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The U.S. drought of 2012

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ABSTRACT

Seeds for the historic drought of 2012 were sown during the back-to-back La Niña episodes of 2010–11 and 2011–12. La Niña, a name given to anomalous cooling of the equatorial waters of the central and eastern Pacific Ocean, often correlates with drought development and expansion across the southern United States. Indeed, drought began to develop across the southern tier of the U.S. during the winter of 2010–11, and quickly intensified during the 2011 growing season. Effects of the 2011 drought were particularly severe in the south-central U.S.

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During the winter of 2011–12, a resurgent La Niña again contributed to drier-than-normal conditions in parts of the U.S. In addition, an unusual configuration of weather systems over the North Atlantic Ocean—including a very strong polar jet stream—kept the prevailing track of major winter storms far to the north over Canada. As a result, much of the U.S. experienced a "year without winter."

Given the antecedent drought conditions across the southern U.S. and the unusual warmth and dryness of the 2011–12 cold season, much of the nation entered the 2012 growing season with below-normal topsoil moisture. April showers staved off drought development, but the late-spring return of warm, dry conditions led to rapid northward expansion of drought across the Plains and Midwest.

An already tenuous moisture situation for rapidly developing crops was aggravated by hotter- and drier-than-normal conditions in May, June, and July. In fact, July 2012 was the second-hottest U.S. month on record (Fig. 1), narrowly trailing July 1936, and the summer also ranked second all-time (Fig. 2), behind only June–August 1936. In addition, the U.S. suffered through its driest summer since 1988.

1. Agricultural background: once-in-a-generation crop calamity

The drought of 2012 was a multi-billion dollar agricultural disaster in the United States. The drought was on par with the drought of 1988, which—according to the National Centers for Environmental Information (NCEI)—caused $40 billion (based on the 2015 Consumer Price Index cost-adjusted value) in mostly agricultural losses. NCEI estimates for the 2012 drought indicate that losses, again largely agricultural, topped $30 billion. Looking farther back, the U.S. drought of 2012 attained similar areal coverage to the U.S. drought of the 1950s, although the early to mid-1950s drought was marked by multiple years of extreme heat and precipitation shortfalls.

Nearly two-thirds (65.45 percent) of the continental U.S. was covered by drought (Fig. 3) on September 25, 2012, according to the U.S. Drought Monitor (USDM). On the same date, U.S. drought coverage—including Alaska and Hawaii—reached 54.77 percent. Both numbers represented records during the history of the USDM, which was first produced in 1999. Using the Palmer Drought Index (PDI), which is designed to classify long-term, rather than agricultural, drought, the drought of 2012 was the nation's worst—in terms of moderate to extreme drought coverage—since the 1950s. PDI drought coverage reached 60.4 percent in July 1954; 58.3 percent in July 2012; 57.6 percent in December 1956; and 52.3 percent in June 1988.

Among row crops, losses were most substantial for grain corn. Pre-drought estimates from the U.S. Department of Agriculture (USDA) indicated an expected U.S. corn yield of 166.0 bushels per acre and production of 14.79 billion bushels. Final 2012 numbers placed corn yield at 123.1 bushels per acre and 10.76 billion bushels—reductions of 26 and 27 percent, respectively. Also hit hard by drought was sorghum, which had pre-drought estimates of 65.0 bushels per acre and 335 million bushels. Sorghum estimates fell to 49.6 bushels per acre and 248 million bushels when final numbers were released. Soybeans, somewhat more drought tolerant due their ability to "shut down" during hot, dry spells and reproduce when cooler, wetter weather returns, experienced a 9 percent yield reduction (from 43.9 to 40.0 bushels/acre) and a

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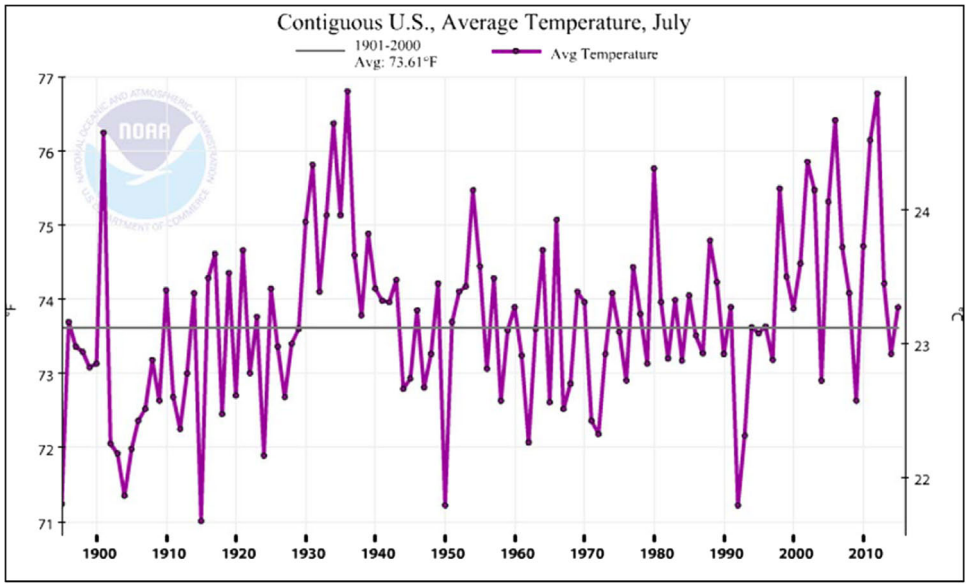

Fig. 1. July 2012 was the second-hottest U.S. month on record, narrowly trailing July 1936.

