

# The Effects of Climate Change on Agriculture in the United States

(U.S. Climate Change Science Program Synthesis and Assessment Product 4.3)



**A**griculture is a \$200 billion industry in the United States. Weather, climate and environmental conditions can significantly impact U.S. agricultural productivity, including a wide variety of crops as well as livestock. Today, with robust scientific evidence showing that human-induced climate change is occurring, it is critical to understand how this commercial sector might be affected. The Synthesis and Assessment Product (SAP) 4.3 provides these insights, particularly focusing on effects of climate on cropping systems, pasture and grazing lands, and animal management. A team of authors – experts in each of the various areas of study – completed an extensive review, analysis and synthesis of the relevant scientific literature related to agriculture. Below, some of the main findings from the SAP 4.3 Agriculture chapter are featured.



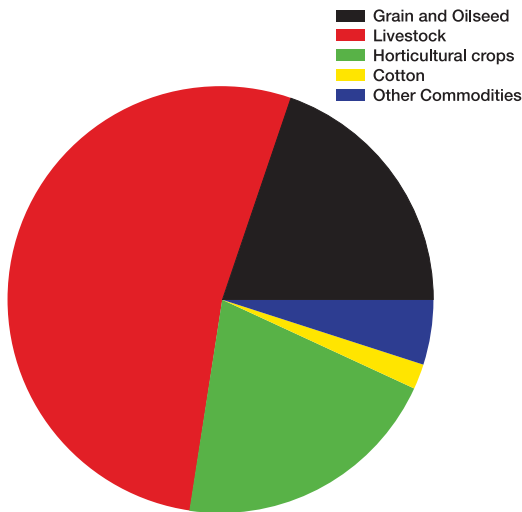


## Findings Related to Cropping Systems

- With increased CO<sub>2</sub> and temperature, the life cycle of grain and oilseed crops will likely progress more rapidly. But, as temperature rises, these crops will increasingly begin to experience failure, especially if climate variability increases and precipitation lessens or becomes more variable.
- The marketable yield of many horticultural crops – e.g., tomatoes, onions, fruits – is very likely to be more sensitive to climate change than grain and oilseed crops.



Market Value of Agricultural Commodities 2002



- Climate change is likely to lead to a northern migration of weeds. Many weeds respond more positively to increasing CO<sub>2</sub> than most cash crops, particularly C<sub>3</sub> “invasive” weeds. Recent research also suggests that glyphosate, the most widely used herbicide in the United States, loses its efficacy on weeds grown at the increased CO<sub>2</sub> levels likely in the coming decades.

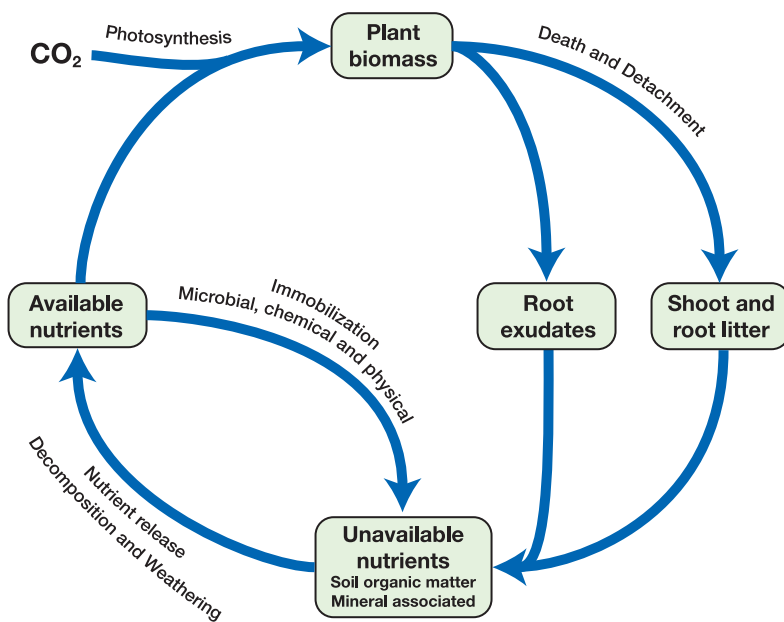
*The sales value of individual crops and livestock. As the chart indicates, crops and livestock represent approximately equal portions of the commodity value. (USDA National Agricultural Statistics Service.)*

- Disease pressures on crops and domestic animals will likely increase with earlier springs and warmer winters, which will allow proliferation and higher survival rates of pathogens and parasites. Regional variation in warming and changes in rainfall will also affect spatial and temporal distribution of disease.



