UF/IFAS Fertilizer Rate and Nutrient Management Studies
Addressing HB 5001 (SA 1480A) and SB 1000, FY 2022-23

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FDACS Contract #28897
Second Quarterly Report to FDACS-AES
Period covered: October 1 to December 31, 2022
Report date: January 31, 2023

Scope of work

To conduct a study designed to examine the appropriate rate for applying fertilizer on tomatoes, potatoes, citrus, corn, green beans, and any other crop identified by (UF/IFAS) as needing further research for normal and economical crop production. The study shall include recommendations on best management practices for supplying fertilizer to the crop to achieve maximum yield and quality goals of the grower while doing so in a manner that minimizes nutrient inefficiencies to the environment.

Second quarter state-level overview – Thomas Obreza

Activities and accomplishments:

- Equipment acquisition to support nutrient management research projects continued.
- Investigators continued recruitment and hiring to fill support personnel positions (post-doctoral associates, graduate students, and technicians, and field help).
- Research staff searched the literature for background information and analyzed data from recent experiments related to current projects.
- Investigators met with grower-cooperators to plan and carry out field experiments designed to develop new crop fertilization best management practices (BMPs).
- Work plans were initiated for fall and winter crops. Plans are coming together for spring crops.
- Field work started with citrus, green beans, tomato, potato, and peaches. Some field experiments were completed, and data analysis was initiated.
- Soil and plant tissue laboratory analysis started.
- Crop modeling work continued.
- Grower education about project objectives occurred at several locations.

Significant findings and/or events occurring during the quarter:

- New support staff were hired.
- Investigators learned how to operate and maintain their new equipment.
- Grower cooperators received progress reports about field activities.
- Decision Support System for Agrotechnology Transfer (DSSAT) calibration is improving.

- Data was analyzed from recently completed field research. Tomato and bean crop yields responded positively to P fertilizer, even on soils testing high in P.
- All projects are underway, but some investigators have no significant findings to report yet.

Activities planned for the subsequent quarter:

- Acquire more equipment.
- Continue consultations with grower cooperators about research in their fields.
- Establish or continue field research with citrus, grain corn, beans, potato, tomato, peaches, hemp, and limpograss.
- Continue laboratory work.
- Address freeze damage in north Florida citrus groves.
- Share information about projects:
    - BMP Summit
    - Citrus industry workshop
    - Citrus health forum
    - Hemp field demonstration
- Continue efforts to improve DSSAT.

Progress made toward overall project objectives:

- Accomplished foundational work to achieve the project objective.
    - Acquired and learned equipment.
    - Hired support staff.
    - Acquired grower cooperators.
    - Developed work plans.
- Initiated and in some cases completed field and lab research to study:
    - Soil test utility and calibration as related to nutrient management recommendations.
    - Tomato, bean, and citrus response to applied fertilizers.
    - Utility of crop models to develop optimum fertilizer management strategies.
- UF/IFAS made an interim change to P fertilizer recommendations for potato.

Identified obstacles or challenges:

- A slowed or broken supply chain delayed the acquisition of new equipment.
- Limited availability of qualified workers slowed or prevented hiring support staff.
- Hurricanes Ian and Nicole negatively affected south Florida vegetable research projects. Flooding from Nicole decreased the number of south Florida trials.
- A late December freeze damaged north Florida citrus groves and a bean project at Hastings.
- These obstacles are limiting some of our progress in accomplishing the scope of work. Part of the project's budget will likely be unspent by the end of the contract unless we develop an alternative spending plan.

Individual investigator quarterly reports (from north to south)

Optimizing Nitrogen Management by Improved Fertilizer Placement and Utilizing Enhanced Efficiency Fertilizers – Hardeep Singh – WFREC-Jay

Activities and accomplishments:

- A small plot combine was received in November, and it was successfully tested on a soybean crop growing at WFREC.
- Purchase of a band fertilizer applicator is underway. Delivery is due by the end of February 2023.
- Graduate student Kulpreet Singh is reviewing the scientific literature pertaining to research studies planned for the coming growing season.
- Investigator and student met regularly to discuss the literature review and the fertilizer type and rate treatments that will be evaluated in upcoming field research.
- Sites were selected for field research at WFREC.

Significant findings and/or events occurring during the quarter:

- No significant findings yet, as field work did not yet start in the 2nd quarter.

Activities planned for the subsequent quarter:

- Accept delivery of the band fertilizer applicator so it is on hand by the time field research plots need to be planted.
- Set up field trials and begin data collection.

