Combine Fires Events Under Hot Dry Harvest Conditions.

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Written for presentation at the
2012 ASABE Annual International Meeting
Sponsored by ASABE
Hilton Anatole
Dallas, Texas
July 29 – August 1, 2012

Abstract. An ongoing problem for sunflower producers in the Dakota's is the concern of combine fires during harvest. Numerous farmers have lost both combines and crops to fires started during the harvesting process. The most recent harvest season produced a large outbreak of fires during soybean harvest in the Upper Midwest. Working with equipment dealerships, producers, state fire marshals, and climatologists, data are being aggregated regarding what regions of the Midwest experienced an outbreak of combine fires during the 2011 harvest season. Weather and crop conditions at the time of the fires will be examined. Total numbers of combine fires will be estimated from sample data, as will the total amount of damage sustained due to these fires. This research may help identify mechanisms leading to combine fires and may lead to modifications in both practices and machines with the goal of limiting the risk of fires during harvest.

Keywords. Combine, Fire, Harvest, Safety, Soybeans, Sunflower.
Introduction

South Dakota has always been among the top leaders in sunflower production, second only to North Dakota. In 2011 South Dakota was the leading state for sunflower production with 777 million pounds (South Dakota surpasses North Dakota, 2012). One problem that sunflower producers continuously face is the risk of equipment fires during harvest season. The dried plants produce high amounts of dust and it is easily ignited by heat sources from combine harvesters. In 2011, the South Dakota oilseeds council funded a project through the Agricultural and Biosystems Engineering Department at South Dakota State University to determine the main ignition sources of the fires during sunflower harvesting and to work towards developing a plan of preventing these types of fires. As researchers at SDSU were working on the sunflower project during the fall 2011 harvest season, a rare phenomenon took place in the Midwest during soybean harvest. The 2011 soybean harvest season brought with it very dry weather which caused numerous farmers to lose both crops and machinery to fires. With work already being done on sunflowers we wanted to investigate the soybean fires to not only help find possible causes of the fires but also to attempt to quantify the amount of damage that was sustained due to fires during soybean harvest in the Midwest. The goal of this paper is to estimate approximately how much damage was caused due to combine fires in the Midwest and also determine what conditions make harvesting operations highly susceptible to fires. By doing this farmers will be more aware of the conditions that warrant extreme caution during harvest to prevent fires.

Methods

To collect our data we talked with farmers and implement dealers in northwest Iowa, Southwest Minnesota, and eastern South Dakota. We also contacted sheriff’s offices and fire chiefs and recorded all fires that emergency personnel were made aware of in numerous counties throughout the above stated region. The focus was primarily on northern to northwest Iowa and Southwest Minnesota due to the fact we did not receive feedback from the counties that were contacted in South Dakota. Ag equipment dealers and farmers proved to be unreliable for recording purposes so the data reported in this paper consists only of fires reported to emergency personnel. Therefore, all fires looked at for this paper was large enough to need the local fire department to be contained. It was not uncommon for producers to mention they heard of a neighbor who had a fire but was able to put out the fire with his/her own extinguisher and had sustained only minor damages. Those fires were not used for our analysis, as it was difficult to have valid information on those types of incidents. After collecting preliminary data and determining where the "hot spots" were for fires, weather data was acquired for specific areas utilizing the Iowa state weather data website: http://mesonet.agron.iastate.edu/AWOS/.
Results
Weather was very favorable for fires during harvest with a majority of the Midwest receiving little to no rain during soybean harvest, in addition temperatures were well above normal and winds were high. Sheldon and Cherokee Iowa areas both experienced a large number of fires during soybean harvest and both received approximately 0.5” of rain between September 15th and October 20th. Forest City Iowa, which is 90 miles east of Spencer, received approximately 4.5” of rain over the same time period. Forest City did not experience high fire danger during soybean harvest. Temperatures, relative humidity, and wind gusts however were very similar between Forest City and Spencer.

![Temperature - Spencer, IA.](image)

**Figure 1.** Average and Maximum temperatures for Spencer, IA during the 2011 fall harvest season.
Figure 2. Percent Relative Humidity levels for Spencer, IA during 2011 fall harvest season.

