PENNSYLVANIA VEGETABLE MARKETING & RESEARCH PROGRAM

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Research Grant Pre-Proposals for 2023

As of November 2, 2022

Board and Committee members are asked to rate the following pre-proposals using the following system:

A – very interested in funding and in receiving a full proposal for final consideration
B – potentially interested in funding – would appreciate a full proposal for final consideration
C – very little or no interest in funding

___1 Evaluation of rapid on-farm monitoring tools for the in-season and site-specific management of the fertigation in high tunnel vegetable production systems

Francesco Di Gioia - The Pennsylvania State University and Leah Fronk, Karly Ragan, Glen Bupp, Thomas Ford - Penn State Extension

Research priority: High tunnel nutrient management and soil health

The productivity and long-term sustainability of high tunnel vegetable production systems is strictly depended on our ability to preserve and maintain the soil health and a good fertility status. High tunnel growers usually invest some money to assess the fertility of their soil before planting their main crop, and if properly done these analyses provide a good estimate of the potential soil fertility status, which can be used to formulate a 'prescriptive' fertilization plan. This approach is generally used for phosphorous, potassium, and other macro and micronutrients, except for nitrogen (N). While N availability in the soil is one of the most important factors affecting our crops, its dynamic in the soil are quite variable over time and the analysis done in pre-planting may not reflect what is available for the crop during the growing season. For this reason and considering that high tunnel vegetable production systems are characterized by an extended growing season and in most cases, fertigation is used to apply fertilizer during the growing season, it is important to assess the availability of mineral nitrogen in the soil throughout the crop cycle in order to adjust the amount of N fertilizer applied through each fertigation at the site-specific level. Over the last four years, my lab with the support of Extension Educators working in different areas of the State, have been working on a rapid soil monitoring tool for the in-season and site-specific management of the fertigation using relatively simple and not-expensive tools that may be easily used on farm. The method consists in collecting soil samples from the root zone every 2-3 weeks, extracting the soil solution with deionized water, and analyzing the extract electrical conductivity, pH, and nutrient content with portable ion selective electrodes directly on farm. Based on the results, the fertilization program is adjusted during the growing season. Testing the method across a range of soils, the method developed so far proved to be effective in detecting variations of pH, EC, and nitrate-N (NO3-N) and we can detect for example a N deficiency or excess. Nevertheless, comparing the results obtained with NO3-N ion-selective electrodes (ISE) with standard laboratory analysis we have observed that the results provided by NO3-N ISEs are influenced by the soil pH and are skewed when the pH of the soil is above 7. To address this issue, we would like to test the use of buffer solutions that can correct the pH of the soil extract before the analysis is performed using NO3-N ISEs. To test and validate this approach we need to test a large number of soil samples from different soils across the state and compare the results obtained using NO3-N ion-selective electrodes with those of laboratory analysis. The results of the research results will be shared with vegetable growers through traditional extension methods.

Estimated funds required to cover soil sampling and shipping cost, plus sample processing, NO3-N ion-selective electrodes and laboratory analysis costs is about
$10,000.

___2 Precision cultivation using camera guidance technology in snap bean

John Wallace and Tosh Mazzone, Penn State University and Lynn Sosnoskie, Cornell University

Recent advances in cultivator technology provide novel opportunities for snap bean growers to use precision cultivation to control weeds with tools such as camera-based guidance systems and in-row cultivator tools. A main goal of precision cultivation technology is to improve the speed, productivity and efficacy of cultivation while automating parts of the cultivation operation. Camera guidance systems facilitate close crop clearances by shifting cultivator side to side, allowing finger weeders to disturb soil in and around the base of crop plants with enough force to kill newly germinating weeds. Thus, camera-based guidance systems can improve the efficacy of cultivation by targeting weeds in-row. Understanding the tradeoff between weed control and crop tolerance is a significant knowledge gap that prevents use of precision cultivation in horticultural crops. Preliminary findings from 2022 suggest that there can be diminishing returns from increasing cultivation frequency while using finger weeding tools. Cultivation is generally more effective for early season weed control, but young snap beans may be more sensitive to mechanical injury during this time. We propose to replicate the 2022 field research trial that will evaluate cultivation timing and frequency of in-row cultivation with finger-weeders and camera-based guidance. Based on the need for additional data, we propose to add a replication of this trial in 2023 in Pennsylvania, as well as an additional field site in Western New York to strengthen the data set. To facilitate additional costs for seed to replicate the field trial at another site, we have increased the proposed budget. Through this research we aim to optimize timing and frequency of in-row cultivation using finger weeders to reduce crop injury while maintaining effective weed control. The results of this research will be shared with growers through Penn State Extension and regional extension meetings.
$1,600

