

Sustainable Canadian Agricultural Partnership

Competitive. Innovative. Resilient.

Silvopasture In British Columbia Information Series

Unit 2. The Science Behind Silvopasture





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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Silvopasture in BC Information Series Content Guide



Core Units

0. Series Overview

1. Introduction

2. Science Behind SP

3.1. SP BMPs - part 1

3.2. SP BMPs - part 2

4. SP Planning

Case Studies

2.c.1 Production Synergies:
Kootenay Tree Farms

2.c.2 Riparian Silvopasture:
Silver Hills Ranch

3.c.1 Small-lot SP: Just Another
Weed Patch Farm

3.c.2 Mature Forest to SP:
Indian Gardens Ranch

4.c.1 Planning on Crown Land:
SP Pilot Project

4.c.2 Adaptive Management at
Aveley Ranch

Supplemental Units

1.s. History of SP in BC

2.s.1. Light & Microclimate

2.s.2. Hydrology

3.s. Managing Damage

Unit 2. The Science Behind Silvopasture

Goal

Understand the scientific foundations for silvopasture design and management.

Prerequisites

Unit 1 - Introduction.

General understanding of plant, soil and animal sciences

Content

1. Basic Concepts: Resource Sharing, Interactions, Development Phases
2. Above-ground Resource Sharing and Interactions
3. Below-ground Resource Sharing and Interactions
4. Livestock Effects

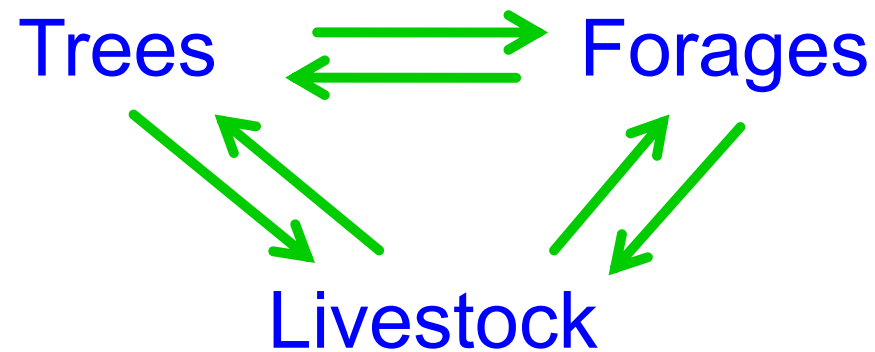
Silvopasture: Agroforestry for Pastures and Range



Managed Grazing + Trees and Shrubs + Forages

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.



Resource Sharing

Primary strategy is to separate resource use in space or time:

1. Multiple canopy layers: make full use of sunlight.
2. Multiple rooting layers: utilize different soil zones.
3. Leverage seasonality: blend species with minimal growth cycle overlap.



Competition and Facilitation

- Balance competitive (negative) and facilitative (positive) effects.
- Livestock can alter the balance.



Balancing Positive and Negative Interactions

Each silvopasture component can modify the growth conditions for the others.
Three possible outcomes:

1. Net Competition: overall productivity, resulting in underyielding.
2. Balanced: no significant impact on net productivity.
3. Net Facilitation: mixtures enhance total productivity, resulting in overyielding.

Management goal: promote positive interactions and minimize negative processes.

Resource Use and Interactions Will Vary

Some interactions can change over time

1. Daily: driven by the angle of the sun and cycle from day to night.
2. Seasonally: driven by the tilt of the earth as it travels around the sun, and biological factors.
3. By Development Stage: as a silvopasture matures through three distinct phases.



Silvopasture Development Phases

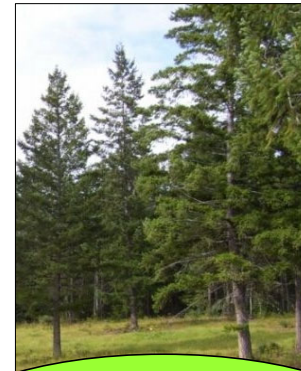
1. **Herbaceous Phase:** Trees, shrubs and forages interact symmetrically and all are susceptible to direct livestock impacts.
2. **Intermediate Phase:** Interactions are limited to soil resources; most livestock impacts on trees and shrubs diminished.
3. **Arboreal Phase:** Mature trees/shrubs control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



