PRODUCTIVITY OF SIMPLE AND COMPLEX MIXTURES OF FORAGES COMPARED IN ON-FARM PASTURES

Matt A. Sanderson, R. Howard Skinner, and Benjamin F. Tracy[1]

Abstract

There are few studies that have taken a practical approach to examining how well complex forage mixtures persist in intensively managed pastures. We conducted an on-farm study to compare changes in botanical composition and yield of simple and complex forage mixtures under grazing. Three forage mixtures (2, 3, or 11-species) were established in replicated 1-ac pastures on a farm in eastern Pennsylvania and grazed by dairy heifers or managed under a 3-cut hay system for four years. The complex mixture yielded more forage dry matter than the 2-species mixture, but this difference was due to the inclusion of a few highly productive forage species. However, nearly one-half of the planted species did not persist beyond four years in the complex forage mixture. Producers should first determine what forage species are best adapted for their farm, and then consider whether a complex mixture of forages is necessary or if separate plantings of different species across the farm would be more useful.

Introduction: Producers are searching for ways to reduce the risk of forage production on pastures. Ecological research suggests that greater diversity of species in grassland ecosystems benefits their productivity and stabilizes their function under stressful conditions (Minns et al., 2001). Some producers use highly complex mixtures of forages in pastures in the belief that different plant species will be valuable in their own time, thus smoothing out productivity during stressful periods. There are few studies that have taken a practical approach to examining how complex forage mixtures persist in intensively managed pastures. We conducted an on-farm study in collaboration with a producer to determine the persistence and yield of complex mixtures of forage species compared with a simple grass-legume mixture.

Materials and Methods: Three forage mixtures were compared under haying and grazing management on a farm in Berks County, Pennsylvania (Table 1). Mixture 1 is commonly used in the northeastern USA. Mixture 2 was chosen by the producer according to her own research and preferences. Treatment 3 was developed as an experimental highly complex planting. Soil at the farm is a Weikert-Berks shaly silt loam. This soil is well drained, contains a high amount (10 to 50%) of coarse rock fragments, and has a low water-holding capacity. Soil pH was 6.4 and available P and K levels to a 6-in. depth averaged 79 and 127 lb/ac, respectively. The producer applied lime at 2000 lb/ac in spring 2000. An automated weather station at the site recorded rainfall, air temperature, and soil moisture.

Two 1-ac paddocks of Mixtures 1 and 3 were no-till planted with a Tye Pasture Pleaser drill (Tye Co., Lockney, Texas) on 28 August, 1997. The previous crop was winter wheat. Glyphosate [N-(phosphonomethyl) glycine] was applied to the wheat stubble at 1.0

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lb a.i./ac two weeks before planting. The producer custom hired the planting of Treatment 2, but the establishment procedures were essentially the same. We selected two 1-ac paddocks of this planting for monitoring. In May 1999, we installed one 20-ft by 20-ft grazing exclosure in each treatment paddock. The area inside the exclosure was used to emulate a three-cut (late May, July, and August) hay management scenario. The area inside the exclosure was fertilized with 36 lb N/ac in April of each year to emulate the N that was recycled to the grazed areas from dung and urine of the heifers.

The paddocks were cut twice for hay, but not grazed, in 1998. Beginning in 1999 and continuing into 2002, paddocks were stocked with 45 to 60 Holstein dairy heifers for a 1- to 2-day period of stay on a 30 to 45-day rotation interval. Grazing started in late April and ended the first week of October each year. All of the paddocks on the farm were cut for hay once in late May or June each year of grazing. The producer discontinued grazing on the farm in late 2002. Therefore, a final harvest was taken from the pastures in April of 2003 before the farm was rented for crop production.

Dry matter yield was measured in 1999 to 2002 by clipping forage from two quadrats (3 ft by 3 ft) inside and outside of each exclosure to a 2-in. stubble height on three dates (June, July, and August) in each year. Aboveground biomass was hand sorted to species once each year and botanical composition was calculated. The experimental design was a randomized complete block. The two pastures of each treatment were considered replicates. The MIXED procedure in SAS (1998) was used for statistical analysis.

Results and Discussion: The pattern of change in botanical composition differed among mixtures managed for hay or grazing (Fig. 1). Mixture 1 under hay management was dominated by orchardgrass. Under grazing management, however, the grass/legume proportion of Mixture 1 fluctuated greatly. Mixture 2 managed for hay was dominated by orchardgrass. Orchardgrass also dominated in Mixture 2 under grazing management, but was decreasing in percentage during 2002 and 2003, with a corresponding increased in alfalfa percentage. Alfalfa percentage in Mixture 2 managed for hay decreased until July 2001 and increased in 2002 and 2003. Tall fescue became the dominant species in Mixture 3 by 2001 under hay or grazing management. Alfalfa did not persist in the complex mixture managed for hay but maintained a relatively stable proportion of the sward (about 20%) under grazing. Chicory did not persist after 1999 in Mixtures 2 and 3 whether managed for hay or grazing. Of the 11 species originally planted for the complex mixture in 1997, only 4 or 5 species persisted into the spring of 2003. Thus, the complex forage mixture tended to become less species rich with time whether cut for hay or grazed.

