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

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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.

General (state level) quarterly report – Tom Obreza

Activities and accomplishments:
- Received bids and quotes, ordered, and purchased equipment.
- Added grad students to projects and hiring technical help.
- Selected sites, developed work plans, designed experiments, and prepared fields.
- Met with grower-cooperators.
- Soil and plant tissue analysis.
- Implemented field trials: Snap beans at Live Oak and Hastings, citrus at three locations, limpograss at Ona, and tomato in Manatee and Glades counties.
- Analyzing data.

Significant findings and/or events occurring during the quarter:
- Reviewed and summarized findings from previous trials.
- Calibrated equipment.
- Developed and improved machine learning computer models.
- Found no increase in limpograss forage production with increasing P fertilizer rate.
- Observed tomato plant size differences among P fertilizer treatments.

Activities planned for the subsequent quarter:
- Procure equipment and supplies.
- Recruit research team members.
- Set up field plot experiments and lab work.
- Apply fertilizer.

- Sample soil and plant tissue.
- Plant field experiments.
- Harvest snap bean trials and measure yield.
- Continue to refine machine learning models.
- Assess hurricane damage.
- Meet with cooperators and stakeholders to discuss progress.

Progress made toward overall project objectives:
- Foundational work is occurring.
- Plans are coming together.
- Equipment and supplies are arriving.
- Capacity to accomplish projects is building.

Identified obstacles or challenges:
- Some investigators report no obstacles.
- Post-doc recruitment; hiring support staff.
- Supply chain issues; equipment availability and cost
- Hurricane Ian effects at Live Oak (bean-minimal), Arcadia (citrus-flooding, fruit loss, possible tree damage), Ona (limpograss will survive), and Duette/LaBelle (tomato – wind and water).
- Data availability to build machine learning models.
- Implementing scientifically sound and statistically analyzable experiments in grower's fields.
- High soil test P in fields.

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:
- Efforts were made for procuring plot combine and purchase order is in place. Vendor agreed to deliver equipment by end of November.
- Graduate student Kulpreet Singh joined the team and is working on literature review for research studies planned for coming year.
- PI and graduate student meet biweekly to discuss the progress on literature review and plan for setting up field trials coming year.
- Selected the vendors who manufactures fertilizer band applicator and meet our specifications.
- Received an updated quote for other equipment's that we plan to purchase and use in this project including LAI and MicaSense Altum-PT Sensor.
- Site selection for conducting trials is done at West Florida Research and Education Center, Jay.

Significant findings and/or events occurring during the quarter:
- None observed yet.

Activities planned for the subsequent quarter:
- Making efforts for procuring band applicator so that we receive it before planting the trials.
- Purchasing the MicaSense Altum-PT Sensor and the LAI (LI-3100C).
- Hoping to receive plot combine and test it.

Progress made towards overall project objectives:
- We are working on purchasing the equipment's needed for conducting the trials next summer.
- The planning for next year field trials is underway and the efforts are made for site selection.
- We are on target to achieve the project objectives.

Identified obstacles or challenges:
- No there are not any foreseen obstacles or challenges that might result in delays in completing the project.

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:

- Planted of new grove (400 plants) at the NFREC for less than 3-year-old part.
- Identified three research sites in north Florida.
- PI had meetings with growers and explained project objectives.
- Trees at all sites were tagged and mapped according to treatment plans.
- Nitrogen levels for three different age groups were adjusted in consultation with soil science experts and growers. For non-bearing less than three-year treatments are 25, 50, 75 and 100 lbs N/ac, for 4-6 years old site treatments are 50, 100, 150 and 200 lbs N/ac, and for more than 10-year-old site treatments are 100, 150, 200 and 250 lbs N/ac.
- Procured vehicles, computers, SPAD meters, refractometers, and chemical/supplies.
- Personnel (graduate student, OPS) were hired.

