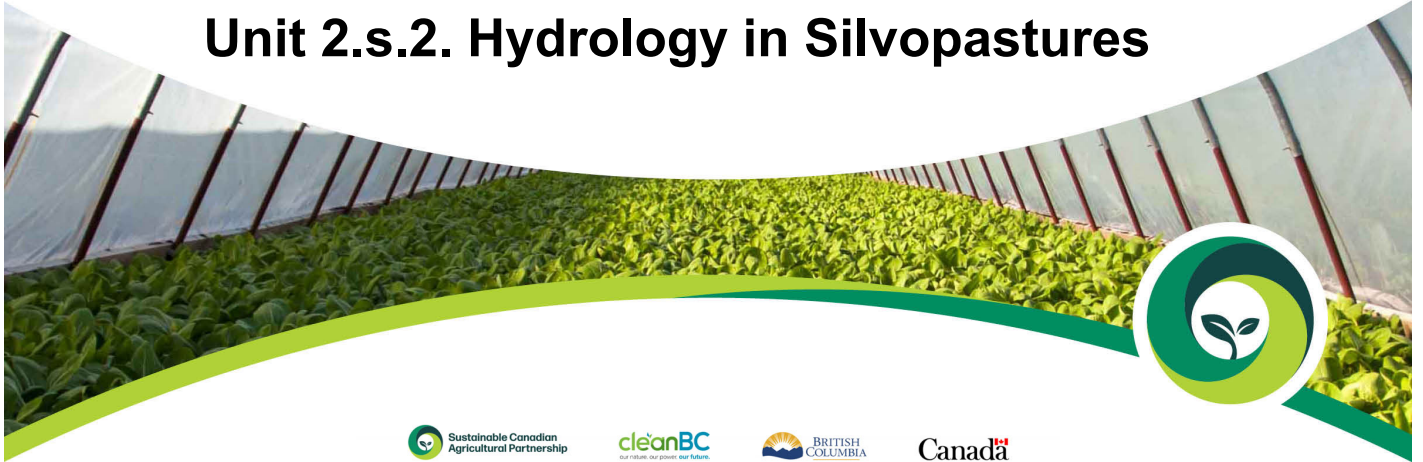


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Silvopasture In British Columbia Information Series

Unit 2.s.2. Hydrology in Silvopastures





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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Insert local indigenous territorial 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.

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 supplemental unit is part of the information series on silvopasture in BC.

It builds on information presented in core unit 2, the science behind silvopasture.

Unit 2.s.2. Hydrology in Silvopastures



Goal

Provide a deeper understanding of the science behind silvopasture design and management, specific to hydrology.

Prerequisites

Unit 2: Science Behind Silvopasture.

Content

1. Silvopasture and the Water Cycle
2. Tree and Shrub Effects on Hydrology

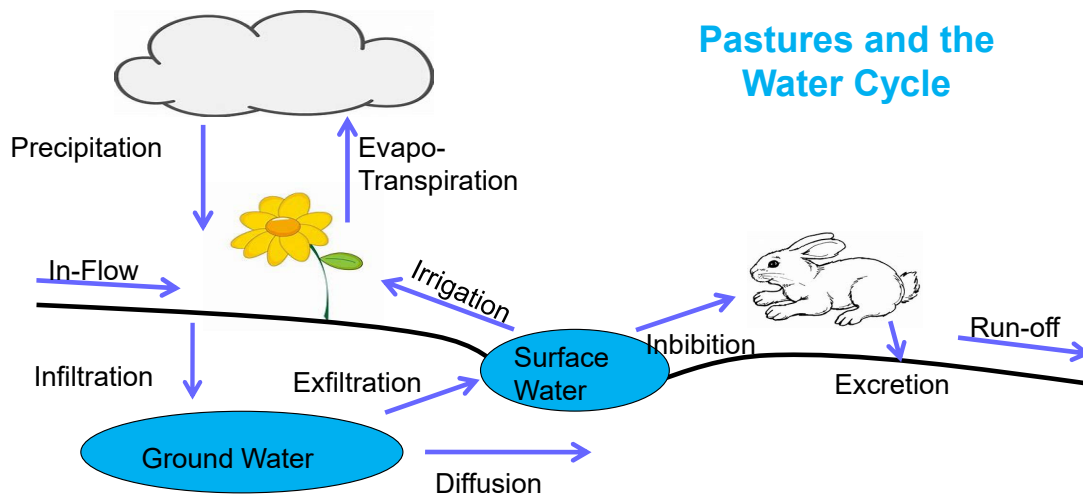
The goals of this unit are to provide a more in depth understanding of the scientific underpinnings to silvopasture, specifically as they relate to water cycling and hydrology.

This supplementary unit covers an advanced topic. You should complete core unit 2 in this information series before moving onto this content. Some post-secondary science knowledge will be helpful.

We will explore the following in this unit:

1. An overview of silvopasture and the water cycle; and,
2. How trees and shrubs change aspects of hydrology in pastures and rangeland settings.

