

The Changing Landscape of National-Scale Droughts

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The 2012 drought is meteorologically similar other national droughts of the past century. This year, however, a variety of factors—such as crop insurance, strong commodity demand, greater conservation tillage, and improved crop genetics—helped to reduce the negative impacts.

The 2012 U.S. drought provided a stark reminder that some droughts are national in scale and that agricultural production is particularly vulnerable to drought. Taking a geographic approach, we define a “national-scale” drought as one for which over 50% of agricultural land is exposed to moderate or greater drought. Over the past 118 years, the U.S. has experienced about nine national-scale drought years (Figure 1), some of which occurred within multi-year droughts such as the Dust Bowl.

In this article we examine several factors that influence the farm-level economic impacts of national droughts. We examine the 2012 drought’s uniqueness among historical national droughts by identifying key differences.

Drought Severity, Extent and Vulnerability

Drought is a shortage in water availability, but comparing one drought to another requires being very specific about what sort of water is relevant—precipitation, surface water storage, soil moisture, etc.—and the time period over which the shortage occurs. In addition, because of regional differences in average water availability, some

normalization to long-run average local conditions is required. One farmer’s drought may be another farmer’s flood.

Meteorologists have developed drought indices that convert weather data—such as monthly precipitation totals and temperature averages—into measures of drought severity. For our purposes, the Palmer Modified Drought Index (PMDI) provides a good measure with which to compare drought severity over time. Under the PMDI, droughts are categorized as moderate, severe, extreme, or exceptional depending upon how far they deviate from average conditions in a given location.

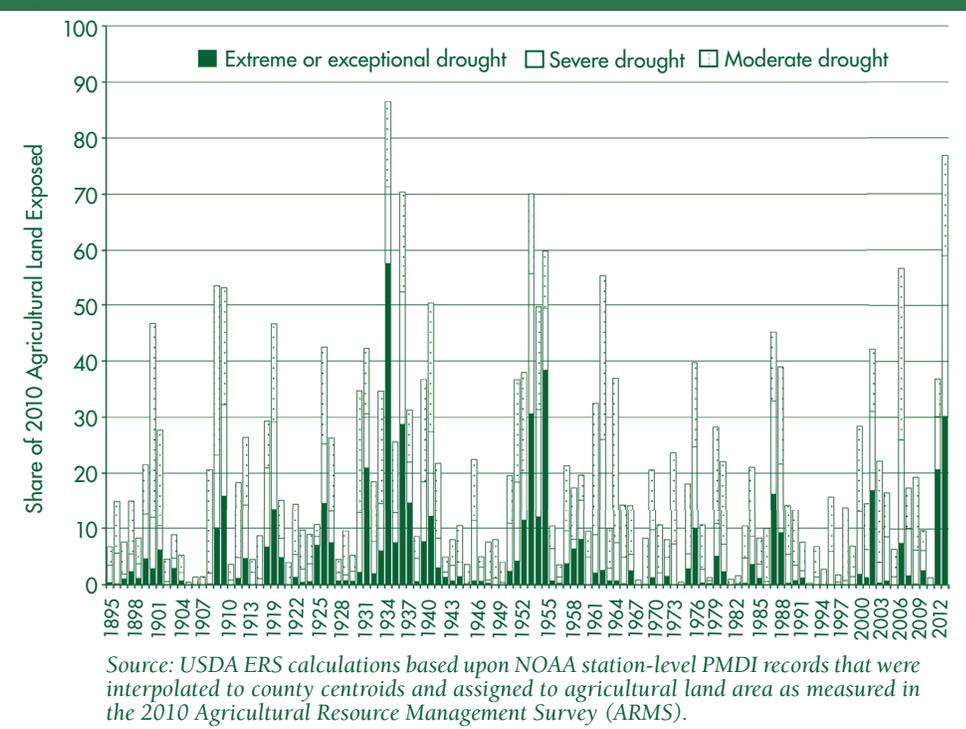
Not surprisingly, the peak of the Dust Bowl, in 1934, was the most extensive and severe drought on record in the U.S. (based on weather records that begin in 1895). In 1934, about 85% of agricultural land experienced moderate or greater drought. Perhaps more surprisingly, 2012 was almost as bad as 1934. In 2012, about 75%

of agricultural land was experiencing moderate or worse drought.

