

Silvopastures: SVAREC Update, Kentland Results and SPAREC Studies

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Silvopasture is the purposeful and managed integration of trees, forages, and livestock. With appropriate management, these intensive, integrated management systems create beneficial interactions among the system components that result in more efficient resource use and greater economic output over the life of the system. Benefits of silvopastures can include increased forage yield or quality, reduced animal stress, improved tree growth and quality, greater farm product and ecosystem diversity and a number of conservation gains (Fike et al. 2004).

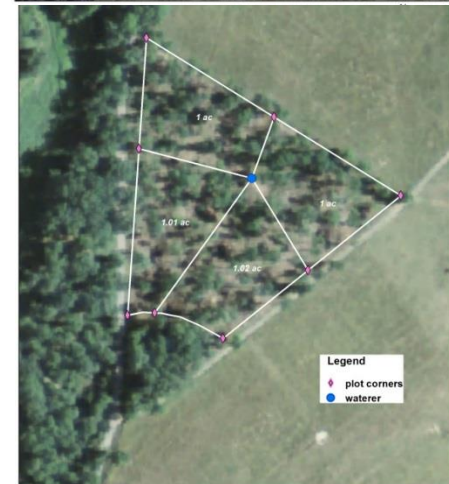
SVAREC project update

The SVAREC silvopasture project aims to demonstrate how a degraded hardwood stand on a medium quality site might be converted into a mixed-use forage and timber producing silvopasture.

The Woods

Prior to thinning, the wooded area was a mixture of various hardwoods namely green ash, black cherry, black walnut and hickory. Other species included: white oak, black oak, black locust, and American elm. The understory was dominated by non-native bush honeysuckle, multiflora rose, and spicebush. There was very little tree regeneration present. Along with an old home site, evidence suggests the area was pastured in the past, and some very large, mature white oak trees were present. The site (4.8 acres) had been fenced to exclude all livestock since the late 1990s. Most of the trees in the stand were smaller pulpwood sized trees, with an average diameter of 10.2". The area was considered fully stocked (an indication of full site utilization).

The basal area of this site averaged around 100 ft² /acre. (Basal area is a forestry unit of measure that sums the cross-sectional area of the trees on an acre.) In choosing how many trees to leave behind, we considered three factors: species, stem quality, and spacing. Our goal was to leave well-spaced trees of suitable quality and characteristics and a residual basal area of about 50 ft²/ac (50% of 100 ft²/ac). Black walnut and white ash comprise the majority of the selected species. Of the 196 trees in the residual stand, 39% are black walnut and 25% are white ash. Following harvest, the



SVAREC agroforestry plots - June 2015

0 25 50 100 150 200 Feet

Demonstration site, pre- (top) and post- thin (bottom).

Images available from the Virginia Information Technologies Agency (<http://www.vita.virginia.gov/isp/default.aspx?id=8412>) and the FSA's National Ag Imagery Program (<http://www.fsa.usda.gov/programs-and-services/aerial-photography/imagery-programs/naip-imagery/index>).

residual stand's average diameter was 9.8" (at 4.5 feet above the ground) and the average Basal area 25 ft²/ac due to the fact that some areas had no acceptable growing stock to leave in the residual stand.

Unfortunately, arrival of the non-native emerald ash borer in Virginia (first documented in 2006) has begun to change the composition of Virginia's forests. Emerald ash borer damage at SVAREC was first noticed in late winter (February) of 2017. A recent inventory of the 45 ash trees present one year ago found 18% dead, 38% in serious decline and 44% in relatively good shape. We expect within 2 years that all the ash will be dead.

We will be restocking the "Silvo" piece of these paddocks with new seedlings. Species under consideration include: black walnut, black locust, honeylocust, Kentucky coffee tree, and yellow poplar, and hickory species among others. These young trees will need protection from cattle browsing, trampling and rubbing damage for several years. The loss of the ash and need to add trees back will provide us opportunity to explore different protection methods.