Progress made towards overall project objectives:

- We made progress on the foundational work needed to enable evaluation of N fertilizer management for north Florida agronomic row crops that will lead to improved BMPs for crop fertilization.
- Protocols for field trials were developed and a site for the trial was selected.
- **Scope of work is 40% complete**.

Identified obstacles or challenges:

- None.

Developing Site-Specific Recommendations on Nitrogen Application Rates and Timing for Cold Hardy Citrus Production in North Florida – Muhammad Shahid – NFREC-Quincy

Activities and accomplishments:

- Recruited a post-doc and graduate student to work on the project.

- Investigator met with growers, graduate students, postdocs, and extension agents to discuss the first fertilizer application timings and methods according to the treatment plan that begins in February 2023.
- SPAD readings (leaf greenness) plus plant tissue and soil sampling were done to evaluate citrus grove nutritional status prior to fertilizer application.

Significant findings and/or events occurring during the quarter:

- No significant findings yet, as the field work was just beginning in the 2nd quarter.
- Investigator presented the scope of the project and objectives at the Extension Cold Hardy Field Day event on October 27, 2022.

Activities planned for the subsequent quarter:

- Meet with our fertilizer supplier to formulate fertilizer blends needed for the treatment plan.
- Apply fertilizer and install soil moisture probes.
- Teach proper field research techniques to students, postdocs, and extension agents associated with the project.
- Meet with grower-cooperators to discuss necessary tree care following recent freeze damage.
- Brief citrus growers about the scope of the project and objectives at the Extension Citrus Health Forum to be held on Feb 23, 2023, at NFREC-Quincy.

Progress made towards overall project objectives:

- We made progress on the foundational work needed to evaluate N fertilizer response in cold-hardy citrus groves that will lead to improved BMPs for north Florida citrus production.
- **Scope of work is 25% complete**.

Identified obstacles or challenges:

- The groves experienced consecutive days below freezing from December 22 to 25. Cold damage was severe on both young and established trees. The full extent of damage will not become fully apparent until the spring growth flush, at which time it will be evaluated.

Precision Ag Research to Fill Knowledge Gaps in North Florida Nutrient Management – Robert Hochmuth – NFREC-Live Oak

Activities and accomplishments:

- Equipment purchases
    - Received a single-row snap bean harvester.

    - Orders in place for trucks, soil sampling rig, small plot fertilizer applicator, soil moisture probes, field plot ATV buggies, tractor, and center pivot Irrigation variable rate upgrades.
- Snap bean N research
    - Cooperating UF/IFAS researchers are summarizing previous north Florida snap bean N rate and source studies conducted in the past 2 years to identify gaps in N fertilizer research and guide research plans for spring 2023 trials.
    - To continue previous N fertilizer source work, a snap bean fertilizer trial was planned with farmer and industry input, then implemented in fall 2022.
    - Currently evaluating methods of controlled release N fertilizer (CRF) application as related to bean yield and quality, leaf nitrogen content, and soil nitrogen content.

Significant findings and/or events occurring during the quarter:

- Data for the recently completed fall snap bean trial are being analyzed and will be added to the snap bean N research database being compiled and summarized as part of this project.

Activities planned for the subsequent quarter:

- Continue purchasing and receiving equipment that will enhance the capacity of the NFREC team to conduct BMP research for targeted crops including corn.
- Snap bean trials will continue in the next quarter. Beans will be harvested with the recently purchased machine.
- Fertigation equipment will be identified and purchased.

Progress made towards overall project objectives:

- We made progress on the foundational work needed to enable evaluation of N fertilizer management for Suwannee Valley agronomic row crops that will lead to improved BMPs for crop fertilization.
- Second quarter work focused on continuing to build capacity for future nutrient management research and initiating snap bean research trials.
- Excellent progress was made on sourcing and purchasing equipment.
- Snap bean N treatments included CRF broadcasted pre-plant and CRF banded over the row. This trial was harvested, and yield and quality data were collected.
- Plans (in collaboration with growers) are being made for spring trials.
- This project will help fill in research gaps on a broad range of snap bean fertilizer aspects and will build upon recent IFAS snap bean research in north Florida including N fertilizer rate, source, and methods of application.
- **Scope of work is 50% complete**.

Identified obstacles or challenges:

- The ever-increasing costs of equipment.
- Supply chain issues have delayed delivery times.

- The snap bean trial was impacted minimally by winds and blowing sand from the two fall hurricanes, but greater impacts were seen with high levels of whitefly-vectored viruses and early frost events in late October and November. These challenges delayed and greatly reduced total bean yields and quality.

