Citrus Research and
Development Foundation, Inc.

QUARTERLY REPORT TO THE COMMERCIAL PRODUCT DEVELOPMENT COMMITTEE OF THE CITRUS RESEARCH AND DEVELOPMENT FOUNDATION

September 2012

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Project Monitoring and Reporting System Overview

This quarterly report to the CPDC is a first look at all eight committee projects in detail. It provides an overview for each project along with its goals, benefits, targeted completion, available resources, current status, issues and gaps and project roadmap. The report also includes budgetary information by project, and consolidated at committee level. The intent is to provide the committee with integrated information needed to inform planning, project prioritization, and resource allocation decisions going forward.

Monthly update reports will be issued in November and December, and the next Quarterly report is scheduled for January 2013.

One of the issues we will need to discuss at the upcoming Committee meeting is the timing and frequency of future meetings. Our next scheduled meeting is January 2013, on or around the date for the Board of Directors meeting. We can schedule telephonic meetings on a monthly basis, or we can hold them on an “as needed” basis when committee decisions or board actions are required.

I welcome your feedback on the content, level of detail, and organization of the report. If there are items that you would like added to or deleted from the report, please let me know. Also let me know if there are items where you disagree, or have additional information or perspective. The goal is to make this a useful working document that we can update on a regularly scheduled basis.

This and future reports attempt to capture the current status of projects and make some reasoned projections about their progress. It should not be viewed as a precise plan or, prediction, but rather a direction because product development and commercialization are inherently filled with substantial uncertainty and technical, market and commercial risk. As the projects move forward, commercial partners will increasingly dictate both direction and pace.

I look forward to our discussions at the September 26 committee meeting, where we will be reviewing in summarized fashion the key elements of each project and get your feedback on their direction and progress.

Thanks and regards,

Jim Dukowitz

Commercial Product Manager

PROJECT REPORTS

Disease Detection: Canine Scouting (Citrus Canker)

Goal

Help accelerate the commercialization of canine scouting to detect the presence of citrus canker in nurseries, fields and pre-packing house locations to benefit the Florida citrus industry. This support includes ongoing mentoring to the J&K Canine Academy as it develops a commercialization plan and roadmap; industry feedback and assistance through pilot programs and related support; assistance in establishing a quality assurance certification of detector program providers; and other support, as appropriate. Depending on the technical success of further research, this may be followed by HLB and possibly other plant diseases in the future.

Benefits

Canine scouting represents an additional screening tool for the detection of Citrus canker diseased trees and fruit, with their potential to provide the following economic benefits to the Florida citrus industry:

- Nurseries can use canine scouting to help ensure that nursery trees will not be quarantined and therefore unsalable.
- Growers can insure trees purchased from nurseries are canker free prior to planting. This can help ensure no new Citrus canker is being introduced into the groves. Thereafter, periodic canine inspections and pruning can help ensure continued canker free status.
- Pre-harvest grove inspections prior to government inspections can increase the likelihood that fresh fruit exporters to the European Union can obtain a Harvesting Permit.
- Growers with current canker infected groves that are either abandoned or used for juice processing, can use canine scouting to help eradicate canker and allow a transition to fresh fruit shipments at higher prices, leading to improved margins.
- Fresh fruit at pre-packing house locations can be inspected prior to going to the packinghouses which contain government inspectors. This will further reduce the likelihood that diseased fruit will enter the packinghouse and be detected. This is particularly relevant for shipments to EU or other citrus-producing states of the US.
- Plans are also underway to expand canine scouting to HLB and potentially other plant diseases.

Description

Research on detection of citrus canker using canine “scouting” for disease detection and management has progressed to the point where it is ready to be commercialized.

USDA/Ft. Pierce researcher Dr. Tim Gottwald has conducted research over the past 12 years that demonstrates that dogs can reliably detect minute concentrations of volatile compounds being given off by canker-infected citrus foliage and fruit. Field and packinghouse trials conducted in 2010-2011 showed greater than 98% detection accuracy.

The majority of the errors were false negatives due to such factors as being downwind from infected trees, and the presence of infected foliage or fruit at the location on a previous run. Temperature was also found to be a factor in packinghouse trials, as panting reduced detection accuracy. A more recent 16 acre field trial also produced positive results.

J&K Canine Academy, the dog training company involved in the citrus canker research program, is now actively engaged in industry awareness programs and seeking service contracts with nurseries and growers with a goal to self fund the launch of this business, Quality Assurance Certification of the detector program provider is an important to ensure high quality standards are maintained in the industry. Dr. Gottwald has developed a testing protocol (See Appendix for more details). The details of the certification program, including who would "own" the program, needs to be worked

Because this is a new and potentially important approach to citrus disease control, CPDC can provide valuable feedback and other appropriate assistance to the commercialization process. The commercialization success ultimately rests on the level of commercial interest from growers, and whether the pilot program achieves desired performance standards.

Additional details on prior research, commercialization plans and certification issues are contained in the Appendix to this document.

Targeted Completion

- J&K's goal is to have created by the end of 2012, industry awareness and acceptance of canine scouting as an effective additional screening tool for the detection of citrus canker.
- This will include successful completion of service contracts in both nurseries and groves, after which J&K will focus on ramping up capacity and managing business expansion.

Available Resources

- Pepe Peruyero, CEO of J&K Canine Academy. He is the main communications point on commercialization issues.
- Tim Gottwald, Research Leader/Plant Epidemiologist, USDA, ARS/Ft. Pierce will provide ongoing support on data collection and analysis.
- CPDC will provide ongoing mentoring and support and provide access to and feedback from Florida growers in support of the commercialization effort.

Status

- J&K is now marketing citrus canker detection services to the citrus industry through its ***Scentworx*** division, offering a variety of programs customized to the need of the client.
- J&K had a presentation/demonstration at the August 2012 Citrus Expo in Ft. Myers followed by a radio interview on AgNet.

- J&K recently completed a successful pre-inspection scouting project for canker at a nursery after which the nursery passed inspection "for the first time in years."
- J&K is currently seeking to initiate a project with a grower. An ideal candidate would be seeking a Harvesting Permit to export fresh fruit to EU.
- J&K has developed the protocol for a 4 month pilot program for growers that would cover 500 to 800 acres. Four dogs and two handlers would cover the entire area in a 30 day period, and then repeat the process three more times. "Level 1" dogs would be used for the first pass (trained to detect high concentrations of disease); with "Level 2" dogs (more sensitive and trained to detect minute concentrations of disease) used for passes two through four. After each pass, the grower will, as appropriate, prune, defoliate or remove the identified diseased trees, leaves or branches. At the end of the pilot program, the grower would have the option to seek a final FDACS inspection to permit for fresh fruit export to EU markets.

Issues and Gaps (Citrus Canker)

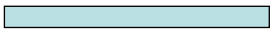
- ***Market Demand Validation***: target markets, level of interest, citrus industry risks, needs and priorities (surveys, focus groups, etc.) This would include an assessment of likely continuation of EU import restrictions due to citrus canker.
- ***Value proposition***: Preparation and communication of cost-payback models for citrus industry.
- ***Competition***: Cost and performance comparisons with alternative approaches, including full costs of human scouting, equipment, copper, total man hours involved. CRDF staff has provided a point of contact that can support this information gathering effort.
- ***Disease Management***: how canine scouts might be used as part of an overall disease management program for citrus canker?
- ***Dog Supply***: Present and projected business capacity for delivery of trained canines
- ***Awareness Campaign*** (e.g. APHIS Plant Management Network, PR, marketing materials, grower channels). This includes preparation of a one-page market positioning document that concisely states the target markets and benefits to users in those markets.
- ***Finalize Business Model***: pricing, contract services vs. lease, etc.
- ***Certification Progra***m: One avenue for exploration is who will take financial and management responsibility for the certification program to maintain high quality standards for canine performance? This might be a good thing for the users to control.
- ***Public awareness/sensitivity***: All dogs recruited for the program are obtained from animal shelters and would be euthanized if not placed in the program. Many are hyperactive or have other characteristics that make them poor pets, hence they were discarded, but they are well suited as detector dogs. The program is therefore friendly for animal activists and those concerned with animal welfare.

