Report 10/31/2014
2013/2014 National Peanut Board/SPRI Research Proposal

I. Identification

Title: PeanutFARM website: delivery of irrigation scheduling, improved methods of peanut maturity determination, and disease prediction to peanut growers

Funding Year: January 1, 2014 – December 31, 2014

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Total Funds Requested: $48,700

Locations: Florida, Georgia, Alabama

Continued Project: Two years of previous support have been received; it is anticipated that a minimum of 1-2 additional years of support is needed to fully validate all tools. Continued minimal support for maintenance of the website is also anticipated. Additional tools are being considered that can take advantage of the existing platform; support may be requested for development of these future tools.

II. Layman’s Summary: To remain both economically and environmentally sustainable, peanut growers require access to new technologies and tools that can maximize production through improved agronomic management of their peanut crop, including ir-season and harvest decisions. With the release of the web based tool, Peanut FARM (Field Agronomic Resource Manager) funded in part by the NPB/SPRI program in 2012 and 2013, growers now have access to a suite of tools. TOOL #1: Peanut maturity predictor. An adjusted growing degree day (aGDD) model for predicting peanut maturity has been incorporated into a web platform and was launched for the 2013 growing season. TOOL #2: Irrigation Scheduling System. Launched with the aGDD tool in 2013, this tool utilizes cumulative aGDD’s and ET to estimate crop water use and provides daily irrigation recommendations. TOOL #3: Digital imaging model (DIM). Our team has finalized the development of DIM to assess peanut maturity and have successfully translated the digital analysis of mesocarp color into a digging date prediction. We are currently developing a web platform for the tool on the PeanutFARM site. TOOL #4: Proposed disease prediction tool. Utilizing the weather based data that is collected on PeanutFARM, Dr. Dufault’s team will implement several disease index tools that will provide growers with disease risk indices for white mold and leaf spots during the growing season.

III. Project Purpose: Both the aGDD and DIM methods have been rigorously tested in GA, FL, and AL over the last two years and analysis of their harvest prediction is indicating at least equal performance with the widely accepted maturity profile board (Williams and Drexler 1981), but with less analysis time and subjectivity. Accumulated aGDD values can be used to predict crop developmental stage in-season and have been incorporated into an irrigation scheduling model. The launching of these tools on a web platform has now made them freely accessible to growers across the tri-state area and there have been 124 growers and researchers registered as users during the 2013 growing season. Further validation testing will help us identify any problems with these models and continue to refine and perfect them. We will also incorporate a novel disease prediction model that will utilize the web platform and weather data already accessed by the program. This new disease prediction tool will further enhance the capability of PeanutFARM and offer another production management technology to peanut growers throughout the southeast. This is a multi-year project.

IV. Hypothesis and Objectives: We hypothesize that growers can manage peanut irrigation scheduling, disease management, and maturity predictions effectively through a set of weather-based algorithms centered on the calculation of aGDDs. We propose continued testing and refining of these tools as well as the addition of a disease prediction model. The specific objectives are: 1) continued testing and validation of the aGDD maturity and irrigation tools; 2) continued in-field and web testing of the DIM model for peanut pod color
analysis and testing of the image upload capability on the existing PeanutFARM website; and 3) develop new disease prediction tools that utilize the weather data from PeanutFARM and test their ability to predict white mold and leaf spots. **Objective 1 and 2:** We expect to continue testing the aGDD model and DIM with samples collected from grower cooperator fields in GA, AL, and FL and on research plots at UF, UGA, and Auburn. Due to the extreme precipitation levels during the growing season of 2013, an adequate test of the irrigation scheduling tool was not possible, so further testing on grower cooperator fields is necessary. **Objective 3:** Utilizing a novel disease risk model developed in Dr. Dufault’s UF lab that relies on soil temperature and rainfall data and other published disease prediction tools (i.e. AUPnut), a disease prediction tool will be launched on PeanutFARM that will access this data already available on the web platform.

V. **Experimental Plan and Methods:** We will accomplish the objectives through the following tasks:

**Task 1:** Continued beta testing with extension agents and growers in 2014 on 2-3 farms each in GA, FL, and AL. One of the most important objectives to accomplish this year is the ability to modify the weather station rainfall data by field. Currently, we have built in the capability to edit the rainfall data per weather station, but cannot edit for multiple fields utilizing the same weather station.

**Task 2:** Continued in-field testing of DIM model for peanut pod color analysis by collection and analysis of samples from the same 2-3 farms in each state that are being used in beta testing of the aGDD website tools during the 2014 harvest season. We will also test and refine the methodologies for image upload and DIM analysis capability on the existing PeanutFARM website in 2014.

**Task 3:** Develop a platform to beta test the delivery of a white mold ensemble risk tool and leaf spot advisory resource based on the AUPnut model. Researchers, extension educators and growers will be asked to evaluate the disease risk tools and platform utility during the 2014 growing season.

Continued validation of the tools on PeanutFARM for current and future cultivars and regions is important for insuring the model’s performance under varying climatic and regional conditions. Beta testing of the irrigation scheduling model utilizing accumulated aGDD’s will be needed in 2014 because high precipitation in 2013 did not allow for an adequate test for the irrigation scheduling decisions.

