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Silvopastoral Systems in the Pine Ridge of Nebraska

E.M. Mousel, W.H. Schacht, H.D. Nickerson, and J. Brandle

Silvopastoral systems as an agroforestry practice are specifically designed and managed for the production of trees, tree products, forage, and livestock. Silvopastures result when forage crops or native forages are deliberately introduced or enhanced in a timber production system for grazing livestock, or timber crops are deliberately introduced or enhanced in a forage-livestock production system. In a silvopasture, timber and pasture are managed as a single integrated system (Photo 1).

Silvopastoral systems are designed to produce a valuable timber component while providing short-term cash flow from the livestock component. Traditionally, beef cattle production has accounted for the majority of livestock enterprises in the Pine Ridge region. The interactions among timber, forage, and beef cattle are managed intensively to simultaneously produce timber commodities, high-quality forages, and efficient beef cattle production. Because silvopastures are a multiproduct system, they reduce the risk of losses due to unfavorable markets, weather, or political decisions. Combining long-term income from timber sales with annual income from beef cattle can provide landowners with greater income continuity than would be obtainable from traditional forest management.

Timber Production and Management

Common timber products from pine forests consist largely of dimension lumber, forest biomass energy, posts and poles, pulpwood, wood stove pellets, and oriented strand board. Timber yield from a stand of trees is related to the conditions under which the trees are growing. Site index groups have been established to assist in planning management of woodlands. Each site index group is defined by soil type and depth, slope class, and aspect to aid producers in determining the potential productivity of a site for timber production. Annual production, in board feet of wood, can then be estimated for each site index group (Table 1).

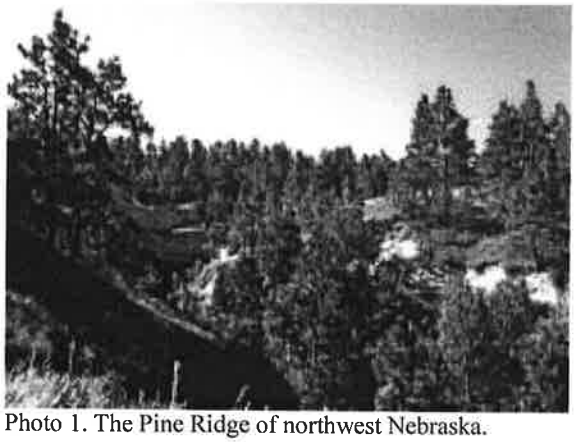

Photo 1. The Pine Ridge of northwest Nebraska.

Appropriate tree densities in silvopastoral systems are based on the optimum production of both timber and forage. Silvopastures are generally stocked at lower tree densities than commercial forests as to not exceed 50 percent light interception at maturity. Once natural regeneration occurs after a timber harvest, spacing of ponderosa pine trees in the Pine Ridge should be approximately 25 to 35 feet apart for optimum forage production. To calculate proper spacing in existing stands, it is generally accepted to take the average diameter of trees in the area plus 8 (D+8) as adequate spacing in feet for optimum tree and forage growth.

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Increasing tree and forage production in an existing stand can be achieved by planned tree thinning (Table 2). In areas where dense canopies of existing trees create too much shade for underlying vegetation, tree thinning may be necessary. In these situations, removing individual trees can achieve proper tree spacing and allow adequate light penetration for optimal forage production. Research has shown that tree growth and forage yields can double when forest stands are properly thinned.

Trees that remain after a stand is thinned should be the best trees in the stand. They should have a fuller crown, appear more vigorous, and generally are larger in diameter than trees to be removed, which are weaker, are deformed or suppressed, and have a smaller diameter.

Table 1. Estimated total board-foot volume production per acre of ponderosa pine in relation to tree growing stock level, rotation age, cutting cycle, and site index.