HLB Research

J&K Canine Academy has submitted a pre-proposal to CRDF for CATP12 research funding to conduct a training program for canine detection of HLB. A key open issue is to what extent pre-symptomatic detection will be possible while the disease is still latent.

The proposed 8 month program could enable HLB detection services to be available to Florida growers by the end of 2013.

Project Roadmap: Canine Scouts

What	Who	Start	End	Jul Aug Sep Oct Nov Dec+
Industry awareness progs	J&K	July	Ongoing	
Validate market demand	J&K	July	Dec	
Nursery pilot project	J&K	Aug	Aug	
Grower pilot project(s)	J&K	Sep	Nov	
Nursery program rollout	J&K	Sep	Ongoing	
Grower program rollout	J&K	Dec	Ongoing	
Quality Assurance Certification program	J&K, Industry	Oct	Ongoing	
Business model evolution	J&K	July	Ongoing	

See Appendix 1 for additional detail on prior research and planned quality assurance certification program.

Psyllid Control (Neonicotinoid Label Modification)

Goals

Expand labeling on Imidacloprid, Clothianidin and Thiamethoxam to include a second soil application during a calendar year at the current maximum labeled per tree rate to protect young trees up to 5-9 feet tall (transplants/replants to 5 years of age) against HLB. At project conclusion, a major commercial product involving each of the above active ingredients will have received regulatory approval for label changes.

Benefits

Extensive research into the epidemiology and spread of HLB in Florida since its discovery in 2005 has indicated that HLB impact on mature trees may be managed to extend the productive life of infected trees over an unknown period of time, while very young trees may be adequately treated per current neonic label instructions. The more insidious problem is the inability to adequately protect transplants and replantings from 3-5 five years of age against HLB.

Without the means to assure control of HLB in these plantings, the economic risks associated with tree replacement may outweigh the expense associated with replanting.

Description

CRDF is working with company producers of products based on the three nicotinoid active ingredients (Bayer, Syngenta and Valent), the Florida Department of Agriculture and Consumer Services (FDACS), and EPA to obtain a 24(c) Special Local Need label change for the state of Florida. The label change would increase the number of applications per year to provide year-long protection for young producing trees from HLB inoculation. Ongoing project management is provided by Dan Botts, President of Third Party Registrants, Inc. under contract to CRDF.

Phase 1 (Complete)

The goal of this phase was to identify and select the most efficacious treatment program for ACP utilizing neonicotinoid insecticides. This involved scheduling multiple meetings with state (FDACS) and Federal (EPA) regulatory agency leaders to discuss implications of neonic label changes and to identify pathways and obstacles. It also involved meetings with the registrants, with researchers and key grower representatives to develop the proposed labeling and use patterns. The proposed approach was then circulated to representative growers and the registrants to ensure consensus and support.

Phase 2(Complete)

The goal of this phase was to work with primary registrants of the “neonic(s)” selected to determine the feasibility of label changes and any impediments to obtaining those changes. This included addressing any concerns over environmental non-target impacts.

Meetings were held with each of the registrants of the active ingredients in the treatment scheme, along with follow-up correspondence, to establish an agreed-upon final course of action. Meetings were also held with State regulatory authorities to obtain their perspectives and incorporate them into label change planning.

Phase 3 (In progress)
The goal of this phase is development of labels and registration documents, submission and supporting the review and final decision process at the state and federal level. This has involved development and oversight of any data acquisition necessary to obtain appropriate use labels requested, preparation of documentation and support for a 24(c) label package for FDACS, support during the review, and coordination of any implementation efforts required upon registration

Phase 4 (In progress)
The goal of this phase is to provide stewarding of the needed information development and submissions to accomplish additional label change. This includes more definitive use instructions as to timing and additional work to support increased rates for the larger tree classifications.

Targeted Completion
- Phases 1 and 2: Complete
- Phase 3: January-February 2013
- Phase 4: June 2013

Available Resources
- TPR/FFVA: Dan Botts (lead consultant and principal communications contact); Mike Aerts, Mike Stuart
- IFAS/CREC: Michael Rogers (collaborating researcher)
- FDACS: Dennis Howard
- Bayer Crop Science (Imidacloprid): Steve Olsen, Alan Ayers
- Syngenta (Thiamethoxam): John Abbott, John Taylor
- Valent (Clothianidin): Jeff Smith
- EPA team

Status
- During January through April 2012 the project team held several meetings with registrants and regulatory authorities
- Since May the team has focused on development data summaries, economic information and the registration package.
- The previously projected August filing date for the Imidacloprid label change slipped to September as growers and registrant worked through issues related to EPA concerns about the impact of an expanded neonic application program on bees.
- During August and September stakeholder meetings, first with the Imidacloprid registrant, then with all three registrants, achieved alignment around labeling pathways and research plans to align to EPA data requirements on nectar residue. The immediate need for a second application in the 5-9 foot tree cohort this season led to a decision to move forward with label language that would permit another application of Imidacloprid before the first of November, along with additional minor label modifications and agreement to follow a common label template.
- In mid September Dan Botts, joined telephonically by CRDF, FDACS and other stakeholders, met with EPA to understand more fully EPA concerns and data

requirements, communicate the significance of the neonic labeling approach to the Florida citrus industry, and to help to set the go-forward research agenda in support of the neonic label modifications. This data will become available over the next citrus bloom season in spring.

- Plans were set in place to rush the Imidacloprid label change application to DACS as soon as possible in September targeting a mid-October approval. The application includes letters of support from growers representing a large majority of current producing acres in the state.
- For Thiamethoxam, the 24(c) submission is projected for October with approval in the November/December time frame. Clothianidin is undergoing EPA review under the label expansion process of PRIA, with approval likely during first two months of 2013, followed by the 24(c) label modification for Florida.
- Phase 4 work is expected to begin once data requirements are clarified from EPA and will continue through the bloom season of 2013 with data collection and analysis during the spring of 2013. Based on that data, additional label modifications are projected to be submitted in late spring 2013.

Issues and Gaps

This process is an excellent example of planning, coordination and alignment of stakeholders to mitigate a number of risks inherent in the label change process:

- Achieving Imidacloprid approval in time for an October application by growers.
- Acquiring experimental data to support the three neonic label change
- Establishing a communications program with bee keepers and organizations
- Ongoing communications among stakeholders to preserve alignment on roadmap and milestones

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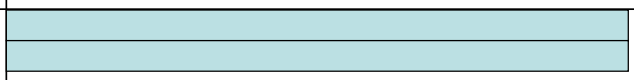
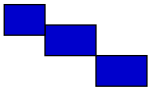
2012-13 Project Roadmap: Neonicotinoid Label Modification

What	Who	Start	End	Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun
FDACS/EPA Mtgs	Team	2011	Jun'13	
Registrant Mtgs	Team	Jan	Jun'13	
Develop 24(c) package for Imidacloprid	Team	May	July	
Submit 24(c) package for Imidacloprid	Bayer	Sep	Sep	
Develop 24(c) package for Thiamelthoxam	FDACs	July	Oct	
Submit 24 (c) package for Thiamethoxam	Syng-enta	Oct	Oct	
Develop package for Clothianidin	Team	Aug	Oct	
Submit package for Clothiandin	Valent	Jan	Jan	
<u>Approvals</u> Imidacloprid Thiamelthoxam Clothianidin	FDACS/ EPA/ Team	Oct Nov Jan	Oct Dec Feb	
Additional Label Changes	Team	Mar	Jun	

See Appendix 2 for additional background.

Antibacterials

Goals

Find the most efficient and effective way to bring the 11 InnoCentive™ and any other promising antibacterial/antibiotic compounds to market as quickly, inexpensively and efficiently as possible.

Benefits

Although HLB resistant citrus varieties are currently being developed to combat the disease, it will likely take more than 10 years to produce and evaluate these resistant varieties in Florida. Since Florida citrus trees are already infected, it is essential to develop an efficient treatment to combat HLB in the interim. Development of a bactericide or other therapeutic compound for the control of HLB would provide an additional tool for effective disease management.