VI. **Measurable Outcomes and Potential Impacts:** The PeanutFARM website was launched during the 2013 season and currently has 124 registered grower and researcher users across GA, FL, and AL. Distribution via the internet of these tools has and will continue to make widespread adoption both fast and simple. Refinement of existing tools and further development of additional tools, such as the disease prediction tool, will add beneficial economic impacts for southeastern peanut growers. For example, a 1-point average grade increase through improved harvest prediction on as few as 1% of US acres could easily pay for 2-3 years of this study. Providing an efficient irrigation scheduling tool easily delivered via the web could decrease irrigation costs and demonstrate grower stewardship of water resources. The addition of in-season peanut disease risk tools to PeanutFARM can be used to complement Peanut Rx to provide growers with the information needed to make quality and cost effective changes to their fungicide spray programs.

VII. **Potential Pitfalls:** None.

VIII. **Results from Previous NPB funding: Deliverables from 2013 funded project:** Work in 2013 included: the addition of AL weather stations on the web platform; continued testing of grower farms in GA, FL, and AL; continued research plot testing of the aGDD and DIM methods on varying cultivars; and the development of a sister website, Peanut Profile that allows for the utilization of the DIM model on user uploaded images. The Peanut Profile sub-site is currently in the final stage of development. The color identification process will be using a combination of J-Query and PHP to allow the end user to upload photos and let the website automatically return a harvest date prediction. This process will involve a complex script that references color identification in hex to known color analysis profiles of peanut harvesting.

The results from this project were presented at numerous grower meetings throughout the Southeast and the PIs have worked closely with growers in troubleshooting use of the site, fielding questions, and implementing changes on the website through grower suggestions.
**Progress to Date (10/31/2014)**

**Task 1:** Continued beta testing with extension agents and growers in 2014 on 2-3 farms each in GA, FL, and AL. One of the most important objectives to accomplish this year is the ability to modify the weather station rainfall data **by field**. Currently, we have built in the capability to edit the rainfall data per weather station, but cannot edit for multiple fields utilizing the same weather station.

**Progress to date:** The ability to edit the rainfall data by field was incorporated in July 2014. Growers can now go into their accounts and modify the rainfall data that is automatically downloaded from the weather station for individual fields using an “edit” button within the “Data Center”, “Edit Rainfall” tabs (Figure 1).

![Rainfall Data for 2014](image)

**Figure 1:** screenshot showing the Edit Rainfall capacity implemented in the 2014 project.

We tested the irrigation scheduling and maturity tools of PeanutFARM on research trials in FL, GA, and AL. Irrigation was scheduled using PeanutFARM for research trials conducted at the Plant Science Research and Education Center in Citra, FL in 2014 (29° 24' 38" N, 82° 10' 12" W). The soil is classified as a Gainesville loamy sand (Hyperthermic, coarse Typic Quartzipsamments). Daily climate data is being recorded using an automated weather station located within 500 m of the experiment.

Irrigation and peanut genotypes were arranged in a split plot arrangement in a randomized complete block design. Each split plot consisted of six rows (12.2 meters in length with 0.91 meter between rows) of two runner (**Arachis hypogea** type peanuts FloRun 107 and TUFRunner 51'), and two valencia (**Arachis fastigiata**) type peanuts New Mexico Valencia C and COC 041. The irrigation treatments were the main blocks and consisted of a rain-fed, six tenths of an inch (60%), and one inch (100%). Irrigation scheduling was determined when 50
relating percent canopy coverage to water loss throughout the growing season ($ET_c = ET \times K_c$). Both irrigation and rainfall are added into the soil water mass balance equation. The two irrigated treatments were replicated three times and the rain-fed treatment was replicated two times due to space limitations under a linear irrigation system.

Four irrigation treatments were applied on all peanut cultivars at 28, 72, 95, and 104 DAP (Figure 2). A fifth irrigation treatment was applied on the runner cultivars after harvesting the Valencia cultivars at 125 DAP. Greater yield of 361 kg ha$^{-1}$ resulted from the reduced (60% of full) irrigation treatment in comparison to the full rate and rain-fed treatment planted to the New Mexico Valencia C cultivar (Table 1). Yields were similar among the different irrigation treatments for the COC 041 cultivar.

Figure 2: Daily (bars) and cumulative (line) rainfall from 22 April (planting date) to 21 September in 2014 at the Plant Science Research and Education Center. Arrows represent when irrigation treatments were applied. Cumulative rainfall for this time period is 56 cm. The average for this time period for the past ten years is 64 cm.

Table 1. Average yield among *Arachis fastigiata* species in 2014. Data was averaged over replications and error represents ± one standard deviation.