Pastures and the Water Cycle



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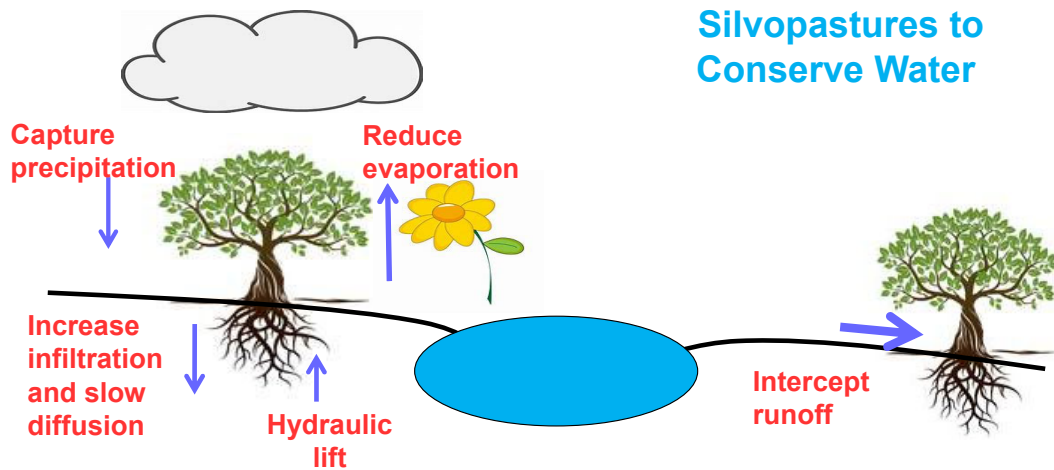
Pastures and rangelands, like all agricultural landscapes, are nested in the local, regional and global watersheds. Water is in constant motion and its motion is in cycle. The water cycle shapes, and is shaped by, management in these land units. The study of the movement of water is referred to as hydrology.

In simple terms, the water cycle traces the movement of water:

- Starting as it evaporates from surface reservoirs (including the oceans, lakes, rivers, streams and soil) and as it is transpired through plants into the atmosphere.
- Water vapour in the atmosphere moves and occasionally condenses into clouds, returning to the earth as precipitation (rain, snow, etc.).
- A portion of the precipitation input moves overland, collects in streams and rivers, or pools in wetlands, lakes and onward to the ocean.
- Another portion infiltrates into the soil and deeper into ground water. In the ground it can diffuse through the earth moving deep into aquifers or resurface through springs and artesian wells.
- On the surface, plants draw on soil water for their needs and transpire water vapour back into the atmosphere. Livestock imbibe (drink) surface water and excrete some in their waste.

The water cycle cannot be stopped. But our management can change the speed of portions of the water cycle and also change the pathways water takes.

Silvopastures and the Water Cycle



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Silvopastures follow the same general pattern of water cycling as conventional pasture and range management. The inclusion of trees and shrubs, however, introduces some very important differences, with implications for water conservation and ultimately the production of the other components (forages and livestock) in the system.

Trees and shrubs:

1. Aid in the condensation of water vapour to precipitation at a landscape-level, by interrupting thermal up-wells;
2. Cool the air and reduce wind speeds, both contributing to lower evaporation rates from the soil;
3. Intercept overland flow and reduce the amount of run-off away from production areas;
4. Break up soil aggregates and provide pathways for increased infiltration into the soil; and,
5. Draw deep layers of water to the surface through the process of hydraulic lift.

We will now look at each of these processes in some more detail.

Silvopasture Hydrology

Precipitation Inputs



Site-level

- Rainfall intercepted by trees.
- Large trees contribute to a rain shadow around the canopy.

Landscape-level

- Trees and shrubs interrupt thermal up-wells. More rainfall events occur.

Precipitation Inputs

At the early phases of silvopasture development, precipitation in silvopastures will mirror that of open pasture conditions. At the arboreal phase, however, tall trees and shrubs impact the total amount of precipitation reaching the understory.

At the site level, the large canopies of trees and shrubs can reduce inputs by intercepting rainfall before it reaches the ground. Indeed, small rainfall events can be completely captured in their canopies and evaporated back into the atmosphere, creating an understory rain shadow effect. Large trees will also channel some rainfall from their branch network, and down the main stem (bole). This concentrates water around the tree root mass to the competitive exclusion of the understory forage crop.

At a landscape level, trees and shrubs can increase local precipitation. They accomplish this by interrupting heating and convective up-wells from the earth's surface that can 'push away' water vapour in the sky. The presence of trees and shrubs therefore can result in more local rainfall events in comparison to areas that are open and dry.

Silvopasture Hydrology

Evapotranspiration

Water Conserved

- Trees and shrubs block air-flow and cool the air. This reduces evaporation from the surface.

Water Used

- Trees and shrubs are large plants that draw water for their own needs and transpire it into the atmosphere.