Description

This project continues development work on the effectiveness of new antibacterials/antibiotics (and combinations thereof) that can be used as active ingredients in commercial products to effectively combat HLB. It will use, but not be limited to, the list of most promising antibacterials/antibiotics evaluated during the InnoCentive™ Challenge as the basis for continued CRDF development activities.

Targeted Completion

- 2015 time frame to develop and optimize products and application dosages and delivery methods, create needed partnerships, and
- 2015+ obtain needed regulatory approvals from EPA for antibacterials (biopesticides).

2017+ obtain needed regulatory approvals from EPA for antibiotics

Available Resources

- Charles Powell (University of Florida, Indian River Research and Education Center, Ft Pierce, FL) is principal investigator and key point of contact for communications purposes.
- CRDF has begun exploratory discussions with two companies with an interest in commercializing agricultural antibiotics and antibacterials

Status

Dr. Charles Powell (University of Florida, Indian River Research and Education Center) has submitted a proposal for a three year development project. The purpose is to advance understanding of their efficacy for control of the HLB bacterium, individually and in combinations, and to determine optimum chemical formulations and application methods that may be registered for field control of HLB

The proposed focus is as follows:

- Treating citrus with the eleven compounds (individually and in selected combinations) and observing bacterial titers, symptom remission and any possible phytotoxicity;
- Testing newly developed application methods for each of these molecules; and

- Evaluate trees and fruits for residues.
- Cost of proposed program is $120K (Year 1) with a 3 year cost of $375K.

In parallel, CRDF staff is working with InnoCentive™ to vet intellectual property and begin conversations with potential commercial development partners to determine their level of interest, and at what stage of the commercialization process.

CRDF staff is also exploring regulatory environment and possible ways to shorten time to commercial availability for some antibiotics/antibacterials

Issues and Gaps

***Patents/IP Management*:** One of the near term decisions that needs to be made is whether or not to pursue patents for any or all of the compounds. This will depend in large part on the perspective of potential development partners**.**

***Managing development contracts*:** Experimental design should have the benefit of a commercial partner perspective and experimental data needs to be collected in a GLP compliant process. For that reason it will be necessary to involve commercial partners in the development work. CRDF staff supports the goals and objectives of the proposed three year development program, recommends approval of the first year at this point, and work with prospective commercial partners who may be in a position to take on all or parts of future development work.

***Company partnerships*:** At this point we have identified two companies that we believe have strong interest in commercializing antibiotics/antibacterials for citrus pest management, and we are approaching them to understand their interests and capabilities. The intent is to develop a partnership to complete development, regulatory and "take to market" stages of commercialization.

***Regulatory roadmap*:** Navigating the regulatory process will require understanding of the concerns and information needs of regulators, and data collection under GLP conditions that meets these needs. In general, antibacterials (biopesticides) such as plant essential oils are expected to have an easier regulatory path than antibiotics. There is an interesting mix of compounds: some are naturally occurring, some are registered for agricultural use in Asia, others are predominately in veterinary medicine, and one is even used to enhance the efficacy of cancer chemotherapy in humans. CRDF staff is working through the list and will plan a pre-registration visit with EPA to discuss our plans and understand their viewpoint and data requirements.

***"Target of opportunity" compounds*:** There may be a number of additional antibacterial and antibiotic compounds in that may already have regulatory approval for other applications, or could be added to an existing registered active ingredient and delivery system. CRDF staff is examining these opportunities and determine whether it may be possible to get a relatively quick regulatory approval, e.g. a Section 3 label expansion, 24(c) special local need, Section 18 emergency approvals.

Project Roadmap: Antibacterials

What	Who	Start	End	Aug Sep Oct Nov Dec 2013 2014 2015 2016 2017
InnoCentive challenge awards selected	Turpen	Aug	Aug	
Proposals for scoping follow-on development	Powell	Aug	Sep	
Approval devt proposal	CRDF	Sep	Sep	
Conduct follow-on development (first year)	Powell/ others	Oct	Oct'13	
Company partnership explorations	Dukowitz/ Turpen	Sep	Ongoing	
Regulatory roadmap	CPDC staff/ companies	Sep	Ongoing	
Partnerships for prod devt/commercialization	CPDC/ companies	2013	Ongoing	
Develop and optimize products	Companies	2015	Ongoing	
Regulatory approvals (antibacterials)	Companies/ CPDC	2015+	Ongoing	
Regulatory approvals (antibiotics)	Companies/ CPDC	2017+	Ongoing	

Psyllid Control (RNAi)

Goal
The goal is to develop a robust ACP control strategy using dsRNA molecules that, when fed to Asian Citrus Psyllid (ACP), "knock out" specific gene functions important to the survival and development of psyllids.

Benefits
An effective "gene knock-out" approach could provide an effective way to reduce ACP populations, thereby increasing tree life and productivity, and significantly reduce the costs associated with psyllid control and HLB treatment.

Description
The emergence of a large number of insect genome projects has already led to identification of many of the genes important for the survival and development of psyllids, and the list continues to grow. The "International Psyllid Genome Consortium" targeted the Asian Citrus Psyllid (ACP) as the first psyllid species to be sequenced, serving as the reference genome for other sequencing projects, providing both the transcriptome and list of predicted genes in psyllids. This information is enabling the research community to work in full light of specific genes of interest.

Since the 1990s there has been a growing body of research on RNA interference (RNAi) demonstrating that double strand RNAs (dsRNAs) can silence the complementary messenger RNA sequences in psyllids and other insects.

Advances in understanding of the ACP genome, along with a growing ability to effect a change in proteins and transcripts through RNA interference (RNAi), has intensified efforts to target RNAi to specific psyllid genes. At least one company (Beeologics, recently acquired by Monsanto) claims to be manufacturing the RNAi material for development purposes.

Combining these newly identified active sequences with RNAi delivery strategies, it is believed that specific psyllid transcripts may be used to reduce and suppress ACPs within an area-wide program.

Based on results from the RNAi InnoCentive™ contest, 14 RNAi gene targets from the Asian citrus psyllid genome were identified by the selection committee as candidates for further evaluation. This selection was made from a screen of 50 Asian citrus psyllid gene targets and was based on results showing that when ACP adults were fed on artificial diets containing dsRNA matching a sequence of a portion of these genes, psyllid toxicity was observed. The initial screen was conducted using an artificial diet system suitable for adults but not for psyllid nymph stages because the nymphs have poor survival on current artificial diet systems.

Recognizing that an effective control strategy will have to affect both adults and nymphs, continued development work must include methods to test nymphal response. Parallel

research has shown that using a Citrus tristeza virus (CTV) expression vector, plants producing psyllid dsRNAs can induce adult psyllid mortality even higher than observed in the artificial diet system, and is suitable for testing the effect of orally ingested dsRNA on nymphal stages because whole plants and excised leaves can be used. Continued development work must identify the best sequence/sequence combinations to target with dsRNA within the psyllid genome and also identify the most economical and efficacious delivery strategy with activity on nymphs as well as adults

Targeted Completion

- 2015 time frame to develop products and delivery methods, create needed partnerships,
- 2016++ obtain needed regulatory approvals from EPA for exogenous, synthetic RNAi
- 2018++ obtain needed regulatory approvals from EPA for "plant incorporated protectant" RNAi.
- 2017-2019+: Commercial availability

Available Resources

- Dr. Charles Powell (University of Florida, Indian River Research and Education Center, Fr. Pierce, Fl) is principal investigator on candidate evaluation
- Dr. Bob Shatters (USDA, ARS, US Horticultural Lab, Ft Pierce, and FL) is research collaborator with Dr. Powell.
- One interested company has been identified for possible collaboration.

Status

Dr. Charles Powell (PI) and Dr. Bob Shatters have submitted a proposal for a two year development program with the following goals:

- Continue development work to identify the best sequence/sequence combinations to target with dsRNA within the psyllid genome,
- Identify the most economical and efficacious delivery strategy by comparing CTV expression and exogenous application to rootstocks (soil drench) or to the scion in combination with penetrant facilitators,
- Conduct psyllid toxicity studies using whole plant caged assays and excised leaf feeding assays with adult and immature psyllids
- Provide experimental data on mode of toxicity of dsRNA through psyllid transcriptome analysis; dsRNA longevity within citrus tree and tissues including fruit, and analysis of cross-species toxicity on the Brown citrus aphid as a test to show specificity of dsRNA action. This data will be made available for subsequent regulatory evaluation necessary for approval of this strategy as a commercial option.
- Total funds requested: $487,383. Year One funds requested $243,650.