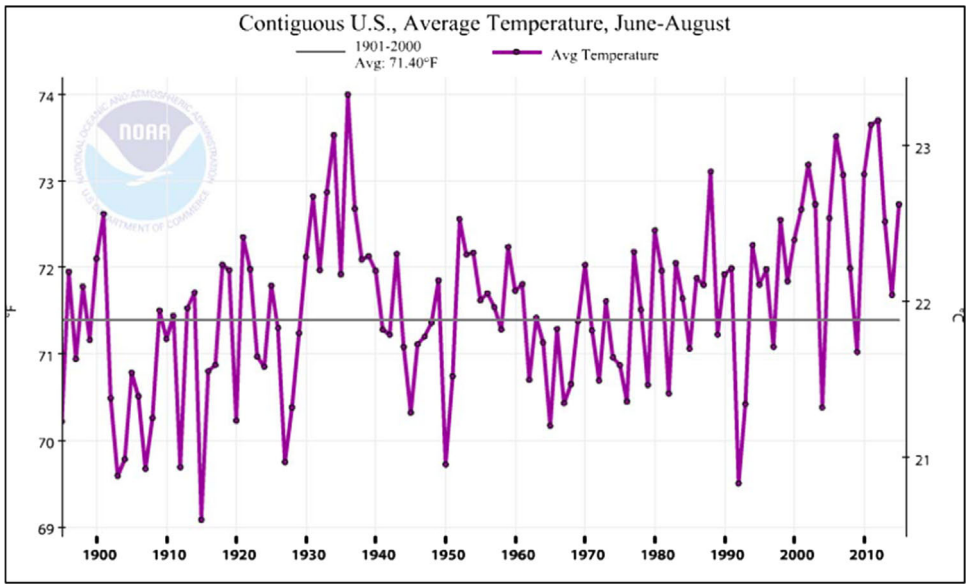

Fig. 2. June–August 2012 was the second-hottest U.S. summer on record, behind only 1936.

5 percent production reduction (from 3.21 to 3.04 billion bushels).

In all, the U.S. is estimated to have lost—based on reductions from pre-drought production figures—approximately 4 billion bushels of corn, about 170 million bushels of soybeans, and 87 million bushels of sorghum. More than one-quarter of the corn and sorghum was lost to the drought. From 2010–2012, U.S. corn yield fell in three consecutive years for the first time since 1928–1930, and for only the third time on record (Fig. 4). Field reports indicated that some crops, including corn, simply ran out of soil moisture due to high evapotranspiration rates.

Another U.S. agricultural sector adversely affected by the drought of 2012 was the livestock industry. According to analysis by USDA, more than three-quarters (76 percent) of the domestic cattle inventory was located in drought at the height of the 2012 dry spell (Fig. 5). Similarly, more than two-thirds (69 percent) of the domestic hay acreage was in drought (Fig. 6). Both of those peaks occurred on September 25. USDA also reported that U.S. rangeland and pastures were rated 59 percent in very poor to poor condition for five consecutive weeks in August–September 2012—the highest such percentage ever recorded during the 1995–2015 period of record.

Late-summer and early-autumn precipitation—including moisture from the remnants of Hurricane Isaac—provided drought relief in some areas, mainly from the Mississippi Valley to the Atlantic Coast, helping to revive pastures and soybeans. However, drought persisted through year's end in much of the western and central U.S., adversely affecting the Plains' 2013 hard red winter wheat crop that was mostly planted in September–October 2012.