Significant findings and/or events occurring during the quarter:
- We do not have significant findings yet, but growers recommended use of proper precautionary measure while entering and leaving their groves to prevent citrus canker.

Activities planned for the subsequent quarter:
- Recruit a post-doc to help with the project.
- We will do initial soil and leaf sampling, and leaf greenness (SPAD) for the project.
- Present the project summary and objective at Cold Hardy Field Day on October 27, 2022.

Progress made towards overall project objectives:
- In first quarter, we have done most of the foundational work for the project comprising 10-15% of project goals.

Identified obstacles or challenges:
- Since citrus grove size is comparatively small in north Florida, we have reduced the number of plants per replicate from 6 to 4. We will have 4 replicates having 4 plants per replicate.
- Recruitment of post-doc was delayed due to visa issues, but he should be able to start in Spring 2023 or sooner.

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

Activities and accomplishments:
Primary activities have been associated with the processes of equipment purchases. We have identified equipment suppliers and received appropriate cost estimates or bids as needed. We have purchase orders in place for a few pieces of equipment, including snap bean harvester (Tri-county Equipment Sales), pick-up truck (Duval Ford), Veris MSP3 soil sampling rig (Veris Technologies), small plot fertilizer applicator (First Products), soil moisture probes (BMP Logic), field plot ATV buggies (Crystal Tractor). The team at NFREC-SV, Live Oak has also implemented a snap bean fertilizer trial. This trial was

planned with the advice of key snap bean farmers and industry representatives in the North Florida region. This trial is a follow-up to previous trials conducted with conventional and controlled release nitrogen fertilizers at various rates. This fall (2022) trial is evaluating methods of application of controlled release nitrogen and the impact on bean yield and quality, leaf nitrogen content, and soil nitrate nitrogen levels at various soil depths (0-12, 12-24, and 24-36 inches).

Significant findings and/or events occurring during the quarter:

Faculty and staff are also analyzing and summarizing previous nitrogen rate and nitrogen source studies in snap beans conducted in North Florida. This summary will help identify gaps in nitrogen fertilizer research for sandy soils in North Florida and will guide research plans for the spring snap bean trials.

Activities planned for the subsequent quarter:

The team will continue the process of purchasing equipment identified in this project proposal, including dual-tire truck to carry Veris rig, tractor, irrigation upgrades and fertigation equipment. All of these items are in process with quotes obtained on all pieces of equipment. This equipment will enhance the future capacity of the team at Live Oak to conduct important BMP research for highly targeted crops, such as corn and snap beans initially. Data collection and harvest of the large-plot snap bean trial will continue in the next quarter with harvesting being completed by the new snap bean harvester.

Progress made towards overall project objectives:

The first quarter of this project is focused on building capacity through equipment purchases and initiating a fall snap bean research trial. Great progress has been made on identifying sources of the equipment and following protocol toward the purchase of the equipment. The fall snap bean trial was implemented on September 7th and data collection is under way. The snap bean seed cultivar is "Caprice" that was planted with a John Deere 1705 Vacuum Planter with a target population of 7 seeds per foot of row. Treatments included: CRF broadcasted pre-plant, and CRF banded in a 15-inch over the row. Plans are also being made for the spring trials associated with this project. 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 nitrogen rate, source, and methods of application.

Identified obstacles or challenges:

The main challenge in equipment purchases is the ever-increasing costs of equipment, above the estimates given back in the early spring of 2022 when the proposal was developed. This is especially the case for trucks. In some cases, other funds at NFREC-SV may be needed to make purchases, if total funding within this project are insufficient to cover the added costs. The snap bean trial was impacted only minimally by Hurricane Ian at Live Oak. The crop sustained some wind and blowing sand damage, but it is expected the trial will continue as planned.

