# The impact of weather on maize yield


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## Why is this important?

In 2012 there was a severe drought across the "breadbasket states" of the USA. As the world's largest producer and exporter of maize the impacts from this were felt globally as prices rose. The drought caused the maize yield to fall by 13% from the year before. Being able to predict food shortages caused by adverse weather conditions is of vital importance. However, before any statistical forecasting model can be built, it is always important to examine the data.

## The data used

As Iowa is the largest producer of maize in the USA maize yield and weather data from its 23 counties were used. The US Historical Climatology Network (USHCN) has 23 weather stations geographically spread across Iowa and their locations determined the counties used. The data covers thirty years from 1980 to 2010.

## Dataset challenges

Some errors in the dataset are hard to spot. For example you wouldn't trust the data from instruments this close to air conditioning units.


**Weather station at Marysville, California**
*Source :surfacestations.org*

## It's not just weather

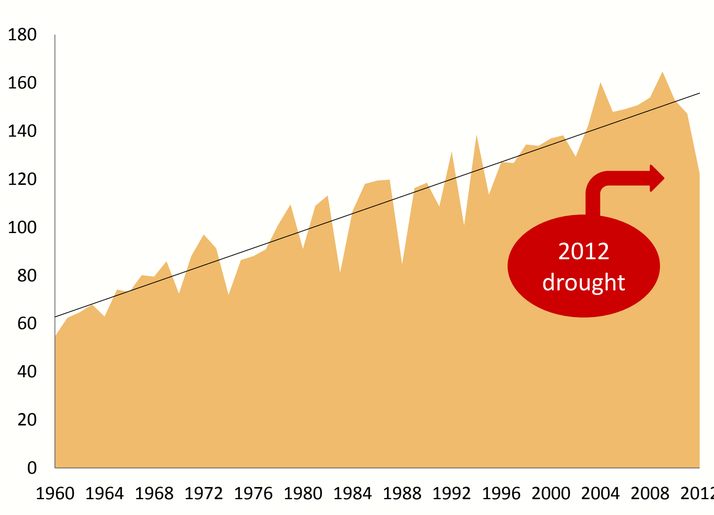


**Figure 1: Annual yield (bushels/acre) for maize in USA**

It's not just the weather that affects the yield. Figure 1 shows the yield has been steadily increasing over time. This is called the "trend yield" and is caused by technological improvements in seed genetics, crop management and fertilizers. To find out how much of the yield variation is due to the weather the technology trend needs to be stripped out. A simple solution is to fit a linear line through the yield and look at the residuals. The residuals will be negative if they fall below the trend line and positive if the fall above the trend line.

## Looking for patterns

Any links between weather conditions and the yield should be revealed as patterns when both are plotted together. Figure 2 compares yield residuals against the maximum temperature and the growing season precipitation. To make any patterns in the data clearer the residuals are divided up into three equally sized pots. Blue squares fall in the lower pot, green circles fall in the middle pot and orange stars fall in the upper pot. There are clusters of blue (lower yield) when there is low precipitation, high maximum temperature and a combination of low maximum temperature and high precipitation.

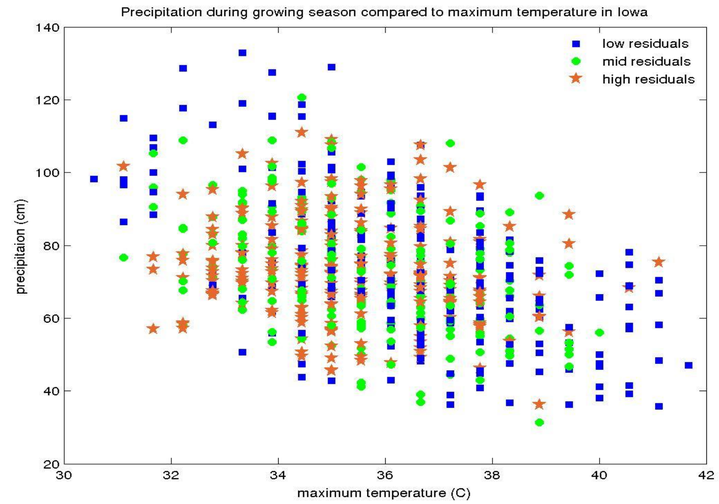


**Figure 2: Comparing the maximum temperature and precipitation during the maize growing season in Iowa with yield residuals. Notice how the blue dots cluster at the extreme ends of the weather variables.**

## Weather that has an impact on yield

Although severe droughts (such as 2012 and 1988) are the cause of the biggest fall in yield, other weather conditions also lower the yield. Too much precipitation, causing flooding, is also detrimental. What the weather is doing at certain key stages of maize development is also important in forecasting the yield. July is a crucial month, if there is too little precipitation during July it is hard for the crop to recover. Higher than average temperatures in August also reduce the yield. Throughout the growing season if the temperature ever gets too high, at roughly 40 C for more than a day, the heat stress on the crop reduces the yield.


**References:**

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