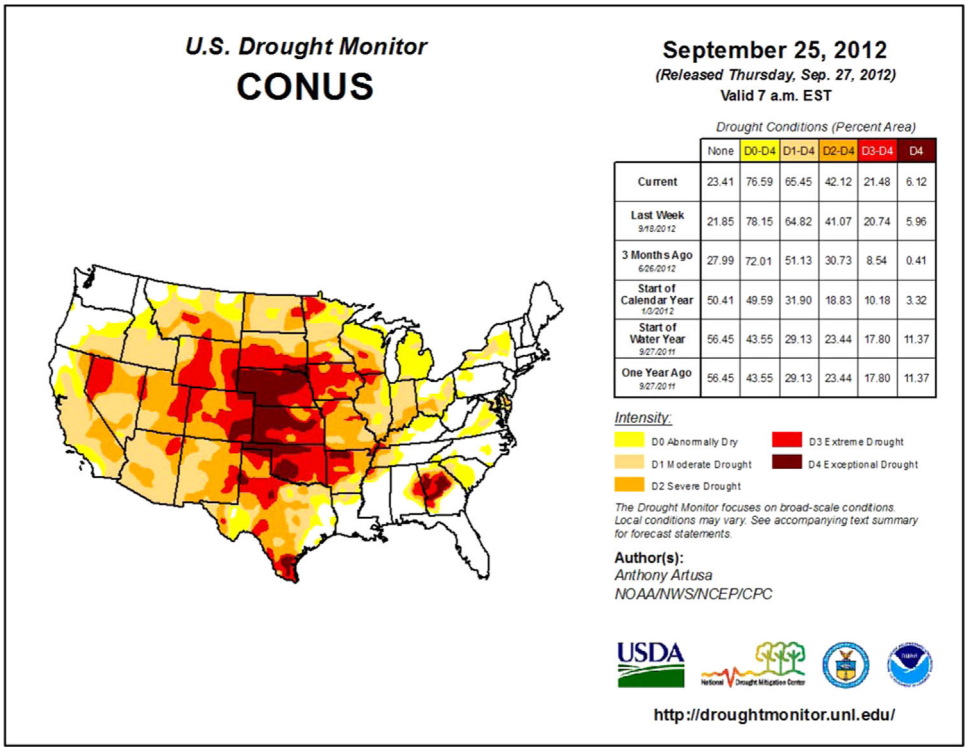

Fig. 3. Nearly two-thirds (65.45 percent) of the contiguous U.S. was in drought on September 25, 2012.

Interestingly, 2012–13 marked the second consecutive sub-par winter wet season in California—a fact that was not widely noted at the time due to adequate statewide reservoir storage following bountiful precipitation in 2010–11 (Fig. 7). In addition, California experienced a wet December in 2012, temporarily quelling drought concerns but showing that brief wet spells can occur amid long-term drought. Ultimately, California would endure its driest calendar year on record in 2013, resulting in extremely poor pasture conditions (Fig. 8) and causing a sharp decline in reservoir storage.

2. 2012 climate and drought details

Exacts causes and triggers of the drought of 2012 are still being debated in the scientific community, owing to the complex atmospheric and oceanic mechanisms that led to chronic precipitation shortfalls. Clearly, La Niña was a U.S. drought trigger starting in late 2010, initially across the southern tier of the U.S. Effects of drought in 2011 were particularly acute in the south-central U.S., where cotton abandonment in Texas was a record-high 62 percent (Fig. 9). That year, Texas—along with neighboring states of Louisiana, New Mexico, and Oklahoma—endured its hottest, driest summer on record.

During the winter of 2011–12, a northward-displaced polar jet stream kept much of the nation unusually warm. According to NCEI, October 2011–March 2012 was the second-warmest such six-month period in the U.S., narrowly missing the record set in 1999–2000.

Given antecedent drought conditions across the southern U.S. and the unusual warmth of the 2011–12 cold season, much of the nation entered the 2012 growing season with sub-par topsoil moisture. In addition, the U.S. growing season got off to a rapid start due to the warmest March on record—averaging nearly 9 °F above normal (Fig. 10). April showers staved off drought development for a while, but a late-spring return of warm, dry conditions (third-warmest, 25th-driest May since 1895) led to rapid northward expansion of drought into the Plains and Midwest.

For the remainder of the 2012 growing season, atmospheric forces largely conspired against U.S. pastures and row crops. From late May to early August, a high-pressure system developed and persisted over the northern Atlantic Ocean, effectively locking in a hot, dry weather pattern across most of the nation. Embedded within the overall hot, dry summer were two severe heat waves—one starting in late June and the other during the second half of July—that were especially harmful to grain corn.

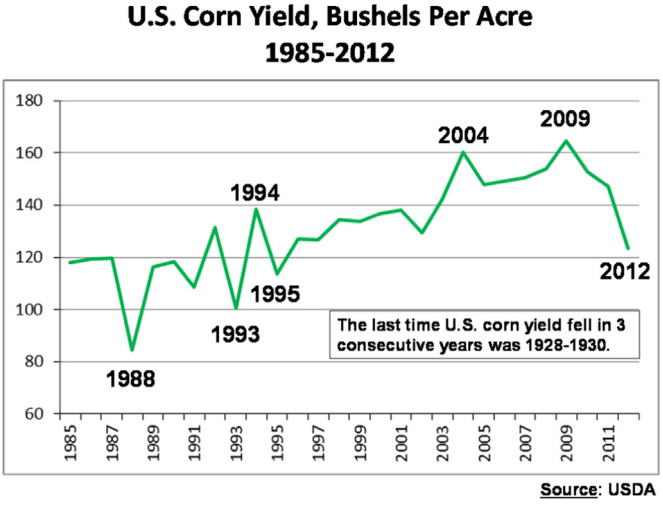

Fig. 4. U.S. corn yield fell in three consecutive years from 2010–2012 for the first time since 1928–1930.

