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Spatial Analysis of Species Diversity in Pastures Using GIS and GPS Technologies

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Abstract
The Rhodes research farm with its large topographic variability and extensive pasture acreage is an ideal site to evaluate the application of precision agriculture technologies to forage production and management. In previous studies at Rhodes it has been shown that forage legumes are adapted to sites with higher slopes (15 - 20%), and increasing species diversity with legumes at these sites improves productivity and forage quality. In the current study we are using global positioning systems (GPS) and geographic information systems (GIS) technologies to describe and map the spatial variability in pasture vegetation and examine its relationship to maps generated for slope, drainage, and electrical conductivity. Our objective is to determine whether these technologies can be used successfully to predict grass and legume distribution within the pastures based on topography and soil properties.

Keywords
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Disciplines
Agricultural Science | Agriculture | Agronomy and Crop Sciences

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Introduction

The Rhodes research farm with its large topographic variability and extensive pasture acreage is an ideal site to evaluate the application of precision agriculture technologies to forage production and management. In previous studies at Rhodes it has been shown that forage legumes are adapted to sites with higher slopes (15 - 20%), and increasing species diversity with legumes at these sites improves productivity and forage quality. In the current study we are using global positioning systems (GPS) and geographic information systems (GIS) technologies to describe and map the spatial variability in pasture vegetation and examine its relationship to maps generated for slope, drainage, and electrical conductivity. Our objective is to determine whether these technologies can be used successfully to predict grass and legume distribution within the pastures based on topography and soil properties.

Materials and Methods

This study was carried out in four pastures. The pastures were divided into three grazing treatments: rotational, continuous, and nongrazed. A survey grade GPS was used to determine elevation at several points within each pasture. Incorporation of this information into ArcView, a GIS software program, enabled interpolation of grid maps for elevation and from these elevation maps interpolation of slope maps was possible. Slopes were classified into the following zones: 0-5, 5-10, 10-15, and 15-20%. Species diversity was measured in approximately 100 2x1ft random plots distributed throughout each grazing treatment in each pasture. Data were collected during May and July 2000. Sampling positions were georeferenced using a GPS and incorporated into ArcView. The relationship of species diversity to slope class was determined by overlaying the sampling points with the slope map within ArcView.

Results and Discussion

Current results have indicated the GPS and GIS technologies were effective in characterizing the topographic variation in the pastures, and slope can be interpolated and classified in management zones that are highly related to species diversity and legume distribution. Species diversity increased linearly from low slopes to high slopes (Figure 1). Slopes classified as 0-5% averaged 2.5 species of grasses and legumes per 2 ft^2 of ground area versus 3.8 species on 15-20% slopes ($P<.02$).

Species diversity was altered by the grazing treatments (Figure 1). Grazing in the pastures improved species diversity over the nongrazed pastures ($P=.002$). Averaged across slope classes, continuously grazed pastures had the highest species diversity with 3.5 species of legumes and grasses occurring within 2 ft^2 of ground area. Rotationally grazed pastures averaged 3.3 species, and nongrazed pastures averaged 2.5. The grazing treatment by slope class interaction was not significant ($P=.39$).

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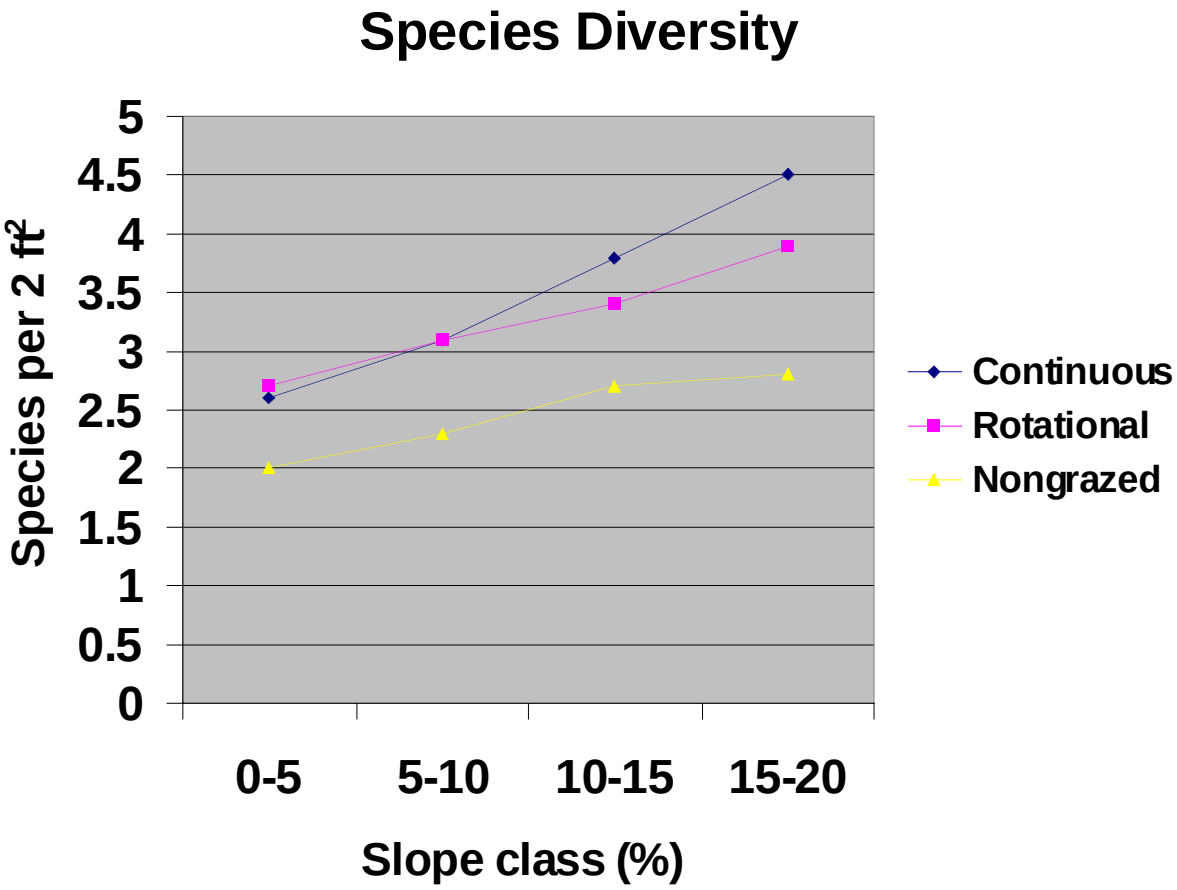

Figure 1. Species diversity measured by the number of grass and legume species per 2 ft^2 ground area in pastures with varying slope classes (0-5, 5-10, 10-15, and 15-20 %) and grazing treatments (continuous, rotational, and nongrazed).