Quantifying Nitrogen and Phosphorus Losses Using Advanced Tools to Estimate Nitrogen and Phosphorus Requirements – Lakesh Sharma – Soil, Water, and Ecosystem Sciences Dept., Gainesville

Activities and accomplishments:

- Worked to acquire equipment for use in upcoming projects:
    - Chevy Silverado 1500 pick-up truck (received).
    - Li-Cor 6800F photosynthesis system with fluorometer (due in early 2023).
    - CI-110 plant canopy imager (due in early 2023).
- BMP team has completed its first year of studying N fertilizer recommendations for Florida corn growers. (Companion research funded from other sources.) This work implemented the aid of active sensors as a tool for N management in corn.

Significant findings and/or events occurring during the quarter:

- A new graduate student has come on board to start working on this project in spring 2023.

Activities planned for the subsequent quarter:

- We are planning a BMP Summit conference to take place in February 2023, where research and findings will be discussed.

Progress made towards overall project objectives:

- We made progress on the foundational work needed to enable evaluation of N fertilizer management for grain corn that will lead to improved BMPs for corn fertilization.
- Equipment ordered for this project should be in place prior to the spring 2023 grain corn season. Corn research will commence with planting in late March.
- **Scope of work is 40% complete**.

Identified obstacles or challenges:

- The biggest challenge this quarter is not having all the equipment in hand destined for use in spring field research.

2022-23 LBR Phosphorus Rate Study – Northeast FL - Potato - Spring 2023 – Christian Christensen – Hastings Agricultural and Extension Center (HAEC), Hastings

Activities and accomplishments:

- Prepared soil and tissue sample collection bags, production timelines, and digital resources for data acquisition and warehousing requirements to support the scope of work.
- Conversations with Tri-County Agricultural Area (TCAA) potato farmers were formalized and field-level production timelines were agreed upon for the 2023 spring potato production season.
- All field research locations have been fumigated and are awaiting P fertilizer treatment applications.
- Equipment purchases:
    - The Kerian sizer grading table is currently in build-out with an expected delivery date no later than January 31, 2023.
    - The four-row Lockwood Planter is currently in build-out. Expected delivery is by February 1st.
    - A pickup truck order has been submitted and is currently undergoing build-out. An expected delivery date is approximately April 1st, 2023.
- Ongoing efforts to hire additional staff to support the project.
- Production timelines for the spring 2023 season have been developed, reviewed, and agreed upon by all participating parties.
- Fertilizer, flags, bags, and tags have been ordered received, and inventoried ahead of preplant soil sampling.

Significant findings and/or events occurring during the quarter:

- No significant findings yet, as the field work was just beginning in the 2nd quarter.

Activities planned for the subsequent quarter:

- Pre-plant soil sampling, flagging of research plots, fertilizer application, planting, installation of environmental sensors, 75% of petiole sampling, and soil sampling at tuber initiation.
- Soil samples will be prepared, packaged, and sent to an analytical lab.

Progress made towards overall project objectives:

- Linear regression models were fitted to the total and marketable potato yield response from the 2022 production season. Experimental design and P rates have been kept consistent in the 2023 season to compare with 2022 findings.
- We are building on the previous year's potato work in the Hastings area that showed a yield response to P fertilizer where soil test P was "high" (meaning no P fertilizer is recommended). This work led to a provisional change in the UF/IFAS P fertilizer recommendation to sanction P application regardless of the soil test value. Confirmation of yield responses under these conditions will likely lead to a permanent change in soil test calibration and/or P fertilizer management for Florida potatoes, with concurrent improvement in BMPs for potato fertilization.

- The TCAA HAEC team is prepared to begin soil sampling ahead of planting. Field-level materials have been ordered, inventoried, and made accessible for deployment to each of the six research sites.
- **Scope of work is 10% complete.**

Identified obstacles or challenges:

- Recruiting and hiring additional staff has been challenging. Localized cost of living coupled with available salary dollars has limited the ability to hire quality staff.