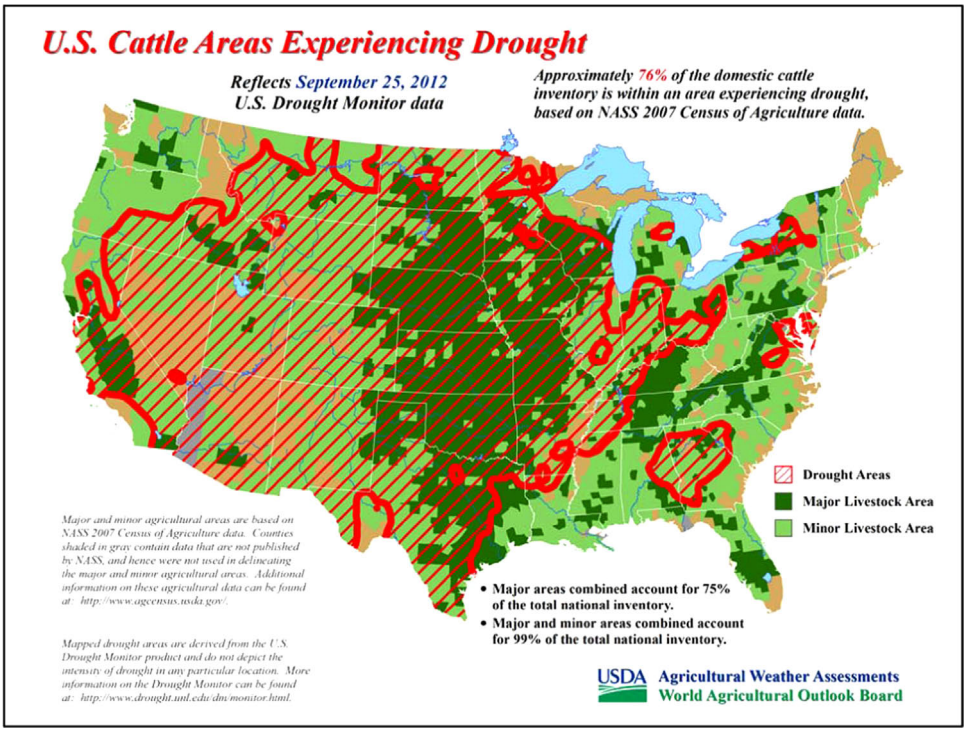

Fig. 5. On September 25, 2012, seventy-six percent of the U.S. cattle inventory was experiencing drought.

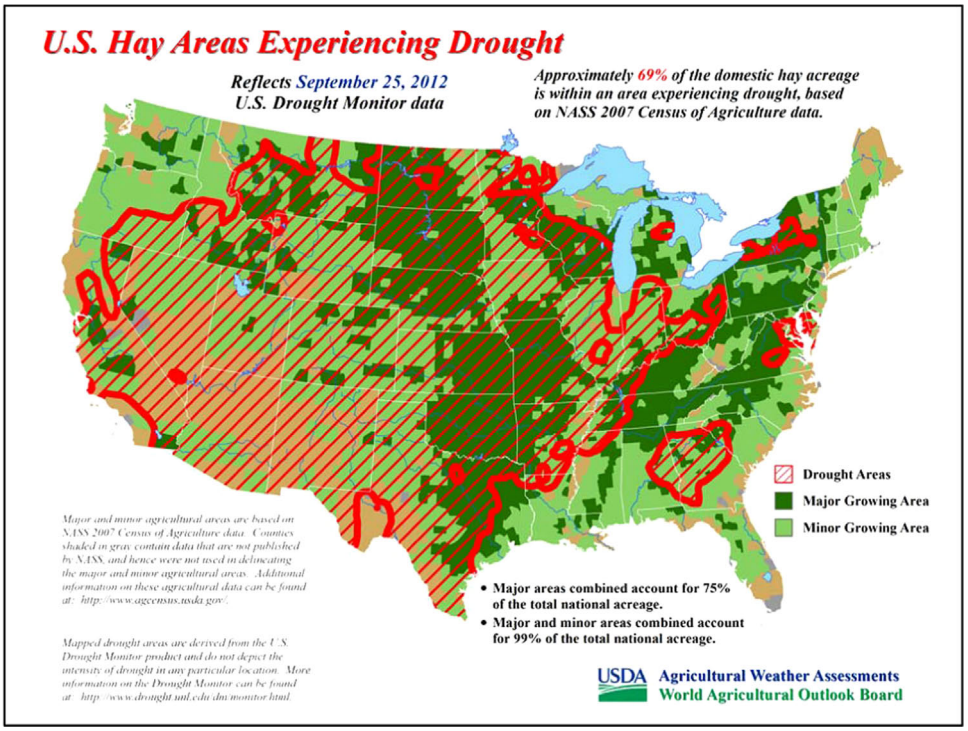

Fig. 6. On September 25, 2012, sixty-nine percent of the U.S. hay acreage was experiencing drought.

3. 2012 historical climate perspective

As previously noted, drought charged northward and intensified during the spring and summer of 2012. Complicating and exacerbating the drought situation, the nation suffered through its hottest year on record, fueled by a record-warm spring and its second-hottest summer. As result, nearly two-thirds (63.86 percent) of the contiguous U.S. was in drought, according to the U.S. Drought Monitor (USDM), by late July. Drought coverage eventually peaked on September 25, with 65.45 percent of the country affected.