___3 Hydroponic Lettuce Nutrient Optimization

Krystal Snyder and Elsa Sanchez, Penn State University and Carla Garzon, Delaware Valley University

The purpose of this project is to reduce fertilizer inputs and costs for hydroponic growers. Hydroponic growers in Pennsylvania need updated nutrient recipes for hydroponic lettuce. Most growers are working with nutrient programs that do not entirely consider the source water nutrients or ones that are based on a modified Hoagland solution for which the macronutrients have not been updated since 1933 (Hoagland, 1933). A lower need for fertilizers will save growers money on overall fertilizer input costs, including for shipping. Lower concentrations of fertilizers in nutrient solutions will also benefit the environment by having less nutrient-rich fertilizer wastewater being disposed of. In this trial, different fertilizer programs for hydroponic lettuce will be evaluated. This project has two experiments. In the first experiment, we will use an NFT system and evaluate these treatments: 1. Control, Modified Sonneveld solution; 2. 25% reduction in nitrogen, phosphorus, and potassium + 25% increase in micronutrients; 3. 50% reduction in nitrogen, phosphorus, and potassium + 50% increase in micronutrients; and 4. 50% reduction in nitrogen, phosphorus, and potassium + 25% increase in micronutrients. Calcium, magnesium, and sulfur levels will stay constant in all treatments. In the second experiment, we will use a deep-water culture system. Plants will receive the same amount of nutrients based on modified Sonneveld. However, the amount of water in the system will be provided at a normal, medium, or high depth.

The data collected for both experiments will be the same. Nutrient solutions will be tested biweekly, and tissue will be tested at harvest, through testing at Penn State's Agricultural Analytical Services Laboratory. Additionally, we will record the pH, EC, temperature, and dissolved oxygen levels in the

nutrient solutions, as well as air temperatures and light levels in the greenhouse. Growth of crop will be measured weekly by centimeter of head and using the Canopeo App to measure green canopy growth. At the end of each crop cycle, we will also record the fresh and dry weight of each head, along with its shelf life. The results of this trial will be published on the Penn State Extension website and presented at the Mid-Atlantic Fruit and Vegetable Convention.

We are requesting that the PVRMB consider funding this effort in the amount of $6704 to cover the tissue testing ($4704) and growing supplies ($2000) for two locations (Penn State and DelVal) in Spring, Summer, and Fall of 2023. Delaware Valley University has agreed to provide greenhouse space and an intern.
$6,704

___4 **Study the impacts of soil aggregate stability on crop nutrient uptake and differences between cropping systems and management practices for growing vegetables**
Dr. Gladis Zinati - Rodale Institute

Management practices that entail intensive tillage for growing vegetables may negatively impact soil aggregate stability and may lead to soil erosion during heavy rainstorms. Soil erosion may carry soil surface particles, pesticides, and nutrients outside the farm to nearby streams. In addition, vegetable crops may have less nutrients available to be taken up. Reduced tillage may counter effect the degradation of soil aggregate stability by using less intensive equipment in tillage, frequency of tillage, or equipment that eliminates the tillage during the vegetable growing season.

The objectives of this proposed project are to assess 1) the wet soil aggregate stability taken from top 0-10 and 10-20 cm soil cores collected in a long-term Vegetable Systems Trial (VST) at Rodale Institute (Fall 2022) and 2) the mineral nutrient uptake in vegetables after harvest in 2023. Funding from the Pennsylvania Vegetable Growers Association for this project will provide PA vegetable growers with information to be used as guide in selecting methods and systems that enhance soil aggregate stability and nutrient density in vegetables. This project could go for one year or over multiple years.
$**7,580**

___5 **Potential Residual Herbicide Programs in Pumpkin**
Dwight Lingenfelter and John Wallace - Penn State and Lynn Sosnoskie, Cornell University