Issues and Gaps

- **Patents/IP management:** One of the near-term decisions that need to be made is whether or not to pursue patents for any or all of the 14 RNAi gene targets. This will depend in large part on the perspective of potential development partners.
- **Managing development contracts:** Experimental design should have the benefit of a commercial partner perspective and experimental data needs to be collected in a GLP

compliant process. For that reason it will be necessary to involve commercial partners in the development work. CRDF staff supports the goals and objectives of the proposed two year development program, recommends approval of the first year at this point, and work with prospective commercial partners who may be in a position to take on all or parts of future development activity.

- **Company partnerships:** There are a relatively small number of companies conducting development work in this space, and we are beginning to approach them to understand their interests and capabilities, with intent to develop a partnership to complete development, regulatory and "take to market" stages of commercialization.
- **Regulatory roadmap.** Navigating the regulatory process will require understanding of the concerns and information needs of regulators, and data collection under GLP conditions that meets these needs. CRDF staff will begin conversations with regulatory authorities to gain perspective on these issues.

Project Roadmap: Psyllid Control (RNAi)

What	Who	Start	End	Aug Sep Oct Nov Dec 2013 2014 2015 2016 2017 2018+
InnoCentive Challenge awards selected	Turpen	Aug	Aug	
Proposals for scoping follow-on development	Powell/ Shatters	Aug	Sep	
Approve proposal for follow-on development	CRDF	Sep	Sep	
Conduct follow on development (first year)	Powell/ Shatters	Oct	2013	
Company partnership explorations	Turpen/ Dukowitz	Sep	Ongoing	
Regulatory roadmap	CPDC/ companies	2013	Ongoing	
Partnerships for prod devt/commercialization	CPDC/ companies	2013	Ongoing	
Develop and optimize products	Companies	2015	Ongoing	
Regulatory approvals (exogenous, synthetic)	Companies/ TBD	2016+	Ongoing	
Regulatory approvals (plant incorp. protectant)	Companies/ TBD	2018+	Ongoing	
Commercial availability	Companies	2017-2019	Ongoing	

Genetic Disease Resistance to Citrus Canker

Goal
Serve as a catalyst to produce and introduce to Florida citrus growers, new transgenic citrus lines based on mature tissue transformation, with disease resistance to citrus canker, and that flower and bear fruit in a short time period.

Benefits
Increase tree life and productivity, and significantly reduce the costs associated with treating Citrus canker

Description
This project deals with genetic transformation of commercial citrus cultivars to make them more resistant to citrus canker. Because of a decline in regenerative and transformation potential, genetic transformation procedures usually employ juvenile material as the source of plant tissue, therefore resulting in the production of juvenile plants. Direct transformation of mature material can ensure the production of transgenic plants that fruit earlier, short-cutting in this way the juvenile tissue phase.

Dr. Leandro Pena at IVIA Spain has produced transgenic mature citrus trees that flower and bear fruit in a short time period using a technique involving the invigoration of clean source adult material, and establishment of adequate transformation and regeneration conditions.

In April 2011, the Citrus Research and Education Center at Lake Alfred established the Mature Citrus Transformation Facility (MCTF) to provide expertise and service in mature transformation of citrus, improve transformation technologies, and teach and train scientists and students. This was made possible by funding from CRDF, with technical assistance and support from IVIA-Spain, and CREC.

CRDF funding allowed the hiring of a University of Florida-based faculty scientist, Dr. Cecilia Zapata, who trained under Dr Pena at IVIA to learn the mature tissue transformation technique and lead the transfer the technology to the Florida lab.

A growth room was constructed, including a clean head house structure that could be used as support of the growing area, and the laboratory is fully operational with the techniques for mature tissue transformation established with marker genes. The industry was polled for input in establishing a few commercial cultivars as clean stock for mature tissue transformation and these lines are now ready for use.

Concurrently several research projects funded by CRDF have claimed success in establishing canker resistance by molecular genetic design in proof-of-concept experiments.

The first mature transformation experiments were performed in November 2011. To date Valencia germplasm has been cleaned and a GUS (“marker”) gene inserted using the

MCTF protocol. Mature Valencia orange has proven to be very responsive to organogenic regeneration. In addition, ruby red grapefruit germplasm and Swingle and Carrizo rootstocks have been cleaned. Progress was made on Hamlin orange. The control cultivar, pineapple orange, has had less satisfactory results to date.

Targeted Completion

- 2017-2019 to get raw material of new commercial cultivars with canker resistant traits
- 2022+ to field plant candidates for evaluation under field conditions for canker resistance and horticultural traits, wide area testing, meeting regulatory hurdles
- Largely concurrent regulatory science, registration and regulatory affairs working with APHIS, EPA and FDA
- The shortened time to flower and bear fruit, coupled with the use of concurrent processes, means canker-resistant budwood could potentially be available to nurseries in as soon as 9 years.

Available Resources

- Full time MCTF Manager (to be hired)
- CRDF: funding and commercialization support
- UF/CREC: house MCTF facility, serve on Steering committee, and employ project staff
- Outside scientific/industry leaders to join CRDF and CREC on Steering Committee
- In the future many additional resources will be required as the commercialization progresses.

Status

Dr. Zapata has recently accepted another position, and CRDF staff is seeking a replacement that will be tasked to take MCTF to the next level in its evolution as a high throughput commercial product development facility.

The focus will be on incorporating high potential candidate genes for canker resistance into commercially important citrus scion and rootstock cultivars, allowing head-to-head comparisons in a high throughput environment, and evaluating performance based on commercial as well as scientific criteria. This will provide an efficient and focused process geared to help get transgenic citrus plants to the Florida industry as efficiently and cost-effectively as possible.

Techniques and protocols transferred from collaborating laboratories will be improved to develop the best possible approaches for mature tissue transformation.

Management of the MCTF will deal with outside scientists and companies, budgeting, personnel and meeting development timelines. The MCTF will be accountable to a steering committee comprised of representatives from CRDF, CREC and other experts that will provide strategic guidance and oversight.

Near Term Issues and Gaps

***Interim oversight of MCTF*:** The most immediate issue is interim oversight of the MCTF until a new manager is hired. CRDF staff is working with Dr. Jackie Burns (CREC) who is arranging interim oversight until a new MCTF manager can be hired. Dr. Burns has identified resources to provide such support on a temporary basis.

***Create a Steering Committee*:** A next step will be to create a Steering Committee of CREC, CRDF and outside experts to provide structure and strategic oversight to the program, and represent the commercial product development interests of CRDF. The MCTF manager will be accountable to the Steering Committee. Membership of the Steering Committee would include representatives from CRDF staff, UF/CREC staff, and 2 or 3 additional members highly respected in the scientific community and/or industry. The Committee can help identify, recruit and screen candidates for MCTF manager.

Hire a new manager. CRDF staff has developed the key requirements for the MCTF manager position, working with Dr Burns as well as current plant transformation facility managers at other universities. The next step will be to post, recruit and screen applicants. The program manager would be a CREC employee but the project would have CRDF funding and Steering Committee oversight as described below.

Determine requirements and assemble resources. Once the MCTF manager is in place, he or she will work with the Steering Committee to determine the technical support requirements for the MCTF lab and clean growing area to rapidly move objectives to completion.

Establish operating model. Need to develop an operational plan and model, including how business aspects of activity will work, including flow of funds, funding requirements, and additional funding sources over time.

Intellectual Property management procedures: Will be managing issues of IP ownership, Freedom to Operate, Material Transfer Agreements, licensing and related matters on a case by case basis.

Launch: Once the support requirements are identified, the MCTF manager and Steering Team will work together to launch the MCTF with a commercial product development focus only and not a research service facility.