Herbaceous



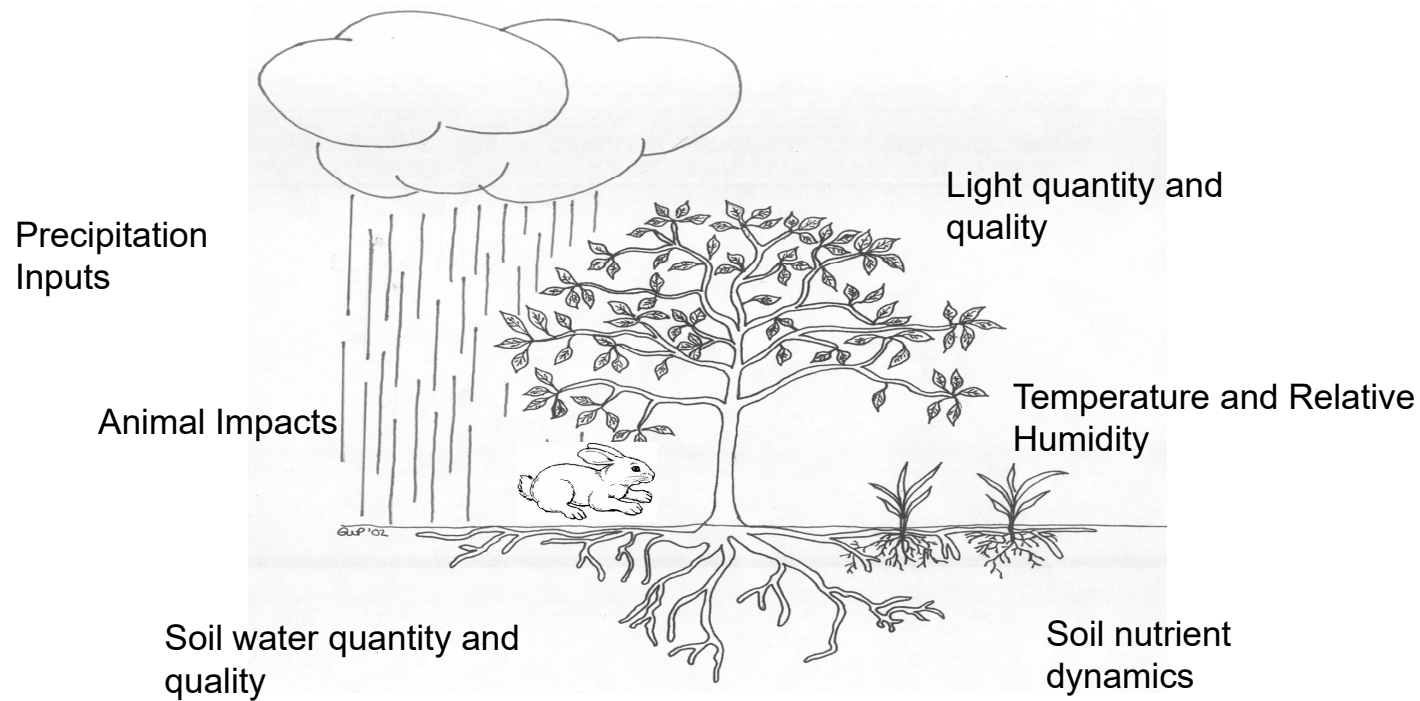
Intermediate



Arboreal

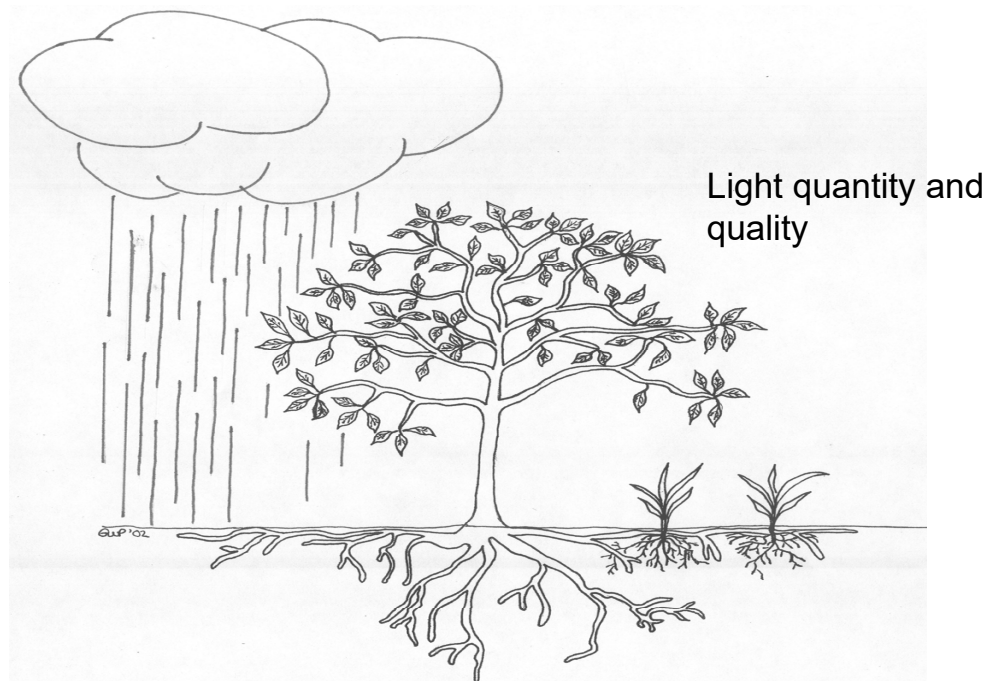
Silvopasture Resource Sharing and Interactions

Above- and Below-ground, Consumption, Deposition and Decomposition



Silvopasture Resource Sharing and Interactions

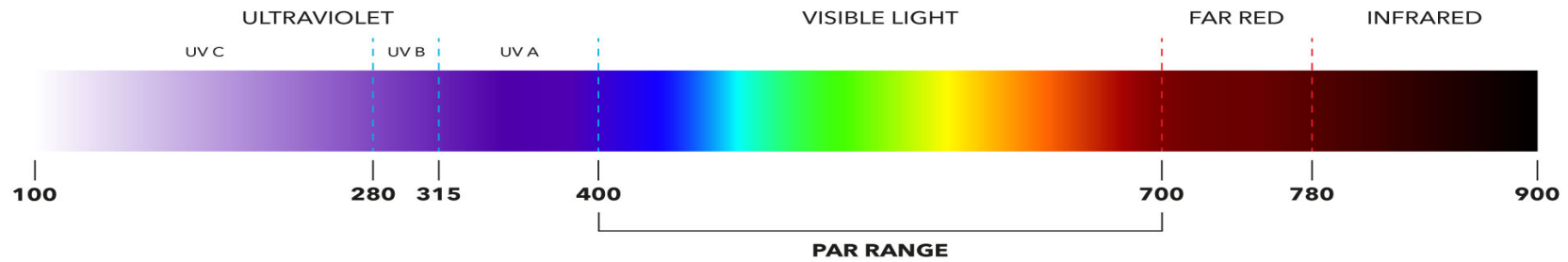
Light Availability and Photosynthesis



- Understory production decreases when canopy above > 30%
- Herbaceous phase: forages can overtop tree and shrub seedlings
- Intermediate/Arboreal phase: trees and shrubs overtop forages

Silvopasture Resource Sharing and Interactions

Light Availability and Photosynthesis



More information on this topic is available in supplementary module 2.s.1.

Silvopasture Resource Sharing and Interactions

Light and Delayed Crop Development

Small light reductions can be beneficial:

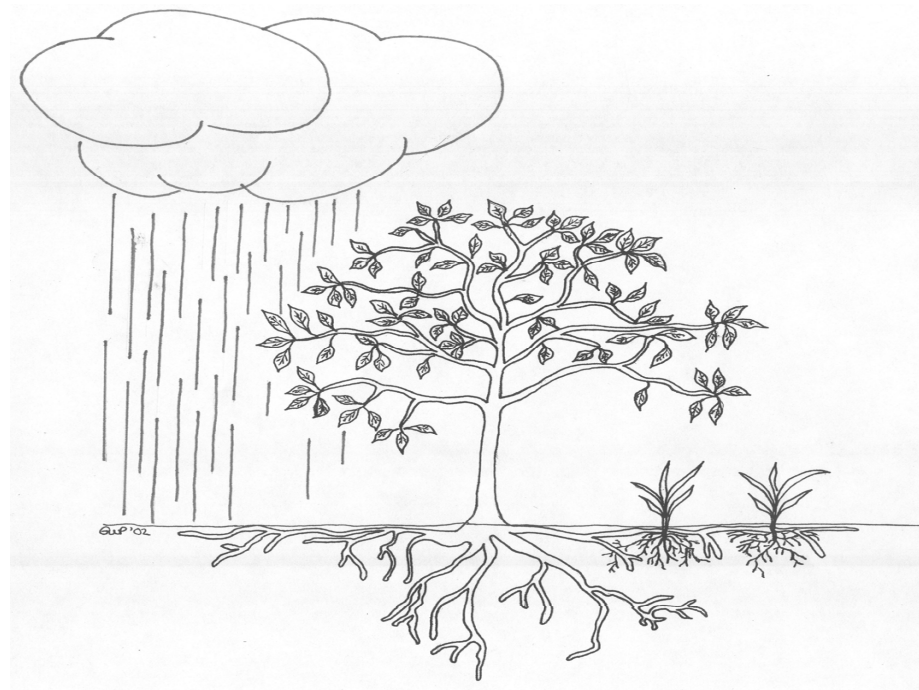
- Delay crop maturation.
- Support lush forage at peak quality later in season.



Silvopasture Resource Sharing and Interactions

Precipitation Inputs

Precipitation
Inputs



Silvopasture Resource Sharing and Interactions

Precipitation Inputs

Positive

- Mature trees and shrubs block air flow, and trap snow.
- Trees and shrubs are a barrier to overland flow of water; roots improve infiltration rates.



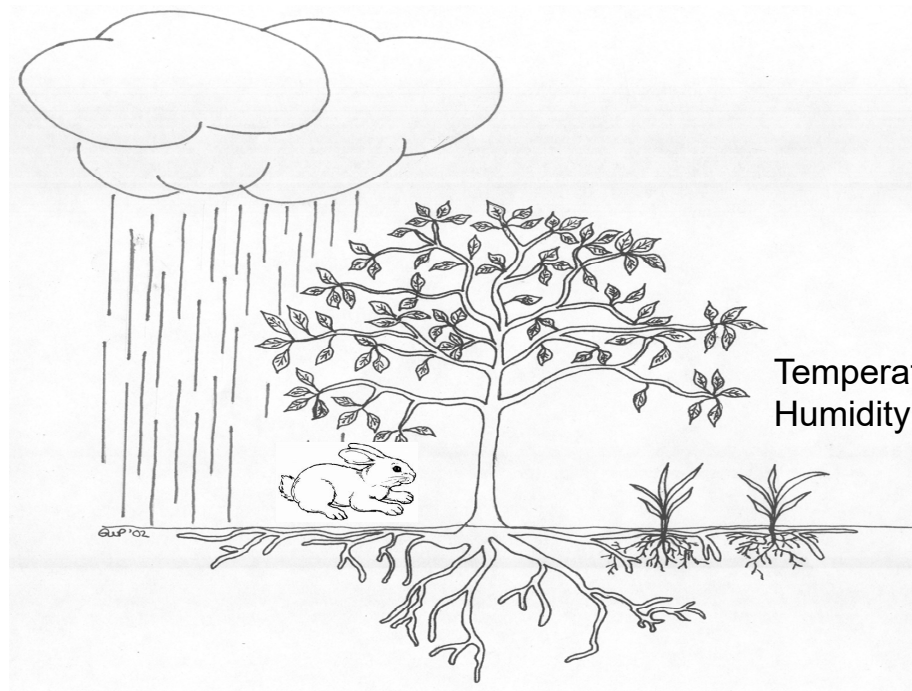
Exposed tree roots, Wikimedia Commons

Negative

- Small rainfalls are intercepted. Some never reach the ground: rain shadow around the canopy.
- Large trees channel rainfall down their stem, reducing the amount reaching the forage crop.