Weed control in pumpkins is challenging for many reasons, including the production practices of wide rows, no-till which excludes use of cultivation, long growing season, and limited number of herbicide options. These practices result in a greater reliance upon herbicides for weed control. Unfortunately, there are very few herbicides labeled for postemergence weed control in pumpkins. Since herbicides play an important role in pumpkin production, it is important that currently registered herbicides are used judiciously and new herbicides (i.e., ones with different active ingredients and modes of action than those currently labeled) are identified that fit into a pumpkin production system and provide effective weed control, minimal crop injury, and environmental safety. Furthermore, it is important to find novel ways to optimize the utility of current and potential new herbicides. One approach to improve overall weed control is to apply a second residual herbicide over the top of the emerged crop, but before the weeds have begun to emerge. This approach is referred to as overlapping residuals.

We propose to apply herbicides such as Dual, Zidua, Warrant, BroadStar and others at the delayed PRE/early POST growth stage (3-4 weeks after planting) to obtain prolonged residual activity later into the growing season. We will compare various herbicide combinations and application timings that include labeled standards such as Command, Curbit, and Sandea to those mentioned above that could potentially receive a label for use in pumpkins. Control of typical annual weeds such as, giant foxtail, velvetleaf, pigweed, nightshade, ragweed, and any other weed species present in the study location will

be evaluated. In addition, we will determine effect of the herbicides on pumpkin injury and any subsequent impacts on yield. The study will be conducted at the Penn State research farm near Rock Springs, Centre County and at Cornell AgriTech in Geneva, NY. Benefits to state and regional pumpkin growers will include updated information in vegetable production guides and other educational resources on how to more effectively control weeds with existing and new products and how best to integrate other effective herbicide modes of action into the program to reduce the potential for resistance.
$1,500

___6 **Evaluation of Fungicide Programs for Powdery Mildew Control in Pumpkins**
Timothy Elkner - Penn State Extension and Beth Gugino - Penn State University

Powdery mildew remains a concern for growers in Pennsylvania. Fungicide efficacy trials have identified new materials that are very effective for powdery mildew management on pumpkin. However, few studies have been conducted examining how these materials could be most effectively used in a season-long disease management program. We propose examining several fungicide programs for powdery mildew control to evaluate a standard commercial program as well as alternative programs that are developed to reduce input costs as well as incorporate biorational materials where possible while maintaining yields, fruit quality and needed fungicide resistance management protocols. A breakdown of fungicide program costs for the season will also be developed.
$6,850

___7 **Evaluating Synergism and Safety Between HPPD-Inhibiting Herbicides and Pyridate**
Lynn Sosnoskie, Cornell University

Postemergence applications of 4-hydroxyphenylpyruvate dioxygenase (HPPD)-inhibiting herbicides (i.e., Callisto, Impact, Empyros, Laudis) are regularly used to control broadleaf and some annual grass weeds in sweet corn production. Tank mixing HPPD-inhibitors with atrazine, a photosystem II (PS II)-inhibitor, is recommended because research has demonstrated additive or even synergistic weed control. However, rotational restrictions and the evolution of herbicide resistance can limit atrazine use in many production systems. Additionally, there is growing concern regarding proposed US EPA restrictions on atrazine applications and supplemental mitigation requirements (See: https://www.regulations.gov/document/EPA-HQ-OPP-2013-0266-1625).

Pyridate, the active ingredient in Tough EC, is also a PS II-inhibitor (although different in binding site to atrazine), and an effective mode of action for weed management in field corn. The manufacturer emphasizes the product's value as a tank-mix partner with other chemistries, including the HPPD-inhibitors, to enhance weed control - particularly the control of herbicide-resistant species - which is a PVGA priority. Currently, the IR-4 Project lists pyridate as a 2023 final residue priority for sweet corn. The objective of our field trials will be to compare the weed control efficacy and crop safety of pyridate formulated as Tough EC applied postemergence alone and in combination with key HPPD-inhibiting herbicides. The trial will be conducted at three locations (PA, NY, DE), which will allow us to compare responses across diverse weed communities and production environments. This data will be crucial for providing growers with novel weed management recommendations. Our results will be communicated to sweet corn producers through regionally based vegetable conferences (e.g. Mid-Atlantic Fruit and Vegetable Convention, New York Producers Expo, Northeast Fruit and Vegetable Conference), updates to the Mid-Atlantic and New York commercial vegetable production guides, and via our statewide extension programs.
$2,000