Long Term Issues and Gaps

The long term, strategic issues and gaps focus on the risk-adjusted return on investment to the Florida citrus industry, given the inherent risks, costs and time associated with development, registration and regulatory compliance, and commercial diffusion

Commercial Partners: Because the citrus industry is highly segmented, there are a relatively small number of companies that have the breadth of operations and resources to help bear the costs of commercialization. Prospective commercial partners need an

adequate return on investment, while the growers and nurseries need low cost and timely access to the new product lines.

Financial Stakeholders: CRDF may need to identify commercial partners and potential non-profit partners and other entities to assist with funding support, particularly for the regulatory process.

Consumer demand: What will be future consumer demand for transgenic citrus?

Roadmap

The near term focus through mid-2013 will be on hiring a qualified manager and staff for the MCTF facility and creating a Steering Committee to establish resource requirements and budgets, and launch.

MCTF will focus on developing and implementing **concurrent processes** for citrus tissue transformation, regulatory compliance, improved protocols, and evolve business and financial models for operation of the facility.

The estimated **4 to 6 year development timeline** to get raw material of new commercial cultivars with canker resistant traits includes soliciting candidate genes and conducting IP and freedom to operate analyses and ensuring proper material transfer agreements are in place; inserting these genes into tissue from commercial cultivars and conduct side by side comparisons in greenhouse and field environments; and identifying the most attractive commercial opportunities

The estimated **5 to 9 years to field plant candidates for evaluation** under field conditions for canker resistance and horticultural traits, wide area testing

The **concurrent regulatory process** will include working with USDA APHIS, EPA and FDA to provide needed studies and information, obtain required permits, and maintain ongoing consultations to help ensure a (hopefully) smooth regulatory approval process.
Once product development and regulatory process are completed, the final phase will be to increase budwood supply to nurseries, and promote its multiplication and distribution.

Project Roadmap: Genetic Disease Resistance (Canker)

What	Who	Start	End	2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022
MCTF Ramp/Launch				
Interim MCTF Oversight	CREC	Sep	Mar'13	
Establish Steering Committee	CRDF	Oct	Dec	
Recruit new MCTF Manager	CRDF/ Steer Comm	Oct	Mar'13	
Establish resource requirements/budgets	MCTF/ Steer Comm	Mar'13	May'13	
MCTF launch	MCTF/ Steer Comm	Jun'13	Jun'13	
Commercialization				
Mature tissue transformation Into commercial cultivars	MCTF	2013	Ongoing	
First raw materials with desired canker traits	MCTF	2017+	2017+	
Field evaluations/wide area testing	CRDF/Com Partners	2017+	Ongoing	
Regulatory studies, permits	CRDF/Com Partners	2013	Ongoing	
Achieve deregulation of first new line	CRDF/Com Partners	2021	2021	
New cultivar budwood to nurseries	CRDF/Com Partners	2022	Ongoing	
Strategic partnerships	CRDF/ Steer Comm	2013	Ongoing	

Diaprepes Root Weevil Control

Goal

The goal of this project is to facilitate commercialization planning for pheromone-based attractant for use in trapping, monitoring and control of Diaprepes abbreviates. This will include CRDF support for continued development and testing through 2014, obtaining a license on the Intellectual Property from USDA, and identifying 2-3 companies to co-fund development and sub-license the technology.

Benefits

The Diaprepes root weevil, *Diaprepes abbreviatus*, is a major pest of citrus, ornamental plants, and root and other commercial crops grown in Florida. This pest has a very wide host range, attacking more than 270 species of plants in 59 plant families. It continues to pose a serious biological threat to the well-being of citriculture in Florida because of its devastating effect on trees, and because cost-effective IPM strategies have been elusive. It is often necessary to remove and replant the majority of trees within root weevil infested orchards, with serious economic consequences to growers.

Introducing pheromones that attract adult weevils can potentially increase the effectiveness of monitoring, mass trappings, improved pesticide effectiveness, and, over the longer term, potentially disrupt mating. Pheromones are non-toxic and biodegradable, and therefore present fewer regulatory issues.

Description.

Dr. Stephen Lapointe at the U.S. Horticultural Research Laboratory/Fort Pierce has discovered an aggregation pheromone and host plant volatiles (kairomones and allomones) that induce arrestment behavior in the Diaprepes root weevil. The pheromone development has advanced through research and is close to commercialization. It was recently synthesized in the lab and is undergoing testing. While not directly related to HLB, root injury by weevils is part of the complex stress interaction that leads to tree health decline, and the impact is greater in the presence of HLB.

The Technology Transfer Coordinator at USDA has contacted CRDF staff to consider playing a lead role in commercialization planning for pheromones associated with Diaprepes root weevil control. There is a patent pending on this work, and USDA may consider licensing the technology to CRDF, which will, in turn, sub-license the technology to companies to incorporate with their own delivery technologies and complete the commercialization process. These companies would be part of a co-development investment pool by each company taking out an option to sub-license the technology incorporate into their own delivery systems.

The roadmap for this project includes:

- Support a two year ARS program to identify optimal blends of pheromone and host plant volatiles for attraction of male and/or female Diaprepes. The recipes for these blends will be provided to cooperating company for incorporation into their

proprietary release devices. Devices loaded with these blends will be tested by ARS at field locations to confirm activity.

- In parallel, to establish licensing terms, negotiate agreements with participating companies, and monitor contract performance to ensure the interests of USDA and CRDF are protected.
- This is an important contractual and structural precedent for how the Foundation might do business in the future.
- There is on-going contact with USDA ARS regarding the need for multiple simultaneous paths and concurrent closing of the licensing, CRADA and agreements with participating companies.

Targeted Completion

- Proposed field testing program through 2014.
- 2-3 additional years to complete product development
- Expected products potentially available to customers in the 2017-2018 timeframe.

Available Resources

- USDA/Ft. Pierce: Steve Lapointe.
- CRDF: Tom Turpen, Jim Dukowitz
- Potential sub-licensee companies that have expressed interest

Status

- Dr. Lapointe has submitted a development budget to CRDF for a 2 year field-testing program.
- The CRDF Program Manager has spoken with three companies about creating a consortium to co-fund this next phase with CRDF matching funds.
- CRDF would be the exclusive licensee and CRADA party while each of the companies would have access through a sub-license from CRDF to combine with their own delivery technologies.
- CRDF staff has been working with USDA ARS Office of Technology Licensing to prepare and submit an application to USDA for an exclusive license for the patent and associated intellectual property associated with Lapointe's findings.

Issues and Gaps~~.~~

Negotiating parallel agreements **-**~~,~~ There is on-going contact with USDA ARS regarding the need for multiple simultaneous paths and concurrent closing of the licensing, CRADA and agreements with participating companies. This will require a major level of effort and we recommend both Tom Turpen and Jim Dukowitz be involved during key parts of the process, which will include the following

- Establishing a valuation for the patent for purposes of licensing/sublicensing.
- Negotiating agreements with two or three companies to co-fund the two year development program by Lapointe, receiving in turn an option to license the technology to commercialize with their delivery systems.

- Finalizing the model and negotiating agreements for flow of royalties from companies as sub-licensees to CRDF to USDA.

***Determining potential uses*:** Pheromones have been used in insect management in three major ways.

- Monitoring a population of insects to determine if they are present or absent in an area or to determine if enough insects are present to warrant a costly treatment.
- Mass trapping, which involves attracting weevils with pheromones then trap them.
- Track and kill, which involves using pheromones to increase the effectiveness of pesticides, thereby reducing the amount of pesticide required.
- Mating disruption, in which an entire area is permeated to interfere with the weevil's ability to find each other.

