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Controls On Biodiversity And Ecosystem Function In Managed Grasslands

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Managed grassland biodiversity and ecosystem function are impacted by human-induced landscape changes that isolate habitats from native seed sources and diminish regional species pools.

Photo credit - Suneeti Jog

Figure 1. Field researcher surveys vegetation in cool-season grassland

Understanding the patterns, mechanisms and consequences of biodiversity is fundamental to ecosystem management and biodiversity conservation. This understanding is particularly important for agricultural landscapes where native biodiversity loss has been acute and the implications of this loss for ecosystem functioning are substantial. Research at the University of Kansas combines intensive field experimentation, extensive landscape survey work on private land, and modeling procedures to evaluate controls on plant biodiversity, native species re-establishment and ecosystem function in the managed cool-season grasslands of eastern Kansas.

FINDINGS OF THE STUDY

Results to date confirm the central role of soil fertility, and disturbance, as influenced by management regime, in governing vegetation dynamics and ecosystem productivity in managed grasslands. A long-term field experiment in cool-season grassland has shown that nutrient fertilization and annual haying combine to influence a wide spectrum of community- and ecosystem-level patterns and processes. Fertilization increases primary production and canopy greenness (NDVI), reduces plant colonization and diversity, reduces successional turnover in the vegetation, and interacts strongly with haying to determine plant community composition. Fertilization reduces soil pH and increases soil phosphorus (P), carbon (C), and nitrogen (N) content. Besides increasing soil C, fertilization also increases the loss of C to the atmosphere as carbon dioxide via enhanced microbial respiration. Haying increases plant colonization and diversity, encourages successional advancement of herbaceous vegetation, increases soil bacterial diversity, and increases soil P content.

Our work also suggests that regional species pools and dispersal limitations strongly constrain plant diversity and interact with

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Figure 2. A field in used in the survey.

fertility and disturbance to regulate both plant community dynamics and ecosystem processes. Sowing experiments have shown that the experimental seed addition of native plant species from the broader regional pool increases local plant diversity and native species abundance. However, these impacts are much more pronounced under low-fertility and/or disturbed conditions where competitive barriers to colonization are reduced. Sown communities also exhibit increased primary production, greater biomass below ground and greater C and N accumulation in vegetation. These functional responses reflect the impact of enhanced plant diversity and the contributions of key native grass and legume species made available via sowing.

Extensive surveys on privately owned grasslands show that current management regime (haying versus grazing) and prior tillage history (tilled in the past or not) explain much of the current landscape variation in plant composition, plant diversity, soil physical properties, soil fertility, and soil carbon stocks. Management regime also influences the spatial structuring of plant diversity patterns within field sites, with the most intensively managed sites (previously-tilled cool-season grasslands) being the most homogenous in spatial structure.

IMPACT

Although native warm-season grasslands represent the major reservoir of plant diversity and native species in this region, species-poor cool-season grassland (hayfield and pasture) dominate the current landscape. Our research indicates that the biodiversity and ecosystem functioning of these cool-season grasslands are strongly constrained by localized management factors that influence resource availability (fertilization, grazing, haying). However, human-induced landscape changes that isolate habitats from native seed sources and diminish regional species pools are also important controlling factors. As the landscape becomes more fragmented and grassland habitats more isolated, seed limitations may become even more acute. These findings have implications for understanding secondary succession on abandoned hayfields and for informing grassland restoration efforts. Many structural and functional attributes of native prairie can be restored in some cases by circumventing dispersal limitations through the addition of seeds. This approach is likely to be more successful under conditions of low-to-moderate soil fertility. The restoration of former cool-season hayfields thus requires the addition of native seeds and cessation of fertilization to facilitate native plant establishment and to assist ecosystem recovery. Our work also indicates that the use of fertilization as a tool to promote long-term carbon sequestration in soil is not likely to be viable, at least in planted cool-season systems. Long-term carbon storage in this system will likely best be accomplished by restoring sites to native prairie vegetation.

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