___8 Monitoring Fall Armyworm

Timothy Elkner and Karly Regan - Penn State Extension

The PA Sweet Corn IPM trapping program has been in place for over 25 years. This system of monitoring sites has provided valuable information to growers enabling them to adjust their insecticide programs during the season to either reduce insecticide applications when insect pressure is low or increase sprays when pressure is high. Recently we have seen instances where fall armyworm, which is not usually a problem, has suddenly reached high population levels that require timely insecticide applications for management. Over time, the traps used to monitor for armyworm have degraded as the plastic breaks down from UV light exposure. Because of limited local funds, monitoring sites have not been able to upgrade their traps and many are at the end of their functional life. In addition, some sites are only trapping for corn earworm, leaving growers in those regions without the needed information to manage outbreaks of fall armyworm. We are requesting funding to replace the armyworm traps across the PA network as well as purchase traps and stakes for a few additional locations not currently trapping.
$1,750

___9 Keeping PA Vegetable Growers Profitable: Statewide Cultivar Trials on Tomatoes

Elsa Sánchez – Penn State University and Robert Pollock, Timothy Elkner, Thomas Butzler, and Megan Chawner – Penn State Extension

Selecting which cultivar to grow is critical to successful vegetable production. When farmers grow high-yielding cultivars suited to an area, they can make a profit. However, because numerous cultivars are commercially available, it can be daunting to select the best ones. Our goal is to provide farmers with up-to-date information for successful, region-specific cultivar selection. We would like to continue our statewide effort to evaluate tomato cultivars in central, southeastern, northeastern, and southwestern Pennsylvania. Since 2008, with funding from the PVRMB, we evaluated green bell peppers, winter squash, bicolor and white synergistic sweet corn, spring and fall broccoli, 15-25 lb orange, smooth-faced pumpkins, muskmelons, and spring and fall cabbage. Regional and statewide recommendations have been disseminated through presentations and articles. Statewide recommendations also appear in the Mid-Atlantic Commercial Vegetable Production Recommendations guide.

We would like to repeat our evaluation of early-maturing, determinate, large, red, slicing tomatoes in 2023 to follow scientific standards and demonstrate the repeatability of the results. In Pennsylvania, tomatoes are a top crop for vegetable farmers. Field-grown tomatoes are grown on 1,586 farms comprising 3,297 acres (Census of Agriculture, 2017). This is up from 1,720 farms growing 2,655 acres in 2012 (Census of Agriculture, 2017). Additionally, 304 growers at the 2011 Mid-Atlantic Fruit and Vegetable Convention were asked, “What specific crops should researchers focus on in order to maintain your operation’s profitability and that of the Mid-Atlantic Vegetable and Fruit Industry? Tomatoes came out as the top response of 18 listed crops. Conventional farming practices will be used at the western, central, and southeastern sites, and organic methods will be used at the northeastern site. We are requesting $20,000 or $5,000 per site for this project. Growing tomatoes requires higher labor needs than the crops we have evaluated before. We are requesting the same amount per site as in the past; however, the number of cultivars we will evaluate in a single year will be lower to account for increased labor costs. We evaluated 11-12 cultivars at each site in 2022. Our plan is for this to continue evaluating different types of tomatoes (varying sizes and times to maturity, heirloom-hybrid crosses, high tunnel types, for example) in the future.

