

# **Livestock Performance and General Considerations for Cattle Management in Temperate Silvopastoral Systems**

Jeff Lehmkuhler, University of Wisconsin-Madison

## **INTRODUCTION**

Silvopastoral grazing includes grazing of naturally established forests or woodlands as well as man-made plantations and orchards. Many areas around the world have large tracts of land which are grazed by ruminants. This land is generally characterized as rugged having a steep slope that prevents its use for production of cereal grains or other arable crops, or other environmental factors limits its ability to produce crops other than forage. During the establishment period of reforestation, a considerable amount of non-woody vegetative growth can occur and compete with the seedlings for nutrients. This competition can be detrimental to seedling survival and hamper growth. This competition is generally eliminated by controlled burning, herbicides or grazing. This can provide an opportunity for ruminant production to control the vegetative competition and if managed correctly has the potential to increase the short-term net returns of otherwise idle land.

Although new interest in combining trees and livestock has been aroused, such a system has been known to be profitable for many years. John H. Peterson Jr. (1987) reported on the following excerpt from Stephenson (1954) describing the cattle husbandry practices of 1783-84 North Carolina backwoods:

With the most careless handling, domestic cattle have increased with the greatest rapidity. It is nothing uncommon for one man to own 100 or more head of horned cattle; some count their herds by the thousands, all running loose in the swamps. By penning up the calves, and throwing out a little corn every day to the dams, the milch cows have been accustomed to come up to the dwelling-house from time to time to be milked. . . . Out of the woods one head with another is sold to the cattle-handlers at 3 to 6 Spanish dollars; and to the owner, has been at so little trouble and expense, this is almost clear gain.

Producers near forested areas still rely on the forest to provide vegetation and shelter for cattle even though drastic changes in management have evolved since the early settlement of the nation.

Orchards and nut bearing plantations can also provide opportunities for combining livestock and trees. Removal of the forage by livestock would increase nutrient recycling, eliminate the operating expense of mechanical harvesting of the forage and provide additional income. It is uncertain as to what species of trees, forages and livestock may best compliment one another. In addition, little information exists for the interactions that may occur as a result of intensively managed grazing.

## OVERVIEW OF PRODUCTIVITY IN SILVOPASTORAL SYSTEMS

Combining cattle and trees to develop a more productive setting is not new to the agriculture industry. For years small family farms have grazed their cattle under the canopy of mature timber stands and wooded areas are still utilized to provide shelter. However, the myth that grass can not be grown under walnut, oaks and other timber species to support adequate gains or grazing days is still held by several to be fact. Recently, researchers have been investigating alternative methods, grazing being one of the more prominent, for controlling forage and brush growth in timber plantations to reduce potential fire hazard and to eliminate competition for moisture and soil nutrients. Further, investigations of systems that combine ruminants and silviculture are helping to identify complimentary management practices.

### *Forage Productivity in Silvopastoral Systems*

Although forage productivity varies largely in these studies, a strong correlation can be seen between light intensity and forage production in pine - forage stands. This relationship is not as prevalent in nut tree - forage systems. The increased forage production observed within nut-tree plantations is likely a result of the tree spacing utilized within pine and nut bearing stands. This relationship may also be explained by the difference in canopy light transmission or the density of the canopies. The canopy structure of walnut and pecan plantings probably allow more light to reach the forage canopy than pine canopies. The accumulation of material under the canopies and the given forage species commonly studied may additionally explain a portion of the variation between the pine and deciduous stands. Accumulation of pine needles may increase the amount of vegetation shaded out when compared to deciduous stands. Most of the research involving pine stands utilizes warm season species which in general are more sensitive to lowered irradiance while cool-season forages are commonly grown with nut trees. This is primarily a result of geographical location. The increases in forage production within silvopastoral systems span across a variety a species such as the variety of southern pines, the Northwest firs as well as the mesquite of Texas. East and Felker (1993) observed a 152% increase in green panic yields under mesquite canopies when compared to adjacent open areas. These responses illustrate the opportunity over a range of climates, species of trees and forages for the implementation of silvopastoral systems.

### *Shade and Forage Quality Interactions*

The effect shade stress has upon forage quality also varies. Kephart and Buxton (1993) illustrated that reduction of ambient sunlight to 37 and 70 % of full intensity resulted in increased nitrogen concentration, decreased neutral detergent fiber, enhanced degradability by in vitro dry matter digestibility while cell-wall composition remained constant. Garrett and Kurtz (1983) presented data suggesting forage digestibility of fescue and orchardgrass was enhanced by shade from walnut canopies (54.5 %, 49.5 %, 56.5 % and 54.0 % for shaded fescue, open fescue, shaded orchardgrass and open orchardgrass respectively). These data coincide with Smith's (1942) findings in which forage quality under black walnuts was greater than adjacent open areas. Green panic, plains bristlegrass, and Virginia wildrye crude protein content was

