ERS Report Summary

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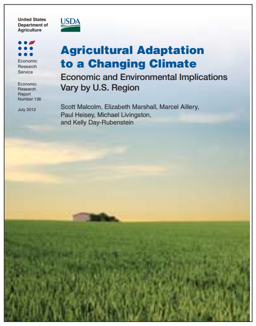

This is a summary of an ERS report.

Find the full report at *www.ers.usda.gov/publications/err136*

Agricultural Adaptation to a Changing Climate: Economic and Environmental Implications Vary by U.S. Region

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What Is the Issue?

Agricultural production has always been affected by variability in weather, and U.S. farmers have adopted production practices and strategies appropriate to their local climate. The weather that shapes the structure of U.S. agricultural production, however, is changing along with world climatic conditions. Climate models predict increases in average temperatures worldwide, with wide-ranging impacts on local temperature and rainfall. Whether such changes present a risk to food supplies, farmer livelihoods, and rural communities depends partly on the direction, magnitude, and rate of such changes, but also on the agricultural sector's responsiveness to changing yield and productivity patterns, production costs, and resource availability. Adaptive behaviors will allow producers to mitigate costs of climate change and even to capitalize on new opportunities. The introduction of crop varieties better adapted to new growing conditions could facilitate this transition.

What Did the Study Find?

The projected impacts of climate change in 2030 vary widely both across climate scenarios and across regions within a single scenario, primarily due to the direction and magnitude of precipitation changes. Farmers' ability to alter crops, rotations, and production practices enables them to lessen the impact of changes in local weather, resource conditions, and price signals. Redistributing production across regions can greatly mitigate the impact of climate change on national agricultural markets. Such redistribution, however, will alter land use and environmental quality. Key findings (with ranges expressed across different climate scenarios) include:

- National acreage changes when farmers adapt are relatively small across climate change scenarios (from 0.2 to 1.0 percent compared with the baseline), although acreage changes vary considerably by region. Crop acreage and planting patterns in the Corn Belt and Northern regions, in general, are less sensitive to climate change than in Southern regions, where yield changes have a wider range across crops (for example, acreage changes in the Delta region range from -9.8 to 5.0 percent). Acreage changes indicate considerable capacity in the agricultural system to reallocate crop production in response to shifting conditions.
- Although climate change leads to higher prices for corn and soybeans under hotter, drier scenarios as a result of considerably lower national yields, adaptation to climate change dampens the rise in prices for most commodities.
- Aggregate national returns to crop production decline with the increasing severity of the climate change scenario. The same trend holds for the Corn Belt, which accounts for over half

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of all returns to U.S. field crop production. The complex interaction between regional yield changes, markets, and production options—combined with the Corn Belt's large production—creates a larger absolute impact than in other regions, although the percentage decline in returns is smaller than in other regions. Changes in returns vary in the other regions, however, with no direct correspondence to the magnitude of the scenario's temperature and precipitation change. This is due to shifts in the economic attractiveness of crops in regions other than the Corn Belt.

- Aggregate impacts of climate change on net returns to crop farmers range from an estimated increase of $3.6 billion to a loss of $1.5 billion per year, under the four climate change scenarios. Spread and redistribution of agricultural pests may reduce these returns by $1.5 billion to $3.0 billion.
- Regionally, crop sector impacts from climate change are likely to be greatest in the Corn Belt, with annual losses ranging from $1.1 billion to $4.1 billion across scenarios. Heightened damage from crop pests could lead to additional losses of $400 million to $600 million in that region. Economic effects in other regions may be positive or negative, depending on how well crop rotation and tillage practices accommodate changes in temperature and precipitation and how market-mediated prices change for predominant regional crops. Drought-tolerant varieties increase returns nationally and in regions that plant them, indicating that further development of drought-tolerant varieties could be beneficial under a wide range of adverse climate changes.
- Changes in crop production result in and reflect changes in crop prices. Soybean markets may be particularly sensitive, with estimated price effects ranging from -4 to 22 percent. Corn prices are estimated to change between -2 and 6 percent, while wheat prices are estimated to decline across all four scenarios. Shifting agricultural pest populations cause the price range to widen and crop prices to increase for all crops except cotton. The availability of drought-tolerant crop varieties is estimated to reduce prices.
- Climate change is projected to slightly increase aggregate natural resource and environmental impacts from U.S. agricultural production, although local effects may be more significant. Cropland area is projected to expand 0.2-1.0 percent, while nitrogen fertilizer losses are projected to grow 1.4-5.0 percent. Rainfall-related soil erosion changes range from -0.9 to 1.2 percent above baseline levels. The disproportionate change in nitrogen loss to water relative to acreage expansion reflects changes in regional crop distribution, input use, and the varying impacts of changes in production practices.

This report focuses on how crop farmers will adapt to changing climate conditions and how extensively changing pest pressures and emergent technologies such as drought-resistant crops might alter the benefits of adaptation. While interactions between the crop and livestock sectors are included in the analysis, changes in the livestock sector are not the focus of the report. Consumers will likewise be affected by adjustments in both the crop and livestock sectors. Livestock producers will see changes in the prices they pay for feed, and retail food prices will adjust to commodity price changes. Our climate change analysis focused on the yield-related impacts associated with increased average temperatures, regional changes in average precipitation, increased carbon dioxide concentration in the atmosphere, the expanded incidence of pests, and the market-mediated price impacts that arise from regional shifts in crops and practices. Model limitations precluded analysis of yield impacts from the potential increase in extreme weather events, nor could the analysis address the potential for, and constraints to, expanding irrigated acreage and water use, which is particularly important in the Western United States where there is already significant competition for water resources.

How Was the Study Conducted?

Downscaled climate projections from four different general circulation models—based on the Intergovernmental Panel on Climate Change's (IPCC) Special Report on Emissions Scenarios (SRES) A1B emissions scenario—represent possible climate futures in the United States. A crop-growth simulator—the Environmental Productivity and Integrated Climate (EPIC) model—is used to estimate the effect on crop yields of associated weather patterns resulting from each climate projection and a suite of environmental indicators associated with each regional production enterprise, which consists of a single crop rotation/tillage/fertilizer regime. Climate projections, historical climate data, and Agricultural Resource Management Survey (ARMS) data are also used to estimate cost and yield impacts associated with potential changes in the geographic distribution and severity of pest and disease outbreaks resulting from climate change. The Regional Environment and Agriculture Programming (REAP) model—a mathematical programming model of the U.S. agricultural sector—is then used to project shifts in regional agricultural production given climate-induced changes in crop productivity patterns and price/demand feedback from national commodity and livestock markets. REAP also allows researchers to estimate the impact on national agricultural production, crop prices, regional farmer income, and—in combination with EPIC results—regional indicators of environmental quality.