In the commercialization process, these will require further assessment to determine commercial opportunity and return on investment

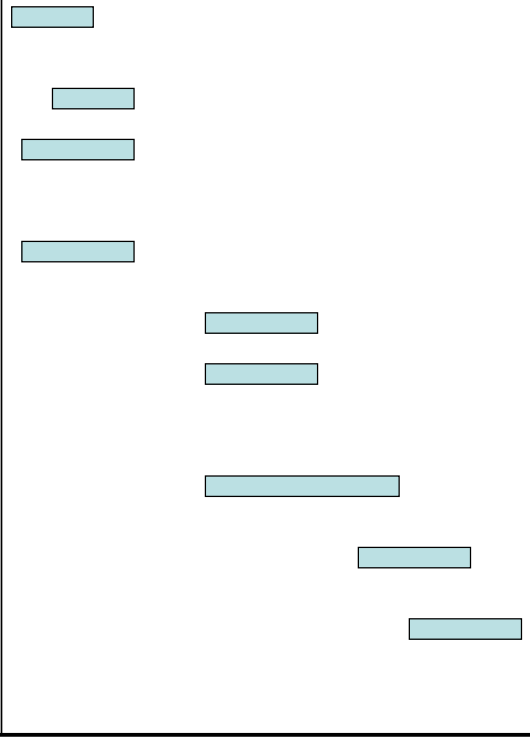
Effectiveness - The pheromones attract adult Diaprepes beetles and therefore do not appear to directly address the problem with larval feeding**,** Adult beetles will feed on leaves causing a characteristic notching pattern. However, the larval stage causes the most serious damage, feeding on roots over a 9-18 month period. Larval feeding will eventually girdle the crown area of the root system, killing the plant. In Florida citrus groves, Diaprepes root damage allows, *Phytophthora*, a very serious and often lethal plant pathogen to invade roots, further hastening the decline of trees.

Market opportunity – The current market is geographically limited, with a relatively small diffusion rate of Diaprepes due to quarantine. Diaprepes is currently a major problem in the Caribbean, especially Puerto Rico, where it is attack citrus, cassava, sugar cane and other plants. It is also a major problem in Florida, arriving in 1964 and spreading today to over 30,000 acres in 21 counties, affecting both citrus and ornamental plants. In 2000, Diaprepes was first reported in the Texas Rio Grande Valley in Hidalgo County, with a second detection site in 2008 in Cameron County. Diaprepes was also found in southern California in 2005, where it is limited to urban areas and a small number of citrus orchards in the Los Angeles, Orange and San Diego counties. It also has been found in Louisiana.

Because of quarantine, the spread of Diaprepes has been relatively slow to date. Should it spread to the agricultural areas of California, or move south into Mexico, Central and South America, the problem and market opportunity would both expand dramatically.

Project Roadmap: Diaprepes Root Weevil Control

What	Who	Start	End	Sep Oct Nov Dec 2013 2014 2015 2016 2017 2018
Submit license application to USDA/OTT	Dukowitz	Sep	Oct	
Notice of Intent in Fed Register (Secure license)	USDA	Oct	Nov	
Negotiate consortium company option agreements	Dukowitz/ Turpen	Sep	Nov	
Negotiate CRADA/license agreement with USDA	Dukowitz/ Turpen	Sep	Nov	
Conduct field study	Lapointe	2013	2014	
Negotiate sub-licensing agreements with companies	Dukowitz/ Turpen	2013	2014	
Companies develop products around licensed patent	Companies	2013	2016	
Ramp up manufacturing and marketing	Companies/ CRDF	2016	2017	
Product introductions to in market	Companies	2017	2018	



Citrus Gene Therapy (CTV Vectors)

Goal

Help ensure that delivery systems and candidate genes for HLB resistance based on CTV vectors are commercialized to the best possible benefit of the Florida citrus industry.

Description

There is a growing body of research on the use of CTV vectors to test the ability of various antimicrobial and anti-psyllid genes to interrupt or prevent HLB. For example, CRDF-funded research by Dawson, et.al. (CATP11) is approaching the problem in three ways.

- First, researchers are attempting to find products that will control the greening bacterium in citrus trees, initially focusing on antibacterial peptides. They are also testing possible anti-psyllid genes.
- Second, they are developing virus vectors based on CTV to effectively express the antibacterial genes in uninfected trees in the field and in new plantings.
- Third, they are examining the possibility of using the CTV vector to express antibacterial peptides to treat trees in the field that are already infected with HLB. With effective anti-Las genes, the vector should be able to prevent further multiplication and spread of the bacterium in infected trees and allow them to recover.

Through funded research by CRDF and other sources, progress is being made in identifying peptides that reduce disease symptoms and allow continued growth of infected trees; greatly improving screening efficiency; modifying the vector to express more than one anti-HLB gene; and modifying the vector to allow addition of a second vector. Research results to date also provide evidence that the use of the CTV expression vector in plants producing selected psyllid dsRNAs can induce adult psyllid mortality even higher than observed that when not using the CTV vector, and this approach enables testing of nymphs as well as adult psyllids.

Targeted Completion

- 2012: Active coordination of commercialization plans with UF and other applicable offices of technology licensing (OTL).
- 2012: Ongoing communication plan is being addressed
- 2012: Delivery system and candidate genes for HLB resistance, proof of principle, permitted field testing
- 2014+: Develop and optimize products, field evaluation
- 2017+: Obtain needed regulatory approvals
- 2017+ :First commercial availability

Available Resources

- University of Florida Office of Technology Licensing and Research Foundation
- Sponsoring companies seeking to license technologies from UF OTL
- CRDF staff.

Status

- At the present time, a delivery system and several candidate genes for HLB resistance with proof of principle have been established, and permitted field trials are in progress.
- A company is seeking to license technology from UF related to improvements on the CTV expression vectors. Some, but not all, of the IP is based on CRDF-funded research.
- UF has filed an additional provisional patent application in September 2011 for CRDF-funded research related to improvements on the CTV expression vectors being developed by Drs. Dawson and Folimonova. An independent IP analysis was completed through CRDF and PIPRA. The provisional patent application and notice of recorded assignment has been forwarded to CRDF. This technology is of interest to the prospective licensee.

Issues and Gaps

- OTL will not execute any exclusive licenses for IP developed using CRDF funding without the prior written consent of CRDF. Also, OTL is seeking a CRDF perspective on its overall licensing approach for CTV vector-related patents, including acceptable terms and conditions related to royalty rates, sublicensing and other issues.
- CRDF must determine how to balance the desire to obtain royalties from its sponsorship of research that created the IP; and the desire to see the technology commercialized and in the hands of growers as quickly and efficiently as possible, and then offered to growers at a price that is affordable and usable.
- A joint discussion between company, CRDF staff and UF OTL staff will be held in late September to iron out licensing issues. CRDF staff has scheduled a meeting with the above mentioned corporate sponsor to discuss a communication plan to growers that meets the needs of the sponsor company, CRDF, growers and the public.
- Commercializing CTV technology will require multiple years of product development, regulatory approvals and “take to market” efforts that may be more than any single company in the Florida citrus industry can bear. The regulatory approvals may be complicated because the regulated article is a new biologic. Additional external funding sources and collaborations will likely be needed to successfully commercialize this technology.
- CRDF will explore these and other longer term issues with the prospective licensee and seek to provide assistance as appropriate in commercializing CTV technology.

Project Roadmap: Citrus Gene Therapy

What	Who	Start	End	Aug Sep Oct Nov Dec 2013 2014 2015 2016 2017+
Preliminary discussions with UF OTL about licensing issues	CRDF staff	Aug	Sep	
Joint meeting to discuss licensing issues	Company/ UF/CRDF staff	Sep	Sep	
Meeting to discuss company communication plan to industry	Company/ CRDF staff	Sep	Sep	
Develop approaches to CTV vector commercialization to support CRDF-funded research and Florida citrus industry	CRDF staff/	Oct	Ongoing	
Develop system and candidate genes for HLB resistance, proof of principle, permitted field testing	UF/ Company	2012	Ongoing	
Develop and optimize first products, field evaluation	Company	2013	2014+	
Obtain needed regulatory approvals	Company/ TBD	2013	2017+	
First commercial availability	Company	2017+	2017+	

Advanced Citrus Production and Harvesting Systems

Goal

Co-design and field test a commercially feasible advanced citrus production and harvesting system (ACPHS) to grow and harvest citrus that integrates higher planting density with suitable rootstocks, intensive cultural management (open hydroponics), pest and disease management (especially Asian Citrus Psyllid and HLB), and new technology concepts and equipment related to harvesting and production for both producers of fresh and processing market fruit.