Silvopasture Resource Sharing and Interactions

Temperature and Relative Humidity



Silvopasture Resource Sharing and Interactions

Temperature

Positive

- Mature trees and shrubs moderate extreme temperatures.
- Radiated heat warms the understory at night and prevents frosts.

Negative

- Understory retains snow cover longer and soils take longer to warm in the spring.



Silvopasture Resource Sharing and Interactions

Temperature

Benefits

1. Animal production and welfare.
2. Forages protected from heat damage
3. Forages have longer frost-free growing period



Silvopasture Resource Sharing and Interactions

Relative Humidity (RH)

- Some forages need higher humidity for the biological processes of growth.
- When the air is too dry they stop growing
- Mature trees and shrubs elevate RH, allowing understory forages to continue to grow.



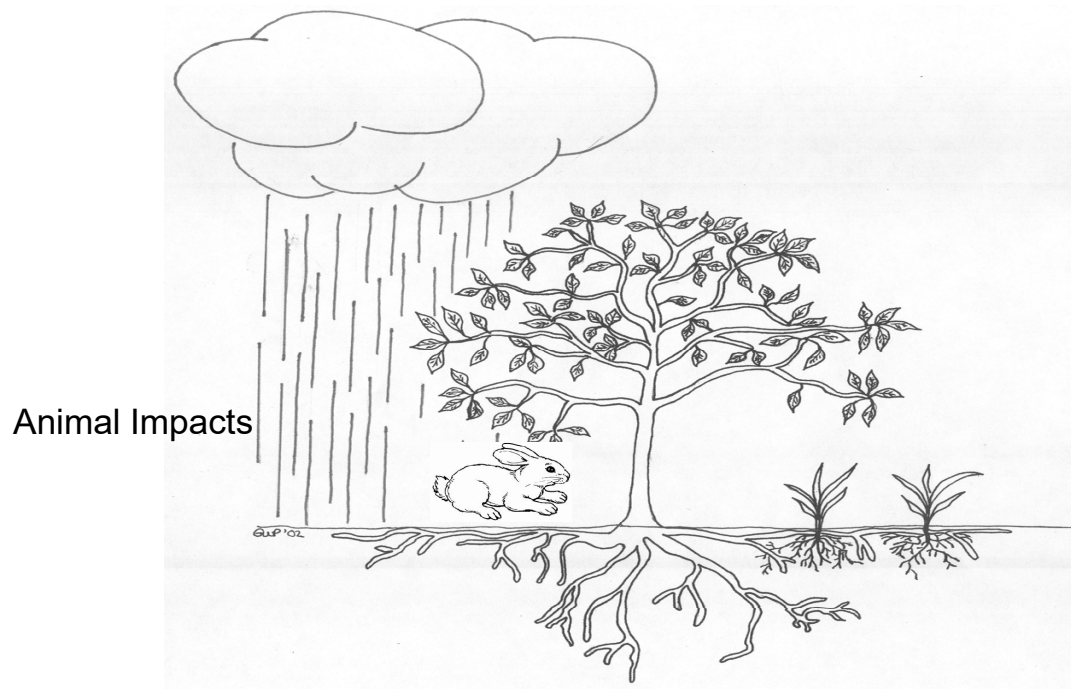
More information on this topic is available in supplementary module 2.s.1.

Break for Questions



Silvopasture Resource Sharing and Interactions

Herbivory and Animal Impacts



Silvopasture Resource Sharing and Interactions



Herbivory and Animal Impacts

- **Grazing and browsing** removes above-ground biomass.
- **Trampling** breaks or wounds stems.
- **Chewing** of bark on pole sized or larger trees.
- **Rubbing** on pole or larger sized trees for scratching or cleaning horns.
- **Shearing** of large surface roots by hoof action.

Silvopasture Resource Sharing and Interactions

Herbivory and Animal Impacts

Positive

- Controlled grazing releases competition.

Negative

- Browsing can damage or kill young trees and shrubs;
- Rubbing can damage pole sized trees;
- Damage that breaks the bark can deform growth or provide disease entry; and,
- Hoof action can damage or deform roots.



Silvopasture Resource Sharing and Interactions

Tree and Shrub Browsing

e.g. Cattle and pine

- Browsing minimal (< 2% of seedlings) and mostly accidental.
- High levels occur when forage is scarce or the tree/shrub species is a preferred source of food.