The Forage

Because we have little information about forage species suitability within shaded sites, a blend of species were planted early November, 2014. The following year red clover was also seeded. The species mixture included: 'Select' endophyte-free tall fescue, 'Benchmark' orchardgrass, 'Remington' perennial ryegrass, 'Baron' bluegrass, 'Pradel' meadow fescue. Each forage species was broadcast at 5lb/acre along with cereal rye at 10 lb/acre (totaling 40 lb/acre).

Shade tolerance of these species is not well known and may vary by variety within species, so this seeding is a bit of a "stab in the dark". Generally, orchardgrass and meadow fescue are considered adapted to more shaded sites and meadow fescue has high digestibility. Tall fescue tolerates some shade as well, and although endophyte-free fescue is considered less tolerant of environmental stressors, it was chosen with the thought that these plants might be more successful in the buffered environment of the silvopasture. Of course, reducing alkaloid exposure is also desired. Perennial ryegrass and bluegrass are considered less shade tolerant but were added for their potential to fill gaps in the forage canopy in sunny areas and because the seed company was interested in seeing their potential use. Reed canarygrass is another shade tolerant species of interest, but seed of low alkaloid varieties were not available for planting.

Seedling recruitment was challenged by the broadcast application. Although drilling is preferred because a drill places seed in good contact with mineral soil, that was not possible in this site with rocks and stumps. An alternative in certain settings is to introduce livestock to work seed into the ground. We do think we observed better seed establishment where the site was mulched (vs. pushed with a blade). This also may be due to greater weed control, but likely the improvement reflects seed "catch", as they fell into (and stayed in) contact with soil.

The Livestock

Initial livestock behavior could be described as “nervous”. Young stockers were not particularly mindful of a single strand of hot wire, so the fencing needed bolstering. Our original intention was to compare a couple of stocking densities in order to see how the pasture responded to different residual heights. The goal was to leave two residual forage heights (3” and 6”) in two of the four paddocks to compare recovery and grazing days, but the early challenge with animal behavior limited our ability to manage this with any precision. In 2016, over the first month of grazing (April 28-Jun 20), steers (409 lb on entry) gained 2.49 and 2.14 lb/d for low and high stocking rates. In 2017, due to time limitations, we’ve simply managed a single group, grazing the pastures in spring using rotational stocking management. One observation from this spring is that steers display preference for certain tree species – specifically Kentucky coffee tree – that was not apparent with last year’s group. This hints at the potential for producers to use animal behavior for vegetation/landscape management.

Kentland Farm Research Results

Maintaining adequate livestock production in silvopastures will be a primary concern for most livestock producers because forage productivity slightly declines in some systems (Buergler et al., 2005; Kallenbach et al., 2006; Kyriazopoulos et al., 2013). Despite resource competition between forages and trees, the decrease in forage quantity might be ameliorated by an increase in forage nutritive value (Kallenbach et al., 2006; Neel et al., 2016). However in some cases, lower soluble carbohydrates (Buergler et al., 2006) and variable responses in terms of fiber digestibility (Fannon-Osborne, 2012) in silvopasture forages challenge this idea. Despite reductions in forage availability, most research has demonstrated no reduction in animal growth (Lehmkuhler et al., 2003; Kallenbach et al., 2006; Fannon-Osborne, 2012). The objective of this study was to determine the forage and animal response to hardwood silvopasture systems compared to open pastures, utilizing lambs as a model for cattle. What is compensating for reduced forage growth in some silvopastures – improved nutritive value in the forages or improved animal well-being?

Methods

In this study, black walnut (*Juglans nigra*) and honeylocust (*Gleditsia triacanthos* cv. ‘Millwood’) based silvopasture systems were compared with open pastures over three summers (2014-2016) at Kentland Farm in Blacksburg. Pastures were rotationally stocked with 5 to 7 crossbred lambs depending on forage availability. A rising plate meter was used to estimate pre-graze forage mass. Forage grab samples were collected and analyzed for nitrogen (N) and neutral detergent fiber (NDF) concentrations. Species percent cover was estimated every four weeks.