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:

Our main activity has been purchasing equipment that will be used in upcoming projects. After assessing equipment needs, quotes were obtained, and we submitted PO requests. We have three purchase orders in place for the following: Chevy Silverado 1500 pick-up truck, Li-Cor 6800F photosynthesis system with fluorometer, and CI-110 plant canopy imager. Our BMP team has also completed its first year of studying nitrogen recommendations for corn growers in Florida. This is the work started in 2022 that implemented the aid of active sensors as a tool for nitrogen management in corn.

Significant findings and/or events occurring during the quarter:

Master's student has been hired and will join in Spring 2023.

Activities planned for the subsequent quarter:

We will continue to track the progress of equipment purchasing as these tools will provide cutting-edge nutrient management techniques that will help my BMP team to revise or update the nutrient management schemes to a precision level that could serve as an example for others. We are also actively planning a BMP Summit conference to take place early next year, where research and findings will be discussed.

Progress made towards overall project objectives:

The main objective of this quarter has been focused on acquiring equipment to be used in upcoming research. The LI-COR 6800F has been purchased, and we are awaiting its arrival. However, we are still in the PO approval stages for both the truck and plant canopy imager.

Identified obstacles or challenges:

Our biggest challenge has been equipment purchase as availability and costs continue to change. While working through this process, we have identified that we have sufficient funding for all equipment and will even be able to add on additional small equipment needs.

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

Activities and accomplishments:
- Preparing soil and tissue sample collection bags, production timelines, and all associated digital resources for data acquisition and warehousing requirements to support to the

proposed scope of work. Moreover, conversations with Tri-County Agricultural Area (TCAA) potato farmers are ongoing to formalize field-level production timelines for the 2023 Spring potato production season.

- Regarding equipment purchases, significant progress has been made towards acquiring the three pieces of equipment budgeted for through the proposed scope of work.
- Efforts to hire additional staff is ongoing. See Section 5 for additional details.

Significant findings and/or events occurring during the quarter:

- None currently. Efforts are ongoing to review the results from the Spring 2022 production season to identify opportunities for improved research outcomes during the Spring 2023 potato production season.

Activities planned for the subsequent quarter:

- The six production sites (three at the Hastings Agricultural Extension Center and three at commercial production fields in St. Johns County) will be identified and flagged for pre-season soil sampling event #1 after January 1st, 2023 (i.e., 30 days prior to planting: February 1st, 2023).
- Fertilizer resources (10-0-10 with sulfur and 0-46-0) will be ordered in preparation for the Spring 2023 production season.

Progress made towards overall project objectives:

- At the time of this report, conversations are ongoing with TCAA potato producers to formalize Spring 2023 potato production timelines.
- Identification of a reliable analytical lab are ongoing.

Identified obstacles or challenges:

- HAEC is experiencing challenges hiring support staff funded by this project. HAEC is optimistic to have the remainder of the staff formally hired by October 21st, 2022.

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 dataset from (2013-JR farm – Zotarelli et al. 2014 and Rens et al. 2015) using DSSAT- Substor Potato model and conducted a global sensitivity analysis using DSSAT - R package. The global sensitivity analysis experiments required running simulations on all possible combinations of selected features and ranges (e.g., 1024 simulations in total).
- Performed statistical analysis of 1024 simulations for comparison and found the closest simulated data according to the experimental data. The best one will be used to generate the simulated data for AI model training.

- Implemented scripts to access and load required data to DSSAT - R package, and run simulations given input parameters.
- In machine learning (ML) modeling work, a new feature 'Nitrogen uptake' was calculated and added to the feature set, and the soil nitrogen prediction (soil model) on stages 4-6 was improved.
- The soil model was trained in a different manner. Instead of training ML using the entire plant growing period, we took each stage as one sample such that the model can predict soil nitrogen based on the initial soil nitrogen level and the weather feature, considering rainfall and other weather parameters. The robustness of this model has significantly improved.
- The soil and potato yield ML models were trained on the entire potato data available (2011 – 2014) with a training/test ratio of 0.75/0.25. The soil model got an average R2 of 0.75 on training data and 0.61 on test data. The yield model got an average R2 of 0.71 on training data and 0.43 on test data. It should be noted that the yield model took the predicted soil nitrogen features from the soil model instead of the real experimental data, which is more challenging.

