Assessment of cattle grazing impacts on integrated crop-livestock systems

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Livestock and crop production systems are often integrated to enhance productivity and land utilization in modern agriculture. Farmers in the Midwest are interested in grazing corn residue after harvest to reduce winter feed costs; however, the effects of cattle grazing on the performance of agroecosystems are poorly understood. Challenges in effectively managing these systems are potentially exacerbated by uneven grazing distributions, which could potentially cause negative impacts on soil properties and subsequent crop production, or represent missed opportunities for improving current management practices. We have developed a long-term approach to study grazing impacts on integrated corn-cattle production systems, and to develop decision support capabilities for sustainable management. Our central hypothesis is that uneven grazing distributions of cattle lead to a spatial heterogeneity of grazing impacts. Our rationale is that if we can better understand the key components and interactions in these systems, then best management practices can be developed to improve the system sustainability. Cattle locomotion data were collected via GPS collars through three fall grazing seasons in central Illinois. In addition, cattle performance, soil properties and crop yield data were collected in each grazing season. A set of analytical tools including data mining algorithms, statistical analysis and spatial analysis were used to study the spatial and temporal patterns of cattle movement during grazing. Based on the patterns identified from movement data, an agent-based model was developed to simulate the herd dynamics on corn stover. Movement of cattle was simulated by modeling the biological motivators of animals (e.g. hydration and hunger) and external factors (e.g. forage, water, and darkness). The effects of two management practices (continuous grazing and strip grazing) on cattle performance and soil properties were also compared to an ungrazed control. The results show that cattle under strip grazing management had increased body weight gain compared to those in a continuous grazing system. Both grazing systems resulted in greater soil bulk densities and penetration resistance than the ungrazed control; however, their ranges are within optimal values for crop production. This study will improve the understanding of the spatial grazing patterns and impacts of cattle on agroecosystems, and provide the modeling capacities for studying different scenarios to identify best management practices for these integrated systems.