<table>
<thead>
<tr>
<th>Irrigation</th>
<th>COC 041</th>
<th>New Mexico Valencia C</th>
<th>FloRun 107</th>
<th>TufRunner 511</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full</td>
<td>2630 ± 410</td>
<td>2487 ± 196</td>
<td>3358 ± 392</td>
<td>3887 ± 747</td>
</tr>
<tr>
<td>Reduced</td>
<td>2358 ± 322</td>
<td>2848 ± 151</td>
<td>4904 ± 309</td>
<td>5543 ± 904</td>
</tr>
<tr>
<td>Rain-fed</td>
<td>2528 ± 433</td>
<td>2487 ± 40.0</td>
<td>4283 ± 600</td>
<td>4818 ± 832</td>
</tr>
</tbody>
</table>
We have also worked with growers in Levy County, FL who are scheduling irrigation with the PeanutFARM website and have received information from the extension agent, Anthony Drew, that the program is working well for predicting the correct irrigation timing. However, rainfall amounts have been excessive in the 2014 growing season as they were in 2013; therefore, we still are not confident that the beta testing for the irrigation scheduling tool is adequate.

**Task 2:** Continued in-field testing of DIM model for peanut pod color analysis by collection and analysis of samples from the same 2-3 farms in each state that are being used in beta testing of the aGDD website tools during the 2014 harvest season. We will also test and refine the methodologies for image upload and DIM analysis capability on the existing PeanutFARM website in 2014.

**Progress to date:** Samples are being collected from four research trials not conducted for this particular trial, but profile board assessments and DIM analyses are being compared. For the irrigation trial described above, the maturity sample analyses have been completed and the board and DIM results for percent black/brown pods are shown below, showing a very close agreement between the two (Figures 3, 4).

![Bar chart showing the ratio of black and brown pods per total amount of pods for digital image (DIM) analysis and hand sorting (based on the profile board) for each irrigation treatment.](image)

*Figure 3. Average ratio of black and brown pods per total amount of pods for digital image (DIM) analysis and hand sorting (based on the profile board) for each irrigation treatment.*
Figure 4. Average ratio of black and brown pods per total amount of pods for digital image (DIM) analysis and hand sorting for each peanut genotype.

In addition, samples have been received and are being processed for a research trial conducted by UGA examining different harvesting dates (at given aGDD values) among cultivars (Figure 5). Blasted pod samples have been received and are being visually color sorted according to the profile maturity board and are being imaged to obtain the DIM value. The percent black/brown pods will be compared between the visual sorting based on the board and the DIM procedure. Analysis is ongoing and samples are still being collected from the field.
Figure 5: Design for maturity study being conducted at the Ponder Farm, Tifton, GA. To date, over 75 of the 128 maturity samples have been received and are being processed by UF.

The upload capability for DIM images onto the sister page of PeanutFARM named PeanutPROFILE has been completed. A virtual server has been established and will allow the web server to transfer data back and forth, transferring scan uploads and file transfers. The new page will incorporate an automated script using C++, running in the background, to execute the secondary automation script that runs the imaging software. The imaging software will process files that were uploaded from the website and stored on the virtual server. The C++ script will then produce an email that sends the harvesting results to the user.

The page is now launched and has the background information about collecting maturity samples, blasting them, and the description of the profile boarding method (Figure 6). There are also instructions about how to scan pods, save the image in JPEG format, and upload to the PeanutPROFILE page. In the background, our team has been able to completely automate the image analysis process so that when an image is uploaded to the PeanutPROFILE page, it will automatically note the users email address, analyze the image and save it with the name specified by the user, and within 20 minutes, will send an automated email message that contains the recommended days to dig. Currently, a server is being set up to be dedicated to the image analysis alone. The page should be fully functional and ready to testing in the next few weeks.
Figure 6: Screenshot images from the PeanutPROFILE sister page showing the upload capabilities for DIM images scanned by users.
Due to an unforeseen delay in getting the server ready, we have been receiving and analyzing images from growers, researchers, and extension agents by hand and emailing responses within 12 hours (Figure 7).

From: pnuprofile@ufl.edu
To: sample@sample.com
Subject: Peanut Profile Submission
Sent: August 9, 2014 at 3:15pm

Message:

Thank you for submitting your image to the UF IFAS Peanut Profile website. Your image was processed and calculated to be **11 days** away from Harvesting. Your Image ID is PeanutImage0001.

Figure 7: example of email message that will be received by users after uploading DIM images for analysis.

**Task 3:** Develop a platform to beta test the delivery of a white mold ensemble risk tool and leaf spot advisory resource based on the AUPnut model. Researchers, extension educators and growers will be asked to evaluate the disease risk tools and platform utility during the 2014 growing season.

**Progress to date:** A spreadsheet algorithm was developed by N. Dufault for white mold risk based on weather data collected by PeanutFARM during the 2014 growing season. This algorithm was delivered to the web designer for incorporation earlier this year. However, the requirement of the algorithm for **hourly** as opposed to **daily** weather data (the current default for PeanutFARM) has proven to be more of a challenge and will require additional funding to implement. Our team has begun to explore the options of incorporating daily data into the risk index, but the performance of the model may suffer and additional testing is needed to compare the performance of a modified model in comparison to the current risk model that requires hourly data. If the hourly data is required, additional funding will have to be sought to include this more complex data set into PeanutFARM.