$20,000

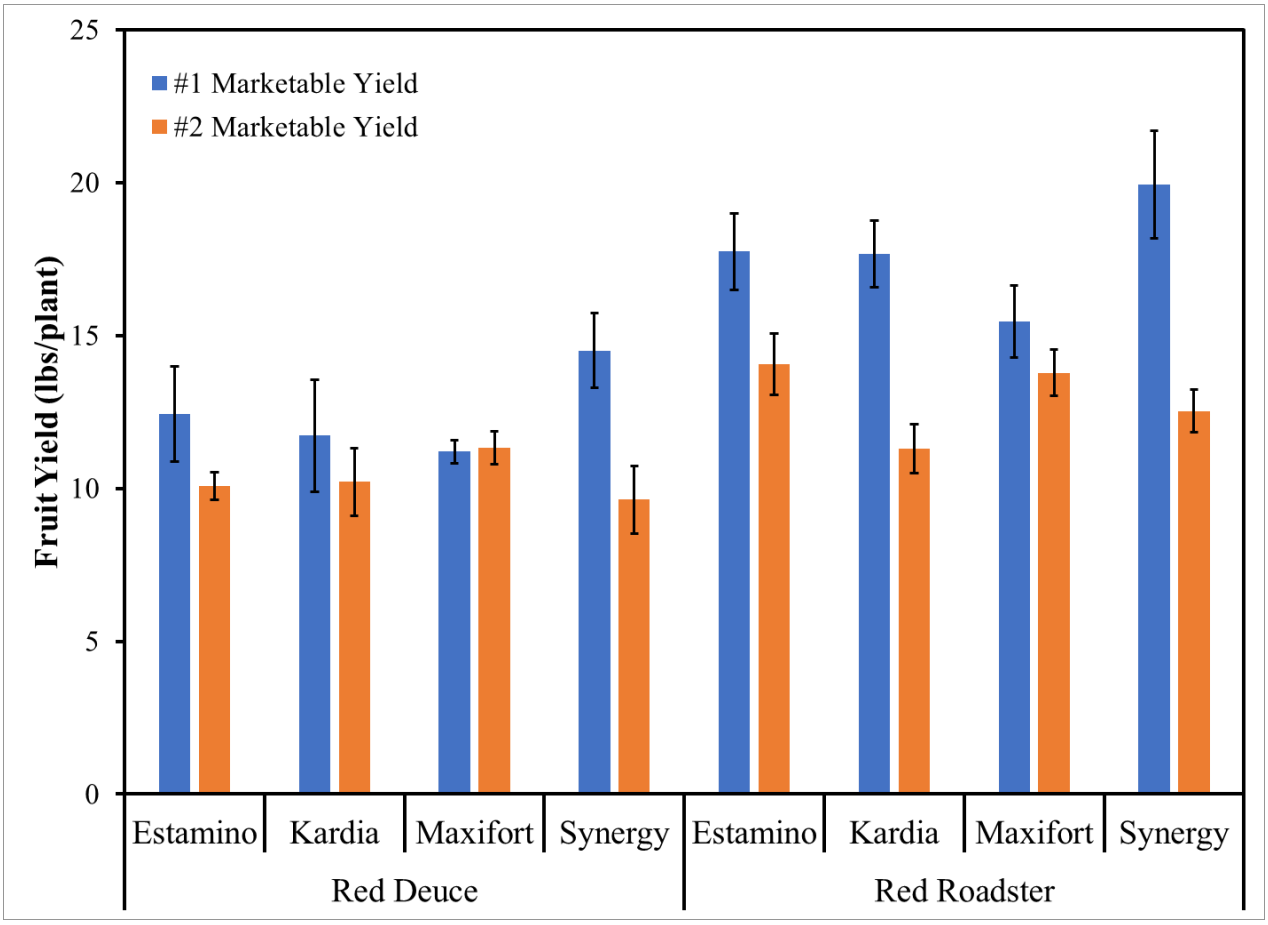
___10 **Evaluation of rootstock-scion interaction and yield performance in fresh-market tomato grown in high-tunnel**

Timothy Elkner – Penn State Extension and and Francesco Di Gioia – The Pennsylvania State University

Research priority: High tunnel variety selection, nutrient management, and soil health