Drought location also matters. Some agronomists and agricultural economists consider the 1988 Midwest drought to have been more severe and of greater national significance than the 2012 drought. One reason is that the 1988 drought hit a greater proportion of the Corn Belt than the recent drought. Another reason is that by more short-term measures (such as the Crop Moisture Index, or CMI) the 1988 drought was empirically of greater severity. While these relative rankings are somewhat sensitive to a number of measurement issues, there is no doubt that 2012 ranks among the worst agricultural, national droughts of the past century—at least meteorologically speaking.

Of course, drought severity, or more precisely exposure to severe drought, is only part of what determines drought impacts. The other part is drought vulnerability.

Figure 1. Exposure of Agricultural Land to Drought



Vulnerability is the sensitivity of impacts to levels of exposure.

Although it is still too early for a full accounting of the 2012 drought impacts, we already know that the 2012 drought is unlike any previous national-scale drought in terms of vulnerability. There are at least three reasons for this: 1) agricultural policies, particularly crop insurance; 2) price responses, particularly given sustained demand drivers; and 3) production practices that influence vulnerability.

Policy Differences in 2012

Major droughts have a history of impacting agricultural policy. The Dust Bowl led to the creation of the Soil Conservation Service (predecessor to today's Natural Resources Conservation Service) as well as numerous other aspects of agricultural policy. The 1988 drought, and the ad hoc disaster assistance provided by Congress in response, created the motivation for major changes to the crop insurance program in the 1994 Federal Crop Insurance Reform Act and the 1996 Farm Act. There may be policy changes that arise from the 2012 drought, but current indications are that the 2012 drought is unique in the extent to which agricultural policies helped to dramatically reduce the vulnerability of farms to drought impacts.

Crop insurance is arguably the most significant change since previous national droughts. While some form of crop insurance has been a part of agricultural policy since the Dust Bowl, the effectiveness of the program at reducing vulnerability only really took hold within the last two decades. The main reason for this has to do with voluntary participation decisions by farmers and the extent to which policies incentivize that participation.

Federal crop insurance works by providing premium subsidies (and other subsidies) to encourage farmers to purchase crop insurance from

private insurance companies that will guarantee some minimal portion of the farmers' expected crop revenues. Some insurance policies are only triggered by yield losses, generally due to factors such as drought, floods, frosts, pests or any number of other "perils." Other policies provide additional protection against revenue losses due to drops in crop prices.

There are a number of different crop insurance products that differ in how expected yields and prices are calculated and how indemnities are triggered, and the menu of available insurance products has changed considerably over the past two decades. For our purpose, the most important changes have to do with farmer participation in the program. As farmers have elected to enroll more acreage and to buy higher levels of coverage, the share of expected crop revenue that is insured has increased dramatically.

For example, we calculated the aggregate coverage rate for corn between 1989 and 2012 by multiplying the average coverage rate for insured corn acreage times the share of planted corn acres that has insurance. The result (Figure 2) shows that the aggregate coverage rate for corn has increased from 20% in the early 1990s to about 60% in the past few years. This places a significant floor on the damages to crop revenue that occur in response to a given national drought. We should note that some other crops, and other sectors such as livestock, are not as well-insured as corn.

Price Response in 2012

The relative strength, or elasticity, of commodity demand plays a large role in drought vulnerability since it determines how much negative yield shocks will be offset by price increases. Demand for crops is generally inelastic, indicating that when a supply shock such as a major drought occurs, the decrease in output is

proportionately less than the increase in prices. This can cause large increases in prices in response to even relatively small declines in supply.

In 2012 prices for corn, soybeans and other commodities increased dramatically. Since crops are traded in a national market, the higher prices provided some relief for farms with major (but not total) yield losses. Price increases almost perfectly offset moderate yield losses and provided a boost in revenue for those farms with close to expected yields.

Historically, prices have not always increased during droughts; the broader economy also plays a role. During the Dust Bowl, commodity demand had already weakened considerably due to the Depression. Producers faced not only declining yields but also weak demand.

The 2012 drought is notable for the demand conditions facing farms, particularly crop farms. Two major factors make 2012 commodity demand unlike previous national droughts. The first is growth in biofuels demand. Notably, corn ethanol production increased dramatically from the 1990s, and now uses over one-third of all U.S. corn production. Perhaps even more importantly in terms of drought vulnerability, the high gasoline prices and renewable fuels mandates that encourage ethanol demand arguably make aggregate corn demand much more inelastic. The second factor is increasing food demand from developing countries, especially India and China. As incomes increase, consumers demand more meat. This, in turn, increases livestock production and drives up grain demand.