Significant findings and/or events occurring during the quarter:
- The soil and yield ML models have potential to predict soil nitrogen and potato yield with an acceptable coefficient of correlation.
- The implemented pipeline to run DSSAT using the R package makes the simulation process much more efficient. The simulated data will be used in the machine learning model soon.

Activities planned for the subsequent quarter:
- Fine-tune input parameters from the original dataset to streamline data input, improve DSSAT simulation with the goal of improving the accuracy of data simulation.
- Apply ML models to calibrate DSSAT simulated data to match the experimental data.
- Develop a time-series ML model to predict soil nitrogen based on weather features, treatments, etc.
- Include the additional phosphorus data in the simulation of DSSAT and ML models as the P-fertilizer data from 2021/22 season becomes available.

Progress made towards overall project objectives:
- We developed multiple models to predict soil nutrients level and potato yield according to the weather data and N-fertilizer treatments. The DSSAT simulation is running as expected, which will be used to help generating data for ML model training.

Identified obstacles or challenges:
- DSSAT simulated data can capture the trends of experimental data (similar distribution but different magnitude), however, we need more tools to calibrate the DSSAT such as adding constraints according to statistic results from multiple simulations or assigning

more weights on the dates that have experimental data and less weights on the dates missing experimental data.

- Data availability - to build a ML model to predict soil nitrogen for a given day of the crop season, we need the time-series data for training. Weather data (rainfall, air, and soil temperature) is measured daily. However, most experimental measured features are discrete values such as soil nitrogen, applied nitrogen, plant biomass, etc, which impose a great challenge on the training of ML models. It is expected that the calibrated DSSAT simulated data will be able to further support the development of specific ML models.

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:
During the first quarter of the project, we recruited personnel (post-doctoral associate, biological scientist, OPS personnel) needed for the successful completion of the project. We may need to recruit additional personnel depending on the workload. The first 2 months of the project were dedicated to the preparation for soil chemical analyses by placing large orders and organizing and rearranging the lab for the new equipment. During August 2022, most, but not all consumable items needed for the duration of the project were ordered, as well an Agilent BioTek Epoch 2 microplate spectrophotometer and computer, pH meter/electrode, and an analytical balance. Items were ordered in bulk to be prepared for possible supply chain issues that may arise over the next year. All equipment has been delivered, except for the microplate spectrophotometer, which has a delivery date of November 11, 2022.

Significant findings and/or events occurring during the quarter:
We have begun calibrating all new equipment in preparation for the analyses of water-soluble P (WSP), Haney H3A-P, Mehlich 3-P, and FeO-P. In addition, we are contacting various analytical labs for price check, turn-around time, the number of samples they can handle per batch, and the quantity of soil needed for Mehlich 3-P analysis to allow us to plan for sending aliquots of the same soil samples to various labs as extraction procedure(s) adopted by commercial labs are not all the same and M3-P concentrations for the same soils can vary from lab to lab.

Activities planned for the subsequent quarter:
We will be continuing with instrument calibration and contacting various labs as mentioned earlier. We will also be purchasing an Environmental Express HotBlock digestion system, the only remaining equipment needed for the project. In addition, we intend to send a first batch of samples to various labs to evaluate M3-P results for their accuracy, and repeatability among the commercial labs. Samples will be selected from soils collected during the first year of legislative nutrient management funding, as well as from a recently completed FDACS project (Contract number 27155) with soils from different locations within Florida.

Progress made towards overall project objectives:
    Satisfactory progress has been made towards the overall project activities.

