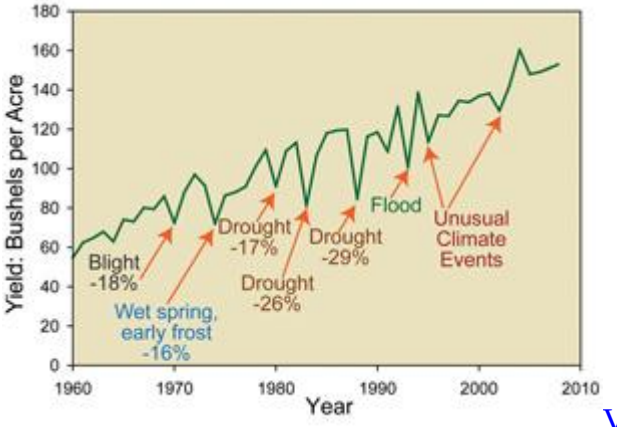
Climate Impacts on Agriculture and Food Supply

EPA (United States Environmental Protection Agency)

Agriculture is an important sector of the U.S. economy. In addition to providing us with much of our food, the crops, livestock, and seafood that are grown, raised, and caught in the United States contribute at least $200 billion to the economy each year. [1]

Agriculture and fisheries are highly dependent on specific climate conditions. Trying to understand the overall effect of climate change on our food supply can be difficult. Increases in temperature and carbon dioxide (CO_2) can be beneficial for some crops in some places. But to realize these benefits, nutrient levels, soil moisture, water availability, and other conditions must also be met. Changes in the frequency and severity of droughts and floods could pose challenges for farmers and ranchers. Meanwhile, warmer water temperatures are likely to cause the habitat ranges of many fish and shellfish species to shift, which could disrupt ecosystems. Overall, climate change could make it more difficult to grow crops, raise animals, and catch fish in the same ways and same places as we have done in the past. The effects of climate change also need to be considered along with other evolving factors that affect agricultural production, such as changes in farming practices and technology.

Impacts on Crops



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Despite technological improvements that increase corn yields, extreme weather events have caused significant yield reductions in some years. Source: USGCRP (2009)

Crops grown in the United States are critical for the food supply here and around the world. U.S. exports supply more than 30% of all wheat, corn, and rice on the global market. [2] Changes in temperature, amount of carbon dioxide (CO_2), and the frequency and intensity of extreme weather could have significant impacts on crop yields.

Warmer temperatures may make many crops grow more quickly, but warmer temperatures could also reduce yields. Crops tend to grow faster in warmer conditions. However, for some crops (such as grains), faster growth reduces the amount of time that seeds have to grow and mature. [1] This can reduce yields (i.e., the amount of crop produced from a given amount of land).

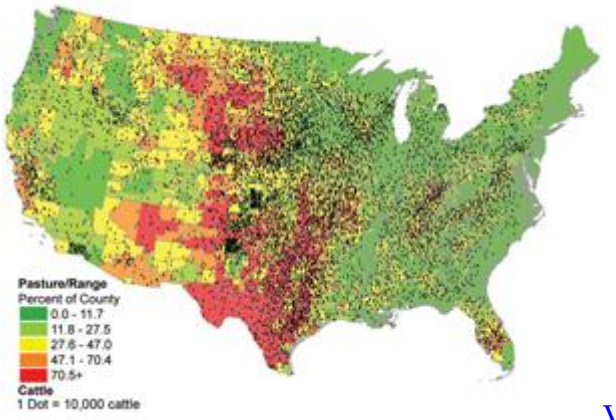
For any particular crop, the effect of increased temperature will depend on the crop's optimal temperature for growth and reproduction. [1] In some areas, warming may benefit the types of crops that are typically planted there. However, if warming exceeds a crop's optimum temperature, yields can decline.

- Higher CO_2 levels can increase yields. The yields for some crops, like wheat and soybeans, could increase by 30% or more under a doubling of CO_2 concentrations. The yields for other crops, such as corn, exhibit a much smaller response (less than 10% increase). [3] However, some factors may counteract

these potential increases in yield. For example, if temperature exceeds a crop's optimal level or if sufficient water and nutrients are not available, yield increases may be reduced or reversed.