Rotation age	Cutting cycle	Tree Growing Stock Level 40	80	120	160
--------years----------		thousand board feet-------			
		Site index 60			
80	20	5.68	7.12	7.84	7.52
120		13.92	18.84	21.24	20.54
80	30	5.92	6.72	7.04	6.72
120		14.28	18.84	20.88	19.92
		Site index 70			
80	20	7.20	8.96	10.40	10.64
120		16.80	24.36	27.60	28.20
80	30	7.68	8.96	9.60	9.76
120		18.12	24.60	27.84	28.32
		Site index 80			
80	20	8.88	11.36	13.20	14.08
120		20.64	29.64	34.20	35.88
80	30	9.76	11.60	12.64	12.96
120		22.32	29.88	34.32	36.00

Pruning the tree canopy can also be an effective method of increasing light penetration to increase forage production. The primary reason for pruning is generally to enhance tree value by increasing the volume of knot-free wood in the stem. Increased pasture production is a welcome by-product of pruning.

Table 2. Number of precommercial thinnings of ponderosa pine in relation to tree growing stock level, cutting cycle, and site index.

Cutting cycle	Site index	Tree Growing Stock Level 40	80	120	160
---years---					
20	50	2	2	3	4
	60	2	2	3	3
	70	1	2	2	3
	80	1	2	2	3
30	50	1	2	2	3
	60	1	1	2	3
	70	1	1	2	2
	80	1	1	1	2

Ponderosa pines essentially have few if any reestablishment costs. Ponderosa pine trees regenerate naturally on their own from seed trees left after mature tree harvests. Ponderosa pine seedlings in silvopastures are not a primary forage source for beef cattle so little preventative measures are needed to protect seedlings when beef cattle are present. Although livestock readily eat many hardwood trees, palatability of conifers is often less than other available vegetation. This provides an opportunity to graze beef cattle in conifer plantations without incurring unacceptable defoliation levels of crop trees.

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Since livestock like some variety in their diet they may consume small amounts of young conifer foliage each day during the grazing period. Mature conifer foliage is relatively unattractive to beef cattle when other green herbaceous feed is available. However, once beef cattle perceive alternate feed to be in short supply, they may begin to actively feed upon tree foliage and young branches. Conifer palatability to beef cattle is generally highest just after bud break when young twigs are 1 – 2 inches long and foliage is not yet fully exposed. Considerable defoliation of young trees can occur quickly if beef cattle density is high. This makes applying proper stocking rates and close monitoring of livestock essential in young silvopastures.

Herbage Production

Understory vegetation found in the Pine Ridge region will depend largely on soil type and topographical position of the site. Areas consisting mainly of mixed grass and ponderosa pine trees on steep slopes are classified as savannah sites and on gentle slopes as silty sites. A savannah site is characterized by shallow to deep, well-drained, steep to very steep soils on uplands. Vegetation on a savannah site with southern and western exposures is dominated by a mixture of warm- and cool-season grasses with scattered ponderosa pine trees (Photo 2). Herbage production on these sites ranges from 1,000 to 2,500 pounds per acre per year. Northern and eastern exposures are generally classified as woodlands with minimal herbage production in the understory. A silty site is characterized by well-drained, nearly level to gently sloped soils on uplands, foot slopes, and stream terraces (Photo 3). Vegetation on a silty site is dominated by a mixture of cool- and warm-season grasses with a variety of sedge, forb, and shrub species. Herbage production on this site is generally 1500 to 3000 pounds per acre per year.

Photo 3. Beef cattle grazing under ponderosa pine in the Pine Ridge region on a silty site. Photo: H. Doak Nickerson

Herbage Yields Under Tree Canopies

Tree canopy density on these ecological sites varies extensively and can limit herbage production when tree canopies become dense enough to restrict light penetration. Annual yields of warm-season grasses can be reduced as much as 50% in areas where tree canopies intercept 50% of available light and can be reduced another 50% if light interception by the tree canopy increases to 80% (Figure 1). Areas where tree canopy density has reached a critical level may need to be thinned or individual trees may need to be pruned to increase light penetration to understory plants. The use of tree canopy

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management techniques can optimize individual tree growth and herbage production to increase net returns to the operation.

