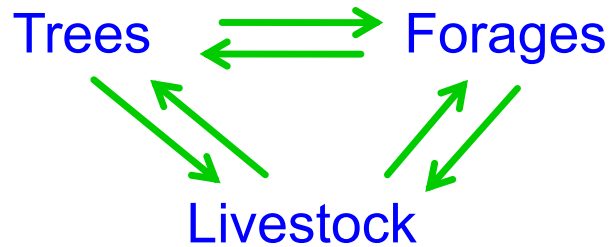
In this unit, we will use our understanding of the science behind silvopastures gained in unit 2, to select appropriate beneficial management practices (BMPs) that maximize resource sharing and positive interactions while minimizing or mitigating negative effects.

In this first of two parts on silvopasture BMPs, we will look at BMPs in the early herbaceous phase of a silvopasture development with an emphasis on the critical management procedures.

Before undertaking this unit in the series it is recommended that you have completed unit 2 on the science behind silvopasture, and you should already have some introductory level understanding of pasture and range management concepts.

Silvopasture is a Type of Applied Ecology

- Understanding basic principles will help design and manage your silvopasture.
- Focus: manage resource sharing and interactions among three components.



5

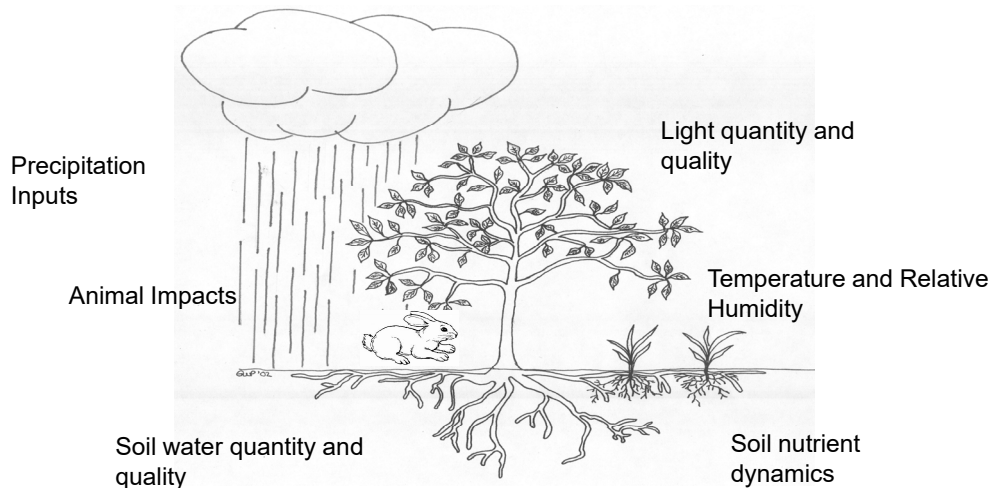
Recall, that in silvopastures there are three primary, interacting components: trees/shrubs, forages and livestock or other grazing animals.

Sharing resources by separating their use either in space or time potentially allows for greater overall production in mixtures than the equivalent combined areas in monocultures of either trees or forage crops.

Optimal production in mixtures can also be supported by encouraging facilitative (positive) rather than competitive (negative) effects, alone or in combination with separating resource use.

Silvopasture Resource Sharing and Interactions

Above- and Below-ground, Competition and Facilitation



6

Resource sharing and interactions always include a mixture of above- and below-ground effects with positive and negative implications for total site productivity.

They all can occur simultaneously and resource sharing and interactions at one level can strongly affect how they occur in another. Also, grazing and other animal impacts can change the balance of resource use and the nature of the other interactions.

How we design and manage our silvopasture determines whether the cumulative effects are net positive or net negative to production.

Silvopasture Development Phases

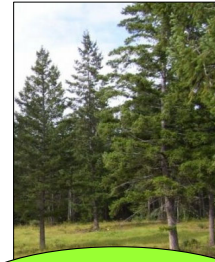
1. **Herbaceous Phase:** Trees, shrubs and forages interact symmetrically, and all are susceptible to direct livestock impacts.
2. **Intermediate Phase:** Interactions are limited to soil resources; most livestock impacts on trees and shrubs are diminished.
3. **Arboreal Phase:** Mature trees/shrubs control availability of most resources and microclimate; livestock have limited impact on trees.