Red clover, birdsfoot trefoil, reed canarygrass, and timothy did not establish well in Mixture 3 and did not contribute much to sward dry matter. Hay management during 1998 and the practice of taking one cutting of hay during the grazing seasons of 1999 to 2002 probably affected the establishment and survival of some low-growing species in Mixture 3. This management probably allowed the taller growing species to gain a competitive advantage by shading low-growing species.

There was no treatment by year interaction for dry matter yield; therefore yields were averaged for years. Dry matter productivity was greatest with Mixture 3 (complex mixture) under hay management, whereas, productivity was greatest with Mixtures 2 and 3 under grazing management (Fig. 2). The primary advantage of Mixtures 2 and 3 compared with Mixture 1 was the inclusion of chicory and alfalfa, both deep taprooted species, on this drought-prone soil. The yield increases resulted from adding a highly productive species may be an example of the ‘sampling effect’ mechanism for explaining plant species diversity effects (Minns *et al*., 2001) or perhaps of facilitation where a companion species benefits the growth and survival of another species.

Conclusions: Our results suggest that planting a complex mixture of forages without regard to the identity of the species in the mixture is not wise. Less than half of the species planted in the 11-species mixture persisted during the entire 6-year experiment. The complex mixture yielded more forage dry matter than the 2-species mixture, but this difference was due to the inclusion of a few highly productive forage species.

Literature Cited:

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Table 1. Composition of the forage mixtures planted in 1-ac pastures on a Berks County, PA farm.

	Target seed rate, lb/ac		Target seed rate, lb/ac
Mixture 1		Mixture 3	
Pennlate orchardgrass	6	Pennlate orchardgrass	1.0
Will white clover	3	Will white clover	3.5
		Puna chicory	2.8
Mixture 2		Saratoga smooth bromegrass	2.8
Okay orchardgrass	3	Barcel tall fescue	2.1
Haygrazer alfalfa	10	Matua prairiegrass	7.2
Puna chicory	2	Paddock meadow bromegrass	3.8
		Norcen birdsfoot trefoil	3.5
		Alfagraze alfalfa	9.4
		Climax timothy	0.4
		Palaton reed canarygrass	0.7