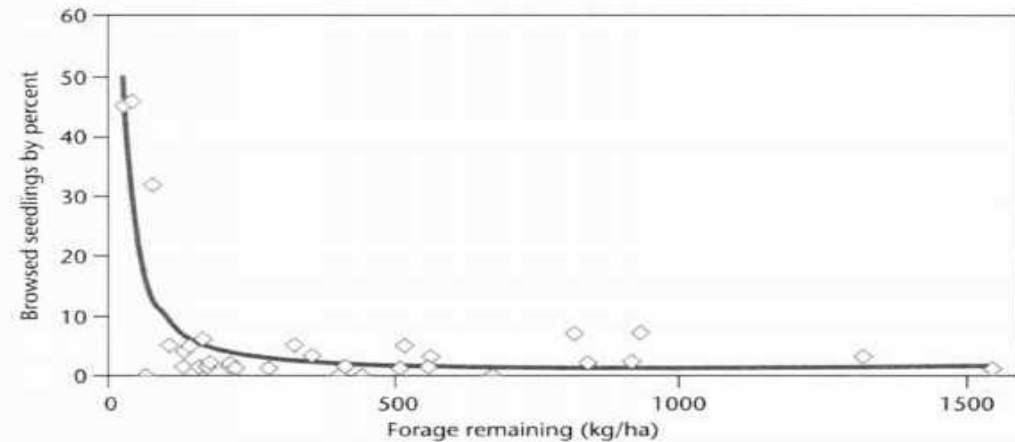


FIGURE 3. Cattle browsing of lodgepole pine relative to remaining forage.

Newman and Powell, 1997

Silvopasture Resource Sharing and Interactions



Tree and Shrub Trampling

- Common in first 2 years: a function of livestock density and tree size.
- Obstacle planting or tree guards can greatly reduce trampling.



Silvopasture Resource Sharing and Interactions

Other Considerations

Positive

- Birds and predatory insects supported that feed on crop and livestock pests.
- Livestock benefit from tree/shrub component in their diet.
- Some livestock species may be calmer/happier with access to treed environments.

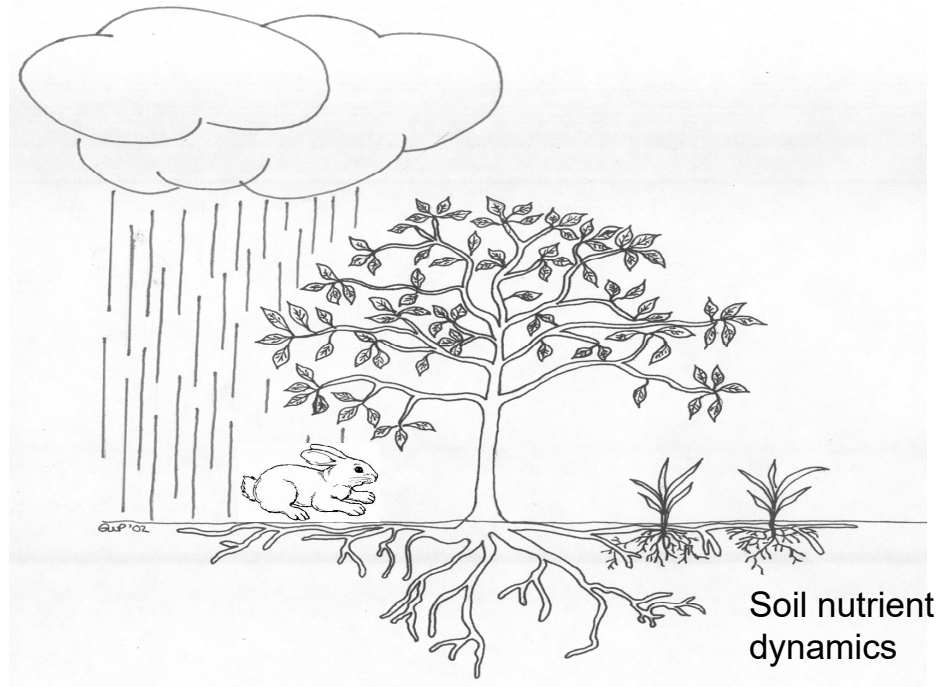
Negative

- Some livestock may experience stress when their line of sight is blocked.
- Predators may find cover in canopies.
- Soil compaction can have secondary effects.