# Findings Related to Rangelands and Pasturelands

- Projected increases in temperature and a lengthening of the growing season will likely extend forage production into late fall and early spring, thereby decreasing need for winter-season forage reserves.
- In both pasture and rangelands, shifts in optimal temperatures for photosynthesis might be expected under elevated CO<sub>2</sub>.
- Climate-change-induced shifts in plant species are already under way in rangelands. Establishment of perennial herbaceous species is reducing soil water availability early in the growing season.
- Increasing CO<sub>2</sub> will alter forage quality; in nitrogen-limited native rangeland systems, CO<sub>2</sub>-induced reduction in nitrogen and increase in fibrous plants (e.g., woody shrubs, trees) may lower quality.



*Nutrient Cycling Feedbacks. While CO<sub>2</sub> enrichment may lead to increased photosynthesis and enhanced plant growth, the long-term response will depend on nutrient cycling feedbacks. Litter from decaying plants and root exudates enters a large soil nutrient pool that is unavailable to plants until they are broken down and released by microbial activity. Soil microbes may also fix available nutrients into new microbial biomass, thereby temporarily immobilizing the nutrients. The balance between these and other nutrient release and immobilization processes determines available nutrients and ultimate plant response. Figure reprinted with permission from Science (Morgan 2002).*



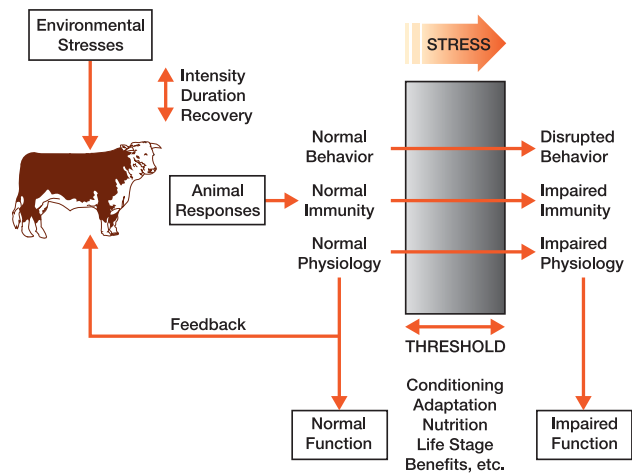


# Findings Related to Animal Management



- Higher temperatures will very likely reduce livestock production during the summer season.
- For ruminants, current management systems generally do not provide shelter to buffer the adverse effects of changing climate; such protection is more frequently available for non-ruminants, such as swine or poultry.
- Benefits from extended forage season production and reduced need for winter-season forage reserves will very likely have significant impact on livestock operations.
- Shifts in rangeland and pastureland plant productivity and type will likely have a significant impact on livestock operations.

*Response model for farm animals with thermal environmental challenges (Hahn, 1999).*



# Findings Related to Agricultural Observing Systems

- Monitoring systems for measuring long-term response of agricultural lands are numerous, but integration across these systems is limited. Existing state-and-transition models could be expanded to incorporate knowledge of how agricultural lands and products respond to global change; integration of such models with existing monitoring efforts and plant developmental data bases could provide cost-effective strategies that both enhance knowledge of regional climate change impacts and offer ecosystem management options. In addition, at present, there are no easy and reliable means to accurately ascertain the mineral and carbon state of agricultural lands, particularly over large areas; a fairly low-cost method of monitoring biogeochemical response to global change would be to sample ecologically important target species in different ecosystems.

