

SILVOPASTURE

An Agroforestry Practice

–benefits to integrating farm and forest management –

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Special thanks to: Rob Kallenbach

Mark Kennedy

Larry Godsey

Outline

- ▶ Silvopasture Defined
- ▶ Historical Context
- ▶ Components of Success
 - *Livestock husbandry*
 - *Pasture management*
 - *Forest management*
- ▶ Integrating the Components
- ▶ Planning and Monitoring



The Silvopastoral System

Combinations of trees, forages, and grazing principles which are integrated and managed to promote broader resource utilization and enhanced farm productivity.





What Silvopasture is NOT

Grazing unmanaged woodlands is NOT a silvopasture practice!

One or two trees in a pasture ...
NOT a silvopasture practice.



Silvopasture

- A. Silvo – from the word “Silviculture”
 - the art and science of tending and producing a forest

- B. Pasture – plants grown for grazing
 - selective production of quality forage for grazing by livestock

*Integrates Forestry, Forage, Livestock practices
and management*

Historical Successes

Southern Silvopasture has successfully integrated pine production and grazed forage



Silvopasture — 4

From A Pasture to A Silvopasture System

There is potential to diversify a grazing operation and improve economic or environmental benefits on many acres through conversion of pasture to silvopasture. Silvopasture is the integration of trees with livestock grazing and forage operations. Research has demonstrated that, if managed properly, forage production can be maintained while producing high value timber.

Considerations

Southern pines (loblolly, longleaf, and slash) have been found to be compatible with forage production and livestock grazing when properly managed. This technical note provides several options for establishment of southern pines in existing pasture systems for the production and management of both forest and forage products. The following are planning considerations to convert from pasture to silvopasture:

Soils

Determine the soil suitability of the area for establishing pine trees. If the soil is not suited to southern pine species do not convert to a pine silvopasture system.

Tree Planting

Determine the desired row spacing for the pine planting. Planting rates from 100 to 400 trees per acre are typically recommended for planting a silvopasture system. Trees may be grown in single rows or in aggregate rows called sets with wide aisles for for-

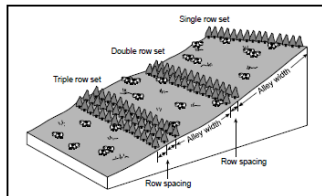


Figure 1. Typical layout diagram showing alley width, row spacing, and tree sets for establishing a silvopasture system in existing pasture.

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<http://www.unl.edu/nac/>

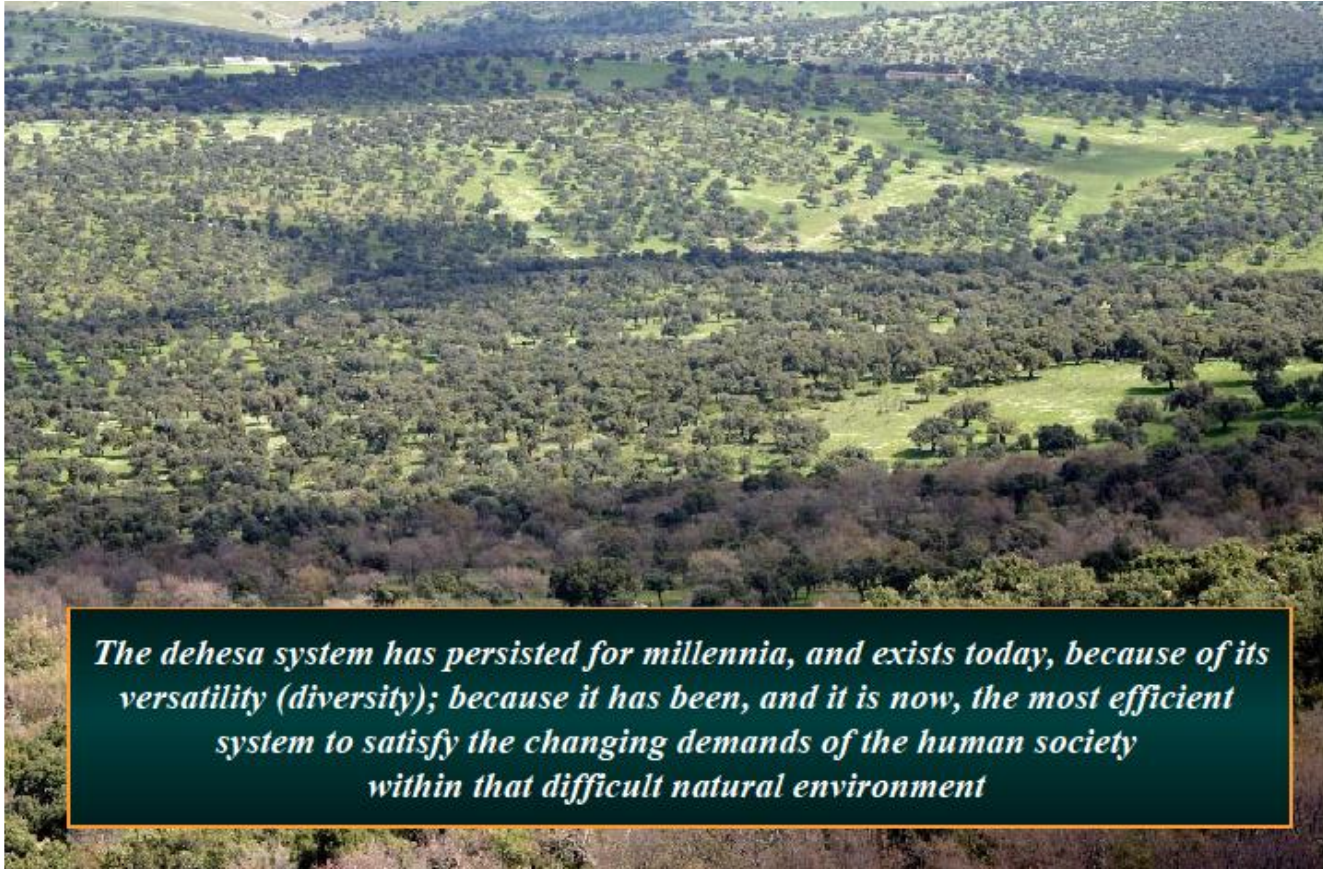


Historical Successes

Midwest Silvopasture has demonstrated short-term success associated with rotationally grazed cool-season forages grown in intensively managed upland oak forests.



