Agricultural species diversity to mitigate
***Aspergillus* crop infection and Aflatoxin B_1 human exposure**

PROJECT PROPOSAL — CLINT VALENTINE

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The human liver carcinogen aflatoxin B_1 (AFB_1) is a prevalent toxin produced by the fungi *Aspergillus flavus* and *A. parasiticus* which infect corn (maize) and nuts in regions of the world that experience hot and humid conditions (Groopman *et al.* 2014). AFB_1 is a DNA-binding toxin that contributes to genetic disease in the form of AFB_1-DNA adducts (Fiala *et al.* 2011). Crops become susceptible to *Aspergillus* through heat stress, high soil moisture, and insect-induced injury. Subsequent human exposure of AFB_1 is endemic in developing countries as a result of grain processing, quality control, and storage practices which favor mold growth (C. W. Schmidt 2013)

There are an estimated 4.5 billion people in the developing world that are chronically affected by aflatoxins in their diet and these exposures may account for between 25,200 and 155,000 cases of hepatocellular cancer yearly (Liu and Wu 2010) as well as 171 million cases of stunting in children worldwide (de Onis *et al.* 2012). In 2013, a cross-sectional study published in *Food Additives & Contaminants* shows that approximately 78% of 3,000 randomly selected serum samples in Kenya had detectable amounts of aflatoxins (Yard *et al.* 2013). In the same National Health & Nutrition survey it was found that approximately 17% of 2,000 randomly selected serum samples in the United States of America had detectable levels of aflatoxin compounds (Yard *et al.* 2013). This contrast shows a need for better agricultural and educational methods to control for aflatoxin exposure in developing nations.

Research involving the infection and transmission of *Aspergillus* species is critical in understanding why liver cancer is the 3^{rd} highest incidence cancer globally (Liu and Wu 2010). The link between aflatoxin exposure and childhood stunting was borne from the research of Kitty Cardwell, a plant pathologist with the Department of Agriculture (USDA). Cardwell compared blood samples from 700 children in her local area of study in Benin and Nigeria with increased levels of impaired growth (Gong *et al.* 2002).

The nonvector-borne fungus *Aspergillus* is resilient in most environments between 54°–118°C with high oxygen content (C. W. Schmidt 2013). Protecting crops is a challenge because *Aspergillus* can grow in many nutrient-deprived environments. Mitigating *Aspergillus* crop infection is further complicated due the difficulty in spotting and removing the infected plants.

It has been shown that genetic diversity within host populations aids in reducing the overall impact of infectious disease. This natural phenomenon has been shown to exist in many examples including mammals, birds, aquatic invertebrates, and plants (Ostfeld and Keesing 2012). Schmidt and Ostfeld first noted that this 'dilution effect' of the pathogen can occur when the species richness of an environment is increased (K. A. Schmidt and Ostfeld 2001).

It is my hope to develop a mathematical model of *Aspergillus* infection and transmission in crops. This model will then be used to simulate different degrees of biodiversity using the principles of spatial ecology and the insights on *Aspergillus* pathology on varying crop types found in in the primary literature. The insights gained from this approach could better inform farmers and grain processors in developing nations to reduce the aflatoxin consumption in the general population.

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