Silvopasture Resource Sharing and Interactions

Soil Nutrient Dynamics



Silvopasture Resource Sharing and Interactions

Soil Nutrient Dynamics

Positive

- Nutrient pumping.
- Shade reduces soil temperatures and increases nitrogen release.
- Livestock cycle nutrients faster than natural decomposition.

Negative

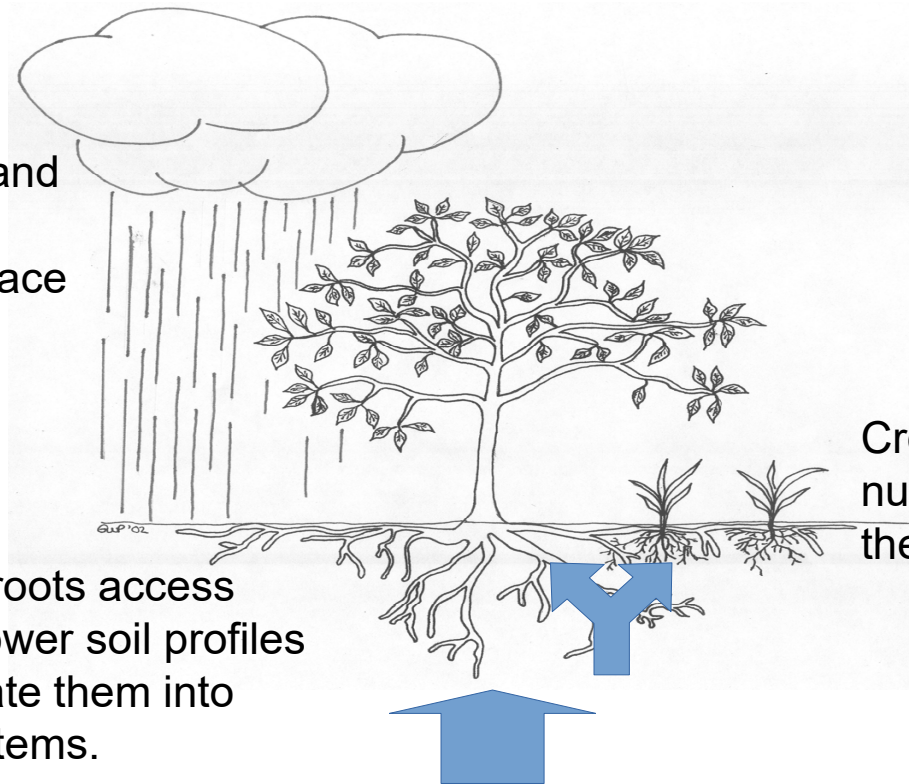
- Where rooting zones overlap, competition occurs.



Silvopasture Resource Sharing and Interactions

Nutrient Pumping

Deep-rooted trees and shrubs relocate nutrients to the surface soil layers.



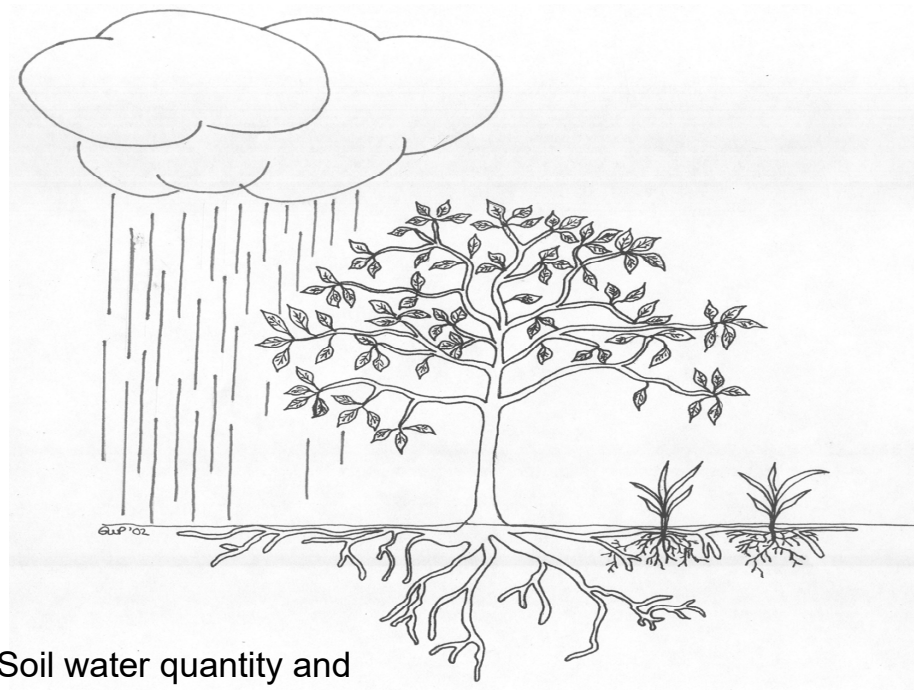
Tree / shrub roots access nutrients in lower soil profiles and translocate them into their root systems.