Herbaceous



Intermediate



Arboreal

7

The development of a silvopasture is dictated by the relative size of the tree and shrub components. It is important to note, that this is not strictly related to their age. They will grow and develop in proportion to the net competition or facilitation they experience over their lifetime.

Herbaceous Phase: All interactions are symmetrical, or proportionate to their size, and all are equally susceptible to direct livestock (positive or negative) impacts.

Intermediate Phase: Tree and shrub canopies have grown to the extent that they no longer compete with the forage layer for light. Competition or facilitation for soil resources are prominent. Livestock interact with, and impact the forage layer, but their impacts on trees and shrubs is limited to physical impacts from rubbing or stepping on surface roots.

Arboreal Phase: Mature trees and shrubs are of sufficient size that they control the availability of both above and below-ground resources. They also now exert a strong influence on site microclimate by controlling temperatures, airflow and humidity. Livestock have limited to no impact on the tree and shrub layers, except where there is high concentration of surface or shallow plant roots.

Silvopasture BMPs

Successful silvopastoral management revolves around managing three critical interactions



	Tree-Forage	Tree-Livestock	Forage-Livestock
Herbaceous	Critical	Critical	Important
Intermediate	Normal	Important	Normal
Arboreal	Critical	Normal	Normal

8

All silvopasture components interact with each other, positively and negatively, over the life-span of the system. But not all interactions are equal in terms of achieving your production and conservation goals.

We will define three types of interactions:

Normal Interactions: require the same level of care and attention as would be present under any pasture or range setting. It is important to note, that silvopastures are not magical. If you blend poor forage, tree and livestock management practices together, you will end up with a poorly managed silvopasture.

Important Interactions: require additional attention because, under a limited number of circumstances, they can cause production challenges. Depending on your silvopasture design and activities, these can occur between forage and livestock in the herbaceous phase, and trees and livestock in the intermediate phase.

Critical Interactions: require careful pre-planning and management to avoid system failures. Successful silvopastoral management revolves around managing these three critical interactions:

- Tree-forage interactions in the herbaceous phase;
- Livestock-tree interactions in the herbaceous phase; and,
- Tree-forage interactions in the arboreal phase

In all other respects, you should always use BMPs for conventional livestock, forage and tree/shrub management.

Herbaceous Phase BMPs

1. **Herbaceous Phase:** Trees, shrubs and forages interact symmetrically (proportionate to their size), and all are susceptible to direct livestock impacts.



Herbaceous

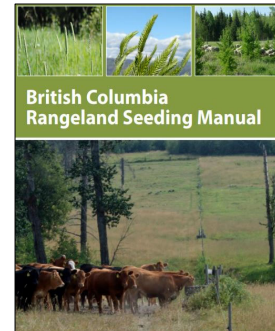
We'll start by looking at BMPs to use in the Herbaceous Phase.

Silvopasture BMPs - Herbaceous Phase

Managing Tree-Forage Interactions

Minimize Tree-Forage Competition with Species Selections

- Species mixtures must balance the short-term risks against longer-term production potential.
- Tree stock: large, vigorous, establishes and grows rapidly.
- Forages: slow to establish, short-stature, shallow-rooted, or grows at a different time of year than the tree.



10

Maximum competition can occur between woody species and forages during the herbaceous phase. Improving the early growth and development of trees and shrubs starts with the selection of species to include in the silvopasture.

First, consider the anticipated level of competition risk, as it can be highly variable from existing or new pastures (very high) relative to recently harvested forest sites (moderate to low). Your species mixtures should attempt to balance the short-term risks of impeding woody species growth against the forage production potential over the longer term.

For your tree or shrub plantings, choose large, vigorous planting stock and plant them when the ground is warm enough and with sufficient moisture such that they can begin growing immediately and not go into 'planting shock.' Direct planting of ungerminated tree or shrub seeds into a forage stand generally has very low success rates.