Using Artificial Intelligence for Improved Crop Nutrient Management – Lincoln Zotarelli – Horticultural Sciences Dept., Gainesville

Activities and accomplishments:

- Generated simulated data for potato N-fertilizer rate response from additional experiments (2013 JR farm, 2013 AS farm, 2014 JR farm, and 2014 AS farm) using the DSSAT- SUBSTOR Potato model.
- Proposed a methodology to calibrate the DSSAT simulated data using the high-level programing language Python. The calibrated DSSAT model could help understand the response of soil mineral N status to rainfall and fertilizer application rate/timing to predict field observations.
- Implemented a new time-series deep learning model based on long-short-term memory (LSTM) to predict daily soil N status based on the daily future projections of weather conditions, soil N concentration, and fertilizer application rate and timing.
- There is insufficient ground truth data (e.g., experimental data comprised only 6 soil sampling days during a potato growing period) to train the LSTM model. We proposed a strategy to solve this major challenge by training the AI model with DSSAT simulated data or curve-fitting data and fine-tuning the model on the limited experimental soil N data. The motivation is that DSSAT simulation can capture the overall trend of soil N concentration during the entire growing season, but the magnitude may be slightly off. The AI model can learn the trend by training on the DSSAT simulated soil N and calibrate by fine-tuning the experimental soil data.
- The proposed training strategy was verified using simulated data from curve-fitting. The time-series model was trained on 2011-2013 field trials (a combination of 13 sites/seasons in total) and tested on trials conducted in 2014. The prediction accuracy of the test set was improved, with r^2 of 0.85 on the test set compared with the previous model's r^2 of 0.61.

Significant findings and/or events occurring during the quarter:

- We applied the proposed calibration method for DSSAT data on the 2013 AS farm, 2013 JR farm, and 2014 AS farm. The calibrated DSSAT soil data can match experimental soil data better, which can improve the training of the AI models.

- The proposed training strategy solved the problem of lacking ground truth soil data, making the training of the time-series model possible.
- The time-series model can learn the relationship between weather (especially rainfall) and soil N with greater resolution. The model can capture the instant effect of heavy rainfall happening on a single day.
- We have verified that the time-series model can work well if the model is trained with enough data. Model performance relies on the quality of training data. Generating high-quality DSSAT simulated data is the major challenge currently. We are exploring different soil parameters and initial conditions to improve DSSAT calibration.

Activities planned for the subsequent quarter:

- Continue to generate and calibrate the DSSAT soil data for other years. We expect to train the time-series model using data from all the farms.
- We verified the proposed training strategy on simulated data from curve-fitting. We will train the time-series model on the DSSAT simulated data to compare the results.
- Conduct more fine-tuning experiments to find the best weights to achieve accurate results without overfitting the limited experimental soil data.

Progress made towards overall project objectives:

- We made progress on work needed to improve the ability of DSSAT to apply AI concepts in determining optimum fertilizer management for a variety of crops.
- We developed a more powerful model that can predict soil N daily. Based on the previous experimental results, we learned that soil N has a significant effect on crop yield. Thus, with this new time-series model we can predict when N will be lacking and how much N should be applied by monitoring soil N in real-time. The combined use of AI and DSSAT crop models can become a reference to evaluate and verify BMP effects on agricultural water quality soon.
- **Scope of work is 50% complete**.

Identified obstacles or challenges:

- None.

Evaluation of Site-Specific Plant P Bioavailability and Lab Accuracy on Mehlich-3 P Fertilizer Recommendations – Vimala Nair – Soil, Water, and Ecosystem Sciences, Gainesville

Activities and accomplishments:

- All needed equipment is in place. The Agilent BioTek Epoch 2 microplate spectrophotometer was the last item to be delivered.
- We started calibrating the spectrophotometer and comparing results with earlier values to ensure compatibility with solution concentrations generated from a manual spectrophotometer.

- We contacted the UF/IFAS Analytical Research Lab, Central Florida Lab, Waters Lab and Waypoint Lab to obtain information on Mehlich 3 soil sample analysis costs and turnaround times.
- We submitted 200 soil samples (100 from a recently completed FDACS project and 100 composite soil samples collected during the first year of legislative nutrient management funding) to each of the labs mentioned above. We are awaiting the results for comparison.

Significant findings and/or events occurring during the quarter:

- We are learning how to operate the Agilent spectrophotometer.

Activities planned for the subsequent quarter:

- Continue calibrating and testing the Agilent spectrophotometer.
- Send additional soil samples from 2021-22 and 2022-23 field research projects to the labs mentioned above. Statistically analyze the results to determine accuracy and reliability of the results among labs.
- Determine water soluble P (WSP) and Mehlich 3 Pin the archived FDACS soil samples and compare differences in values due to sample storage.
- Compare in-house spectrophotometrically determined Mehlich 3-P (inorganic P) and total P in a Mehlich 3-P solution as analyzed using inductively coupled plasma spectroscopy.

Progress made towards overall project objectives:

- We are accomplishing foundational work (lab analysis procedures) to be able to compare soil sample analysis between labs, and to understand the forms of P extracted by the Mehlich 3 solution. Such understanding may allow development of BMPs that describe unique calibration curves customized by site, soil type, and crop grown.
- Progress in achieving our objectives has been satisfactory, but we are awaiting soil samples from other investigators in this project to obtain soil from different regions of Florida for site-specific evaluation.
- **Scope of work is 30% complete**.