Forage Quality

Forage quality of understory plants may be affected by the low light and lower temperatures associated with tree canopies (Figure 1). Higher temperatures during growth can reduce digestibility of both cool-season and warm-season grasses. Warmer conditions increase the structural portion of plant cells relative to the more easily digested cell contents. Plants growing under a tree canopy tend to stay green longer in summer and flower later than grasses in the open. Higher protein content of both grass types has been observed in conifer forests than in open areas. Differences in forage quality as a result of tree canopy density should be taken into consideration at the landscape level when selecting and implementing a grazing system. In pastures with both open and wooded areas, quality of the available forage will vary considerably. Grazing systems should be implemented with pasture fences that separate open and wooded areas. Timing of grazing of individual pastures should be based on stage of growth and quality of forage plants.

Grazing Management for Silvopastoral Systems

Grazing systems in the Pine Ridge should focus on management of key forage species for optimum beef cattle production and efficient use of available water for beef cattle. Season-long continuous grazing systems, where animals are allowed access to the entire pasture for the entire grazing season, are low management and low input systems. Harvest efficiency in these systems generally is low because of patchy livestock distribution. These systems can be detrimental to long-term pasture health as key species in heavily grazed areas lose vigor and cannot compete with encroaching undesirable species. Properly planned rotational grazing systems provide pasture plants periodic deferment or rest and usually improve livestock distribution by decreasing pasture size and distance to water.

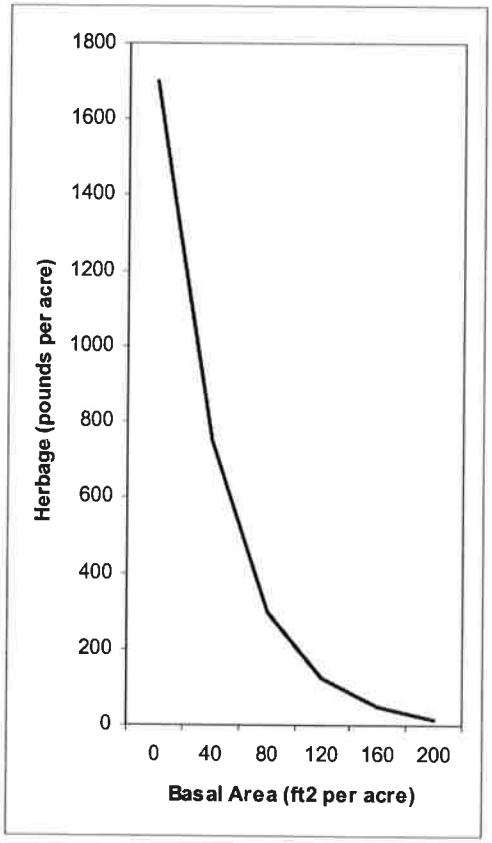

Figure 1. Relationship of forage yield to basal area of ponderosa pine.

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However, because of higher costs associated with fencing and water developments, implementation of rotational grazing systems can require a significant investment.

Fencing arrangements for a rotational system in the Pine Ridge should take advantage of topography, tree density, and available water where possible to optimize livestock distribution throughout the pasture and protect water sources from excessive use by beef cattle. Livestock tend to congregate in lower level areas and avoid movement into steeper upland areas when possible.

Photo 2. Beef cattle grazing under ponderosa pine in a silvopasture on a savannah site. Photo: H. Doak Nickerson

Fencing arrangements should exclude beef cattle from areas directly adjacent to streams, creeks, and ponds and use water gaps as a means of controlling beef cattle access to alleviate overuse of these areas. In diverse landscapes, each pasture in rotational grazing systems should include as little diversity in topography and tree density as possible. Segregating topographic position or tree density by pasture allows the manager to control use of different land types. Proper fencing patterns can be used to force livestock to use less favorable sites (e.g. steep slopes) and limit access to more favorable sites (e.g. level, higher shade sites).

Identifying critical stocking rates for a grazing system is essential for successful management of pastures in the Pine Ridge. Stocking rates can be determined in a number of different ways including methods used by the Natural Resources Conservation Service (NRCS). Contact your local NRCS field office or UNL extension office for stocking rate information.

Silvopastoral System

Economic risk in a silvopastoral system is reduced because multiple products are produced in the system, which likely have an established market. Production costs are reduced and marketing flexibility is enhanced by distributing management costs between timber and beef cattle enterprises. Using silvopastoral systems in the Pine Ridge region can make both timber and beef cattle production systems more profitable.