The price impacts of the drought have led to farm sector income being forecast to hold steady in 2012, only declining slightly below 2011. This is not unprecedented; net farm sector income increased slightly in 1988. Income for the average farm business that specializes in major field crops is

expected to increase, while some farm businesses that specialize in livestock production are forecast to experience declines in income. While crop producers are expected to benefit from insurance indemnities and high prices in 2012, livestock farm income appears to be more vulnerable to drought impacts due to increasing feed prices.

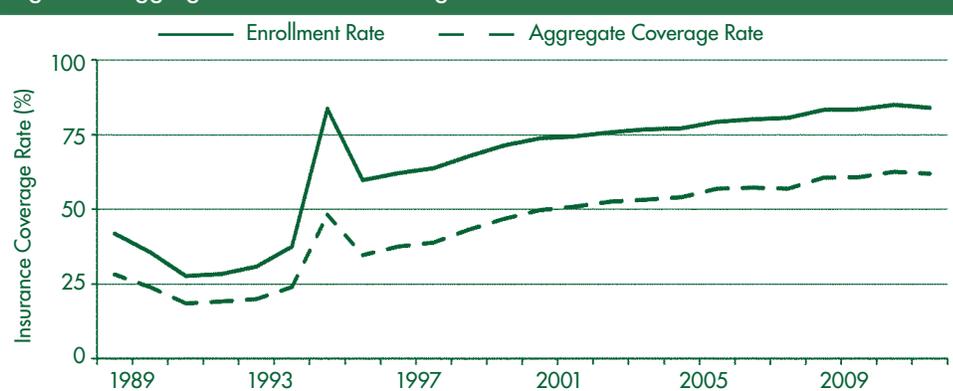
Production Practices in 2012

Beyond crop insurance and market-level reactions, the 2012 drought was also a unique national drought due to changes in crop production practices. Recent research suggests that drought vulnerability, measured as the sensitivity of crop yields to drought of a given magnitude, has been decreasing. While this research focused only on a few states and looked primarily at moderate drought, if these results hold for other states and for the severity of the 2012 drought, then there will be growing interest in determining exactly what has changed to reduce yield vulnerability.

One line of argument suggests that crop genetics have improved drought tolerance. A number of new drought tolerant corn varieties are now entering the seed market, but these are not yet widely planted. A more likely explanation is that selection for greater yields has come, in part, through improved water use efficiency, which is not the same as drought tolerance but is very closely related.

Another line of argument suggests that meteorological droughts, as measured by precipitation and temperature-based indices like the PMDI, do not accurately measure changes in soil moisture availability. One reason would be that no-till and conservation tillage has increased dramatically over the past two decades, in part in response to the availability of herbicide-tolerant seed varieties. Conservation tillage has the effect of reducing soil moisture loss, particularly during higher temperature periods.

Figure 2. Aggregate Insurance Coverage Rate for U.S. Corn



Notes: The "enrollment rate" is the share of corn acreage enrolled in each year, which is calculated as the net acreage enrolled in insurance (USDA, RMA) divided by the total planted acres (USDA, NASS). The "aggregate coverage rate" is the enrollment rate times the acreage-weighted average coverage rate (USDA, RMA).

A variety of other factors also influence drought vulnerability. Planting times are now occurring earlier, which moves the sensitive plant development stages earlier in the season. Due to a prolonged period of high commodity prices and low interest rates, the farm sectors debt to asset ratio is at a historic low, which reduces the risk of debt default due to drought.

Lastly, there have been some increases in supplemental irrigation as well as improvements in irrigation efficiency, which reduce water losses. Any of these factors could have been important in some of the regions impacted by the 2012 drought.

In conclusion, the 2012 drought was a major negative shock for U.S. agricultural production. For some farms and for some regions, the 2012 drought was a crisis. However, despite being meteorologically similar to earlier national droughts, it appears that the 2012 drought was not as damaging to the national agricultural economy as previous droughts and there are many reasons why this is the case.

An important challenge for looking forward—to the possibility of increasing drought risk under many climate change scenarios—is determining whether drought vulnerability in the future will look like the 2012 drought, the 1934 drought, or like something entirely different.

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For additional information, the authors recommend:

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