Lambs were weighed every four weeks to compare system gains. Time-lapse cameras documented sheep behavior every 60 seconds. Intravaginal temperature sensors were constructed from blank controlled internal drug release (CIDR) devices and small temperature loggers. These were set to remotely log temperatures every 10 minutes and then inserted into a subset of the ewes each week.



Figure 1: Lamb performance was compared in these open pastures (left) and black walnut (middle) and honeylocust (right) silvopasture systems in Blacksburg.

Forage characteristics and lamb performance

The forage productivity of the black walnut silvopastures was about 30% lower than the productivity of the honeylocust silvopastures and the open pastures. In one year (2016), the forage productivity in the honeylocust silvopasture exceeded that of the open pasture.

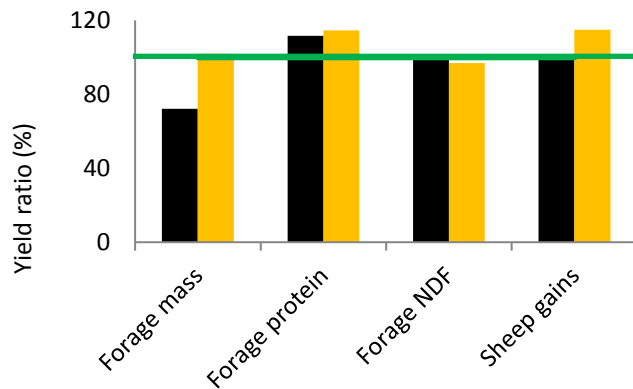


Figure 2: Although forage productivity in the black walnut silvopasture was lower than the other systems and there were little nutritional differences in the forages, lambs in the silvopastures gained as well or better than lambs in the open pastures (black = black walnut silvopasture; yellow = honeylocust silvopasture; green = open pasture).

From a nutritional perspective, the forages in the silvopastures had slightly greater levels of protein, although this likely led to little difference in lamb performance as it was typically adequate for lamb growth in all systems throughout the study. The honeylocust silvopastures had slightly lower levels of NDF. This seems to have been driven by more clover in those systems, particularly in the first year following frost-seeding.

Lambs in the silvopastures gained as well or better than the lambs in the open pastures. Although the ADGs of lambs in the black walnut silvopasture exceeded the ADGs of the lambs in the open pastures, we stocked the black walnut silvopastures with fewer lambs because of the lower forage productivity. Thus, it is more appropriate to consider total system output. In this case, there was no

difference in the total animal productivity of the silvopastures compared to the open pastures. Even with the potential products available from the trees, the lamb outputs of the silvopastures were no different than the outputs of the treeless pastures. It is clear that something besides forage characteristics alone is driving animal performance in silvopastures.

Lamb behavior and body temperatures

From the analysis of the time-lapse imagery, we found that the lambs in the silvopastures grazed more frequently and more evenly throughout the midday hours compared to the lambs in the open pastures. The lambs in the silvopastures spent more time lying down. The lambs in the open pastures spent about 2 hours longer each day standing up. In addition to the extra energy expenditure of standing versus lying down, time spent lying down is a traditional metric of animal comfort. It is clear that the lambs in the silvopastures were more comfortable than the lambs in the open pastures.

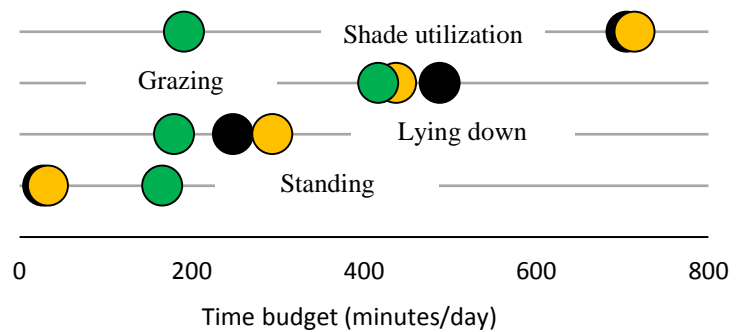


Figure 3: Lambs in silvopasture spent more time lying down and less time standing; (black = black walnut silvopasture; yellow = honeylocust silvopasture; green = open pasture).