found to be significantly greater when grown with mesquite when compared with adjacent open areas while no difference in dry matter digestibility was observed (East and Felker, 1993). Balocchi and Phillips (1997) also reported herbage crude protein content was greater under the canopy of *Pinus radiata* agreeing with Kephart and Buxton's and East and Felker's findings. Their findings also indicated a depression for in vitro dry matter digestibility as modified acid-detergent fiber increased with shade stress disagreeing with Kephart and Buxton's and Garrett and Kurtz's data. This response may, however, be a resultant defense tactic of the forage to grazing pressure which was not present in the other two studies. Wolters (1973) working with longleaf pine stands in Louisiana additionally revealed that forage crude protein was greater under the canopy when compared to the open. Wilson (1996) observed similar responses with tropical grasses in which 50% shade increased both dry matter and nitrogen yield when compared to forages grown in full sun. This work also showed that shade increased the amount of live material present by 4%. Other research coincides with the conclusion that shade improves nitrogen content of herbage (Wong and Wilson, 1980; Walgenbach and Marten, 1981). Research conducted at the University of Missouri has tested a variety of forage species and their response to 0, 50, and 80% shade (Lin, 1997). The responses for yield, %ADF, %NDF, and %CP were measured in this study to identify species that could be incorporated into an agroforestry system. These data revealed that C-4 grass yields were greatly suppressed by shade in spring-early summer and summer-fall periods while tall fescue and orchardgrass were not significantly altered by 50% shade. Forage %NDF and %ADF was not altered or slightly increased due to shading for most species observed in this study. Crude protein percentage of most cool-season grasses was increased as the degree of shading increased while legumes were unaffected coinciding with previous research. Increased forage quality within silvopastoral systems would greatly enhance the acceptance of these practices as individual animal performance would be expected to be increased as a result of greater nutrient digestibility and utilization.

### ***Livestock Performance under the Canopy***

Cattle and sheep are the two primary species utilized in silvopastoral systems. In some instances emphasis is also placed upon the grazing wildlife within the area. Sheep are utilized quite heavily in the Northwest fir plantings while cattle are the predominant animals grazed in the southern pine plantations.

Animal performance is generally dependent upon two parameters. The first is forage availability and the second forage quality. In order to meet the animal's genetic potential for growth, lactation, calving percentage, or any other performance measurement, ample high quality forage is required.

Animal performance has not been shown to be depressed by the presence of timber given forage availability is not limiting. Quigley et al. (1984) demonstrated that continuous grazing of a Ponderosa pine-Bunchgrass range resulted in increased performance over a 10-year period when compared to deferred rotational grazing. Gains of cattle grazing an Eucalypt plantation in Brazil were approximately 0.5 kg (Couto et al., 1994). Calves grazing pecan orchards for herbage control had average daily gains of 0.42 kg. When management strategies changed and more emphasis was placed on maintaining higher quality forage, calf gains were approximately

0.60 kg per day (Mitchell and Wright, 1991). Walnuts planted in pastures provided a 22 % increase in steer gains for bluegrass pastures in Tennessee (Neel, 1939). Gains for calves grazing in young ponderosa stand were similar to those of Mitchell and Wright averaging 0.61 kg over the six-year grazing study. Calf performance was slightly higher in a longleaf pine stand over a ten year study period irrespective of grazing intensity with daily gain averaging 0.79 kg (Pearson and Whitaker, 1974). However, percentage calf crop decreased from 82% for light grazing pressure to 70% for heavy intensity. Cow and calf performance on southern pine areas has also been shown to respond to grazing management. These studies further illustrate the potential for combining cattle and timber as animal performance appears to be similar to open pasture grazing.

### ***Tree Growth-Grazing Interactions***

Little data exists explaining the impact grazing has on tree performance. The majority of the research has investigated the affects of grazing on tree regeneration. There appears to be no conclusion as to whether grazing is detrimental during this period. Evidence does exist for increased seedling damage by cattle due to trampling and browse damage by sheep, however, the conflict arises as to the actual seriousness of this damage.

When trees such as Virginia pine are used for Christmas tree production, damage can be substantial if trees are not protected from grazing (Pearson et al., 1990). On the other hand, sheep grazing had no effect on height or diameter growth of Douglas fir trees from four years of age through eight (Sharro et al., 1992). A second study conducted by Sharro and co-researchers (1996) illustrated no depression in either height or diameter growth in an agroforestry system involving grazing by sheep when compared to the control forest setting. An earlier study conducted by the same researchers revealed a significant improvement in both diameter and height growth of four to six year old firs (Sharro et al., 1989). Grelen and co-workers (1985) examined the results of grazing a slash pine stand from establishment through 18 years of age. No differences for height growth were observed between ungrazed, lightly or heavily grazed stands for five and 18 year measurements. The study did indicate an increase in the number of planted trees lost for the heavily grazed areas when compared to the ungrazed planting. Interestingly, the heavily grazed areas were significantly larger in diameter than the ungrazed (19.05 cm versus 17.02 cm for grazed and ungrazed respectively). This could be attributed to a decrease in nutrient competition between forage and trees, a decrease in tree-tree competition since survival was lower or a combination of the two. Lastly, no differences were observed for total volume production. Couto and co-workers (1994) observed similar results with Eucalypt trees in which grazing did not hinder the diameter or height growth. Lewis (1985) observed similar responses in which grazing bahiagrass under a pine canopy increased tree height growth after 8 years by 1.4 m. The published research suggests that grazing will not depress tree growth and may improve performance possibly allowing for a shortened rotation by eliminating vegetative competition.

