**Investigator (Name and Department):**

Dr. Dominic Reisig, Entomology and Plant Pathology

**Student Consultants:**

Autumn Biggie – Plan of Action

John Hinic – Project Description

Brennan Clinch – Next Steps

**Project Description:**

Our client is trying to determine what factors lead to the abscission of reproductive tissue in cotton. Bollworms are a very important insect pest of cotton, but the type of bollworm feeding that leads to abscission is not very well understood. This experiment has two primary objectives: (1) to determine which factors are most important in the abscission of cotton reproductive tissue, and (2) how this varies across different varieties of cotton.

The experimental design of this project involved testing several different Bt protein varieties in cotton (Bollgard II, WideStrike, TwinLink, non-Bt) across three different years (2014, 2015, 2016), with four replicates per year. It is expected that the years will capture much of the unknown variation due to things like environment or insect resistance, but that the four varieties will have similar performance relative to each other across all years.

To collect the data, the researchers cleared all abscised tissue from each plot at a weekly cadence. They then froze the tissue and analyzed them closely to record many variables of interest: the type and extent of tissue damage (i.e. the type of feeding), the bollworm pressure, the diameter/growth stage of the plant, etc.

Once the analysis is complete, the Dr. Reisig is looking to publish the findings. However, they must still be practical and interpretable enough for him to apply in practice. When he goes to a cotton farm, he wants to be able to figure out what is causing the abscission there, so providing a conceptually intuitive analysis will be a high priority.

**Plan of Action:**

To answer the research questions of the study, we will perform an initial exploratory data analysis, but the bulk of our efforts will be focused on modeling abscission of cotton bolls as a function of the other variables in the data set. To facilitate proper model training and performance measurement, we will split the data into a training and test set, with 75% of the data in the training set and 25% in the test set. The training data will be used to train the models, while the test data will be used to examine their accuracy. It is important to separate the training and test data to avoid introducing bias, since the models should not be evaluated based on how well they predict on data they have “seen before.”

Exploratory Data Analysis (EDA) will be conducted on only the training set as well in order to avoid the bias mentioned above. Our purpose is to ensure that our findings are applicable to cotton fields outside of this study, and that the models will predict with accuracy given new data.

The following methods will be considered as possible candidates for modeling: Logistic Regression, Decision (Classification) Tree, Boosted Trees, and Random Forest. We will use cross-validation to select the best model parameters when applicable, train the models using the training set, and evaluate their performance with the test set. The goal is to provide models that predict abscission with the highest accuracy while maintaining interpretability/utility of results. We will also explore the possibility of an interaction between feeding type and variety, and produce any related plots.

The Logistic Regression and Decision Tree models are expected to be the most interpretable. A decision tree graphic will be provided as a visual representation of the relationships between variables. The Boosted Trees and Random Forest models are expected to produce the highest accuracy, but are less interpretable due to “averaging” over many generated trees. However, we can still produce a plot of variable importance measures from the Random Forest model and compare it to the results from other models.

**Next Steps: Who is responsible for what and by when.**

Look over the data and other information in order to determine clarification questions for the next meeting with the client. *Autumn, John and Brennan, finish by 6/3.*

Send email to client scheduling second meeting. *John, finish by 6/3.*

Find any underlying issues with the data which can be resolved/cleaned before the second meeting with our client discussing our clarifications. *Autumn, John and Brennan, finish by 6/14.*

Have a second meeting with the client clarifying the top variables of interest and research questions. *Autumn and John, finish by 6/16.*

After meeting with the client again and getting clarification, clean out any remaining issues with the data given the top variables of interest. *Autumn, John and Brennan, finish by 6/23.*

Perform initial analysis of the data/fit different models and then present findings to client. *Autumn, John and Brennan, finish by 7/3.*

Prepare the first draft of the final report. *Autumn, John and Brennan, finish by 7/10.*

Have any issues from the initial analysis fixed or modified, perform final analysis, present final analysis to client. *Autumn, John and Brennan, finish by 7/19.*

Have any modifications about the interpretability, conclusions, or study resolved and have the final presentation. *Autumn, John and Brennan, finish by 7/24.*

Turn in the final report to the client. *Autumn, John and Brennan, finish by 7/31.*