Figure 3. Wind Speeds in mph for Spencer, IA during 2011 fall harvest season.
The four graphs above show the weather data for Spencer, IA during the 2011 harvest season. A majority of the fires reported occurred on September 29, October 7, and October 14. The temperature on these days was not extremely high but did reach above 60 degrees Fahrenheit on all three dates. The relative humidity graph shows that the 29th of September had very low relative humidity values, along with the 7th of October. The 14th of October however had an average relative humidity value of 62.5% which indicates fires are possible during high humidity.

Looking at the two wind graphs, wind speed and wind gusts, both have three distinct peaks that indicate days which were very windy. Those three peaks fall on September 29th, October 7th, and October 14th. These are also the three days which we experienced the heaviest fire problems. This indicates wind may be a bigger factor in producing fires than extremely low humidity levels. Grain moisture samples were also collected for the dates and all ranged in the 6-9% range (p. lybrer, personal communication, March 16, 2012). This is very dry which produces fine, dry dust that is easily ignited.

Fire results were obtained from 18 counties in northern Iowa and southwest Minnesota. From those counties 100 combine fires were reported. Of the 15 counties who reported fire data to us, 6 of the counties included field fires during harvest. In those six counties, an additional 84 field fires were recorded. Many of the field fires started in fields producers were harvesting in or directly downwind from at the time of ignition. This would suggest that a spark came off of the machine and acted as the ignition source. Figure 5 below is a map of Minnesota and Iowa. The circled section highlighted in yellow is the region we gathered our data from.
Figure 5. Map of Minnesota and Iowa with focus area highlighted in yellow.
Economic Impact

The map above shows the counties in pink which we were able to gather fire numbers from. If the county has only one number listed in it that is the number of machinery fires which that county’s emergency personnel were contacted for. If the county contains a number followed by a “/” and another number, the first number is machinery fires, the second number is field fires. Most of the field fires which did not engulf the machine were started in a field being combined or downwind of the harvesting operation.

The fires which we have recorded include only fires which a fire crew was dispatched to. In talking with various implement dealers and producers, it was determined that if the fire crew was dispatched the combine likely suffered severe damage. Cost of replacement was estimated at $100,000 based on feedback from implement dealers (A. Popken, A. Schmidt, C. Fey, personal communication, April 20, 2012). I will also assume that the counties in our sampled region which we did not talk to experienced similar fire problems as the others in the area. I will use an average of 6.67 combine fires per county in the affected area. At approximately 36 counties that is an estimate of 240 combine fires. Using the $100,000 cost of replacement, we can
estimate a total cost of approximately 240 million dollars. This is likely a conservative number considering many machines today are worth more than $100,000 and it does not include any producers who had small fires they were able to extinguish themselves and have less extensive damage.

**Conclusion**

Every producer in the Midwest this past harvest was aware of the dry conditions and the possibility of fires. Certain counties in Iowa even had harvesting ban’s on during the fall, encouraging farmers to leave the crop sit until more favorable weather conditions allowed for safer harvesting conditions. This past fall was a unique situation and many farmers say they have never seen anything like it, this does not mean it will not happen again however. In recent we have been seeing more drastic weather patterns. This spring has again been an example of this, as we go long stretches without rain, but when we do receive precipitation it is in the form of strong thunderstorms and heavy amounts of precipitation. This could mean another dry stretch during harvest season 2012. Hot dry weather during harvest puts farmers at very high risk of experiencing fires while harvesting. However, what seems to cause fires to be very common is when hot dry conditions are combined with extremely high winds and dry crop conditions. If we have dry conditions and start experiencing wind speeds close to the thirty mile per hour range and above, it is likely fires will be inevitable, and producers should delay harvest until evening hours when winds decrease or wait for precipitation.

Under the event of dry harvest conditions some steps producers can take to reduce the risk of fires include (Humburg, 2012):

- Reduce rotor speeds while opening the concaves until a few seeds are left in the head. The less aggressive the machine is to the crop the smaller the volume of fine dust produced.
- Reduce the groundspeed to unload the machine. Running at a fraction of capacity is not what producers want to do, but will reduce the temperature of the exhaust system as the engine operates at lower pressures and consumes less fuel.
- Keep the engine compartment and exhaust system as clean as possible.

**References**