Historical Successes



The dehesa system has persisted for millennia, and exists today, because of its versatility (diversity); because it has been, and it is now, the most efficient system to satisfy the changing demands of the human society within that difficult natural environment

Opening paper. XXIst General Meeting. European Grassland Federation. Badajoz (Spain) April 2006

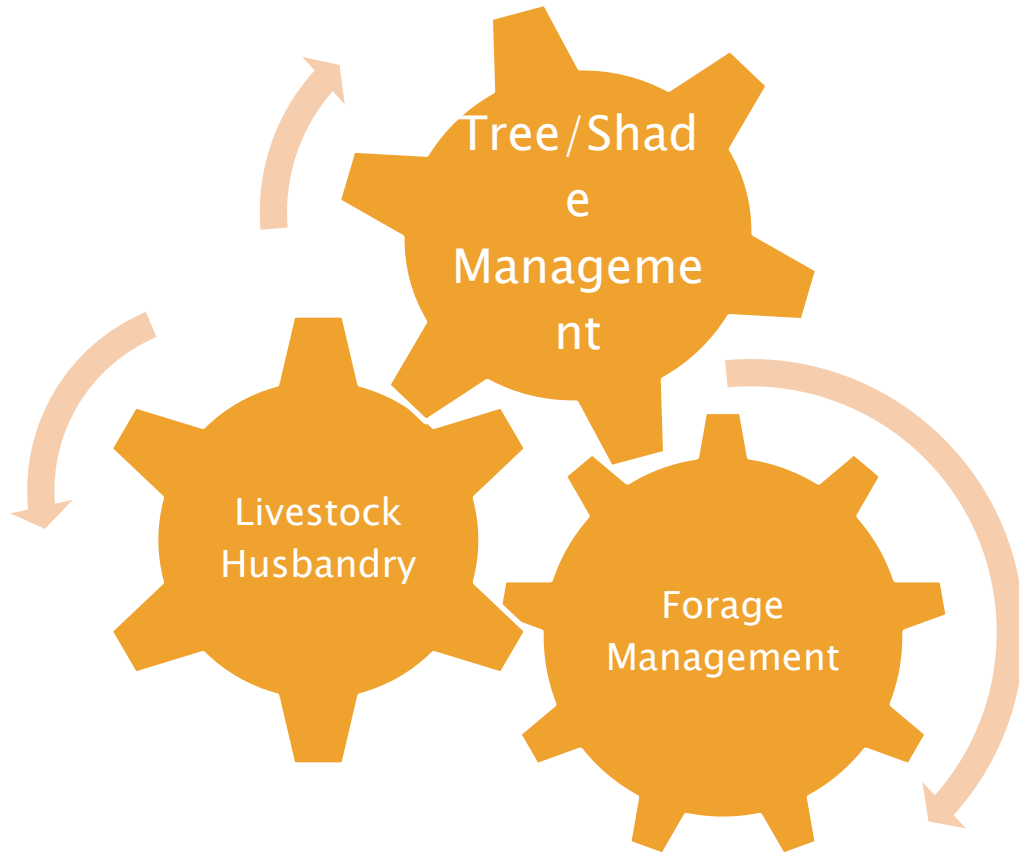
Source:

Prof. Leopoldo Olea-Márquez de Prado. School of Agricultural Sciences. University of Extremadura

Prof. Alfonso San Miguel-Ayanz. School of Forestry. Polytechnic University of Madrid



Components of Success



Do cattle need shade?

- ▶ It depends!
 - Are cattle grazing endophyte infected fescue?
 - Is the Temperature–Humidity Index (THI) over 72?
 - Have the cattle been selected for short hair coats and heat tolerance?
 - Is plenty of good quality water present?
 - What is the overall condition of the animals?
 - What are the animals accustomed to?

Shade – When it is probably needed

- Shade is probably beneficial any time Temperature–Humidity Index (THI) is above 72.
 - Especially if livestock are grazing endophyte infected fescue

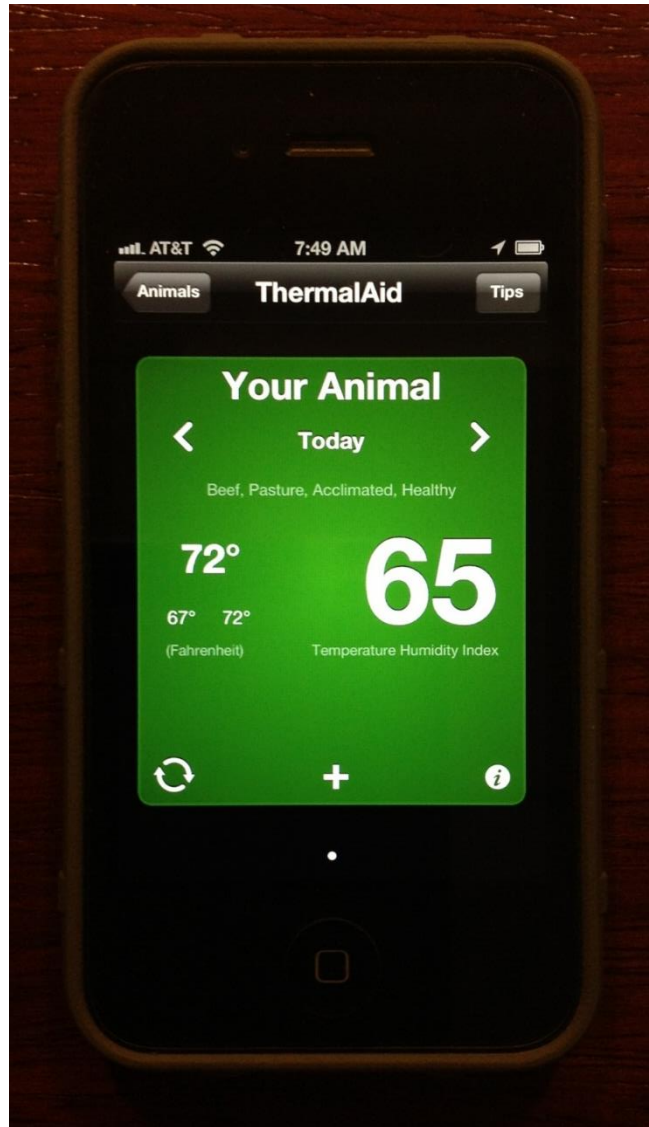
Figure 1. Temperature Humidity Index (THI)¹ for Dairy Cows. Modified from Dr. Frank Wierama (1990), Department of Agricultural Engineering, The University of Arizona, Tucson, Arizona.

DEG	RELATIVE HUMIDITY																							
F	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100			
75																72	72	73	73	74	74	75	75	
80																								
85																								
90																								
95																								
100																								
105																								
110																								
115																								
120																								

¹THI = (Dry-Bulb Temp. °C) + (0.36 dew point Temp., °C) + 41.2

If more than two cows out of 10 have respiratory rates exceeding 100 breaths per minute, then immediate action should be taken to reduce heat stress.

There's an
App for that!



Shade – good and bad ?

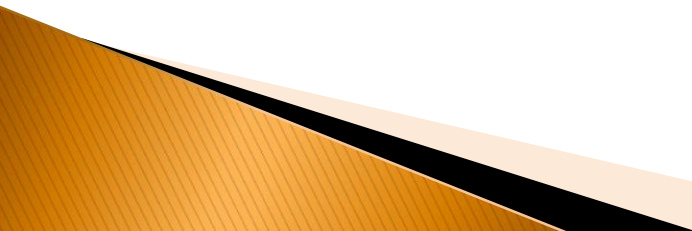
- When shade is isolated in only a few areas of a paddock there is nutrient transfer from the grazing area to the shade, eventually killing the trees and lowering productivity of the paddock.



Shade Benefits – – Cattle and Goats

- ▶ Improved animal condition
- ▶ Improved milk production
- ▶ Improved breeding efficiency
- ▶ Improved feed intake
- ▶ Improved weight gain
- ▶ & Improved nutrient distribution?