Identified obstacles or challenges:
    Hurricane Ian will likely cause significant delays in obtaining new soil samples for our study from field projects that may have to be reinitiated. However, plans are being implemented to use archived samples whenever possible, primarily 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:
    Equipment vendors have been contacted and the lab requirements are being tallied with the instrument versions and specifications. Some of the vendors have been asked to provide updated quotations as per the discussions. Details of the vehicles available on state contracts were compiled and a suitable vehicle has been identified, primarily based on the earliest possible delivery. An order has been routed through the budget approval process.

Significant findings and/or events occurring during the quarter:
    Most suitable laboratory equipment is being identified based at competitive pricing commensurate with budget availability.

Activities planned for the subsequent quarter:
    Quotations are expected to be finalized and orders placed for all equipment items proposed.

Progress made towards overall project objectives:
    Expect to acquire, install, and put all instruments to use after training the staff.

Identified obstacles or challenges:
    Delays in equipment and vehicle acquisitions likely due to the prevailing market conditions and pricing fluctuations.

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:
- Survey growers to determine current NPK fertilizer practices use.

- Postharvest soil and leaf samples nutrient status from trial sites in Citra.
- Soil and leaf samples nutrient status from growers' sites in In Lake County, two peach Orchard.
- Drying soil and leaf samples in oven at 55°C.
- Soil and leaf samples will be sent out to Agricultural Water Lab for Analysis soon.

Significant findings and/or events occurring during the quarter:
- We do not have significant findings yet to be reported.

Activities planned for the subsequent quarter:
- Complete data analysis of first soil and leaf samples taken from both trial site and growers' orchards.
- Zinc sulfate application to be applied in late November to defoliate peach trees in trial site (part of orchard maintenance).
- Winter pruning of peach trees in trial site is scheduled to be done in late December (part of orchard maintenance).

Progress made towards overall project objectives:
- In the first quarter, we have completed the majority of the initial work for the project, corresponding about 15% of the project goals.

Identified obstacles or challenges:
- None to report.

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:
During this quarter, we identified research sites in southwest and southeast Florida Flatwoods, central Ridge and Florida panhandle in collaboration with grower cooperators and Extension agents. We have flagged trees for the project and have mapped all sites. Overall, we have a total of 14 sites including 1 grapefruit grove, 5 mature Valencia orange blocks, 2 young Valencia orange blocks, 3 mature Hamlin orange block and 3 mature mandarin blocks. Treatments for citrus fertilization were adjusted in consultation with grower cooperators from the original 4 treatments 100, 150, 200, 250 lbs N/ac to include 300 lbs N/ac. Phosphorus rates were also adjusted in consultation with growers from 0, 7.5, 15, 30, 60 lbs/ac to 0, 10, 20, 40, and 80 lbs/ac.

We also procured vehicles and other equipment needed for the project including Spadmeters, weather stations and others. Personnel were also hired including three postdoctoral research associates, 4 research assistants, two biological scientists, and three graduate students.

Significant findings and/or events occurring during the quarter:

No major significant findings yet, but growers recommended use of controlled release fertilizer or conventional granular fertilizer at field sites for ease of application of treatments and to avoid making any mistakes on the grower's end and the requirement to overhaul existing fertigation systems.

Activities planned for the subsequent quarter:

We plan to recruit a biological scientist to help with the project. We will finalize initial soil and leaf sampling for the project and canopy determinations. Fall fertilization and preliminary harvest for Hamlin, grapefruit and mandarin blocks will also be done in the next quarter.

Progress made towards overall project objectives:

So far, we have done foundation work for the project and fulfilled close to 10% of project milestones.

Identified obstacles or challenges:

One site in Arcadia for our grower cooperator Alico was severely affected by flooding from Hurricane Ian with about 20 in of rain on Sept. 28, 2022. This has limited our access to the site until a few months out and we can resume sampling and fertilization in Spring 2023. All sites in the southwest and southeast Florida flatwoods and the central Florida ridge lost fruit due to the strong winds from Hurricane Ian varying from 20 to 90 miles/hour but the trees are expected to recover.

