Generating Geographic and Temporal Heat Maps of Aflatoxin Incidence using Regularized Linear Models

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Objectives

This project seeks to develop a model that uses geographical weather & climate data to generate aflatoxin production predictions.
The project can be broken down into the following goals:

- Weather data collection from NOAA database
- Aflatoxin data collection from primary articles
- Model development
- Heat map implementation

Introduction

A naturally occurring poison, **aflatoxin** is the byproduct of the mold *Aspergillus flavus*, and can have serious health implications for both humans and livestock [2, 4]. Besides causing possibly fatal liver damage in animals [1], aflatoxin is known to cause liver cancer in humans [6]. Recent droughts have further contributed to the incidence of aflatoxin, as **drought stress** increases corn plants' susceptibility to the fungus [3, 5, 8].
Numerous pet and livestock food companies have been forced to recall their products [2,3]. Usually, the problematic crops originate in fields in the southeastern U.S., in which corn production is a large portion of the economy [7]. These recent outbreaks pose a large threat to the agricultural sector of the region, as companies may choose to relocate their production to lower-risk areas.
The threat of aflatoxin is combatable, however. Awareness is key: once farmers know what areas of their fields are at risk, they can take preventative measures to inhibit the spread of the toxin [5].

Methods

Data Scraping

- Environmental Data from NOAA GSOD data set
- Aflatoxin values from primary articles (database compiled by Jonathan Senn)

Model Development

Initially, I developed simple linear regression models that take weather conditions and output predicted aflatoxin production values. In the future, I plan to move on to more sophisticated modeling techniques.

Heat Map

The final step in the process will be to make the models accessible to farmers and other interested parties by creating a map that shows aflatoxin risk (see Figure 2).

Contact Information

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Results

State/Region	Year	Number of Stations
AR	1998	4396
	1999	5171
	2001	5778
IA	1983	4015
IN	1983	3960
MO	1982	6337
	1983	6352
	1984	6454
MS	2009	8359
	2010	9092
NC	1978	6284
	1979	6017
Continental US	1973-2015	24558

Table 1. Weather data collected by state by year

Descriptive Statistic	Number of Stations
Mean	6017.92
Standard Deviation	1568.36

Table 2. Descriptive statistics of weather data by state

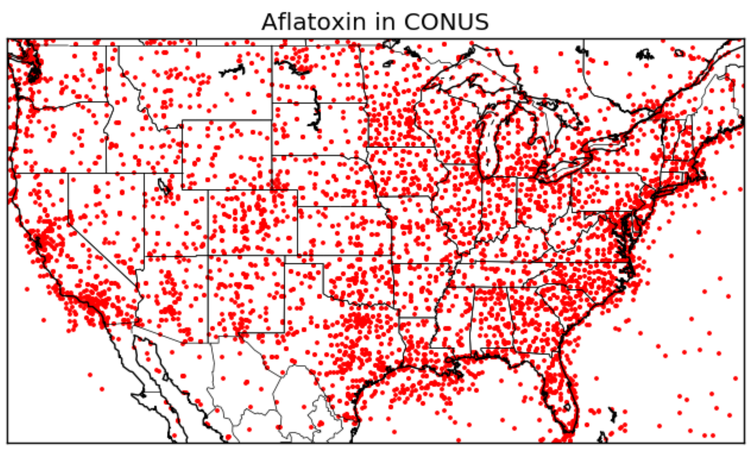

Figure 1. Station distribution in the continental US.

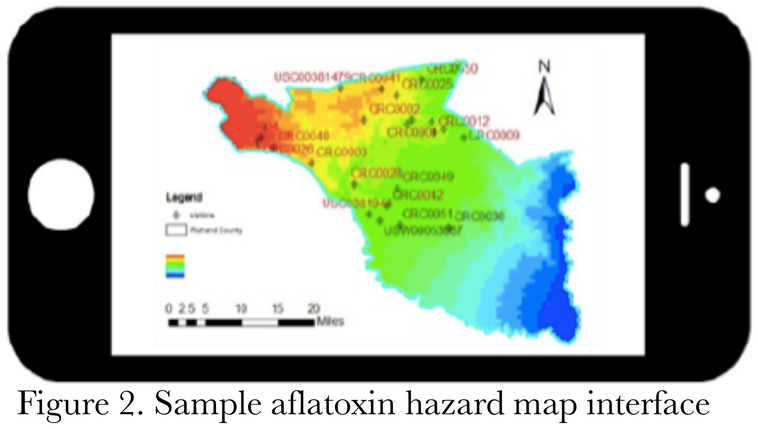

Figure 2. Sample aflatoxin hazard map interface on a smart phone.

Conclusion

Through the development of a **mathematical model** that utilizes geographic environmental data, such as temperature and humidity, to predict **aflatoxin incidence**, I hope that this project will decrease the incidence of aflatoxin in corn. When paired with interpolation and visualization techniques, this model can be represented as a **heat map** which shows high-risk aflatoxin areas at a given time, allowing famers to focus their preventative efforts and efficiently address the issue to impede the production and spread of aflatoxin.
Finally, this information must be disseminated to those who can benefit from it and made easily accessible to farmers through a website or mobile application, similar to the weather radar. All of these are next steps to be achieved in the time remaining in my grant period (until December 2017).

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Selected References

[1]Associated Press. (2006, May 10). Toxic Pet Food May Have Killed Dozens of Dogs. NBC News. Retrieved from http://www.nbcnews.com/id/10771943/ns/health-pet_health/t/toxic-pet-food-may-have-killed-dozensdogs#.VoLCHRorIxg
[2]Brinkman, M. (2005, December 20). Diamond Pet Food Recalled Due to Aflatoxin. Retrieved from http://www.fda.gov/Safety/Recalls/ArchiveRecalls/2005/ucm111929.htm
[3]Gillam, C., & Ingwersen, J. (2013, February 25). Dog food recall underscores toxic danger in drought-hit U.S. corn (E. Walsh, Ed.). Reuters. Retrieved from http://www.reuters.com/article/us-usa-corn-aflatoxinid USBRE91O16B20130225
[4]Godwin, J. (2011, September 7). Farmers should have corn tested for aflatoxin. Retrieved from http://www.ncagr.gov/paffairs/release/2011/9-11aflatoxintests.htm
[5]Hart, J. (2014, September 15). Mycotoxins a concern for North Carolina corn famers. Southeast Farm Press. Retrieved from http://southeast farmpress.com/grains/mycotoxins-concern-north-carolina-corn-farmers
[6]Liu, Y., & Wu, F. (2010). Global Burden of Aflatoxin-Induced Hepatocellular Carcinoma: A Risk Assessment. Environmental Health Perspectives, 118(6), 818-824. http://dx.doi.org/10.1289/ehp.0901388
[7]U.S. Department of Agriculture. (2016). 2015 State Agriculture Overview: South Carolina. National Agricultural Statistics Service. Retrieved from https://www.nass.usda.gov/Quick_Stats/Ag_Overview/ stateOverview.php?state=south%20carolina
[8]US grain sector on high alert for aflatoxin in drought-hit corn. (2012, August 30). Reuters. Retrieved from http://in.reuters.com/article/usa-drought-aflatoxin-idINL2E8JTA5T20120829