But – it does depend:

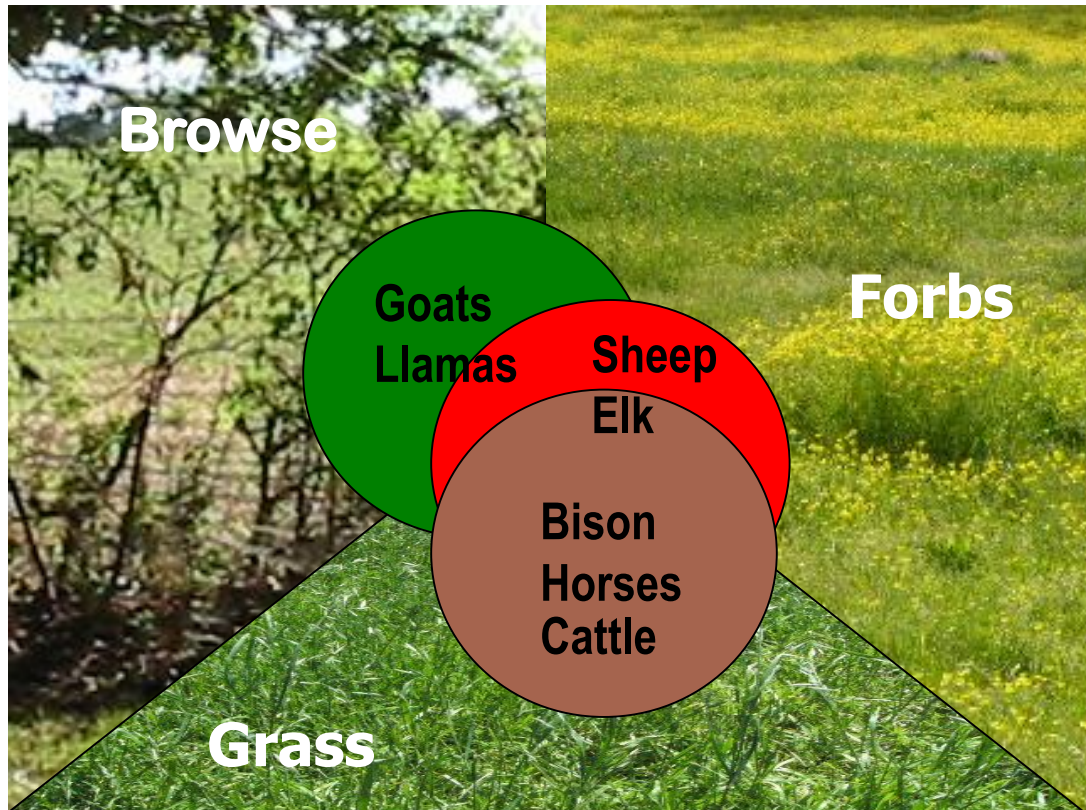
- ▶ Animal selection
 - ▶ Temp.–Humidity Index above 72
 - ▶ Endophyte infected fescue
 - ▶ Rotational Grazing
- 

Components of Success



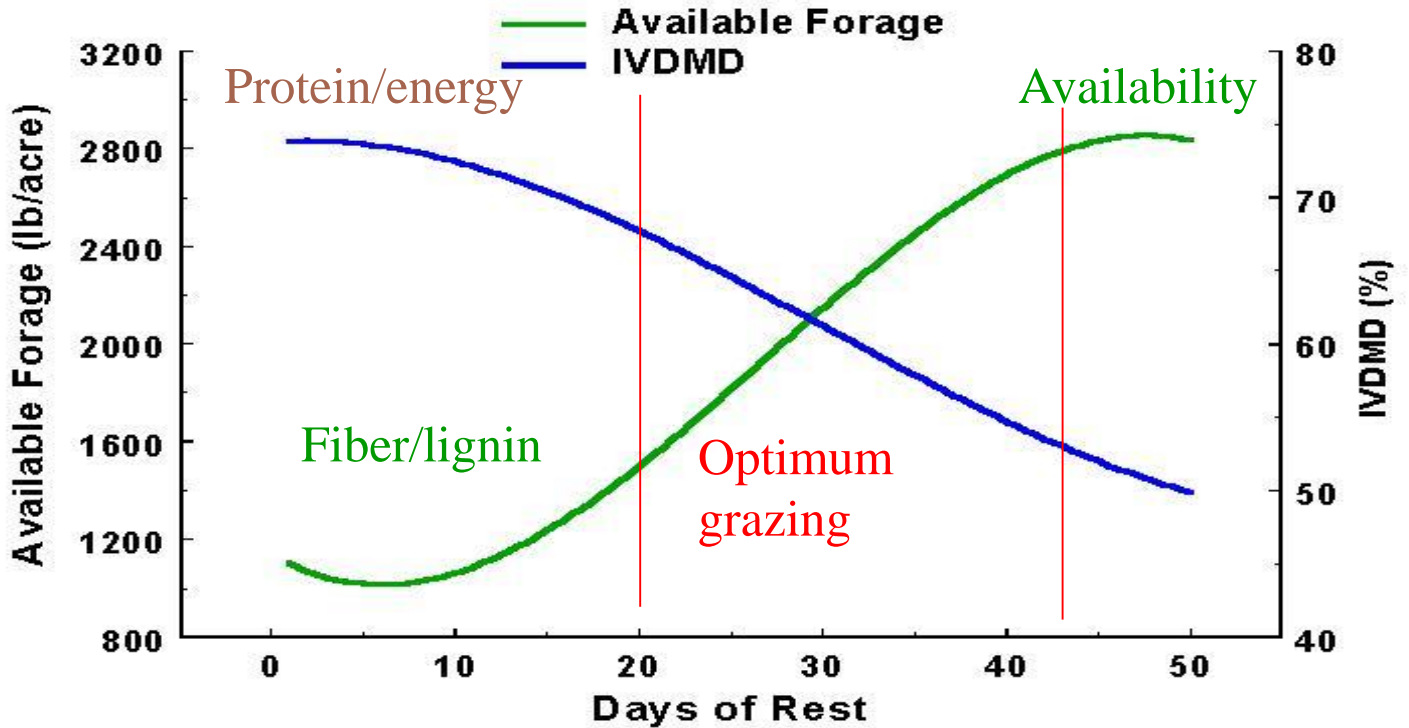
Designing Silvopastoral Systems

--Forage Management --



Optimize Forage Quantity & Quality

Management Intensive Grazing - - *Forage Rest Periods*



Rotational Grazing is Essential !!!