- More extreme temperature and precipitation can prevent crops from growing. Extreme events, especially floods and droughts, can harm crops and reduce yields. For example, in 2008, the Mississippi River flooded just before the harvest period for many crops, causing an estimated loss of $8 billion for farmers. [1]
- Dealing with drought could become a challenge in areas where summer temperatures are projected to increase and precipitation is projected to decrease. As water supplies are reduced, it may be more difficult to meet water demands.
- Many weeds, pests and fungi thrive under warmer temperatures, wetter climates, and increased CO_2 levels. Currently, farmers spend more than $11 billion per year to fight weeds in the United States. [1] The ranges of weeds and pests are likely to expand northward. This would cause new problems for farmers' crops previously unexposed to these species. Moreover, increased use of pesticides and fungicides may negatively affect human health. [1]

Impacts on Livestock



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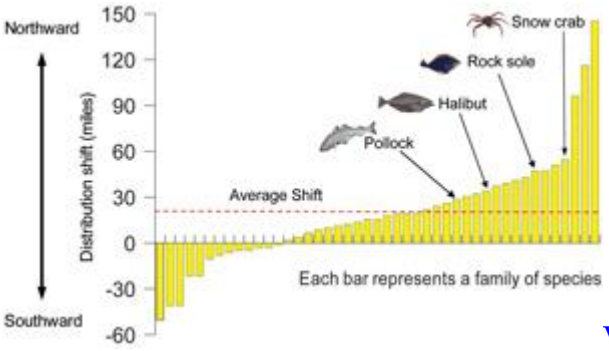
Beef cattle and pasture/rangeland distribution in the continental United States. Source: USGCRP (2009)

Americans consume more than 37 million tons of meat annually. [2] The U.S. livestock industry produced $100 billion worth of goods in 2002. [4] Changes in climate could affect animals both directly and indirectly.

- Heat waves, which are projected to increase under climate change, could directly threaten livestock. A number of states have each reported losses of more than 5,000 animals from just one heat wave. [1] Heat stress affects animals both directly and indirectly. Over time, heat stress can increase vulnerability to disease, reduce fertility, and reduce milk production.
- Drought may threaten pasture and feed supplies**.** Drought reduces the amount of quality forage available to grazing livestock. Some areas could experience longer, more intense droughts, resulting from higher summer temperatures and reduced precipitation. For animals that rely on grain, changes in crop production due to drought could also become a problem.
- Climate change may increase the prevalence of parasites and diseases that affect livestock.The earlier onset of spring and warmer winters could allow some parasites and pathogens to survive more easily. In areas with increased rainfall, moisture-reliant pathogens could thrive. [3]
- Increases in carbon dioxide (CO_2) may increase the productivity of pastures, but may also decrease their quality. Increases in atmospheric CO_2 can increase the productivity of plants on which livestock feed. However, studies indicate that the quality of some of the forage found in pasturelands decreases with higher CO_2. As a result, cattle would need to eat more to get the same nutritional benefits.

Impacts on Fisheries

American fisheries catch or harvest five million metric tons of fish and shellfish each year. [2] These fisheries contribute more than $1.4 billion to the economy annually (as of 2007). [5] Many fisheries already face multiple stresses, including overfishing and water pollution. Climate change may worsen these stresses. In particular, temperature changes could lead to significant impacts.



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The ranges of marine species have shifted northward as waters have warmed. Source: USGCRP (2009)

- The ranges of many fish and shellfish species may change. Many marine species have certain temperature ranges at which they can survive. For example, cod in the North Atlantic require water temperatures below 54°F. Even sea-bottom temperatures above 47°F can reduce their ability to reproduce and for young cod to survive. In this century, temperatures in the region will likely exceed both thresholds. [1]
- Many aquatic species can find colder areas of streams and lakes or move northward along the coast or in the ocean. However, moving into new areas may put these species into competition with other species over food and other resources, as explained on the Ecosystems Impacts page.
- Some diseases that affect aquatic life may become more prevalent in warm water. For example, in southern New England, lobster catches have declined dramatically. A temperature-sensitive bacterial shell disease likely caused the large die-off events that led to the decline. [1]
- Changes in temperature and seasons could affect the timing of reproduction and migration. Many steps within an aquatic animal's lifecycle are controlled by temperature and the changing of the seasons. For example, in the Northwest warmer water temperatures may affect the lifecycle of salmon and increase the likelihood of disease. Combined with other climate impacts, these effects are projected to lead to large declines in salmon populations. [6] [7] [8]

In addition to warming, the world's oceans are gradually becoming more acidic due to increases in atmospheric carbon dioxide (CO_2). Increasing acidity could harm shellfish by weakening their shells, which are created from calcium and are vulnerable to increasing acidity. [1] Acidification may also threaten the structures of sensitive ecosystems upon which some fish and shellfish rely. [3]

International Impacts

Internationally, the effects of climate change on agriculture and food supply are likely to be similar to those seen in the United States. However, other stressors such as population growth may magnify their effects. For example, in developing countries, adaptation options like changes in crop-management or ranching practices or improvements to irrigation are more limited than in the United States and other industrialized nations.

To learn more about adaptation options, visit the Agricultural and Food Supply Adaptation section.

Impacts to the global food supply concern the United States because they can affect food prices here at home. In addition, food shortages abroad can pose humanitarian crises and national security concerns.

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(http://www.epa.gov/climatechange/impacts-adaptation/agriculture.html)