Identified obstacles or challenges:

- Our study depends on incoming soil samples from the other investigators. We have not received samples from any of them since their work was significantly affected by hurricanes. We are currently using archived samples to test lab accuracy of Mehlich 3-P soil test results.

Capacity Building at the IFAS Analytical Services Laboratories to Support Nutrient Management Research Work in Florida – Rao Mylavarapu – Soil, Water, and Ecosystem Sciences Dept., Gainesville

Activities and accomplishments:

- State vehicle has been acquired.
- All equipment vendors have been contacted and quotes were finalized for the inductively coupled plasma (ICP) spectrometers.
- Other equipment is also in the process of getting finalized for purchase.

Significant findings and/or events occurring during the quarter:

- No significant findings yet, as the new suite of lab equipment is just getting assembled.

Activities planned for the subsequent quarter:

- Complete purchases of the new ICPs, a CN analyzer, soil pH robots, and digester blocks.

Progress made towards overall project objectives:

- We are accomplishing foundational work (lab equipment assembly) to be able to analyze soil and plant tissue samples from research projects and producers. Sample analysis results will contribute to improved soil test calibration and crop nutrient management recommendations for years to come.
- **Scope of work is 25% complete**.

Identified obstacles or challenges:

- The work is on schedule without any interruptions. The labs are well prepared to analyze all samples from the project.

Developing a Guideline on NPK Application Rates and Timing for Low-Chill Peaches Grown in Florida – Ali Sarkhosh, Horticultural Sciences Dept., Gainesville

Activities and accomplishments:

- Soil sample collection and laboratory analysis
- Fertilization application to trees at varying rates of N, P, and K.
- Winter/dormant tree pruning in the orchard.

Significant findings and/or events occurring during the quarter:

- Not applicable yet.

Activities planned for the subsequent quarter:

- Soil sample collection.
- Fertilization with different rates of N, P, and K.
- Leaf sampling and analysis.
- Fruit thinning.
- Harvesting fruit.

Progress made towards overall project objectives:

- We have completed most of the initial field and laboratory work for this project.
- We made progress on foundational work needed to evaluate N-P-K fertilizer response in peach orchards that will lead to improved BMPs for north Florida peach production.
- **Scope of work is 35% complete**.

Identified obstacles or challenges:

- None.

Developing Site-Specific N and P Rates for Young and Mature Sweet Oranges, Grapefruits, and Mandarins in Florida – Davie Kadyampakeni – CREC, Lake Alfred

Activities and accomplishments:

- We completed soil and citrus tree leaf tissue sampling and analysis.
- We ordered custom blended fertilizer to be applied at varied rates at all sites according to the project workplan.
- We procured weather stations and installed them at all research sites to generate site-specific weather data for future use in crop-soil modeling or to predict trends in nutrient uptake and leaching.
- We harvested baseline fruit in Hamlin orange and Satsuma mandarin blocks.

Significant findings and/or events occurring during the quarter:

- No major findings yet.
- Project objectives and expected outcomes were presented to cold hardy citrus growers at the Citrus Cold Hardy Field Day event on October 27, 2022, at NFREC-Quincy.

Activities planned for the subsequent quarter:

- Evaluate citrus fruit juice quality and shelf life.
- A workshop and field day is scheduled on February 15, 2023, in Lake Alfred to inform the citrus industry about the practical elements of the project and other related results.
- Continue fruit harvesting and fertilizer applications.
- Economically analyze selected fertilization treatments.

Progress made towards overall project objectives:

- We made progress on the foundational work needed to evaluate N and P fertilizer response in Florida peninsula citrus groves that will lead to improved BMPs for central and south Florida citrus production in the era of greening disease.
- We have made good progress measuring tree growth plus leaf and soil nutrient status.
- **Scope of work is 50% complete**.

Identified obstacles or challenges:

- As reported in the first quarter, Hurricane Ian caused severe fruit drop at our Arcadia site due to winds up to 90 miles/hr. The trees are expected to recover. Flooding limited

our access to project sites, causing fertilizer application to be delayed 2 to 3 months as we waited for water to drain.
- Hurricane Nicole largely bypassed most of our sites and did not significantly impact the project.
- In late December, our central Florida ridge and southwest/southeast flatwoods groves experienced air temperatures between 27 and 32F. This freeze caused limb damage, but the trees are expected to recover.
- Recruitment of two new biological scientists failed due to an insufficient candidate pool. The investigator will recruit temporary staff to support the project in the next 6 months and consider recruiting higher-level technical help again in the next fiscal year.