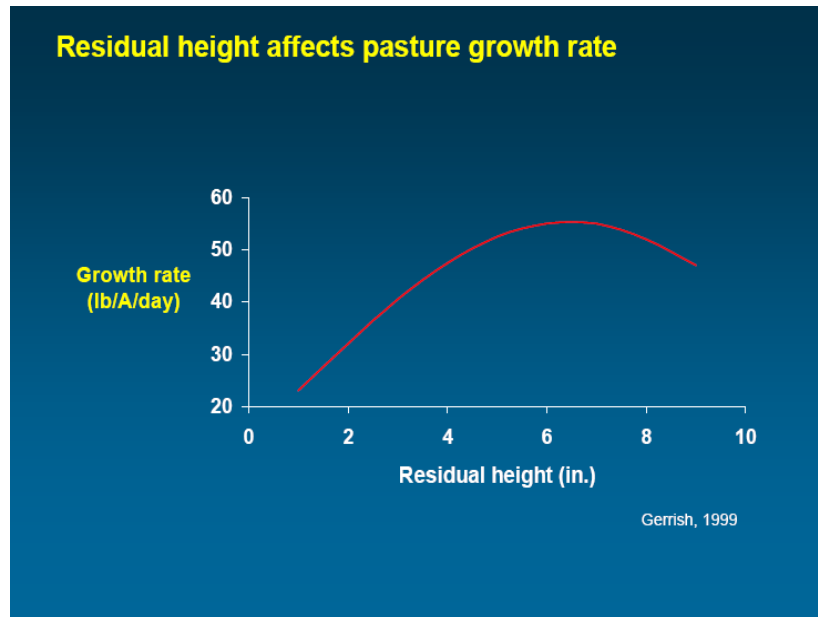
- ▶ The amount of residual left in a pasture after each grazing affects:
 - Root system
 - Health and vigor of plants
 - Photosynthesis/rate of plant regrowth

% Leaf Removed	% Root Growth Stopped
10	0
20	0
30	0
40	0
50	2 to 4
60	50
70	78
80	100
90	100



Designing Silvopastoral Systems

1. Grazing Periods less than 5 days
2. Rest periods 20 – 45 days or longer depending on grass growth rates
3. Grazing Heights:
 - Cool Season:
 - In @ 8 – 10"
 - Out @ 3 – 4"
 - Warm Season:
 - In @ 12 – 18"
 - Out @ 6 – 8"
4. Monitor and Evaluate – soils, forage, trees, animals
5. Make adjustments as needed



Insight from New Research

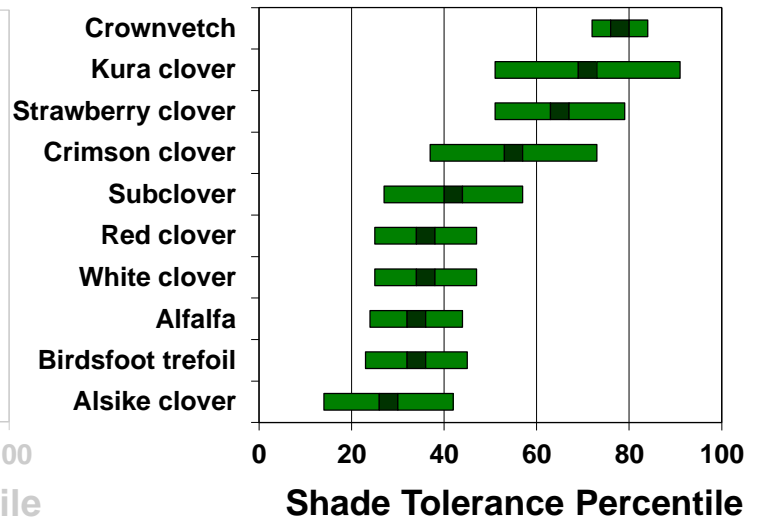
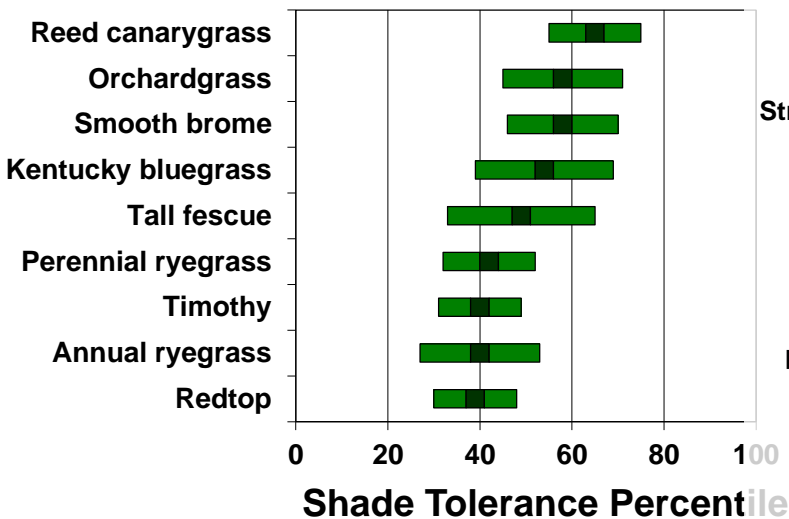
The Effect of Light / Shade

Under 50% shade Cool Season Grasses and Forbs

1. Increase or maintain yield;
2. Improve quality –
 - Reduced lignin and improved digestibility
 - Increased, or no change, in ADF, NDF, CP
 - Improved N content

Designing Silvopastoral Systems

Cool-Season Grasses and Legumes



Forage Growth Differences

Silvopasture:

- Forages start growth earlier in spring, continue later in fall
- Forage yields higher in heat of summer

