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Development, Adoption, and Management of Drought-Tolerant Corn in the United States

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What Is the Issue?

Droughts have been among the most significant causes of crop yield reductions and losses for centuries. Although Federal disaster program and crop insurance payments tend to be higher during droughts, they typically do not fully compensate farmers for drought-related losses.

Most crop farmers have limited options to reduce the damaging effects of drought. Producers with access to ample sources of irrigation water can, at least partially, mitigate certain drought stress. However, many water-intensive crops—including corn—are mostly grown on non-irrigated cropland. Drought tolerance in corn is a characteristic that has been the subject of research for decades, but has only recently been commercialized. Drought-tolerant (DT) corn produced using conventional breeding methods was commercially introduced in 2011. Hybrids genetically engineered (GE) for drought tolerance were introduced in 2012, but were not broadly available until 2013. GE drought tolerance protects corn plants from drought somewhat differently than conventionally bred drought tolerance and generally took more time to commercialize, both of which can influence the timing of adoption. However, the vast majority of DT corn planted in 2016 had one or more GE traits (e.g., herbicide tolerance and/or insect resistance).

To date, little has been reported about the adoption and use of DT corn in the United States. This report fills that void, examining the development, adoption, and management of DT corn in the United States, emphasizing the roles of recent and frequent exposure to drought, and farmers' moisture-conservation practices, choices of GE seed traits, and irrigation.

What Did the Study Find?

Over one-fifth of U.S. corn acreage was planted with DT corn in 2016. DT corn accounted for only 2 percent of U.S. planted corn acreage in 2012. By 2016, this share had grown to 22 percent. The pace of adoption is similar to the adoption of herbicide-tolerant corn in the early 2000s.

DT corn made up roughly 40 percent of corn acreage in some drought-prone States. In 2016, 42 percent of Nebraska corn acres and 39 percent of Kansas corn acres were planted with DT seed. These and other States with a 25-percent or higher adoption rate, such as South Dakota and Texas, experienced at least one severe-or-worse drought between 2011 and 2015. Northern corn-producing States, such as Minnesota, Wisconsin, and Michigan, experienced less-severe droughts during this time period. Adoption rates in 2016 on corn acres in these States were lower, ranging between 14 and 20 percent.

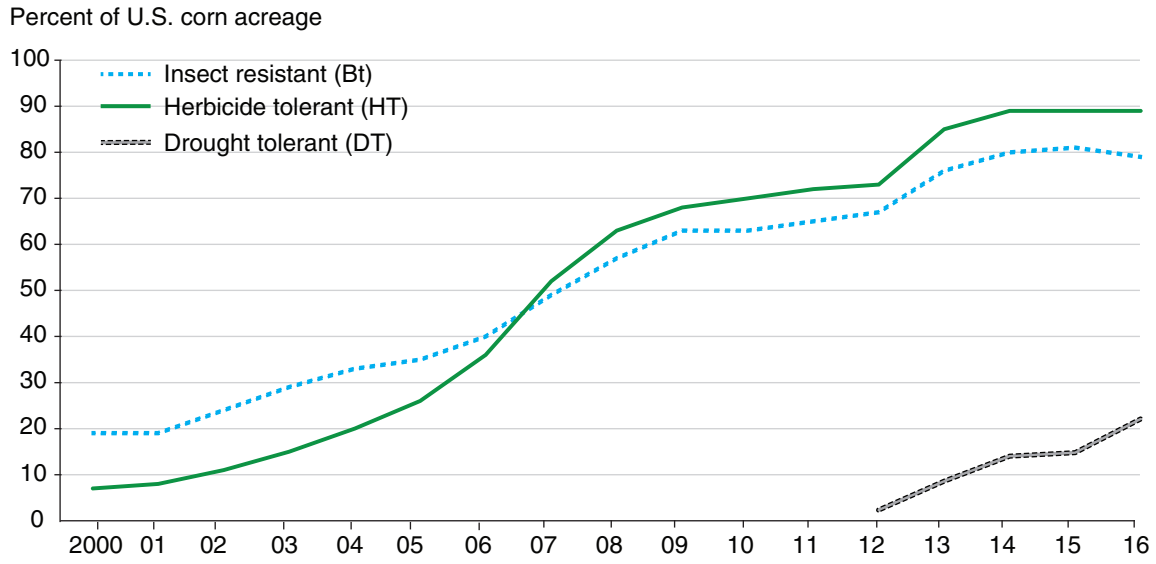
At least 80 percent of DT corn acres were planted in 2016 with seed conventionally bred for drought tolerance. Just under 20 percent of DT corn acres were planted with seed genetically engineered for drought tolerance in 2016. At the national level, 3 percent of all U.S. corn acres in 2016 were planted with seed that had been genetically engineered for drought tolerance.

The vast majority of DT corn in the United States has been genetically engineered for herbicide tolerance, insect resistance, or both. In 2016, 91 percent of DT corn fields were planted with hybrids that were also herbicide tolerant and insect resistant. Herbicide-tolerant (HT) corn can be sprayed with certain weed killers that do not damage the crop. Insect-resistant (Bt) corn is resistant to damage from certain insects that feed on corn.

Some conservation practices are more common on DT corn fields than on non-DT corn fields. Nearly 41 percent of DT corn fields in 2016 were not tilled, compared to 28 percent of non-DT corn fields. More broadly, 62 percent of DT corn fields in 2016 used tillage methods that minimally disturb soils (i.e., conservation tillage), compared to 53 percent of non-DT fields. In 2016, DT corn was more common on fields that had been planted with soybeans in 2015 than fields that had been planted with spring wheat. These trends may reflect climatic influences, since no-till practices and crop rotations influence soil moisture retention. However, the fraction of corn fields that were cover cropped (i.e., planted with a non-corn crop the previous fall to cover the soils over winter) did not vary by DT seed use in 2016.

Figure 2

Percent of U.S. corn acres planted with insect-resistant, herbicide-tolerant, and drought-tolerant hybrids, 2000-16



Note: The insect-resistant (Bt) and herbicide-tolerant (HT) lines also include acreage planted with stacked corn hybrids. Stacked hybrids contain both herbicide tolerance and insect resistance.
Source: USDA, Economic Research Service (ERS), "Adoption of Genetically Engineered Crops in the U.S." data product; USDA, ERS and National Agricultural Statistics Service, 2016 Agricultural Resource Management Survey; other sources (see Note to appendix fig. A-1).

How Was the Study Conducted?

We analyze data from the Agricultural Resource Management Survey (ARMS), which is jointly administered by USDA's Economic Research Service and National Agricultural Statistics Service. The report draws on field-level data from the 2016 ARMS survey of corn producers, representing 88 percent of U.S. planted acres in that year. ARMS data on yields, field characteristics, seed choices, tillage, crop rotation, irrigation, and other production practices are linked with county drought data from the U.S. Drought Monitor. We also discuss trends in private firms' DT corn market shares using company-reported data.