For your forage selections, choose short-statured, shallow-rooted species. Mixtures are preferable to single species plantings to ensure good forage establishment and a minimum ingress of weeds. Forage species that initiate growth later in the growing season (e.g. cura clover) can also be used to shift forage resource use away from the early critical spring period of tree and shrub growth.

The BC Rangeland Seeding Manual has pre-screened some forage species suitable for silvopasture plantings to assist you in your species and variety selections.

On Crown lands, note that your forage species selections must consider all land use and conservation objectives, not just silvopasture outcomes. Discussing the potential for a silvopasture project with your FOR District is a first step.

Silvopasture BMPs - Herbaceous Phase

Managing Tree-Forage Interactions

Goal: Minimize Tree-Forage Competition with Vegetation Management

- Create a 1- to 2-m minimal vegetation zone for 2 to 3 years.
- Counter-act short-term forage competition window.

Options

- Herbicides
- Mats and Mulches
- Manual or Mechanical Weeding
- Grazing



11

For susceptible trees and shrubs, or where growing-season soil moisture deficits are predictable, it may be necessary to keep a 1- to 2-m vegetation-managed zone around the seedlings for the first 2 to 3 years in order to suppress forage-tree competition.

The need for vegetation management will vary greatly from site-to-site and other management inputs used. For example, forage species planted for longer-term productivity may introduce short-term, intense competition on the crop tree or shrub. But this can be off-set with timely vegetation management.

There are several options for vegetation management in a silvopasture setting, each with advantages and disadvantages for individual settings. We will explore each in turn:

1. Chemical controls;
2. Mats and mulches;
3. Manual or mechanical weeding/brushing; and,
4. Prescribed grazing.

Available options will also depend on land tenure and associated regulation.

Silvopasture BMPs - Herbaceous Phase

Managing Tree-Forage Interactions

Vegetation Management: Herbicides

- Widely used in BC
- Regulatory compliance: transport, storage, application, disposal
- Herbicide choice restricted by mixed species
- Livestock access restricted after treatment
- Application restricted to prevent drift, set-backs from water



12

Vegetation management with chemical controls is used throughout BC in conventional forestry and agriculture. The wide-spread use reflects the low direct treatment costs per unit area. In silvopasture settings, they will generally only be considered for use when grazing is not possible.

There are rigorous management requirements for regulatory compliance in the use of herbicides and other pesticides in BC. Anyone using chemical controls need to adhere to the provisions under the *Integrated Pest Management Act* and its regulations, including any required training for Pesticide Applicators and permissions for pesticide use. Always follow all of the label directions on herbicides.

And herbicide choice and availability may be restricted by the specific mixture of trees, shrubs and forages you are establishing. And livestock access may be restricted for a period of time after treatment.

Restrictions on herbicide use mean that it may not be legally possible to treat the full area of a silvopasture using chemical controls. You are required to use buffers and exclusion zones to prevent drift outside of property boundaries, or impacts on water wells, surface water bodies or species and habitats at risk. Other vegetation control measures will need to be used in these sensitive zones.

Silvopasture BMPs - Herbaceous Phase

Managing Tree-Forage Interactions

Vegetation Management: Mats & Mulches

- Cost and labour considerations
- Organic mulch adds OM as it breaks down.
- Inorganic mulch has better vegetation control, but extra labour for removal.
- Some mulches create rodent habitat.

Vegetation Management: Manual or Mechanical

- Most labour-intensive option
- Mechanical control can be restricted by topography



13

Mats and Mulches

There are a range of weed-suppression mats and mulching options that can be placed around the base of trees or shrubs to suppress competing plant growth. The unit costs of mats and the additional labour to install and potentially remove at a later date, usually restrict their use to high-value trees and shrubs.

The material used for mulching is also an important consideration. Inorganic mulches (e.g. woven plastic or landscape fabric) have been shown in BC trials to provide superior vegetation control, but they will break down over time with weathering or impacts from livestock traffic. This necessitates extra costs to remove and dispose of the materials or it will create the risk of adding plastic pollution into the environment. Organic mulches, though less effective in vegetation suppression, have the benefits of not requiring removal and disposal, and in fact, can add significant organic matter, with benefits to soil quality, as they decompose.