Benefits

Provide an integrated approach to citrus management in the presence of HLB and other challenges facing the U.S. citrus industry. Project success will be measured primarily in terms of shortening the time to profitability and increasing the per-acre net economic returns to citrus growers. It proposes to do this through higher fruit yields and fruit quality, especially during the early years of a grove; improved management options/reduced risks associated with diseases (especially HLB), and increased efficiencies of various operations that ultimately reduce unit costs of production.

Description

This multi-state, multi-commodity, trans-disciplinary program is motivated by the cumulative negative effects on the U.S. citrus industry of pests and diseases (in particular citrus canker and HLB), water management issues, extreme weather (hurricanes), excessive real estate speculation and increased importation of citrus products into the U.S. As a result, since the late 1990s, Florida has lost about 33% of its citrus bearing acreage, Arizona has lost about 40%, Texas has declined slightly and California acreage, while stable, has shifted production toward seedless mandarins. These challenges will continue into the future as the impacts of HLB are increasingly felt outside Florida, and have set the stage for this U.S. citrus industry collaboration to develop new approaches and technologies to focus on high productivity groves producing high quality fruit on less land, using fewer inputs with a smaller environmental footprint.

The ACPHS project has seven research components:

- Identify superior rootstock/scion combinations for maximum performance and longevity
- Identify and field test horticultural practices to balance tree growth with early fruiting, nutrient and water consumption, and increased yields
- Determine best pest management practices, especially for Asian Citrus Psyllid
- New equipment platforms for production, including an over the top mass harvester that includes multi-purpose vehicle platform, shaker and catch frame, fruit handling system, auto-guidance and yield mapping
- Develop an adaptable precision sprayer system to improve chemical efficacy, reduce production cost and reduce environmental impacts
- Conduct economic and social impact evaluations, including investment and decision-support tools for growers, lenders and researchers

- Conduct program evaluation, outreach extension and education to engage growers in system adoption

Targeted Completion
- 5 year program
- Some benefits to growers could come earlier through participation in commercial field trials as part of the plan, and some of the NIFA advisory committee are already doing this kind of production system testing.
- Some benefits related to licensed new product development and commercialization could come beyond the 5 year time frame.

Available Resources
- ACPHS Advisory Group with citrus producers and various supporting industry reps.
- Endorsements by several citrus industry organizations
- ACPHS Working group of citrus professionals from four states
- ACPHS partnerships with universities, manufacturing and service industry
- Dr. Tom Burks (UF Gainesville) is CRDF point of contact
- Institutional supporters like CRDF provide cost-share through cash and project-cost matching\
- CRDF is funding components of this now (rootstock/scion at UF)

Status
In late January 2012 the ACPHS team submitted its third proposal to USDA SCRI based on raising $9.9 million in cost share to fund ACPHS research and development trials in Arizona, California, Florida and Texas. In previous years, the project was scored as medium priority, while the latest submission scored a high priority, ranking third overall, and was recommended for funding by the scientific panel and USDA program leaders. Unfortunately, due to funding constraints, only two projects were able to be funded, although there is still a possibility that one of the top two problems may not be able to collect their cost-share and ACPHS would be funded as the alternate.

Despite the disappointment, with the encouragement of the USDA program leaders the ACPHS Scientific Team and Grower Advisory board have decided to be prepared to resubmit its proposal for the 2013 round with minimal revisions, and to secure funding of $10 million in USDA SCRI funding, along with $10 million in state and citrus industry cost share for a total project size of $20 million. The biggest challenge for the ACPHS team will be to recover the $10 million in cost share commitments made for last year's submission.

Dr. Tom Burks has requested that the CRDF board once again make a cost-match commitment of $1.5 million over five years composed of $1 million in cash and $500 thousand for in-kind cost-share. This is the same amount that was approved by the CPDC and CRDF Board in December 2011 in support of the 2012 SCRI application.

Issues and Gaps

- **Timing:** The fall 2013 likely start-date for the project would mean that the cost-match commitment would not take effect until at least September 2013, and therefore would fall outside the CRDF 2012-2013 budget. Regarding the $500 thousand request for in-kind project support, CRDF can only provide commitment of cost-share on projects during the period that they overlap with the project against which they are matched.
- **Flexibility:** CRDF is increasingly required to make cost-share commitments in the process of securing funding from many of our sources. As the number of such commitments increases, it could limit CRDF flexibility in the types of projects it can support.
- **In-kind support:** CRDF staff identified a number of its currently funded projects that appear to be eligible to meet the cost share requirements for in-kind support for the ACPHS project.
- **Redundancy**: BoD requested CRDF staff meet with Tom Burks before the end of the year to review the revised proposal to insure the scope of work is not redundant with currently funded CRDF projects, and will benefit the industry in a way that warrants its cost share commitment.
- **Agreement.** The agreement with Tom Burks should include a definition of those portions of the ACPHS project that are funded by the CRDF cash commitment, with associated budgets and scope; access to reporting for those aspects of the project that are directly funded, and for those aspects that relate to CRDF in-kind support commitment; and IP issues.

Roadmap

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Project Roadmap: ACPHS

What	Who	Start	End	Aug Sep Oct Nov Dec 2013…….....2018
CRDF BoD decision on $1.5 million cost-share commitment	CRDF BoD	Aug	Aug	
Informal Notification to ACPHS team	Browning	Aug	Aug	
Go-No Go decision by ACPHS team on proposal submission to SCRI	Burks/ ACPHS team	Oct	Dec	
Review ACPHS revised proposal	CRDF staff	Nov	Dec	
CRDF formal commitment letter	CRDF staff	Nov	Jan'13	
ACPHS team proposal submission to SCRI	CRDF/ Burks	Jan'13	Feb'13	
Cost-match commitment takes effect	CRDF	Sep'13	Ongoing	
Program implementation	ACPHS	2013	2018	

DRAFT BUDGET OVERVIEW

Table 1: CPDC Draft Budget Overview

Category	Budget Item	FY2011-12	FY 2012-13	1st Qtr
Projected Expenses			Budget	
Commercial PD Operations				
	CPD management - General	$ -	$ 25,000	$ 16,433
	CPD contract support	$ 71,400		
	CPD travel	$ 4,000	$ 10,000	$ 853
	Product develop. worshops		$ 25,000	
	Subtotal	$ 75,400	$ 60,000	$ 17,286
Commercialization Projects				
	A Neonicotinoids		$ 170,828	$ 3,300
	B RNAi		$ 389,600	$ 2,420
	C Antimicrobials		$ 268,900	$ 1,100
	D Canker Traits		$ 313,267	$ 77,767
	E CTV Vector		$ 22,140	$ 16,420
	F ACPS		$ -	$ -
	G Canine Detection		$ 13,400	$ 6,600
	H Diaprepes Pheromones		$ 13,400	$ 2,200
	Non-Projected			
	Total Projects	$ -	$ 1,191,535	$ 109,807
	Total CPDC Expense	$ 75,400	$ 1,251,535	$ 127,093
Projected Revenues				
	CPDC Management Budget		$ 215,000	
CPDC Project Budget	Base Budget CPD projects A-H	$ 600,000	$ 657,672	
	Innocentive Contract	$ 280,000	$ 280,000	
	PIPRA Contract 2011-12	$ 15,540	$ 15,540	
	FDOC 11 contract Neonic Equip	$ 112,500	$ 112,500	
	SCBG Neonic nectar sampling		$ 60,000	
	#583 Research Projections $		$ 306,667	
	Total Revenues Budgeted		$ 1,647,379	$ -