The lambs were found to actively follow the shade of the trees, spending over 90% of the day within shade. As a result, the ewes in the black walnut silvopastures had 0.7 F° cooler vaginal temperatures than the ewes in the open pasture during the hottest hours of the day (1:00 – 5:00 PM). It is not clear why lambs in the honeylocust silvopasture had similar vaginal temperatures to lambs in the open pastures, but it could be

because of less shade provided by honeylocust trees, consumption of more forage by lambs in these systems, reductions in nighttime cooling potential, or a combination of each of these factors. Both tree species modulated the effect of the environment on lamb body temperatures, though honeylocust trees had less of an effect. The variable effect of tree species on animal physiology may be an important consideration for producers designing a silvopasture system.

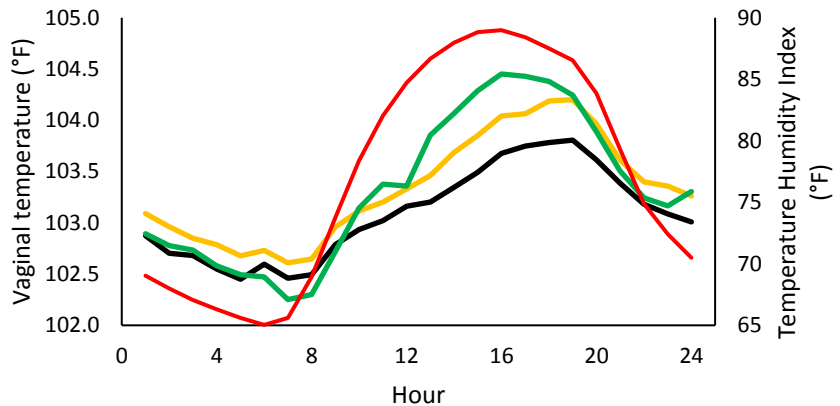


Figure 4: The black walnut trees kept lambs cooler during the hottest part of the day (Left hand axis: black = black walnut silvopasture; yellow = honeylocust silvopasture; green = open pasture; Right hand axis: red = Temperature Humidity Index of the farm).

Conclusion to Kentland study

Even with the potential products and ecosystem services rendered by the trees in these hardwood silvopastures, these systems had similar animal output compared to the conventional open pastures during the summer months. In addition, these silvopastures sheltered the lambs from ambient summertime conditions, leading to improved animal welfare compared to open pastures. The different products and services provided by both of these tree species should be an important consideration in silvopasture design.

Future Studies in Blackstone

We are beginning a study this summer on heifer performance and development in the silvopasture systems compared to the open pastures at the Southern Piedmont Agricultural Research and Extension Center in Blackstone.

Forty acres were converted to four different treatments over the past few years.

- Twenty acres were clear cut, of which:
 - Ten acres were planted back to alleyways of loblolly pine (*Pinus taeda*).
 - Ten acres were converted to open pasture.
- Twenty acres were thinned to silvopasture density, of which:
 - Ten acres contain mostly loblolly pine.
 - Ten acres contain mostly hardwood species.

The cool season forages planted in these treatments in 2016 are ready to support grazing livestock. Forage species and seeding rates included novel endophyte tall fescue (BarOptima PLUS E34) at 12.5 lb/acre, orchardgrass, alfalfa, and red clover at 5 lb/acre, and ladino clover, perennial ryegrass, and meadow fescue at 2 lb/acre. Similar work to the Kentland study is planned, although with cattle instead of sheep.

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Figure 5: Heifers relaxing in the shade of this newly established silvopasture at the Southern Piedmont AREC in Blackstone.

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