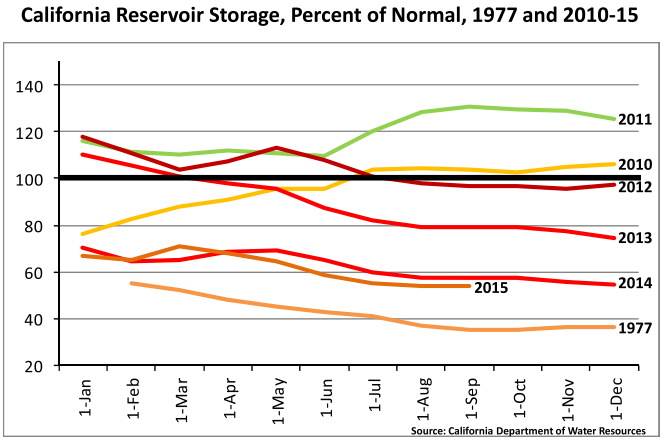

Fig. 7. California reservoir storage, as a percent of normal, is shown for 1977 and 2010–2015.

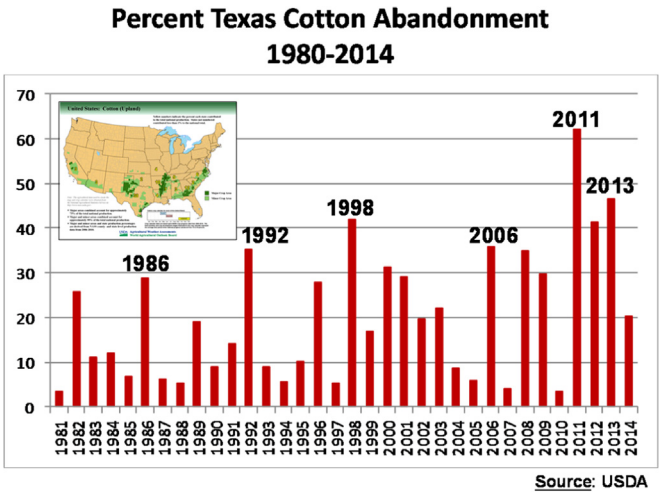

Fig. 9. In 2011, Texas cotton growers abandoned a record-high 62 percent of their planted acreage.

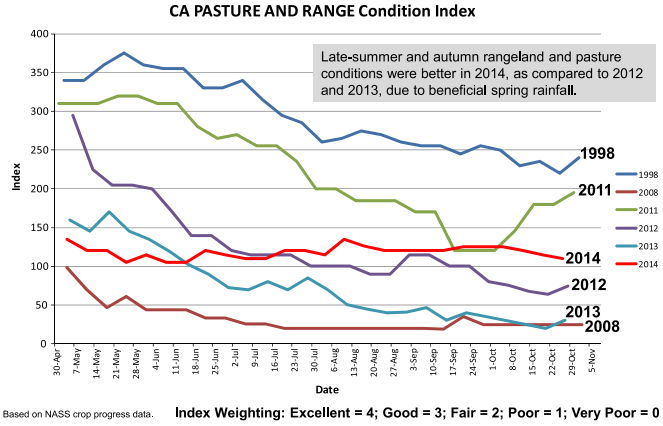

Fig. 8. California endured record-setting dryness in 2013, adversely affecting rangeland and pastures.

According to preliminary data provided by NCEI, the nation's annual average temperature of 55.3 °F was 3.3 °F above the 1901–2000 mean, demolishing the 2006 standard of 54.3 °F (Fig. 11). In fact, seven of the nation's ten warmest years on record have occurred in the last two decades—along with 2006 and 2012, they are 1998, 1999, 2001, 2005, and 2007. The only pre-1998 years still on the record books for top-ten warmth are 1921, 1931, and 1934. During 2012, all but three (Georgia, Oregon, and Washington) of the Lower 48 States reported one of their ten warmest years on record, and 19 states from the Southwest to the Northeast set annual records for warmth.

The nation also suffered through its driest year since 1988, and 19th-driest year on record (Fig. 12). Annual precipitation averaged 27.53 in. (92 percent of normal) across the contiguous U.S. For Nebraska and Wyoming, it was the hottest, driest year on record. Nebraska's record for dryness had stood since 1936. Near-record dryness dominated several other states, including Arkansas, Colorado, Delaware, Georgia, Illinois, Kansas, Missouri, and New Mexico. In contrast, relatively wet conditions prevailed during 2012 in the Pacific Northwest, the central Gulf Coast region, and parts of the Northeast. Washington ranked highest, reporting its fifth-wettest year.

4. Summary and conclusions

The drought of 2012 was the nation's most widespread agricultural disaster since 1988, and by some measures the worst U.S. drought since the 1950s. Yet, in its initial stages, the 2012 drought was viewed favorably by row-crop producers across the Plains and Midwest, as open field conditions promoted a torrid planting pace. U.S. corn planting was 20 percent complete by April 17—the earliest date on record—and surpassed the halfway mark before the end of April. By May 15, corn planting had reached the 90-percent mark, a feat previously accomplished only in 2000 and 2004.

Conventional wisdom has often held that early planting is conductive to higher-yielding crops. This is especially true for corn, which predictably moves through its reproductive and grain-fill stages of development, regardless of weather conditions. Therefore, it has been historically assumed that early-planted corn will advance through the reproductive stage prior to the hottest part of the summer, benefiting the crop. In 2012, however, an early (late-June) hot spell and subsequent (July and August) heat cost the corn crop more than one-quarter of its yield and production potential. At the height of the 2012 drought, in late July, nearly 90 percent of the U.S. corn and soybean production areas were located within an area experiencing drought (Figs. 13 and 14).