The increased adoption of high tunnel production systems is leading also to an increased adoption of grafted tomato plants. The rootstock selection and the rootstock-scion combination are key factors for the successful use of grafted plants. Previous studies have shown that the use of vigorous rootstocks can help overcome soilborne pest and pathogens as well as abiotic stress conditions (low and high temperatures, water stress, salinity, alkalinity). In a preliminary study conducted at SEAREC in Southeast Pennsylvania during the 2021 growing season we have observed consistent differences in terms of yield and plant growth testing eight combinations between two scions 'Red Deuce' and 'Red Roaster" and four rootstocks (Estamino, Maxifort, Kardia, and Synergy). We were funded to repeat this study in 2022 and established the planting but lost the trial to soil borne herbicide contamination. We propose to repeat this same study in 2023 and compare these grafting combinations in terms of yield, plant growth, nutrient uptake, and fruit quality. Treatments will be arranged according to a split-plot experimental design with four replications. Biometric assessments and plant tissue analyses will be performed to assess nutrient uptake. Fruit yield and quality response will be evaluated. Outreach activities will be organized to show the results of the study. Estimated funds required to cover field supply, hourly wages, and laboratory analysis:

$10,000



Preliminary results showing final marketable fruit yield for category #1 and #2 fruit.

___11 **Breeding fresh-market tomatoes for production in PA**

Majid R. Foolad - The Pennsylvania State University

Objective**:** To develop breeding lines and F_1 hybrid cultivars of fresh-market (FM) tomato with disease resistance and other desirable characteristics suitable for production in PA.

We have developed elite fresh-market (FM) tomato breeding lines, including large-size (slicer), plum, cherry, and grape tomatoes, with strong resistance to foliar diseases, including early blight (EB) and late blight (LB), and general resistance to other tomato diseases, including Septoria leaf spots and bacterial canker. Our inbred lines also exhibit other desirable characteristics, including high yield, early maturity, superior fruit quality, and adaptation to PA conditions. Most of our inbred lines are elite and ready to be used as parents for developing F_1 hybrids for commercial evaluation. During the past several years we developed a large number of FM tomato F_1 hybrids, which were evaluated at Penn State research Farms, and also trialed by several national/international seed companies, PA tomato growers, and PSU Extension Educators. For example, in 2022 we trialed 107 elite FM large-size F_1 hybrids with EB resistance, 89 elite FM large-size F_1 hybrids with EB + LB resistance, and 82 grape tomato F_1 hybrids with EB and/or EB + LB resistance, and shared some of our F_1 hybrids with several seed companies (Gardens Alive, Gowan Seed, High Mowing Organic Seeds, HM Clause and Johnny's SS), PA vegetable growers, and PSU Extension Educators for field trials. In 2022, we also developed 12 NEW FM large-size F_1 hybrids with EB resistance and 12 NEW FM large-size F_1 hybrids with EB + LB resistance, which were evaluated in 2022. Currently, we are developing 11 NEW Regular FM large-size F_1 hybrids (EB resistant), 23 NEW LBR FM large-size F_1 hybrids (EB+LB resistant), 27 NEW FM Plum F_1 hybrids (with EB and/or EB+LB resistance) and 28 NEW grape tomato F_1 hybrids with EB resistance, and reproducing seed of 17 LBR FM large-size F_1 hybrids (with EB+LB resistance), all in Costa Rica. In 2023, all of our elite FM tomato F_1 hybrids as well as the NEW hybrids (currently being produced in Costa Rica) will be trialed by us at Penn State, with select number of them trialed by several seed companies, growers and researchers.

The Main Objectives of our 2023 FM tomato breeding projects include:
1) Production of new seed of various types of FM tomato F_1 hybrids, including Regular and LBR large-size, plum and grape, in Costa Rica;
2) Field evaluation of our Regular (EB resistant) FM tomato F_1 hybrids, including large-size, plum and grape);
3) Field evaluation of our LBR (EB+LB resistant) FM tomato F_1 hybrids, including large-size, plum and grape);
4) Cooperative evaluation of select number of our FM tomato F_1 hybrids (large-size, plum and grape) by seed companies;
5) Development and trialing of elite FM tomato inbred lines (large-size, plum and grape) with EB and/or EB+LB resistance, suitable for future hybrid production; and
6) Continuation of our projects to screen for bacterial canker resistance and identify resistance genes to be deployed in our breeding lines.
$8,000

___12 **Breeding processing tomatoes for production in PA**

Majid R. Foolad - The Pennsylvania State University

Objective: To develop breeding lines and F_1 hybrid cultivars of processing (PROC) tomato with disease resistance and other desirable characteristics suitable for production in PA.