Recruitment of one graduate student was delayed due to visa issues but he should be able to start in Spring 2023. One biological scientist position was not filled yet due to insufficient application pool and we hope to get the position filled by December 2022.

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

Activities and accomplishments:

- The experiment has been established, treatments applied, and the initial samples collected. The initial soil samples for nutrient concentration and microbiome were collected and stored for later analysis. Forage samples were also collected, processed, and stored. Water samples were collected after every rain event greater than 5 mm. The volume was measured, and a subsample was stored for total P analysis.
- The OPS was hired to help with forage, water, and soil sampling. I am searching for the graduate student, but it has not been selected yet.
- The Kubota ATV has been ordered and PO supplied to the vendor. The delivery date is expected to January 2023

Significant findings and/or events occurring during the quarter:

- The preliminary data indicated that there was no increase in forage production with increasing levels of P fertilization. The cultivar Gibtuck had greater forage production than Floralta, which will result in greater soil P extraction and eventually greater need to replace the extracted P with fertilizer.

Activities planned for the subsequent quarter:
- There will be 1 additional forage sampling and the final soil sampling in the next quarter. In addition, water sampling will continue using the same criteria described above until the end of the experimental period.
- All forage, soil, and water samples will be processed and prepared for analysis, which will start in January 2023.

Progress made towards overall project objectives:
- The activities are progressing as planned and the data generated from the samples collected in this quarter will allow the investigators to refine the P recommendations for limpograss in South Florida.

Identified obstacles or challenges:
- The project was challenged by unusual climactic conditions (limited rainfall in the summer) and hurricane Ian (last week of September); however, the water monitoring devices will capture the extreme rainfall variability and the authors will make inferences about the potential impact on the treatments.

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:
- Activities/accomplished for this quarter were focused on meetings of the project team and with the stakeholders and UF/IFAS fiscal staff, developing and implementing experimental designs, project planning, and addressing the Hurricane Ian effect. The PI and the team met with growers before the project start date to secure their participation that included commitments for tomato and potato experiments. Meetings were held with the statistician team member prior to and after the start date to discuss crop or site-specific experimental designs to achieve the project goals of evaluating recommendations, identifying site-specific factors (select locations), and active engagement with stakeholders. The main site-specific factor considered are the effects of irrigation and drainage. While the field team actively met, two meetings for the entire team were held on July 28 (zoom) and September 16 (GCREC). Stakeholders also joined (09/16) via Zoom to provide feedback on experiments and communication. Meetings within and among the two regional teams (Central and South FL) occurred on daily to weekly basis to actively develop and modify experimental designs and data collection

protocols. Throughout the quarter, the team met with growers to obtain feedback on the scale, P_2O_5 rates, and harvesting and grading logistics.

- Experiments Implemented: Two tomato experiments (Manatee and Glades Counties), were started with six P2O5 rates (0, 50, 75, 100, 150, and 200 lbs/acre) applied at bedding (July 11 and 24). Transplanting occurred on August 23 and September 15, respectively. Pre-bedding and at planting soil samples and tissues samples were taken. Sites were instrumented to collect rainfall and hydrologic data with soil moisture probes installed on selected treatments. Protocols for different components (fertility, water, pests and disease, economics) were discussed in the team meeting on September 16; soil-plant-water protocols have already been developed or being modified while development of protocols for biotic stressors (pests/diseases) and analytical model for financial elements were started. In-person meetings with bean grower cooperators were held at their farms. Disease ratings were conducted.
- Personnel: Several key personnel were hired while search for others continued.
- Dissemination/Extension Activities: Project plans and preliminary results from the project have been presented at four stakeholder meetings/conferences: 1) SWFREC/IFAS Vegetable Advisory Committee (August); 2) Farm Bureau (two, August), and 3) FL Tomato Conference (September).

