

Species Diversity in Pasture Systems

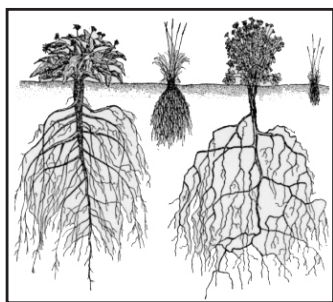
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Ecologists, by training, have an interest in the role of species diversity in the productivity of pastures. All agricultural systems function within parameters defined by ecological principles. It seems logical that the more closely agricultural systems simulate natural ecosystems, the more likely it is to capture efficiencies. Natural grasslands become more resilient and more productive as the grasslands become more diverse. It should follow that a more diverse pasture plant community should be more efficient, too, and should produce more forage. Recent research by the USDA-ARS pasture systems research unit in Pennsylvania suggests that this may be the case.

There is no question that simple mixtures using species with similar growth patterns are easier to manage, but will greater benefits be realized if management of complex mixtures can be mastered?

Ecological Principles that Govern Pastures. Grazing systems bear more resemblance to natural ecosystems than any other agricultural crop, and several ecological principles at work can be observed in pastures. Two that relate directly to the species diversity question are competition and succession.

Figure 1.



Plants in the pasture compete for sunlight, space, water, and nutrients. Individual plants of a single species compete directly with each other for resources because they can be utilized in exactly the same way. Two different species planted together use resources in different ways and while they still compete, they are more readily able to co-exist. An orchardgrass plant and an alfalfa plant are a good example (Figure 1). Differences in rooting depth, leaf size and shape, and nutrient needs make these two species quite compatible. As more species are added, the finite resources of the pasture become more fully utilized. Some native prairie plant communities have up to 200 different species, each having a unique niche in the ecosystem and utilizing resources in its own unique way. While no individual species' productivity is maximized, the productivity of the system as a whole is optimized.

Ecosystems move from simplicity to complexity in a process called succession. When a field is plowed, the succession clock is reset, and Mother Nature fills the void with fast growing, heavy seed-producing annual species (commonly known as "weeds"). These early successional species move in to take advantage of the unutilized resources. If nature is allowed to take its course, they are soon replaced by longer-lived perennial species and gradually the plant community becomes more complex. With complexity comes stability and resource use efficiency. In contrast to the simple successional community, if one species declines there are several others to fill in the gap and productivity is maintained.

This is what Skinner and his colleagues found when they compared a two-species simple pasture mix with a complex 11-species mixture. Even though the two species were perennial, the researchers still observed instability in the clover-orchardgrass mixture over time as it swung from grass dominance to a more balanced mix and back again (Figure 2).

Figure 3 shows the comparative stability researchers observed in the complex mixture. The 11 species varied over time in relative abundance, but none became dominant in the mixture, and more importantly, the productivity and quality of the pasture varied less over time than it did with the simple mixture.

Are Complex Mixtures More Productive? If ecological principles apply to pasture systems, increasing the number of species in a pasture could result in improved resource utilization and perhaps greater productivity. The ARS research suggests that this may be the case.

Skinner and other researchers measured photosynthesis in the simple vs. complex mixtures. Findings show photosynthesis was greater in the 11-species mix than in the 2-species mix in summer and fall. In another study, Sanderson found rooting depth was greater in a complex 9-species mixture than it was in the 2-species mix. Together, these two factors contributed to significantly greater forage production of complex mixtures under both grazing and haying management (Figure 4).

This research suggests that ecological principles do apply to 'tame' grasslands as they do to natural grasslands, and that increasing species diversity may improve pasture productivity. In addition,

Figure 2.

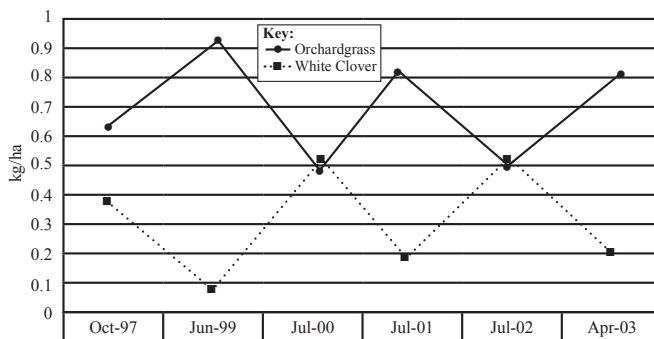
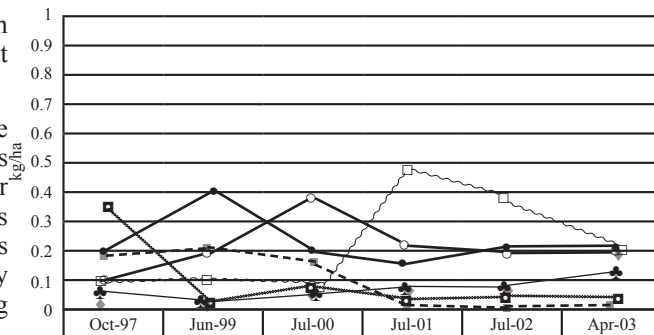


Figure 3.



adding diversity to pastures can increase the pastures' resilience in the face of extreme or highly variable weather conditions. It is far less likely to lose an entire stand to winter-kill if there are 10 or even six species than working with only two or three. The ARS research, conducted during drought conditions, showed that greater rooting depths in the complex mixtures contributed to their performance under low moisture conditions.

Many grazing 'experts' recommend against planting more than two or three species together in a pasture. Certainly there are challenges associated with differing maturities, stature, and other growth parameters that are avoided by using simple mixtures. These experiments suggest that complex mixtures are manageable. The ARS researchers found no differences in forage quality between complex and simple mixtures, and intake was higher for the complex mixtures (Deak et al). All of these data suggest that graziers may wish to utilize ecological principles to help guide their pasture management.

References:

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Figure 4.