In the livestock industry, U.S. producers who had been forced to move their animals northward during the southern Plains' drought of 2011 had little choice in 2012 but to reduce their herds or import feed at great cost from some of the wetter corners of the country. In 2011, livestock inventory fell 13–15 percent in New Mexico, Oklahoma, and Texas, but rose 5–8 percent in Colorado, Iowa, Nebraska, and Wyoming (Fig. 15). Oklahoma lost 23.6 percent of its pre-drought cattle inventory—1.3 million head—during the three-year period ending January 1, 2013, while Texas lost 16.5 percent of its pre-drought cattle inventory—2.2 million head—during the four-year period ending January 1, 2014 (Fig. 16).

Eventually, the drought of 2012 migrated westward, taking aim on the western U.S. For example, California suffered through its driest calendar year on record in 2013, bringing national attention to a drought that had begun in 2011–12. By mid-May 2013, about half of the country remained in drought, nearly all across the western and central U.S. On May 12, 2013, more than one-third (39 percent) of the U.S. winter wheat was rated in very poor or poor condition, up from 14 percent at the same time in 2012.

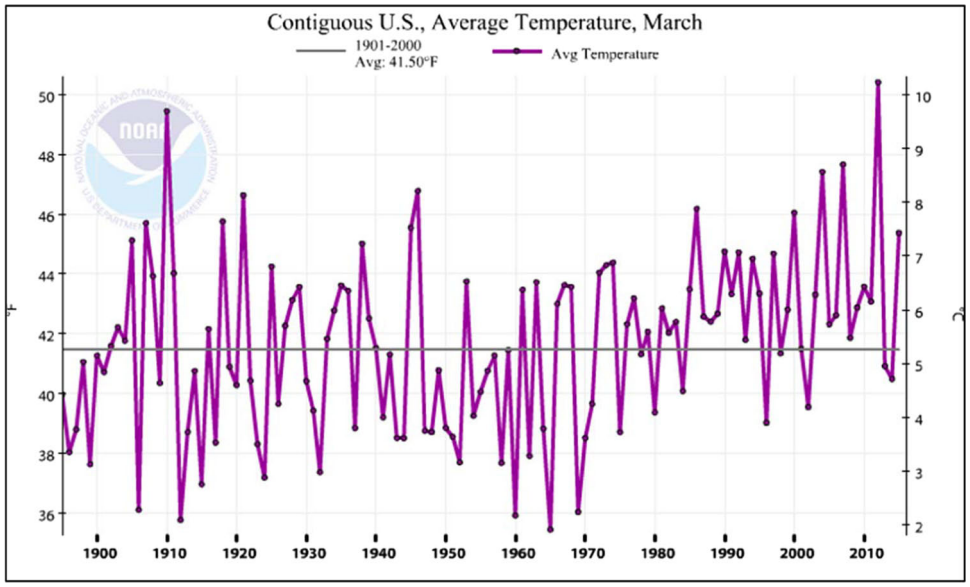

Fig. 10. In 2012, early-spring U.S. warmth resulted in the breaking of a 102-year-old March temperature record.

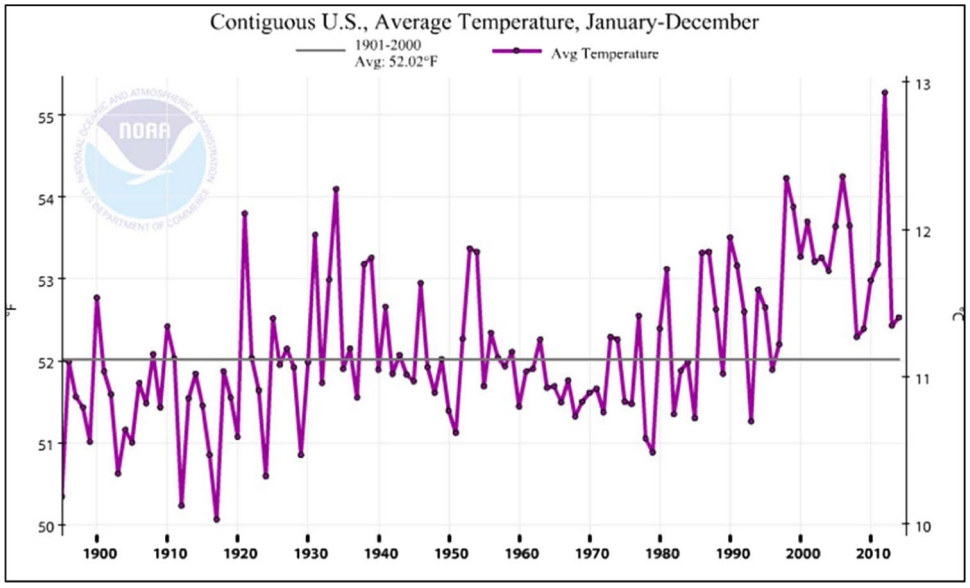

Fig. 11. In 2012, unrivaled U.S. warmth led to the highest annual average temperature on record.