Some mulching may also promote rodent habitat adjacent to a crop tree or shrub. The increased damage from rodent feeding may negate any benefit from using this control option.

Manual or Mechanical Controls

Hand pulling, chopping and mowing are also options, but are generally the most labour intensive available. They have the benefit of not requiring set-backs from sensitive areas, but some mechanical controls using power equipment may be restricted due to safety concerns or their impracticality on strongly sloped areas or rough topography.

Silvopasture BMPs - **Herbaceous Phase**

Managing Tree-Forage Interactions

Vegetation Management - Livestock

- Primary benefit of silvopasture.
- Livestock preferences must be understood.
- Defer grazing or use other BMPs when strong preference for browsing.
- Effectiveness increased by combining grazing with other treatments.



14

Given that silvopastures are intended for livestock use, their role in vegetation management for the establishment of a tree or shrub crop can be seen as a primary benefit of integrated management.

There are legitimate reasons, however, why they may not be the best choice in the first few years of a silvopasture. Indeed, as will be discussed later in this unit, deferring grazing is a BMP which can be employed in the early herbaceous phase to protect tree and shrub seedlings from browsing and trampling damage.

Moreover, if the silvopasture management strategy dictates low or moderate animal stocking, then grazing alone may not provide sufficient vegetation control unless applied repeatedly or in combination with other treatments.

Silvopasture BMPs - **Herbaceous Phase**

Managing Tree-Livestock Interactions

Minimize Woody Species Damage

- Trampling
- Browsing
- Root-zone compaction



15

Managing tree-livestock interactions are also critical to the success of your silvopasture in the herbaceous phase.

It is important to understand that unless a full-seedling protection device is used, some incidental damage will occur, even under the most diligent management regime.

We will look at three categories of potential animal impacts on tree and shrub seedlings in the herbaceous phase:

1. Trampling - direct damage caused by stepping on the plant;
2. Browsing - direct damage caused by eating part of the plant; and,
3. Root-Zone Compaction - indirect damage caused by compressing the soil around the plant roots.

Silvopasture BMPs - Herbaceous Phase

Managing Tree-Livestock Interactions: Trampling

All trees and shrubs are susceptible to trampling until they are at least 50 to 60 cm tall.

- Exclude or minimize use until tree or shrub is taller than threshold; or,
- Use physical protections around woody seedlings.
- Action guided by relative costs.



16

Unless completely protected by a physical barrier, trees and shrubs in the presence of grazing animals, are subject to trampling damage risk until they grow in sufficient size to be a visual or physical barrier to animal movement. As a rule of thumb, this is when they attain 50-60-cm in height (about 2 ft).

Livestock do not step on trees and shrubs on purpose. Rather, it is random effect relative to the animal density as they move about the site. Anywhere livestock accumulate (e.g. trails or watering sites), trampling damage can be expected to increase proportionately to the increased animal density.

The two primary strategies to minimize or eliminate trampling damage are:

1. Exclude or minimize livestock presence until trees and shrubs are taller than the threshold value; or,
2. Use physical protection around the woody seedlings.

Your action will likely be guided by the costs of tree/shrub plantings being protected, relative to the expected returns from 1 to 3 years of grazing that is deferred.

Silvopasture BMPs - **Herbaceous Phase**

Managing Livestock-Tree Interactions - Trampling

Livestock Barriers for Individual Trees



Obstacle planting



Tree guards



Barriers to prevent trampling come in various forms, ranging from no or lower-cost improvisations, such as using obstacle planting, up to more expensive tree tubes and mesh enclosures.

Obstacle Planting

In obstacle planting, new tree or shrub seedlings are planted adjacent to a natural object (e.g. rock or stump) such that the obstacle becomes the barrier to animal movement. This planting technique is well-documented for successfully reducing trampling damage. However, it is not practical for silvopastures established in a green field setting (e.g. a pasture with newly planted trees) where the rocks and large woody debris have been removed.