Refining P Fertilization Recommendations for Limpograss in South Florida – Joao Vendramini – RCREC, Ona

Activities and accomplishments:
- Forage, water, and soil samples were collected, processed, and analyzed at our laboratory at Ona or were sent to a commercial laboratory.
- A graduate student was recruited and will start in spring 2023.
- A lab technician processed lab samples and maintained the experimental field site to prepare for 2023 research.
- A Kubota ATV was received.

Significant findings and/or events occurring during the quarter:
- No new findings to report. We are awaiting plant and soil sample results.

Activities planned for the subsequent quarter:
- 2023 research will start in March.

Progress made towards overall project objectives:
- We made progress on the foundational work needed to evaluate P fertilizer response of limpograss that will lead to improved BMPs for central and south Florida forage production.
- We completed the collection and analysis of the forage production data and are finishing the tissue P concentration analysis. The relationship between the plant tissue P concentration and forage accumulation will define the critical tissue P concentration, and tissue testing could be used to improve the P fertilization recommendations for limpograss in south Florida.
- **Scope of work is 60% complete**.

Identified obstacles or challenges:

- Hurricane Ian flooded the forage and soils laboratory at Ona, which delayed the analysis of forage, soils, and water samples. However, we relocated to a temporary building, and we are making progress in the analyses.

Developing Phosphorus Recommendations and Site-Specific Management for Tomato, Potato, and Green Beans through Large-Scale Participatory Research with Stakeholders – Sanjay Shukla, SWFREC, Immokalee

Activities and accomplishments:

- Six experiments (two potato, two tomato, two bean) were implemented in central (CFL) and south (SFL) Florida.
- Fields were identified based on grower consultation, soil characteristics, field layout, and available data. At some sites, soil was sampled and analyzed for Mehlich 3 P to select the fields.
- Experimental designs for SFL sites were modified specifically to evaluate site-specific factors for some sites in consultation with growers. The main site-specific factors considered relate to irrigation and drainage where a shallow water table is maintained.
- Plant, soil, and water monitoring continued for seven experiments (two potato, three tomato, and two bean).
- Six P_2O_5 rates were used for tomato (0, 50, 75, 100, 150, 200 P_2O_5 lbs/acre) and potato (0, 46, 92, 135, 183, and 229 lbs/acre) experiments.
- For bean, four P fertilizer rates were used in CFL experiments (0, 40, 80, 120 P_2O_5 lb/acre) while five rates were used in SFL experiments (0, 40, 80, 120 P_2O_5 lb/ac, grower standard).
- A fifth treatment with liquid fertilizer (pop-up, N and P) application at planting was added to represent commercial SFL farm conditions where it is a prevalent practice.
- For one SFL bean site, we developed a calibration method for a large-scale air-boom fertilizer applicator.
- Efforts were made to use alternative liquid P (without N) for SFL bean experiments but given the potential effects on soil pH, decision was made to use only dry fertilizer formulations for the four P rates.
- In consultation with growers, the need for a 12-ft drop-in fertilizer spreader was identified to apply fertilizer more accurately to multiple rows without drift to rows assigned to other treatments.
- Harvesting was completed at one of the two tomato experiments.
- Due to errors in applying P at one of the potato sites, another site was provided by the grower.
- Rain, water levels and soil moisture instruments were installed, and data processing was initiated.
- Soil and plant tissue samples were collected pre-bedding and at-planting. Samples were shipped to the analytical laboratory.

- Disease severity monitoring was completed at two tomato sites and was initiated at other sites. Lab samples were analyzed to confirm the presence of pathogens and/or diseases.
- Nematode soil and root samples collected from the two tomato sites are being analyzed. Season-end root samples and root gall ratings were collected at both locations.
- The method for economic analyses is continuing to be developed using the price data from the USDA-AMS and NASS. A partial budget template was developed for the three crops. Data from UF/IFAS Vegetable Production Guide was transcribed and will be combined with other data.
- Data entry, QA/QC, and preliminary analyses were initiated for completed experiments.
- Additional personnel were hired while the search for others continues.

