Diverse forage mixtures effect on herbage yield, sward composition, and dairy cattle performance

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Introduction Managing complex mixtures of plants to take advantage of spatial and temporal variability in land and climate may be one ecological approach to increase productivity of pastures. We tested the hypothesis that complex mixtures of forage species would yield more herbage and reduce weed competition compared with a simple grass-legume mixture in grazed pastures.

Materials and methods Four mixtures were established in replicated 1-ha pastures at University Park, Pennsylvania, USA in the autumn of 2001: 1) orchardgrass (*Dactylis glomerata* L.)-white clover (*Trifolium repens* L.); 2) orchardgrass, white clover, chicory (*Cichorium intybus* L.); 3) orchardgrass, tall fescue (*Festuca arundinacea* Schreb.), perennial ryegrass (*Lolium perenne* L.), red clover (*Trifolium pratense* L.), birdsfoot trefoil (*Lotus corniculatus* L.), and chicory; and 4) six species mix plus white clover, alfalfa (*Medicago sativa* L.), and bluegrass (*Poa pratensis* L.). The experimental design was a randomized complete block with two replicates. The pastures were subdivided into smaller paddocks and stocked rotationally with lactating Holstein cows during April to August in 2002 and 2003. Four cows grazed each treatment. Herbage allowance was 25 kg/cow per day of dry matter. Cows were fed a 13% crude protein corn-based concentrate (1 kg/4 kg milk) in two equal feedings after milking. Cows were moved to a fresh paddock after morning and afternoon milking. Herbage intake was estimated by the chromic oxide technique during May, June, July, and August in each year. Lactating cows were not available after August 1 of each year, therefore, pastures were mob grazed with 21 dry cows for one day in mid August (2003) and early September (2002 and 2003) to complete the grazing season. Animal performance was not measured on the dry cows. Pre-grazing and post-grazing herbage mass was measured twice each week during the grazing season with a calibrated rising plate meter. The botanical composition of each pasture was measured during each grazing cycle by hand separating clipped samples before and after grazing. Data were analyzed as a randomized complete block design. Treatments (mixtures) were fixed effects and blocks were random effects.

Results In 2002, herbage yield was lower ($P<0.05$) on the orchardgrass-white clover mixture compared with the more complex forage mixtures (Table 1). In 2003, with much greater rainfall, there were no significant differences in herbage yield among mixtures. In 2002 the yield increase with increased seeded species richness resulted from adding a highly productive species (chicory), an example of the 'sampling effect' mechanism for explaining plant species diversity effects. Weed proportions were similar ($P>0.05$) for the two- and three-species mixtures, whereas the six- and nine-species mixtures had lower ($P<0.05$) weed populations than the simple mixture. Sown species composition of the pastures changed greatly during the experiment, with the complex mixtures simplifying to fewer species.

Table 1 Herbage yield, weed components, and dairy cow productivity. Weed proportion, milk yield, and herbage intake are means of two years

	Herbage yield		Weed	Milk	Herbage
Mixture	2002	2003	proportion	yield	DMI
	kg DM/ha		% of DM	kg/cow per day	
2-species	4800	9000	18	34.1	12.1
3-species	7400	9900	15	35.3	12.1
6-species	7900	11300	11	34.4	12.1
9-species	7400	9000	4	34.3	11.4
SEM	280	766	2.1	1.1	0.49

Conclusions Complex forage mixtures were more productive than a simple grass-legume mixture during drought and also had reduced weed pressure. Individual animal performance was similar among simple and complex mixtures. Increasing plant species diversity on pastures may be a short-term way to increase forage productivity and reduce weed competition. Stability of species composition in complex mixtures, however, may be a problem in the long term.