Tree Guards

Individual tree protection can incur considerable installation costs, but are generally very effective at eliminating trampling damage. Individual tree protection is usually employed for high value tree and shrub plantings or where natural obstacles are absent.

Silvopasture BMPs - Herbaceous Phase

Managing Livestock-Tree Interactions - Trampling

Livestock Barriers for Tree Clusters or Rows



Debris fencing, or
Temporary electric fencing



Random elevated debris

A more detailed description of protection strategies is provided in supplemental unit 3.s.1.

18

For silvopastures planted with trees in multi-row or cluster designs, conventional fencing or other linear barriers (e.g. debris fencing, random elevated debris) can be used to protect groups of tree and shrub seedlings.

A more detailed description of various tree protection strategies is provided in supplemental unit 3.s.1.

Silvopasture BMPs - Herbaceous Phase

Managing Livestock-Tree Interactions - Browsing

- Some browsing is expected (<2%) until the growing points are inaccessible.
- Severe damage can occur when no other feed is available.
- Severe damage can occur when the tree is a preferred species.
- Seedlings are most susceptible from early spring to early summer.



19

Browsing damage on woody species can be more complex to manage than trampling. Browsing is a function of individual livestock feeding preferences. But preference is always relative to a host of factors, and thus constantly changing.

If the crop tree or shrub species is not a preferred food source and other preferred forage and browse species are available, then a small amount of incidental (accidental) browsing damage can occur until the tree/shrub has extended its growing points above where they can be accessed by the livestock.

If, however, the tree or shrub species is more palatable to the livestock, or no other feed is available, heavy to severe damage can occur. And the onset of browsing damage can occur quickly.

In any given production setting, tree and shrub seedlings are most susceptible to the impacts of browsing each year from the onset of bud growth until stem elongation occurs. For most species in most locations in BC, this will occur from early spring to early summer.

Silvopasture BMPs - Herbaceous Phase

Managing Livestock-Tree Interactions - Browsing

Relative palatability is a complex subject: 'eating at the buffet':

- Individual species and breed preferences (biological);
- Individual animal and herd preferences (learned);
- Palatability changes with time of year, weather (chemical/physical).



When thinking about livestock preference and palatability, we can use the analogy of a buffet dinner being served to a large gathering of very hungry agroforesters. If the buffet is not constantly replenished, what gets removed is a function of the individual preferences of those choosing items and what is still available on the buffet table. Those at the front of the line, can choose their favorite dishes from the full range of options. Those at the back of the line will find their first, second or third choice has been depleted, and they must take something of lower preference or go hungry. And if there isn't enough food to go around, then the last to the buffet might have to eat napkins, or switch from forager to predator.

The same pattern of cascading use, relative to preferences and availability, also applies to livestock and the available forage and browse species. Livestock may not want to eat a tree or shrub, or like it. But if nothing else is left, they will eat to survive. This becomes more complex however, than just understanding the biological preferences of different species and breeds. Individual animals and herds can develop a taste for trees and shrubs through learned behaviour. And palatability can change with the time of the year, and weather events (such as drought or frost), which modify the chemical and physical characteristics and therefore the taste and texture of plants.

Silvopasture BMPs - Herbaceous Phase

Managing Livestock-Tree Interactions – General Browse Palatability



	Cattle	Sheep	Goats
Aspen	High	High	High
Birch	Low	Low	Moderate
Cottonwood	High	High	High
Maple	Moderate	Low	High
Pine	Low	Moderate	Moderate
Spruce	Low	High	Moderate
Willow	Moderate	High	High

This table provides some broad palatability indications for common tree and shrub species in BC. But do not consider these as fixed. Expect a learning curve.

Silvopasture BMPs - **Herbaceous Phase**

Managing Livestock-Tree Interactions - Browsing

Management strategies

- Ensure good livestock distribution: use mineral supplements, water sources.
- Monitor utilization closely: preference an expression of what is available.
- The more intensive the grazing, the more intensive the monitoring required.
- Train your animals to graze on target species.
- Multi-species grazing.