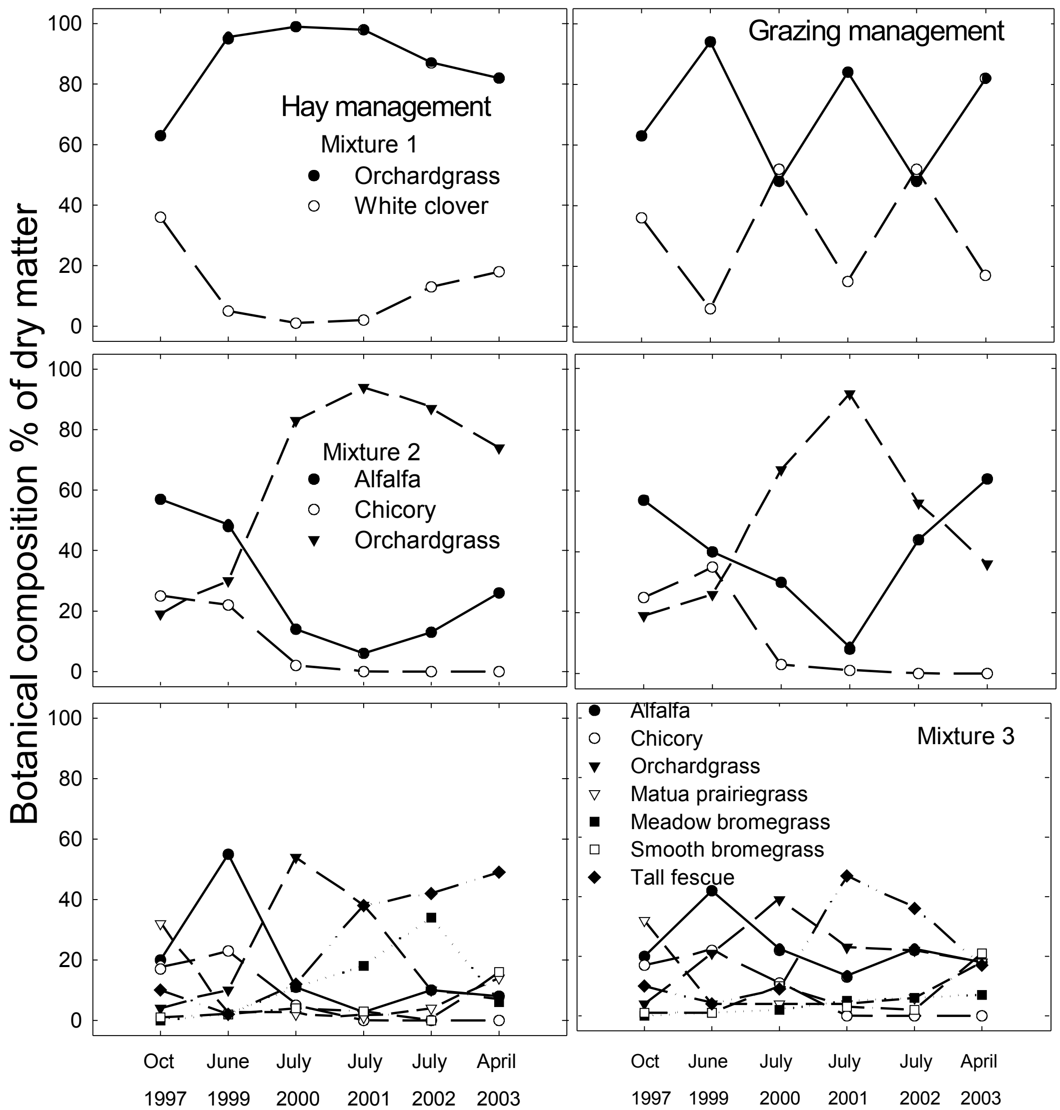

Fig. 1. Botanical composition of three forage mixtures under grazing or haying management in southeastern PA. The mixtures were orchardgrass-white clover (Og/Wcl); orchardgrass-alfalfa-chicory (Og/Alf/Chc); and alfalfa, orchardgrass, chicory, white clover, meadow bromegrass, smooth bromegrass, birdsfoot trefoil, Matua bromegrass, tall fescue, reed canarygrass, and timothy (Complex). White clover, reed canarygrass, timothy, and birdsfoot trefoil did not establish in the complex mixture. Grazing exclosures were installed in May 1999. Data are averages of two replicate pastures for each sampling date.

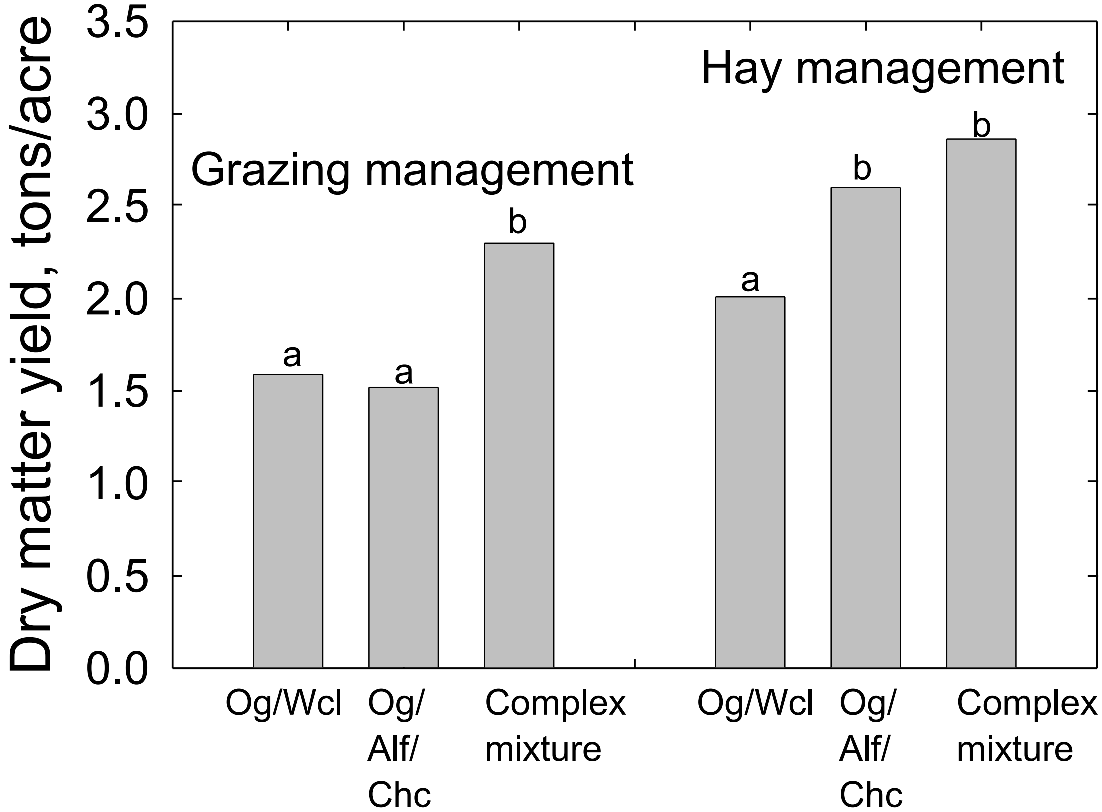

Figure 2. Dry matter yields of three forage mixtures under grazing or haying management in southeastern PA. The mixtures were orchardgrass-white clover (Og/Wcl); orchardgrass-alfalfa-chicory (Og/Alf/Chc); and alfalfa, orchardgrass, chicory, white clover, meadow bromegrass, smooth bromegrass, birdsfoot trefoil, Matua bromegrass, tall fescue, reed canarygrass, and timothy (Complex). White clover, reed canarygrass, timothy, and birdsfoot trefoil did not establish in the complex mixture. Data are averages of two replicate pastures and four years. Bars with similar letters do not differ ($P < 0.05$).

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