At Penn State, we have developed elite processing (PROC) tomato breeding lines with strong resistance to foliar diseases early blight (EB) and late blight (LB), and general resistance to other tomato diseases, including Septoria leaf spot and bacterial canker (we have established a comprehensive project on bacterial canker resistance; PhD thesis of Jonathan Bonfiglio). The PSU PROC tomato inbred lines have also been bred for other desirable characteristics, including high yield, early maturity, superior fruit

quality, and adaptation to PA conditions. Most of our lines are elite and ready to be used as parents to develop F_1 hybrids for commercial evaluation. During the past few years, we developed a large number of PROC tomato F_1 hybrids and trialed them at Penn State research Farms. For example, in 2022, we trialed 49 elite PROC tomato F_1 hybrids with EB resistance and 64 PROC F_1 hybrids with EB + LB resistance. We also shared select number of our elite F_1 hybrids with three tomato processing companies, Fermano Foods Inc., Red Gold, and Hirzel Canning, which trialed our material under their production conditions. For example, in 2022 Furmano trialed 22 PSU elite PROC tomato F_1 hybrids, of which 7 were trialed in large scale (40,000 seed each) and 15 in experimental scale. Similarly, each of Red Gold and Hirzel Canning company trialed 21 PSU elite PROC tomato F_1 hybrids in 2022. All three companies want to re-trial these and more of our hybrids in 2023, in particular at commercial scale. For example, for Furmano trials in 2023, we have identified 5 hybrids to be trialed at 150,000 plants each, 9 hybrids to be trialed at 40,000 plants each, and about two dozen hybrids to be trialed in experimental scale. We are making agreement with the University to allow such large-scale trials by Furmano in 2023, and currently we are in the process of sending parental seed to Costa Rica for the production of hybrid seed.

The Main Objectives of our 2023 PROC tomato breeding projects include:
1) Production of commercial-scale (150,000 or 40,000) seed of 14 elite F_1 hybrids in Costa Rica;
2) Production of experimental-scale (1000 each) seed of a total of 36 F_1 hybrids, including 20 Regular (EB resistant) and 16 LBR (EB and LB resistant) hybrids in Costa Rica;
3) Field evaluation of our Regular PROC tomato F_1 hybrids (EB resistant), including 20 new hybrids that are being produced (2022-2023) in Costa Rica;
4) Field evaluation of our LBR PROC tomato F_1 hybrids (EB + LB resistance), including 16 new hybrids that are being produced (2022-2023) in Costa Rica;
5) Trialing and development of elite PROC tomato inbred lines with EB and/or EB+LB resistance suitable for future hybrid production;
6) Trialing of our PROC hybrids in collaboration with three Food Processing companies (Furmano Foods, Red Gold and Hirzel Canning); and
7) Continuation of our projects to identify new sources of resistance to bacterial canker and genetic analysis (e.g. gene mapping) of resistance.
$8,000

___13 Ube, A New Crop for Pennsylvania Farmers

Thomas Ford and Elsa Sánchez - Penn State Extension

Ube (*Dioscorea alata*), the purple water yam, is popular with consumers in the Philippines, India, France, Thailand, Malaysia, China, and more recently, the USA because it can be used in an array of traditional foods. This unique sweet, starchy tuber has a nutty or vanilla-like flavor profile with a distinctive purple flesh. Ube is rich in antioxidants, and it has taken the culinary world by storm because it can be used to flavor ice cream, pudding, pastries, and even waffles.

Pennsylvania farmers are always searching for new crops to offer to customers. Recent additions include ginger, turmeric, saffron, and specialty mushrooms. Ube has the potential to be added to this list. It is a tropical perennial that can yield large harvestable tubers in the field in 6-7 months in the Philippines. We wish to investigate the potential of Ube as both a high tunnel and hydroponic crop in Pennsylvania. Our goals are to 1) demonstrate that Ube can be produced successfully in protected culture environments in Pennsylvania and 2) produce small-sized consumer-friendly tubers that will be accepted by Pennsylvania customers. We will grow Ube in high tunnels and hydroponically in a greenhouse using similar methods as used for “baby” ginger. Additionally, we will use in-row plant spacing in high tunnels, and 5-gal grow bags in the greenhouse to produce small tubers similar in size to sweetpotatoes.
$6,500

Total Requested by Pre-Proposals - $90,484