### ***Physical Properties of Forest Soils Following Grazing***

A large concern with forest grazing is the impact on soil properties. Forest soils tend to be very fragile and in general highly erodable. The majority of the forested areas are sloping

hillsides and when disturbed can begin to lose topsoil quickly. Almost all research conducted to the present suggests that grazing compacts forest soils to moderate depths (41 cm) and over a sustained length of time can compact the soil to 0.9 m in depth (Linnartz et al., 1966; Rhoades et al., 1964; Duvall and Linnartz, 1967).

Agroforestry systems are in general different than grazing on forest soil and native vegetation found within the timber stands. Silvopastoral systems are in general a more intense management system. Improved forage varieties are planted to maximize herbage production to support grazing. Currently, grazed pastures may be planted with widely spaced trees to maintain productivity of both tree and vegetation. In general, the soil characteristics are different under these systems as they will already be compacted as is the case with previously grazed pastures. In addition, more precautions may be taken to prevent soil erosion from the use of sod forming grasses. Bezkorowajnyi, Gordon and McBride (1993) conducted a study in which they examined the effects of cattle grazing on the performance of trees planted into already grazed pastures. Their results illustrated that compaction to depths of 19.5 cm were greater in grazed areas when compared to ungrazed fields. These effects were seen after three months of grazing. However, no differences were seen in the first months indicating the potential for short duration grazing systems. Further, they applied three levels of compaction (low, medium or high) to potted seedlings and observed shoot growth of poplar cuttings was reduced for medium and high compaction levels. They additionally observed that root length growth was enhanced as compaction increased. Short duration grazing of seedlings during establishment, therefore, may stimulate root mass development without sacrificing shoot growth and photosynthesis capacity. Additional studies investigating grazing – soil interactions are needed to aid in the development of proper management of silvopastoral systems.

### **RECENT SILVOPASTORAL RESEARCH EFFORTS IN MIDWEST**

Research conducted by the University of Missouri agroforestry group continues to address the management of the silvopastoral systems. Lehmkuhler et al. (1998) investigated implementation of managed grazing versus continuous grazing management on animal, forage and tree responses for one area of a black walnut plantation in southern Missouri. Using a high stocking rate and short grazing period, they observed an increase in forage availability and a tendency for improved quality under the managed grazing system in comparison to the continuous system agreeing with previous research. When botanical composition was investigated, continuous grazing resulted in a larger percentage of dead material comprising the samples which was interpreted as a reduced efficiency of forage utilization while the rotationally grazed paddocks had higher amounts of clovers and grass. These forage productivity factors help explain trends in performance improvements for rotationally grazed cattle. Tree growth, both diameter and height, were not affected by grazing.

In a second trial conducted at the same location, these researchers investigated the response to varying the stocking density (Lehmkuhler et al., 1999). Initial stocking rates of 4.9 or 9.9 animals/ha for six weeks followed by 4.9 animals/ha for two weeks using rotational grazing management were investigated. Increased stocking rates resulted in reduced performance of Holstein heifers which agrees with other research. Forage availability and

quality varied little between the two stocking rates. When forage availability was expressed as a quantity of live forage, it was determined that forage availability was below calculated intake levels five of the eight weeks. The researchers concluded that the use of total forage availability is not as accurate at predicting performance as is using live forage availability.

How does one go about establishing a silvopasture? One approach is to establish forage under the canopy of trees and thin the stand as necessary to maintain enough light transmission to support adequate forage production. The alternative is to establish seedlings into existing pastures. The challenge with this approach for existing cattle operations is the loss of grazing acres. The forage would need to be harvested mechanically rather than grazed or the seedlings would need to be protected from grazing animals. Lehmkuhler et al. (2003) investigated methods of protection for newly planted seedlings of red oak, honey locust, pecan and black walnut. Protection methods investigated were a foliar application of denatonium benzoate, a single strand of electrified poly-wire or no protection. Pastures were grazed for eight weeks each of two years. Use of foliar deterrent was not an effective strategy to prevent seedling damage while the electric fence protecting nearly all trees from damage. Cattle grazed in pastures with trees gained similarly to those in pastures without trees indicating. Though an investment is required in temporary fencing, this management strategy allows continued utilization of the grazing area during the establishment phase of the silvopastoral system. Additionally, the use of electrical fencing systems compliment managed grazing using rotational or strip grazing.

## SUMMARY

Silvopastures allow for diversity of the landscape and production systems. Several factors must be considered when designing this type of system including forage response to shade and grazing pressure, tree performance when animal pressure is present, soil characteristics, as well as the animal utilized. Grazing pine stands appear to have no detrimental effects on tree performance, however, little information exists detailing the responses of grazing deciduous nut bearing trees. Livestock performance may be impacted depending upon the type of animal utilized in relation to the species of trees in the silvopastoral system. However, in most instances, proper management allows for complementation of woody biomass and livestock production.

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