Table 2: Draft Project Budget Overview

	FY2012-13	1Q Actuals
CPD Operations		
CPD Mgr Gen	$ 25,000	$ 16,433
Contract Spt		
CPD Travel	$ 10,000	$ 853
Prod Devt Wkshops	$ 25,000	
Subtotal Operations	**$ 60,000**	**$ 17,286**
Commercialization Projects		
CPD12A Neonicotinoids		
Program Mgr		$ 3,300
FFVA Regulatory Retainer	$ 30,000	
Third Party Registrations	$ 28,328	
M. Rogers IFAS	$ 112,500	
Subtotal	$ 170,828	$ 3,300
Neonic Nectar Sampling Study (Projected)	*$ 60,000*	
CPD 12B Psyllid Control RNAi		
Program Mgr	$ 6,600	$ 2,420
InnoCentive Contract	$ 145,000	
Evaluation Powell (Proposal)	*$ 238,000*	
Subtotal	$ 389,600	$ 2,420
12C Antibacterials		
Program Mgr	$ 13,400	$ 1,100
InnoCentive Contest	$ 135,000	
Evaluation Powell (Proposal)	*$ 120,500*	
Subtotal	$ 268,900	$ 1,100
12D. Canine Resistant Traits		
Program Mgr	$ 6,600	$ 1,100
Mature Transformation #583 Zapata	$ 306,667	$ 76,667
Subtotal	$ 313,267	$ 77,767
12E CTV Vector		
Program Mgr	$ 6,600	$ 1,100
IP Landscape PIPRA	$ 15,540	$ 15,540
Subtotal	$ 22,140	$ 16,420
12F Advanced Prod Systems		
Program Mgr		
Other		
12G Canine Detection		
Program Mgr	$ 13,400	$ 6,600
Other		
Subtotal	$ 13,400	$ 6,600
12H Diaprepes Root Weevil Control		
Program Mgr	$ 13,400	$ 2,200
Other		
Subtotal	$ 13,400	$ 2,200
Total Project Budget	**$ 1,191,535**	**$ 109,807**
Total	**$ 1,251,535**	**$ 127,093**

APPENDICES

1. Canine Scouting Background
2. Neonic Background

Appendix 1: Canine Scouting Background

Citrus Canker Research

USDA/Ft. Pierce researcher Tim Gottwald began initial research efforts in 1999 to determine a dog's ability to detect minute concentrations of citrus canker volatile/aromatic compounds with a focus on grapefruit. He successfully trained a criminology dog to correctly identify a canker scent based on air samples captured on cotton pads through a Scent Transfer Unit with 98% accuracy. That research was discontinued following the events of September 2001 when the dog was diverted to explosive detection.

In the 2005 time frame, Gottwald began a second effort with APHIS/USDA agriculture detector dogs, teaching them both recognition and response (to alert by sitting) when detecting the citrus canker infected fruit and small infected trees in blind boxes. Although results were very promising, there was no consistency in the training due to the dogs being shipped out to ports to detect agricultural products in baggage, so the training was discontinued.

In the third and on-going attempt, Gottwald has used a commercial training facility, J&K Canine Academy of High Springs Florida, to train canines for the detection of canker infected grapefruit trees using a new training approach called "self discovery". J&K Canine Academy, led by CEO Pepe Peruyero, has an ongoing commercial business training detector dogs (PepeDogs) and is known for work in detecting bedbugs, termites, search and rescue and cadaver tracking. Through a combination of internal USDA and ARS funding, J&K support, and a $50,000 grant in 2009-10 from FCPRAC, Gottwald and J&K have conducted field and packinghouse trials that have further demonstrated the ability of canines to detect canker infected grapefruit with high reliability.

Four field trials were conducted between July 2010 and May 2011 using plot sizes of 100 grapefruit trees in a 4X25 row design. Ten replications were conducted in which the proportion of diseased trees ranged from 2 to 10%. Infected trees were randomly distributed. Results showed average detection accuracy of 98.3%, with false negatives at 1.2% and false positives at 0.5%. Analysis of the data suggested that the incidence of higher false negatives was due to two factors: tree proximity downstream from other "positives", and the tree was found "positive" in a prior run.

Packing house trials on grapefruit conducted over two days in April 2011 showed average detection accuracy of 98.2%, with false negatives of 1.3% and false positives of 0.5%. Analysis of the data suggested that error rate increased with temperature due to the dogs panting. During the trials, the dogs identified two boxes with canker fruit missed by human trained technicians.

More recently, a 16 acre field trial on grapefruit trees was completed, also with favorable results. This data is being analyzed and will be publicly reported when complete.

Quality Assurance Certification Program

There is legitimate concern that unscrupulous companies will make unfounded claims and secure contracts with ill-trained dogs and handlers. As a result, there will be a need for a certification process to ensure quality is at highest level in maintained. There are existing testing protocols used in other dog detection industries, e.g. pest management, narcotics detection, and "port of entry" customs inspections. The tests are generally very straight forward, with simple "pass-fail" outcomes.

Dr. Tim Gottwald has developed a testing protocol that would be required for any individual, business and/or entity which is planning to supply the industry with citrus detection canines. The planned protocol includes the following:

- Three separate areas of evaluation that include five runs for each area;
- A 95% or higher detection of infected plants (controlled identification), fruit (packing houses) and trees (groves) must be obtained to pass the canine trainer evaluation process.
- The process shall also require a 5% or less false and/or miss rating to pass
- Pass or fail results will be provided at the completion of the process upon compiling the test data from each area evaluated by qualified USDA personnel.

Areas to be completed for the selection process will consist of:

- Five runs of 100 trees during each run, in a field setting, where randomly generated numbers and location of infected plants are placed that the team must detect.
- Five runs of 100 boxes of fruit during each run, inside a fruit packing house, w here a randomly generated number and location of infected fruit are placed that the team must detect; and
- Five runs of a five acre plot, containing mature trees, in an actual grove, where upon completion, USDA inspectors will confirm or deny alerts with due diligence and their (qualified USDA inspectors) results will be final.

Upon failing to meet the listed standards, entities will not be eligible for re-test for a six month period from the date of the final test results being presented.

Final details of the testing protocol, along with details of how this program would be implemented, must be developed, including who will be the regulatory authority for certification. In the pest management industry, an industry association created a non-profit entity that manages the certification process. This may be an attractive model for canine scouting of plant diseases such as citrus canker.

Appendix 2: Neonic Background

Extensive research into the epidemiology and spread of HLB in Florida since its discovery in 2005 has indicated that HLB impact on mature trees can be managed to extend the productive life of infected trees. The more insidious problem is the inability to adequately protect transplants and replantings up to five years of age against HLB. Without the means to assure control of HLB in these plantings, the economic risks associated with tree replacement may outweigh the expense associated with replanting.

Dr. Michael Rogers of the University of Florida (IFAS) has developed a recommended psyllid control program for young trees which is based in large part on the use of soil-applied neonicotinoid insecticides. One of the unique characteristics of the soil applied neonicotinoids is their ability to prevent the phloem-feeding behaviors required for successful HLB pathogen infestation/inoculation of healthy plants. When a psyllid begins feeding on a plant, it takes more than 1 hour before a psyllid reaches the phloem system of the leaf. If a plant has been treated with a neonicotinoid insecticide, psyllids get a "taste" of the Imidacloprid or other neonic active ingredient in the leaf tissue and quit feeding long before they are able to successfully inoculate a healthy plant with the pathogen. This anti-feeding behavior lasts about six weeks, significantly longer than that provided by any of the currently available foliar insecticide applications (pyrethroids, carbamate, organophosphate and other classes of chemistries.)

Research studies have found that these neonic insecticides can greatly reduce the likelihood of trees becoming HLB diseased within the first three years after planting. These research results have been confirmed in multi-year field evaluations of new tree plantings. Twelve months after planting, trees treated with neonicotinoid insecticides every six weeks, coupled with foliar insecticide sprays of products with different modes of action to mitigate resistance development to the neonicotinoids, have remained HLB-free. This level of performance can be achieved for trees up to three years old (approximately five feet in height) under current labels, depending on timing intervals and use rates per tree.

As trees mature beyond three years old to the 5 to 9 foot range, HLB disease begins to appear in these young tree plantings, and they can become HLB infected at non-manageable levels long before reaching full bearing potential.. This is because of the current per acre preseason restrictions on the amount of neonicotinoid active ingredients that may be applied under present Section 3 labels, while adequate for the very small plantings, is insufficient to protect the larger size of tree, and must be proportionally increased. As a result, increasing the per season use rate to allow additional applications of soil-applied neonicotinoids will provide the additional protection for 5 to 9 foot trees that is required to provide continuity of citrus production in future years. This is critical because losing as few as five percent of young citrus trees currently in the ground to HLB can result in the loss of economic viability for growers.