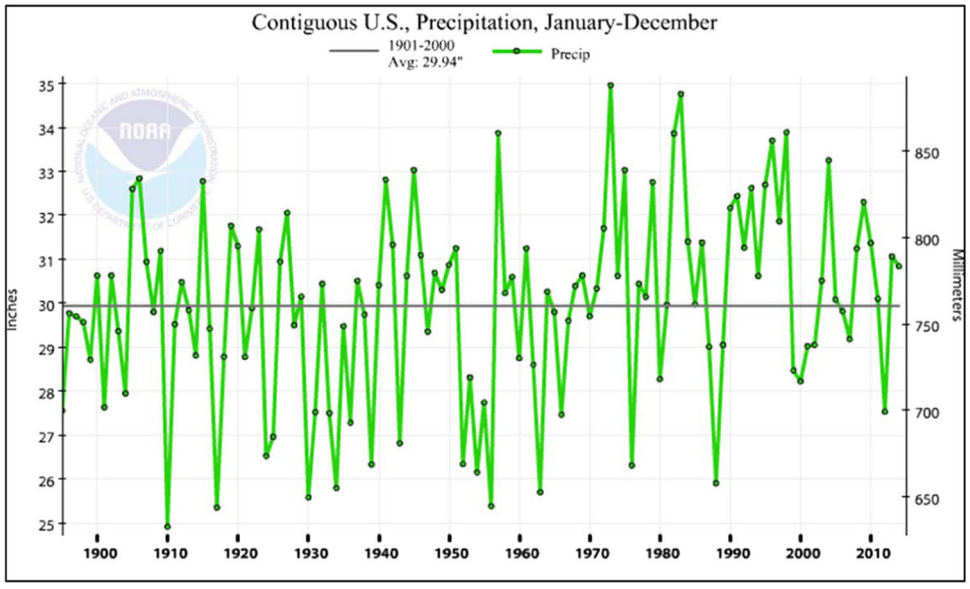

Fig. 12. In 2012, the U.S. experienced its 19th-driest year on record and driest since 1988.

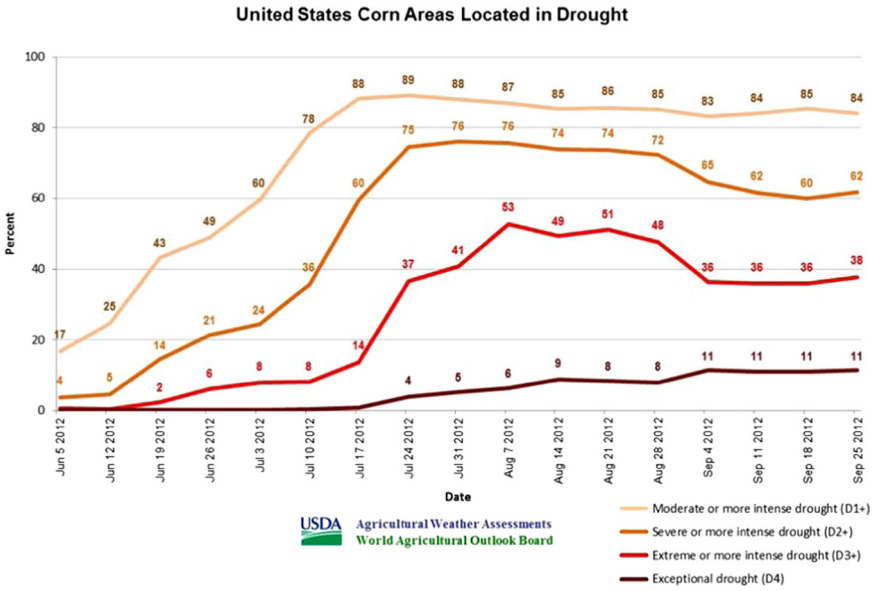

Fig. 13. On July 24, 2012, eighty-nine percent of the U.S. corn production area was located in drought.

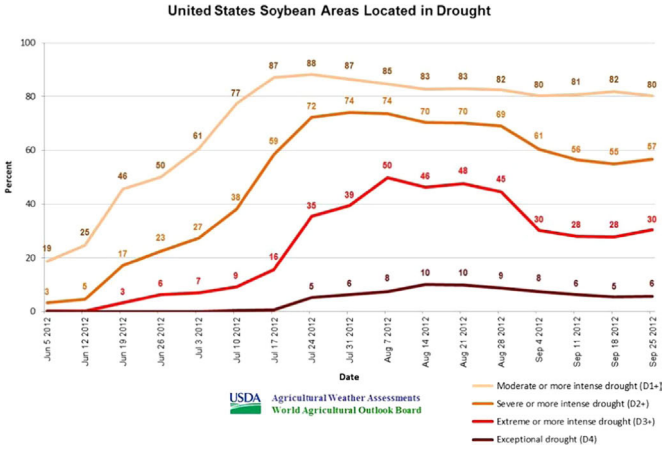

Fig. 14. On July 24, 2012, eighty-eight percent of the U.S. soybean production area was located in drought.