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Evapo-Transpiration

Evapotranspiration is the combined movement of water from the earth's surface to the atmosphere. It includes evaporation from the soil, and any surface water aggregations (e.g. streams, wetlands, lakes, etc.) together with transpiration. Transpiration is the movement of water from the soil up through the roots and vascular systems of the plant and into the atmosphere through the leaf openings (stomates).

The net effect of trees and shrubs on the water balance can be positive or negative. From a positive perspective with integrated production, mature trees and shrubs block air flow. In the winter months, this causes wind driven snow to drop this precipitation into the understory, and thus act as a snow trap. Trees and shrubs however, are also very large plants and can move a disproportionately large amount of soil water into their tissues and then transpire it to the atmosphere, to the competitive exclusion of ground vegetation.

Silvopasture Hydrology

Interception

Trees and shrubs are a barrier to water movement.

Infiltration

Greater portion of water inputs (precipitation, irrigation, overland flow) moves into the ground with tree and shrub presence.



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Interception and Infiltration

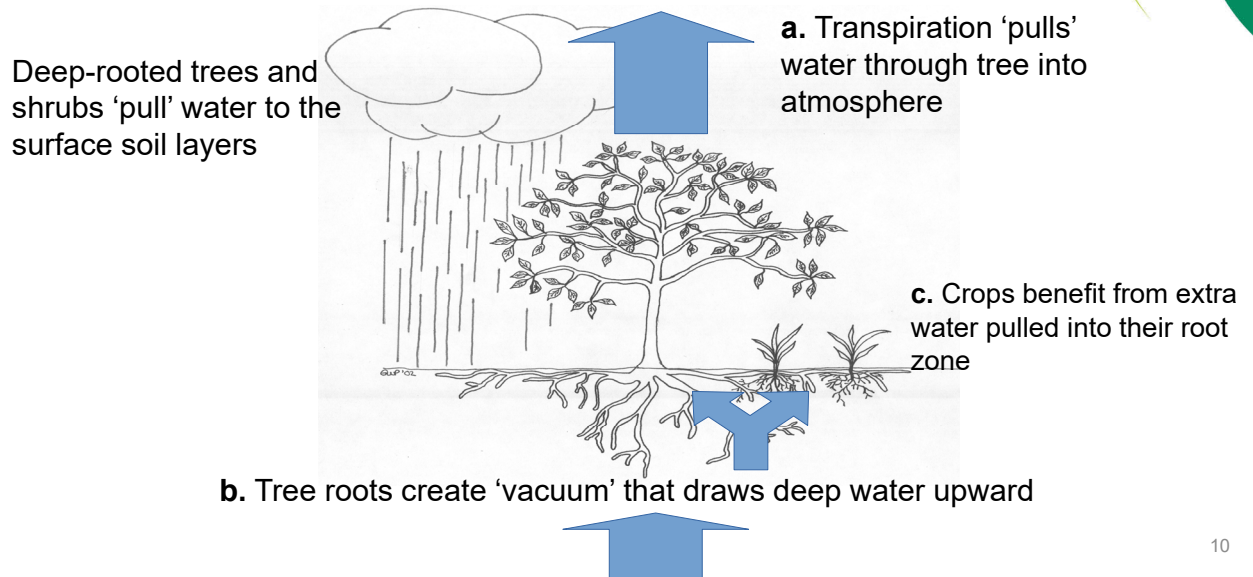
The large roots systems of trees and shrubs create a greater barrier to overland flow of surface water than bare soil or small rooted plants. By slowing water flows, a greater fraction of that water has the opportunity to soak into the ground. It also greatly reduces the erosive power of surface water because it takes away its kinetic energy (energy from movement).

Infiltration rate (IR) is the proportion of surface water inputs from precipitation, irrigation, overland flow and animal excretion, that moves into the soil profile. IR greatly increases with the presence of trees and shrubs. The positive impacts on IR can be attributed to the following:

1. Decompacting effects of the root systems break soil crusting and compaction areas. Indeed, the hydrostatic pressure inside tree roots is strong enough to crack rocks.
2. The large root network creates additional pathways for water movement, making for more rapid transfer from surface to sub-surface layers.
3. The tree and shrub root network adds organic matter and habitat for soil organisms, both which work to further decompact the soil and provide infiltration paths.

Silvopasture Hydrology

Hydraulic Lift



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Hydraulic Lift

While large trees and shrubs use a large amount of water, they can also provision deep water to the surface layers to counterbalance the removals. They do this through the process of hydraulic lift. Similar to nutrient pumping, hydraulic lift is a process by which large, deep-rooted plants access water in lower soil horizons and draw it to the surface.

With very large canopies of actively growing leaves, the transpirational 'pull' created by trees and shrubs sucks water towards their roots. This creates a vacuum that counter-acts the effects of gravity and propels some soil water upwards into shallower root zones.

In many instances, not all of the water drawn up is fully captured by the trees or shrubs. This can be significant when the overstory species, with the top of its canopy in full sun, partially shuts down photosynthesis in response to the dryer air above. The forage species in the understory however, benefiting from elevated relative humidity, will continue to photosynthesize and draw soil water at full capacity.

Questions and Discussion



Questions and discussion.