Significant findings and/or events occurring during the quarter:
- Preliminary assessments for tomato indicate some differences in plant size differences among the treatments. Bacterial spot was detected at the same site. Discussions with bean growers indicated variations in the method of P application; majority of SFL growers use both dry (pre-bedding) and liquid (at seeding) formulations with liquid fertilizer containing both nitrogen and phosphorus (polyphosphate) which poses a unique challenge of holding the nitrogen input constant for treatments while varying P inputs. Preliminary experiments at a SFL bean farm were conducted to evaluate if phosphoric acid can be used as an alternative liquid P source. However, field and lab measurements showed soil pH to drop below 4. Alternative formulations/methods are being discussed with growers. Given the relatively small season and variations plant/bed spacings, harvesting, and irrigation, the rates for bean are likely to limited to four (0, 40, 80, 120 lbs/acre P_2O_5).
- Hurricane Ian: Plantings at both tomato sites suffered varying and significant damages. Preliminary assessments, in consultation with cooperator, were made on September 29-30 at the SFL site.

Activities planned for the subsequent quarter:
- One tomato (SFL), three potato (C and S FL) and two bean experiments are planned depending on the delays caused by the hurricane. Hurricane damage assessments will be continued for both tomato sites and a summary will be presented. A meeting with stakeholders will be organized.

Progress made towards overall project objectives:

- Significant progress has been made in designing and implementing the experiments; developing and implementing data collection and analyses protocols; communication with growers to ensure buy-in and commitments; and dissemination of plans and preliminary results. The team made changes in plans as needed, with stakeholders' feedback. Overall project progress is satisfactory.

Identified obstacles or challenges:
- Main challenges encountered are: 1) effects of Hurricane Ian on two ongoing tomato experiments and related delays on future experiments for all three crops; 2) addressing the observed differences in bean production practices especially the use of liquid phosphorus (pop-up); 3) effects of continuing supply chain problems on procuring materials/supply including instruments; and 4) hiring personnel. Challenge 1) is being evaluated and meeting with grower cooperators are being planned. Some instruments were damaged or needed to re-installed. Hurricane effects on tomato experiments will be discussed in the next quarterly report. Challenge 2 is being addressed with wide consultation with growers to find alternatives fertilizer formulations and methods with exploratory field trials to select the best alternative by balancing between scientific rigor and feasibility of implementing them in commercial operations. Challenge 3 has been continuing but the team is working with suppliers to minimize the impact on data collection. Challenge 4 is due to combination of the short-term (1-year) nature of the project, limited pool of qualified professionals, and rising costs.

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

Activities and accomplishments:
- Assessment of baseline soil-P status and identification of trial locations: The baseline soil-P status of potential fields identified to conduct the P-rate studies at TREC and Live Oak were assessed. Soil samples were collected from both locations and were analyzed for P-content. Samples from TREC showed a gradient of P-levels. The field was plowed one more time with an effort to remove the P-level gradient by mixing the soil. The second round of soil samples was collected and tested for P-level. Part of the field was found to be suitable for the study by slightly reducing plot sizes. Similarly, soil samples from Live Oak had high P-level. Live Oak was deemed to be not a suitable location for this P trial. The results were in agreement with Mr. Bob Hochmuth's assessment during a meeting on June 29th, 2022. As a result, soil samples were collected from Hastings Agricultural Extension Center (HAEC) in Hastings on July 6, 2022. The data showed that there were some beds with low P levels and thus, HAEC was selected as the trial location for this study.
- Establishment of field experiment at HAEC: Bed 316 at HAEC was chosen for the study at HAEC. Land preparation was conducted on September 8, 2022, and snap bean seeds were planted on September 13, 2022.

- Soil and plant tissue sampling: In-season soil samples and plant tissue samples were collected from the HAEC experimental plots on September 27, 2022.

