

Scientists study effects of rising carbon dioxide on rangelands

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Rising carbon dioxide (CO₂) levels can reverse the drying effects of predicted higher temperatures on semi-arid rangelands, according to a study published today in the scientific journal *Nature* by a team of U.S. Department of Agriculture (USDA) and university scientists.

Warmer temperatures increase water loss to the atmosphere, leading to drier soils. In contrast, higher [CO₂ levels](#) cause leaf stomatal pores to partly close, lessening the amount of water vapor that escapes and the amount of water plants draw from soil. This new study finds that CO₂ does more to counterbalance warming-induced water loss than previously expected. In fact, simulations of levels of warming and CO₂ predicted for later this century demonstrated no net change in soil water, and actually increased levels of plant growth for warm-season grasses.

"By combining higher temperatures with elevated CO₂ levels in an experiment on actual rangeland, these researchers are developing the scientific knowledge base to help prepare managers of the world's rangelands for what is likely to happen as climate changes in the future," said Edward B. Knipling, administrator of the Agricultural Research Service (ARS), USDA's principal intramural scientific research agency.

The results cover the first four years of the eight-year Prairie Heating and CO₂ Enrichment (PHACE) experiment on native northern mixed grass rangeland. The study is being conducted by the ARS Rangeland Resources Research Unit (RRRU) at the High Plains Grasslands Research Station near Cheyenne, Wyo.

ARS plant physiologist Jack Morgan leads the study, which uses both CO₂ pipelines and thermal infrared heaters to simulate global warming conditions predicted for the end of the century: 600 parts per million (ppm) of CO₂—compared to today's average 390 ppm—and day/night temperatures raised by 3 and 5 degrees Fahrenheit, respectively.

Based on these findings, warmer temperatures would likely play a role in changing the relative success of various grass types. "Only the warm-season grasses had their growth boosted higher by CO₂ and warmer temperatures," Morgan said. "If this leads to a competitive advantage for warm-season grasses, it may increase the challenges faced by ranchers who desire cool-season grasses for early-season forage."

Elise Pendall and David Williams at the University of Wyoming at Laramie and Matthew Wallenstein at Colorado State University at Fort Collins also are participating in the study, which will be completed in 2013. Retired ARS soil scientist Bruce Kimball, designer of the infrared heater system, is helping conduct the study. Kimball serves as a research collaborator at the ARS U.S. Arid-Land Agricultural Research Center in Maricopa, Ariz.

Grass-dominated, dry rangelands account for approximately a third of the Earth's land surface, providing most of the forage eaten by livestock. This research, the first of its kind on this scale for rangelands, supports the USDA priority of helping farmers and ranchers throughout the United States and the rest of the world best adapt production practices to variable climate patterns.

Morgan said more research is needed to determine how the water-savings effect applies over the long run and in other types of semi-arid rangelands as well as to croplands in semi-arid areas. "It is important to understand that CO₂ only offset the direct effects of warming on soil water in this experiment, and that it is unlikely to offset more severe

drought due to combined warming and reduced precipitation projected for many regions of the world," he said.

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