Significant findings and/or events occurring during the quarter:

- We observed increasing yield trends as P fertilizer rate increased for both tomato experiments that suffered hurricane damage. Average yield for the 200 lbs/ac treatment was 20 to 40% higher compared with the 0 lb/ac rate. Mehlich 3 P at both sites was higher than 45 ppm, the current threshold above which zero P is recommended by IFAS. Statistical analyses are needed to confirm yield response.
- Similar trends in numerical values of yield response to P were also observed in one CFL bean experiment.
- Few to no root galls were seen in the two tomato experiments.
- Data are currently being processed for detailed statistical analyses.
- A meeting with growers and commodity groups was organized to discuss the project plan and timeline, progress and preliminary results, and the mechanism IFAS uses to develop recommendations.
- Preliminary results were shared with grower cooperators as it became available.
- Project plans and/or preliminary results were presented to FL Farm Bureau, FL Watermelon Convention, and an IFAS Nutrient Management Project Stakeholder Meeting that included growers and commodity leaders from north Florida. One of the main feedback items from the stakeholder meeting was to improve communication and incorporate grower input.

Activities planned for the subsequent quarter:

- The final harvest in the second of our two tomato experiments will occur in January 2023.
- One tomato, two potato (table-stock), and one (or two) bean experiments will be planted.
- The number of new bean experiments (one or two) in SFL will be decided based on the lessons learned and availability of land and personnel given the narrow harvesting window from multiple experiments resulting from hurricane-related delays.
- Plant and soil sampling, processing, and analyses will continue for all sites.
- Hydrologic monitoring will continue at all sites.

- Disease and nematode monitoring will continue for all tomato crops.
- Sensitivity analysis on the data output (yield) of different P fertilizer rates for economic analyses will be completed. Costs and benefits under various P inputs will be evaluated.
- QA/QC for plant, soil, and water data will continue.
- Exploratory data analyses will be completed to identify methods for statistical analyses.
- Continue hiring additional personnel and acquire additional instruments and equipment.

Progress made towards overall project objectives:

- We conducted field trials with growers to evaluate P fertilizer response of tomato and are on track to complete similar work with potato and bean. These results will build on previous work to establish site-specific soil test P calibration and P fertilizer management recommendations and BMPs for maximum economic yield while minimizing nutrient inefficiency.
- Considering the effects of hurricanes, project progress is better than expected.
- While data collection continues, hurricane effects combined with a personnel shortage and delays in acquiring instruments and equipment will likely prevent us from completing 100% of our planned scope of work in FY 2022-23.
- **Scope of work is 35% complete**.
- Preliminary assessment indicates that the team will be able to complete 60-80% of the planned experiments and data collection in FY 2022-23.

Identified obstacles or challenges:

- Two hurricanes, Ian (September) and Nicole (November) impacted fresh vegetable farms in CFL and SFL including the partner farms that agreed to participate. The effect of two hurricanes was a major setback in implementing tomato and bean experiments.
- Winds and rainfall from hurricane Ian affected two tomato experiments with damage to crop (whipping/twisting of plants, tattered leaves, blown flowers, bruised fruit), beds (plastic and drip tape blown/twisted, washing of bed soil, bent stakes), plant ties, and instruments. The damage was more severe on older CFL plants holding golf ball-size fruit compared with younger SFL plants. After consulting growers and assessing damage, we decided to continue the experiments. In SFL, almost 10% of plants were severely damaged. Interim results indicate that the yields from both experiments are significantly lower than normal.
- Hurricane related delays resulted in cancellation of two tomato experiments.
- Bean experiments were delayed and/or cancelled due to a combination of hurricane damage to crops and machinery, unavailable land due to delays in commercial plantings, delay in acquiring instruments and equipment due to supply-chain issues, complexities of incorporating liquid P application, narrowing of the harvest window for multiple experiments, and lack of personnel.
- While progress has been made to hire personnel, it remains a challenge due to the project's short-term (1-year) funding window, a limited pool of qualified professionals, and rising costs. The year-to-year nature of project funding poses a challenge due to

insufficient time to process and analyze the data and hiring of qualified personnel. If possible in the future, longer-term funding would allow more time to collect and analyze data and increased flexibility in dealing with challenging factors like extreme weather.

Optimizing Phosphorus Management for Snap Bean Production on Mineral and Calcareous Soils of Florida – Haimanote Bayabil, TREC, Homestead

Activities and accomplishments:

- Experimental Activities at TREC
  - Snap bean plots were planted on 11 Oct 2022 and harvested on 13 Dec 2022.
  - Lysimeters and soil moisture sensors were installed in selected plots.
  - Emergence and flowering data were recorded.
  - Water samples collected from lysimeters for P analysis.
  - Soil and tissue samples were collected three times during the growing season.
  - Plant height, canopy cover, above-ground biomass, stomatal conductance, SPAD reading, and leaf water potential were collected throughout the growing season.
  - Drone multispectral images were collected weekly.
  - Data processing was initiated.
- Extension Activities at TREC
  - An in-person field day was held with 45 attendees on 8 Dec 2022. Project objectives and preliminary findings were communicated to growers. A total of 19.5 CEUs were provided.
- Experimental Activities at Hastings Agricultural Extension Center (HAEC)
  - Soil and plant tissue samples were collected in Oct and Nov 2022 and analyzed shortly thereafter.
  - Beans were harvested in Nov.