Crops benefit from extra nutrients turned-over into their root zone.



Silvopasture Resource Sharing and Interactions

Soil Water Quantity and Quality



Soil water quantity and quality

Silvopasture Resource Sharing and Interactions



Soil Water Quantity and Quality

Positive

- Hydraulic lift.
- Reduced evaporation.
- Improved water quality.

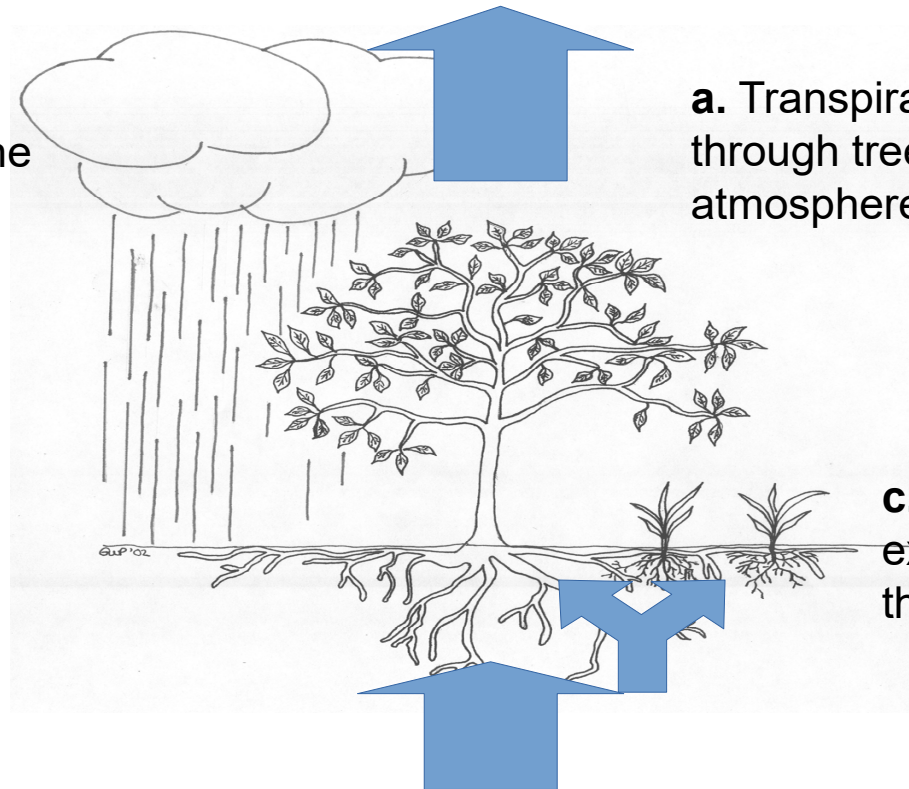
Negative

- Where rooting zones overlap, competition occurs.
- On heavy soils, or those prone to flooding, longer periods of saturation.

Silvopasture Resource Sharing and Interactions

Hydraulic Lift

Deep-rooted trees and shrubs 'pull' water to the surface soil layers



a. Transpirational 'pull' through tree into the atmosphere

c. Crops benefit from extra water pulled into their root zone

b. Tree roots create a 'vacuum' that draws deep water upward

Questions and Discussion