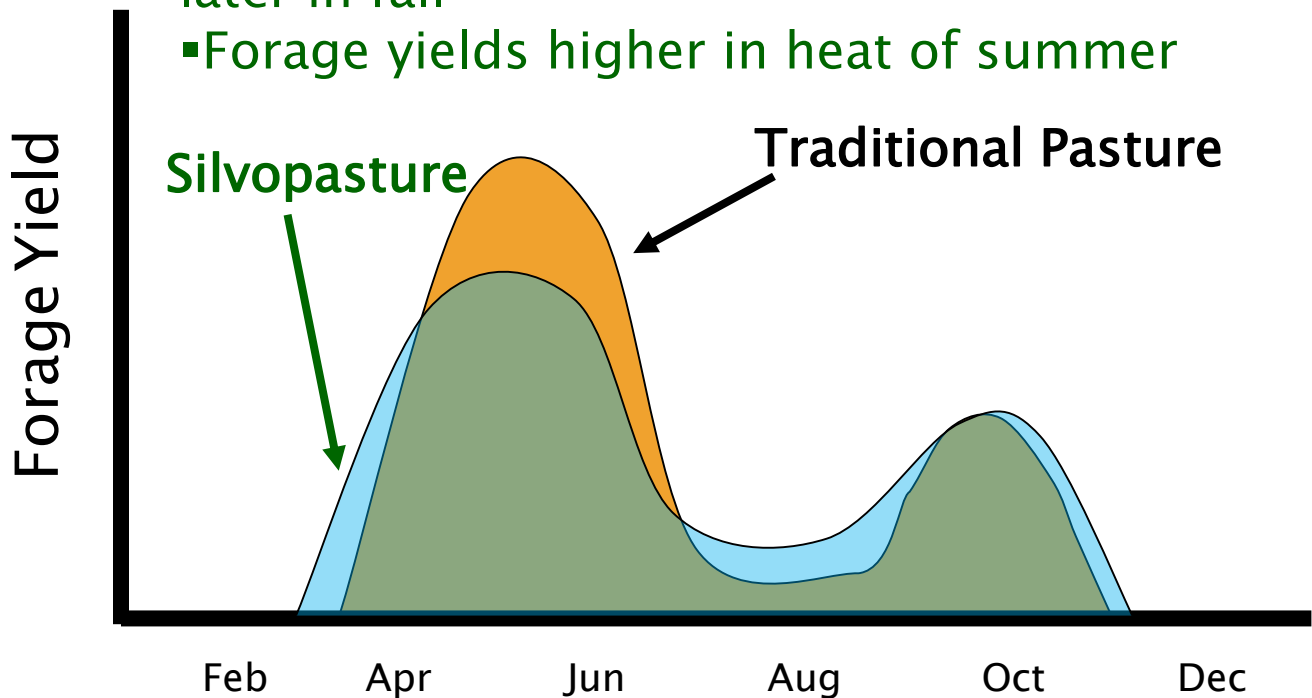
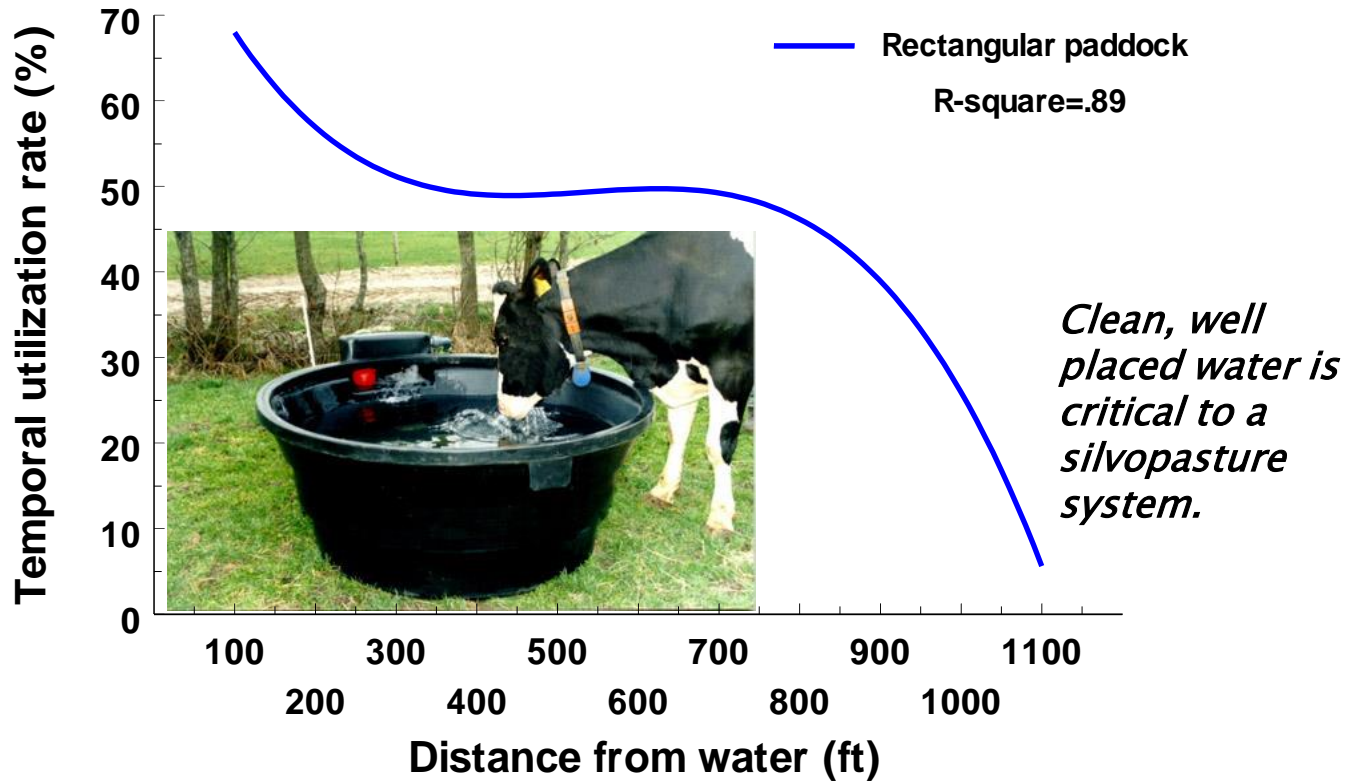


Figure 1. Impact of distance from water on temporal utilization rate in rectangular 10 acre paddocks.



Components of Success





This portable shade structure covers an area 15' x 20' and costs about \$1000 (\$750 in materials and \$250 in labor).



Silvopasture – Shaded Naturally

Establishment and Maintenance

- ❑ Trees into Pastures
 - ❑ Pastures into the Forest

Silvopasture – Shaded Naturally

Trees into Pastures

- 1) Select species appropriate for the site.
 - a. Soils Units (local NRCS or Extension)
 - b. What is growing on or adjacent to the planting area.
 - c. Dig a hole – texture and depth

What are the landowners interests



Species Selection

1. Trees matched to site conditions
2. Produce a light shade
3. Produce desired products
 - Nuts, Timber, Syrup ...
4. High value
 - grafted vs. nursery seedlings
 - Black Walnut vs. White Oak
5. Deep rooted

Silvopasture – Shaded Naturally

Trees into Pastures

1) Select Species appropriate for the site.

2) Weed Control –

a. Mechanical

b. Herbicide

c. Mulch

i. Vegetation – living or dead

ii. Fabric

Silvopasture – Shaded Naturally

Trees into Pastures

- 1) Select Species appropriate for the site.
- 2) Weed Control.
- 3) Protection from Grazing.**





Benefits of Establishing Trees in an Existing Pasture

1. You Choose the Species

2. You Choose the Spacing

**** Proper configuration and species selection will influence both the available light for forage production with an added benefit of reduced likelihood of tree damage from mowing ****

Planting Configurations

Clustered or
Grouped Trees



Considerations:

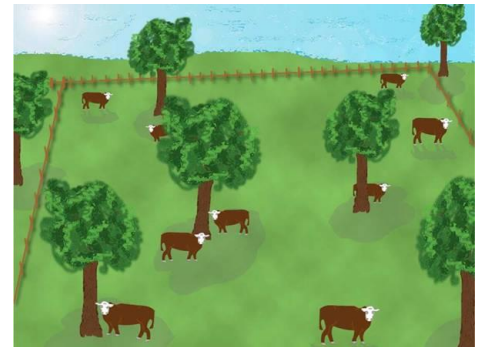
1. Shade Management

2. Mowing

3. Fencing

4. Product growth and
harvest

Single Trees



Rows



Silvopasture – Shaded Naturally

Establishment and Maintenance

- Trees into Pastures
- Pastures into the Forest

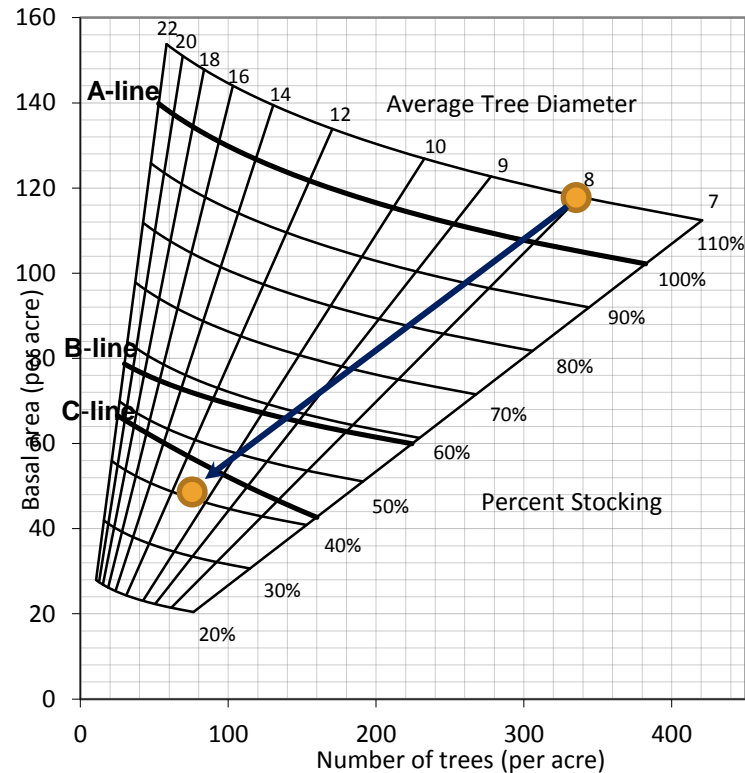
Existing Forest Managed for the Silvopasture Practice

Considerations

1. Select the highest quality trees to remain as crop trees
2. Manage for appropriate light levels
3. Select appropriate sites
4. Rotationally graze to minimize adverse effects



MU Wurdack Farm Silvopasture Research



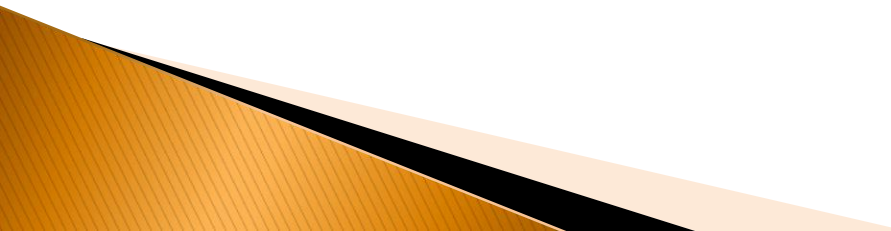
Thinned Treatment Summary

- ❖ Overstory Tree count per ha reduced by ~60% to 67 tpa
- ❖ Residual basal area reduced from 112 to 45 ft²/ac
- ❖ Stocking approximately 40%
- ❖ White oak 70% of residual
- ❖ Black oak 20% of residual

Use Tree Selection methods *similar* to Crop Tree Thinning

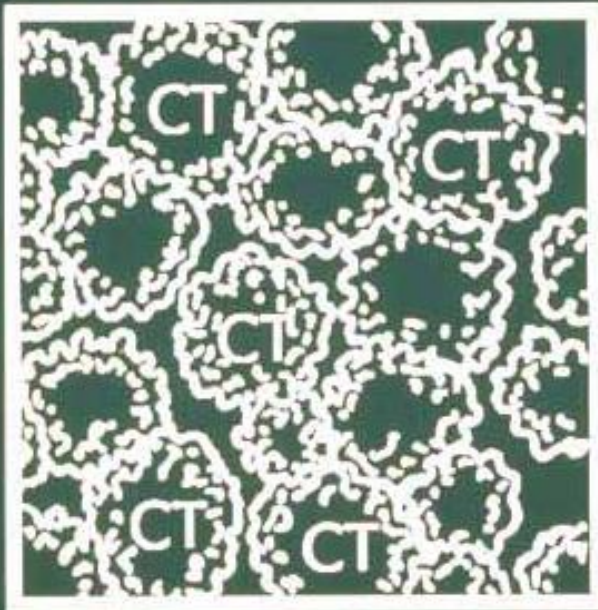
1. Identify “best” trees
 - i. Site appropriate
 - ii. Quality related to objectives

 2. Thin around “best” trees to open the crown
 - i. 50–60% open across the site

 3. Identify next “best” tree
- 

Thinning

Before



After





Thin for light

Thin for quality



Other Activities

1. Soil testing
2. Soil amendment
 - i. Lime
 - ii. Fertilizer
 - iii. ?????
3. Grass seeding
4. Regeneration
5. Future thinnings



Pasture in the Woods

Possible Concerns

Log quality impacts – –
epicormic branch development?

Site impact/degradation – –
growth rates of residual trees

Regeneration – –
what about the next generation
tree

Regeneration

1. Seed
2. Seedlings (existing or planted)
3. Stump Sprouts

The key will be protection & weed control !!!