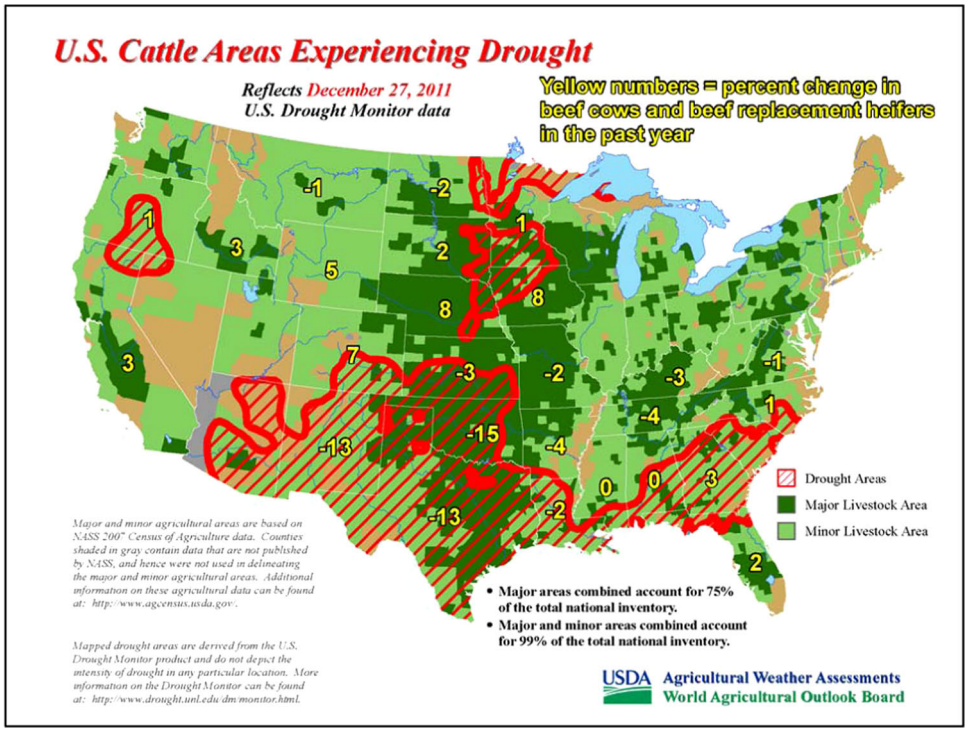

Fig. 15. Prior to the drought of 2012, there was a significant northward shift of livestock inventory.

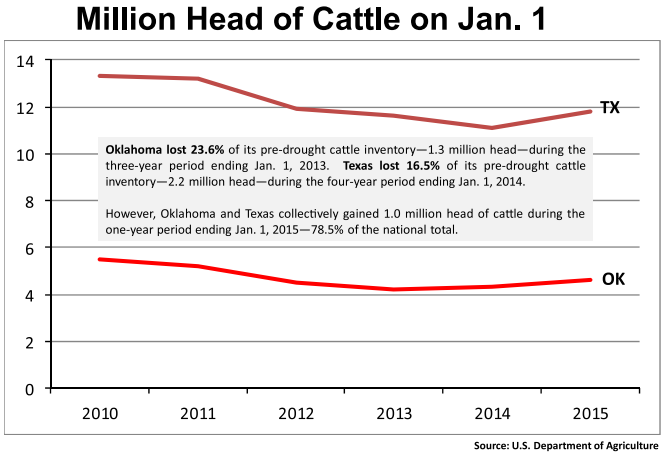

Fig. 16. Oklahoma and Texas lost substantial cattle inventory due to drought, beginning in 2011.

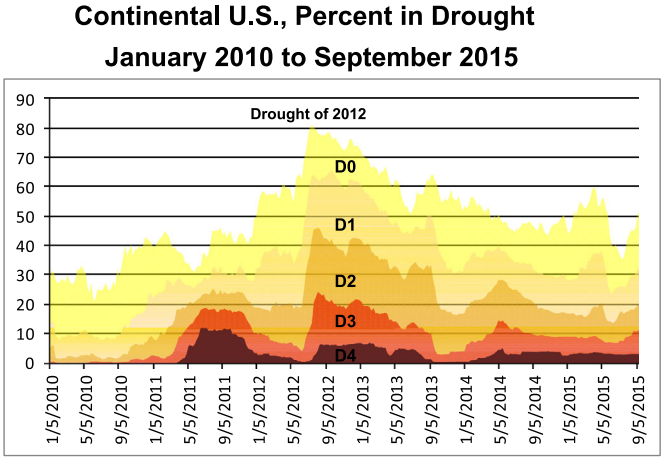

Fig. 17. Since early 2011, there has been an elevated amount of U.S. drought, compared to historical averages. Based on the U.S. Drought Monitor depiction, drought coverage peaked during the summer and autumn of 2012 with nearly two-thirds of the continental U.S. in drought (D1 or worse).

(Incidentally, the 2012 winter wheat crop matured and was largely harvested before significant drought developed.)

Looking back, 2012 represented the peak of a period of elevated U.S. drought coverage that has dominated the 2010s (Fig. 17). While causes of the drought of 2012 included La Niña, as well as other anomalies in both the Pacific and Atlantic Ocean basins, the complexities of oceanic and atmospheric interactions preclude identifying a single trigger for such rapid and unexpected U.S. drought intensification.