22

Managing grazing to ensure good distribution and rotation is your first, best option to lower the risk of browsing damage on lower-preference tree and shrub species. Good livestock distribution over the site, by using strategic water and mineral placement, or using temporary fencing or active herding, means less risk of prolonged animal loafing at any given location. When animals congregate, their preferred food sources diminish and they will start to turn to lower palatability options, including crop trees and shrubs.

Monitor utilization closely and be prepared to move your livestock to a new paddock as their preferred species disappear. And the more intensive the grazing system that is used, the more intensive your monitoring must be. The switch from preferred forage and browse to your less palatable crop trees or shrubs can happen in a matter of hours.

Animals can also be conditioned or trained, to target vegetation types. This may be an effective strategy where there is significant cover of lower-palatability weeds around the crop trees (e.g. thistle).

If you have the flexibility, multi-species grazing can be utilized to allow grazing by one livestock species that will avoid the crop tree/shrub in the herbaceous phase and then shift over to a second livestock species, once the tree or shrub has grown beyond its most vulnerable size.

Silvopasture BMPs - Herbaceous Phase

Managing Livestock-Tree Interactions - Browsing

- Use obstacle planting or physical barriers
- Use chemical deterrents



A more detailed description of protection strategies is provided in supplemental unit 3.s.1.

23

As with the strategies used to minimize trampling damage, the use of physical barriers are also effective at protecting seedlings from browsing damage.

Additionally, chemical deterrents have been developed that, when sprayed onto the foliage of crop trees or shrubs, have an odour that may repel livestock or wild ungulates.

These and other options are discussed in more detail in the supplemental unit 3.s.1. on managing tree and shrub damage.

Silvopasture BMPs - Herbaceous Phase

Managing Livestock-Tree Interactions - Soil Compaction

- Generally not an issue with moderate stocking rates and rotational use.
- Seasonal freeze-thaw cycle naturally de-compacts soils.



24

In most silvopastures, some soil compaction will occur, but it will not have significant or long-lasting impacts with rotational use at moderate stocking rates, and with good animal distribution across the site.

Seasonal freeze-thaw cycles will naturally decompact most grazing-related compaction in the interior of BC.

Some more permanent compaction however, can be associated with areas that are repeatedly used heavily in each grazing period, e.g. trails and livestock handling areas.

Silvopasture BMPs - All Phases

Managing Livestock-Tree Interactions - Soil Compaction

- Heavier livestock with shallow tree/shrub roots on clay soils, increases the risks of negative impacts.
- Decompaction may not be possible on clay soils without additional management inputs.
- Special consideration needed to prevent compaction when soils are saturated.



Combinations of larger livestock (cattle and horses), shallow-rooted tree and shrub species (i.e. those with a high proportion of their roots spreading horizontally), and heavy-textured soils (i.e. high clay content), can significantly increase the risk of negative compaction impacts.

When wet clay soils are compacted, their soil particles can fuse together creating persistent compaction. Likewise, soils that are saturated with water present a higher risk for compaction. This includes the seasonal saturation that results from frost coming out of the ground in the spring, or inundation from flooding of riparian areas.

When these risk factors are present, a good practice is reducing or eliminating grazing during the first 1 to 3 years, and/or delaying livestock turnout annually until soils have sufficiently dried in the late spring/early summer.

Silvopasture BMPs - Herbaceous Phase



Managing Livestock-Forage Interactions

- Follow BMPs you would use for any new pasture or range seeding.
- If seeding will be part of establishment, silvopastures will typically require scarification to ensure a good seed bed.
- Adjust animal stocking to account for exclusion zones around tree/shrub seedlings .



26

As with most new forage stands, the potential for grazing impacts can be most significant during establishment on the not-yet fully grown forage plants. Introducing grazing too early may weaken or kill new forage plants, and also increase the risk of browsing on crop trees and shrubs if the new forage stand is not at a sufficient production level to support your herd.

For silvopastures established on recently harvested forest sites, scarification of the surface to break up and mix the surface organics with mineral soil may be required to ensure good forage establishment.

If other BMPs are being used to create temporary exclusion zones around the crop trees or shrubs, ensure that you adjust your animal stocking to account for the reduced area that livestock are actually using.

Questions and Discussion



Questions and discussion.