Significant findings and/or events occurring during the quarter:

- TREC: The highest P fertilizer rate (160 lbs P_2O_5/acre) resulted in the highest bean yield.
- HAEC: Bean yield increased as the applied P fertilizer rate increased. The 160 lbs P_2O_5/acre rate resulted in the highest yield.
- The project team is currently discussing the need to include a P_2O_5 rate higher than 160 lbs/acre in the next experiment to reach the inflection point of green bean yield in response to P fertilizer rate.

Activities planned for the subsequent quarter:

- At TREC
  - Start an experiment on a commercial farm.
  - Start 2nd experiment at the TREC farm.
  - Conduct at least one field demonstration.
  - Process soil, water, and tissue samples.
  - Continue analyzing experimental data.

- At HAEC
    - Measure biomass of plant tissues.
    - Continue and complete all data analysis.
    - Start a new trial at HAEC.

Progress made towards overall project objectives:

- We conducted field trials to evaluate P fertilizer response of snap bean. These results will combine with similar work in SW Florida to establish P fertilizer management recommendations and BMPs for maximum economic yield while minimizing nutrient inefficiency.
- **We have finished about 40% of the planned work** for 2022-2023 and we are currently on track to accomplish 100% of all planned activities. We are collecting additional data we did not plan to collect so it can be used for crop modeling and machine-learning activities.
- The project team believes that progress towards achieving the overall objective of the project (developing P BMPs for snap bean) requires at least another year of study.

Identified obstacles or challenges:

- At HAEC
    - Last growing season, both hurricanes Ian and Nicole damaged our trial beds, which we fixed without significant damage to plants. However, the data may have some inaccuracy.

Accelerating Collaborative Hemp Fertilizer Research to BMP Development of Rate, Timing, Source, and Site-Specific Management – Zachary Brym, TREC, Homestead

Activities and accomplishments:

- Tropical Research and Education Center (TREC) equipment PO has been executed with delivery expected Q3-Q4.
- TREC remote sensing cameras PO is in process.
- Everglades Research and Education Center (EREC) equipment PO has been executed with delivery expected Q3.
- Plant Science Research and Education Unit (PSREU) liquid applicator quote received but waiting for the shipping quote.
- Hemp nutrient research studies nearly spending down FDACS account ahead of gap funding.

Significant findings and/or events occurring during the quarter:

- No findings to report yet.

Activities planned for the subsequent quarter:

- Continue processing and receiving equipment orders.

- Review UAV policies for possible Q3/Q4 purchase.
- Complete purchase for fertigation system at TREC.
- Begin hemp nutrient management research studies for 2023 planting season.

Progress made towards overall project objectives:

- We made progress on the foundational work needed to evaluate N-P-K fertilizer response of hemp that will lead to new recommendations and BMPs for hemp production.
- TREC:
    - Nutrient management equipment is to be deployed to develop an organic hemp rotation with cover crops and minimize external nutrient applications.
    - Equipment will also be dedicated to several nutrient management studies for rate and timing in conventional systems for fiber, seed, and flower production.
- EREC:
    - Performing nutrient analysis of soil samples to assist in development of BMP recommendations for nutrient management of hemp production.
    - The Everglades Soil Testing Lab continues to run soil analysis with the old instruments. It has been a challenge to keep these going so we are looking forward to receiving the new instruments.
- PSREU:
    - Equipment will be dedicated to several nutrient management studies for rate and timing in conventional systems for fiber, seed, and flower production.
    - Research operational budget across hemp nutrient management team to support 2023 growing season.
    - Ongoing research progress is in preparation of peer-reviewed manuscripts necessary to establish BMPs for hemp fertilization.
- Scope of work completion:
    - TREC: **45%** (most POs complete, awaiting delivery; sensing unit PO in progress).
    - EREC: **50%** (POs complete, awaiting delivery).
    - PSREU: **50%** (one PO complete and delivered, one PO in progress).
    - Research studies: **0%** (primarily Q3-Q4 activity).

Identified obstacles or challenges:

- TREC:
    - UAV purchase is not possible due to existing FL restrictions. The drone currently considered for purchase is confirmed Blue sUAS approved.