Significant findings and/or events occurring during the quarter:
- Nothing to report

Activities planned for the subsequent quarter:
- Activities at TREC: Field trial at TREC will start during the second week of October and snap bean cultivar BA0958 will be planted. Phosphorous will be applied using Triple Super Phosphate (46% P2O5) fertilizer. In addition, lysimeter and soil moisture sensors will also be installed for selected treatment plots. Two irrigation treatments will be applied using the variable rate irrigation (VRI) system. In addition, a cover crop (sorghum-Sudan grass mix) will be planted on the other field where the baseline Soil p level was found high to prepare the field for the next experiment in 2023. Soil samples will be collected four times: pre-plant, 15 DAP (Seedling stage), 35-40 DAP (Flowering stage), and during harvest. Leaf samples will be collected three times, 15 DAP (Seedling stage), 35-40 DAP (Flowering stage), and during harvest. At harvest, additional samples will be collected from different parts of the plant (pods, leaves, stems, and roots) for tissue nutrient analysis. Porewater will be collected from selected plots after every irrigation or rainfall event. Plant height and green canopy cover will be measured. Major phenological dates including emergence, vegetative stage, flowering, maturity, etc. will be recorded from each plot. Tentatively, drone-based images will be gathered a few times using multispectral sensors. Bean yield and quality will be measured at harvest from the middle rows.
- Activities at HAEC: Soil samples will be collected on October 11 and 25, 2022. Plant tissue samples will be collected on October 4, 11, 18, 25, and November 1, 2022. Snap beans will be harvested in early November. Soil and plant tissue analyses and data processing will be performed.

Progress made towards overall project objectives:
- The project is going as planned at the two locations (TREC and HAEC). The experiment at HAEC is almost 50% complete and all data are being collected needed to meet project objectives. We also anticipate the experiment at TREC to go smoothly and plan to collect more data than initially planned. Overall, we are on the right track toward achieving overall project objectives.

Identified obstacles or challenges:
- High P-level in most soil samples both at TREC and Live Oak were found to be unsuitable to conduct P-rate studies. This required relocating one of the studies to HAEC and adjusting initially planned plot sizes at TREC.
- We are not able to start a fertigation trial at HAEC this fall because we don't have enough budget. HAEC budgeted more than $17,000 per acre for the costs including

$15,000 per acre for the fertigation system. We are still trying. If there is a possibility we will run a fertigation trial next spring.

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

Activities and accomplishments:
- An equipment vendor in the UF system has been identified for the tractor, grain drill and sickle bar mower for TREC field operations with a request pending for quote. Quotes for drone and camera have been collected, though further consideration is required due to the pending drone purchase restrictions. Hemp nutrient management field season 2022 at TREC, PSREU, and WFREC is complete with harvest samples being prepared for analysis.
- The granular fertilizer applicator for PSREU has been purchased. The fertilizer liquid applicator has yet to be quoted and ordered due to supply chain issues. The new instruments for EREC are in the ordering process.

Significant findings and/or events occurring during the quarter:
- The drone originally proposed is not on the approved list for Florida DMS. Currently approved drones are not capable of carrying the proposed camara payload. An alternate drone unit with longer flight times and additional features was identified from the DoD Blue list, but is also not on the Florida DMS.
- Ongoing hemp research across the state suggests moderate nitrogen rates were associated with increased yields, but also potentially increased loss to the environment. Background phosphorus or minimal application were also observed in preliminary trials.

Activities planned for the subsequent quarter:
- Complete PO for equipment at TREC.
- Complete PO for multi spectral camara and mounting system.
- Initiate field season 2023 with gap funding.

Progress made towards overall project objectives:
- Hemp research is ongoing with information being generated by a team of graduate students. Research is narrowing the operational range of hemp nitrogen management; however, various crop production and quality indicators are optimized across the range of nitrogen application rates investigated.

Identified obstacles or challenges:
- Site-specific management was proposed through the use of aerial images which is in jeopardy due to the 2023 restrictions on drone purchase and operation. Vendor responsiveness and supply chain issues are current obstacles for multiple other equipment purchases.