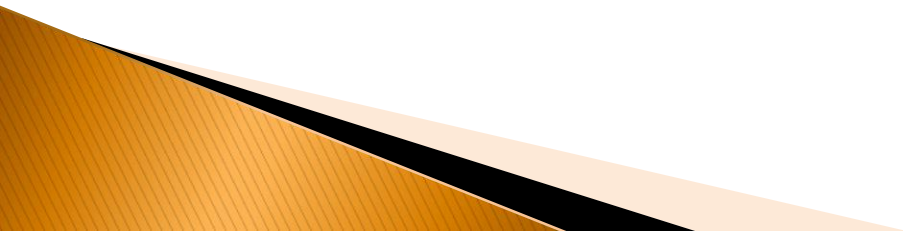


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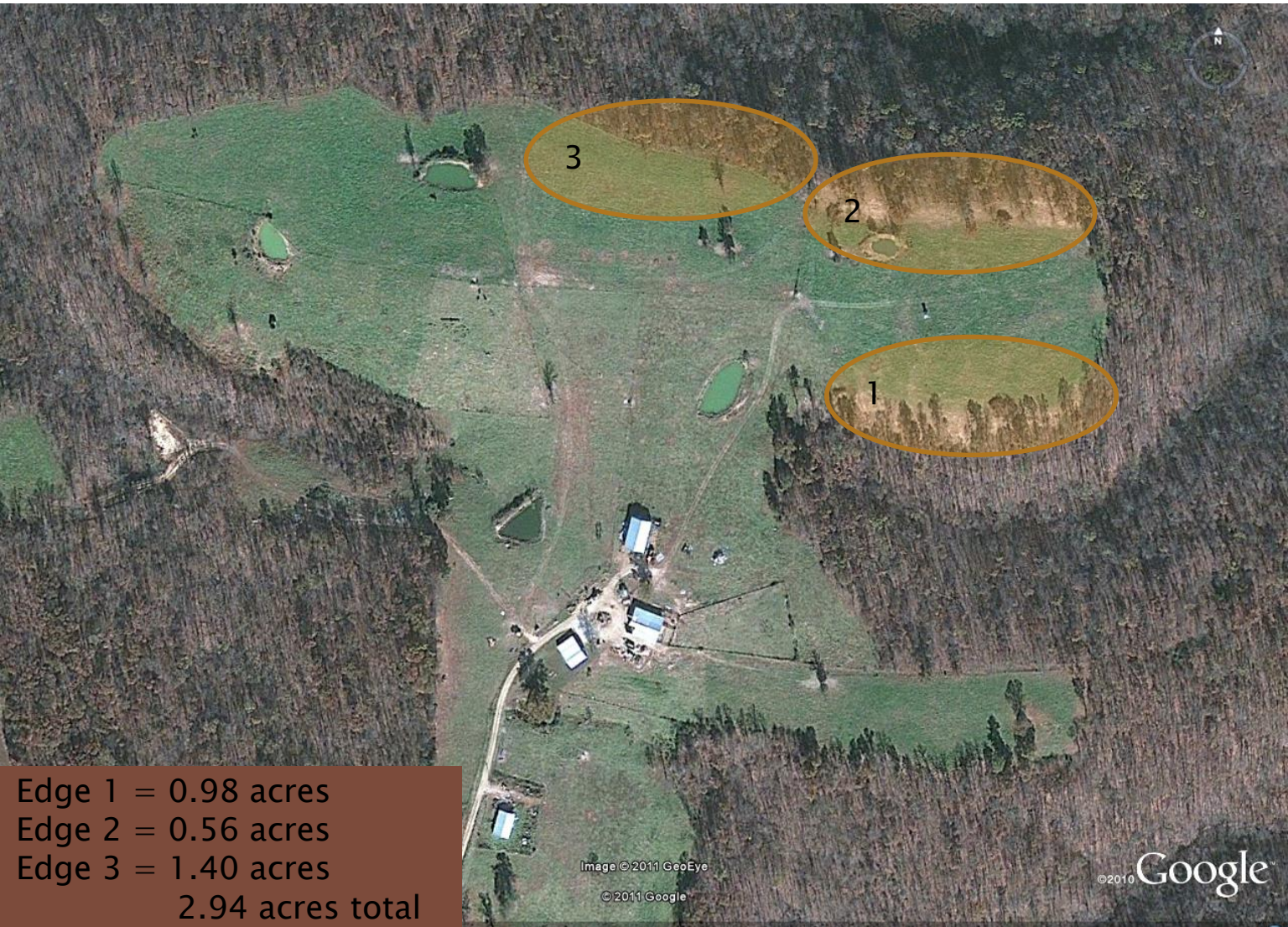


Case Studies



The Tomazi Farm

- 210 acres divided into 31 paddocks
 - 6 – 9 acres each paddock
 - 84 head cow/calf operation
 - Rotational grazing system
- Reason for adopting silvopasture:
 - Improved weight gain in the heat of the summer,
 - Increased grass acreage without purchasing or renting (put non-productive land into production)



Edge 1 = 0.98 acres
Edge 2 = 0.56 acres
Edge 3 = 1.40 acres
2.94 acres total

Image © 2011 GeoEye

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Edge 1: Established in 2010, area cleared was approximately 85 ft x 500 ft



Edge 2: Established in 2010, area cleared was approximately 60 ft x 407 ft



Edge 3: Established in 2011, area cleared was approximately 84 ft x 723 ft

Economic Analysis

- From June 15 – Aug 15, 2010
 - ADG: 1.6 – 2.1 lbs/hd/day
 - (Typical ADG: 0 – (- 1) lb/hd/day)
 - \cong 96 – 126 lbs/hd
 - \$130 – \$170/hd
 - \$10,920 – \$14,280 increase in profit
- The silvopasture edges are estimated to cost about \$1200/acre (\$3,500 total).
- B/C ratio: 3.12 – 4.08

The Williams Farm

- 7 acres divided into 2 paddocks
 - Eastern black walnut (*Juglans nigra* L.) planted in 1977 and grafted in 1980
 - Part of a rotational grazing system
- Reasons for adopting silvopasture:
 - Personal interest in producing black walnut for the nut and timber market
 - Increased pasture rental income



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Economic Analysis

- **Additional Income Opportunities**
 - Cash rented the pasture to neighbor
 - \$35 – \$40 per acre
 - 40% – 60% increase over standard pasture rental rates of \$25 per acre
 - **Black Walnut Markets**
 - Sold seed nuts from 1996 – 2008 to a local nursery
 - 800 lbs x \$1.50/lb = \$1200 per year
 - Sold nutmeat from 1987 – 1996 to a local market
 - 50 lbs per year at \$3 per pound (net) = \$150 per year
 - Sold nuts to local nut huller from 1987 – present
 - 500 lbs x \$0.10 per lb = \$50 per year

Economic Analysis

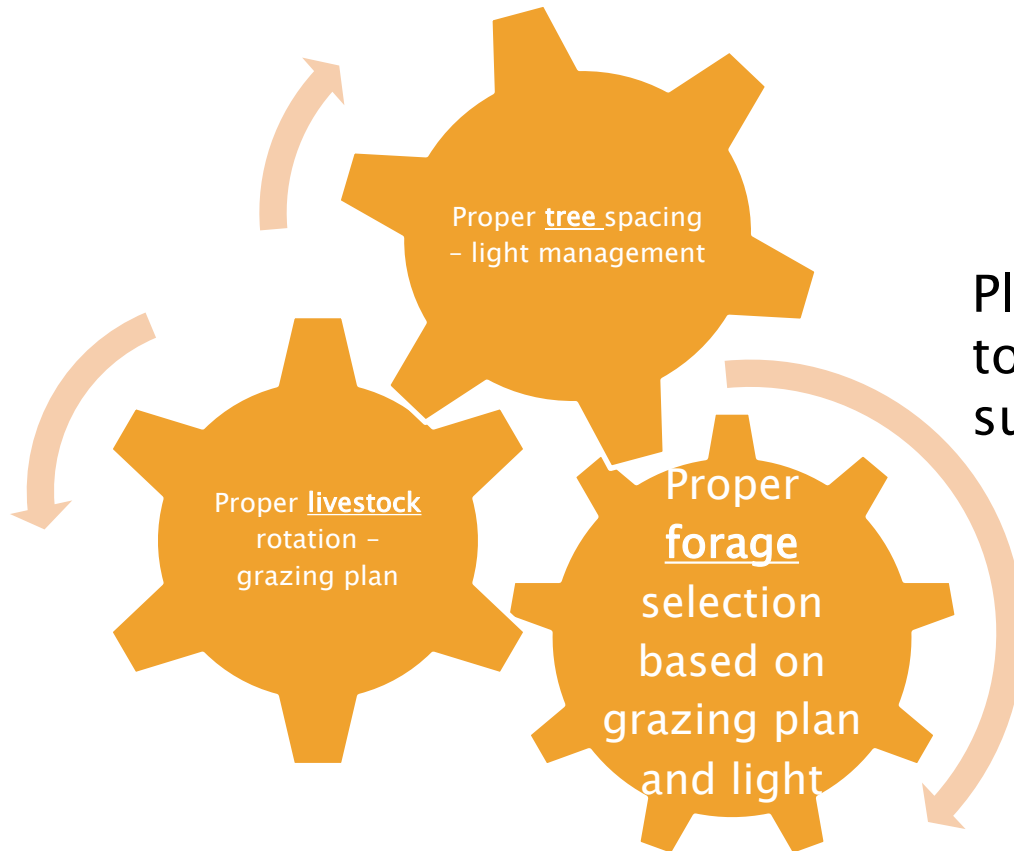
- The silvopasture cost about \$5,334 total to establish (\$762 /acre).
- Annual Maintenance Costs were about \$65 per acre per year
- $NPV_{(6\%,44)}$ of the Silvopasture: \$2631 /acre
 - (pasture at \$25 per acre $NPV_{(6\%,44)}$ is \$385/acre)
- Rate of Return : 12%
- B/C ratio: 4.21

Outline

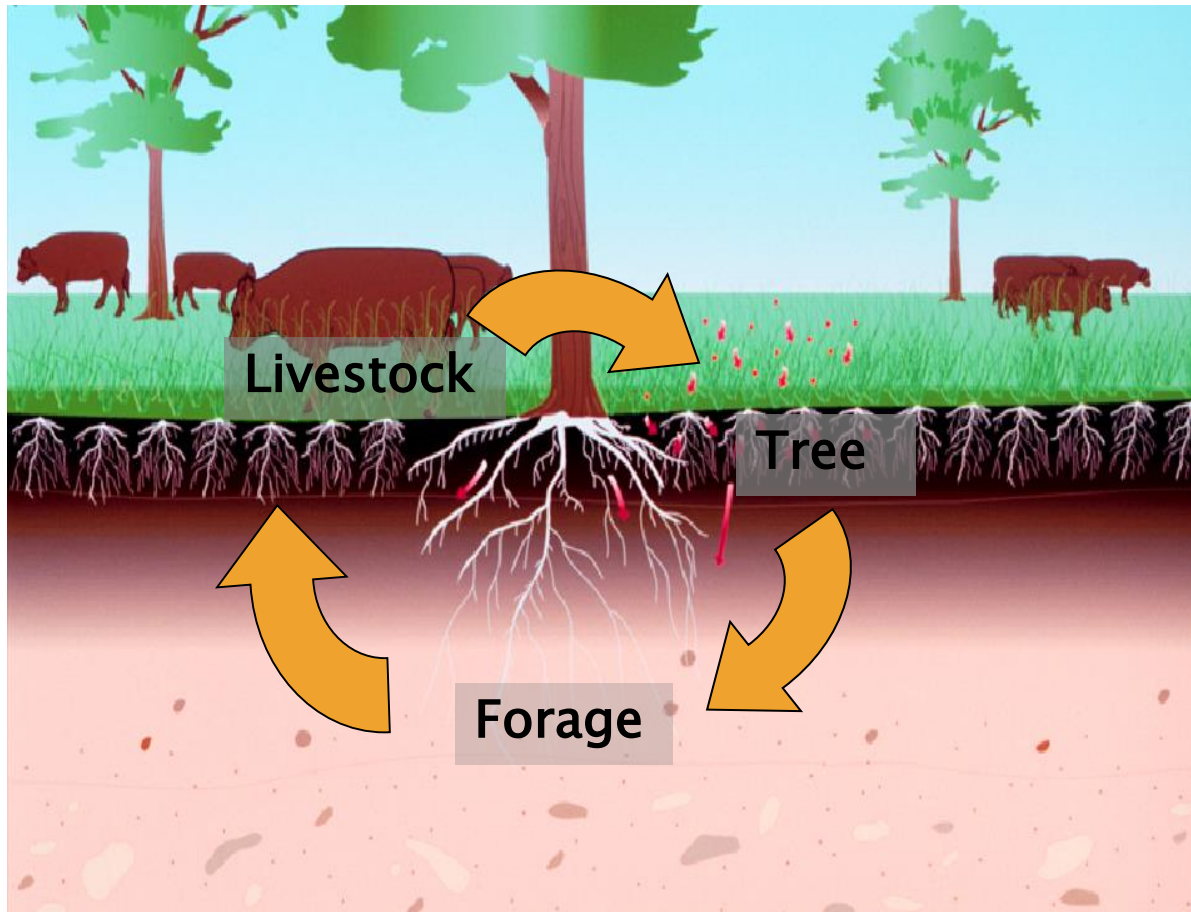
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Designing Silvopasture Systems



Planning leads
to success and
sustainability!



Understanding and Taking Advantage of - Interactions

Designing Silvopastoral Systems



Thinning the Forest

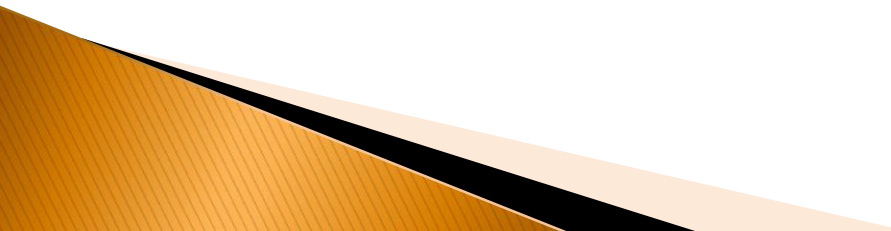


Planted in the Pasture

In most cases, plan to create and maintain:

- 50% light for cool-season forages
- 50–70% light for warm-season forages.
- Thin every 5–7 years

Process to a successful Silvopasture Practice

1. Is the landowner practicing rotational grazing?
 2. Does each paddock have water?
 3. Overseed forages as necessary to develop appropriate shade tolerant pasture.
 4. Manage/maintain tree spacing to create desired light levels (i.e. plant spacing or crop tree thinning intensity)
 5. Plan to integrate paddocks with trees to the grazing system so that livestock stress is minimized.
- 

Silvopasture Pitfalls

3 Potential Problem Areas

Forage:

- i. Wrong forage for the light and/or site
- ii. Too much shade

Livestock

- i. Lack of a rotational grazing plan – Overgrazing
- ii. Distance to water (paddock size – water system)

Trees

- i. Wrong tree for the site
 - ii. No plan for regeneration
- 

Final Comments

Long-term viability of all of our agricultural practices (including forestry) hinges on productivity and the enhanced utilization of resources without their degradation.

Through appropriate combinations of trees, forages, and grazing principles, productivity and resource utilization can be enhanced.

This is Silvopasture.

Questions?



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Balance Livestock Numbers with Forage Supply

- **Stocking rate:** The number of animals or animal liveweight assigned to a grazing unit on a seasonal basis.
- **Carrying capacity:** The stocking rate that provides a target level of performance while maintaining the integrity of the resource base.
 - Stocking rate has an effect on intake and availability.

Carrying capacity of pasture is determined by four factors

$$\text{Carrying Capacity} = \frac{\text{Forage Production} \times \text{Seasonal Utilization Rate}}{\text{Daily Intake} \times \text{Length of the Grazing Season}}$$

MU Wurdack Farm Silvopasture Research

Soil Fertility Adjusted

1. 5 tons ENM pelletized lime/ac
(initial pH 4.3)
2. 450 lbs 0-150-75 NPK / ac



Forages Established in the Spring 2003

1. Kentucky 31 tall fescue (34 lb/ac)
2. Red clover (2 lb/ac)
3. Marion lespedeza (7 lb/ac)



MU Wurdack Farm Silvopasture Research

To better understand how oaks, and their size, canopy and density, influence silvopasture light.

All measurements taken from the center of each treatment, including:

- DBH
 - Basal Area
 - Hemispherical Photographs & GLA
 - Crown measurements
-

** 6 growing seasons after thinning, canopy has gone from about 50% to close to 70% coverage

