Solutions for environment and development
Soluciones para el ambiente y desarrollo

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Final Report

Project Preparation Grant STDF 286

"Accessing new ornamental plant markets by reducing phytosanitary issues through participatory research and extension: the Clean Stock Program"

October 2009

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INTRODUCTION

International trade represents a phytosanitary risk due to the potential for moving pests between countries. The opening of markets and new trade agreements has forced countries to apply a series of sanitary and phytosanitary measures to protect human health as well as the health of natural and agricultural ecosystems, which can be threatened by the introduction of animals, plants, pathogens, insects and other contaminants through imports. Concern about invasive species has caused substantial pressure to revise international standards for the protection of plants due to problems caused by invasive species (Mack *et al*. 2000, Campbell and Schlarbaum 2002, USDA 2004).

Interceptions of pests and rejection of crops at ports of entry are costly to exporting business who must pay the costs of fumigation or for the consequences of delayed shipments. Use of fumigants may also reduce the quality of the crops and the environment and can have an impact on an exporting country's image. The importing country is also affected by the introduction of unwanted pests and higher costs of the crops themselves. According to the United States Department of Agriculture Animal and Plant Inspection Service (APHIS) between 2006 and 2009, there were more than 4800 interceptions due to plants coming from Costa Rica. Of the reported interceptions from Costa Rica 80% were from the ornamentals *Dracaena* sp., *Codiaeum* sp. (Croton), *Schefflera* sp., *Cordyline* sp. and *Alpinia* sp. (Ginger), as well as false coriander (*Eryngium foetidum*) and pineapple (APHIS 2009).

A series of international rules have been established to reduce the risk of pest dispersal on a global level. Programs that reduce quarantined pests on exported crops, which are formally known as Clean Stock Programs (CSP) have been proposed to successfully face changes in international standards for plant protection. These programs established in producer countries must be supported by scientific studies that guarantee the drastic reduction of pest abundance before being exported. The first country in the world to implement such a program was Costa Rica with the CSP developed for the ornamental plant, *Dracaena.* This program was a highly successful venture that resulted in participating growers tripling their exports, while reducing the number of plants intercepted at US ports to near zero. As a result of the research that documented levels of risk posed by plants of a particular size class, the Costa Rican Ministry of Agriculture has initiated a process with APHIS to relax size restrictions on this crop. These changes are likely to greatly increase markets for this plant in the US.

Experience with *Dracaena* has highlighted the need to better understand pest-crop interactions, to develop solutions at the farm system level, and to involve producers in project activities in order to effectively develop and transfer knowledge. The main objective of this project proposal grant (STDF 286) was then to write a proposal that will focus on minimizing the phytosanitary risk of the exported crops to maintain access to the US market and open up new markets based on certified, high quality products.

A proposal was developed in order to improve the capacity of producers to grow crops that meet export standards through research activities, which identify the most efficacious practices for growers, and the development of a training program to share information with producers. The goal of the proposed project **" Management Practices to Reduce Interception of Quarantined Pest Species (BMPRS)"** is to promote trade and increase new market opportunities in the US for cut flowers, (*Alpinia* sp.),: ornamental crops (*Dracaena* sp.*, Codiaeum* sp., *Schefflera* sp., *Cordyline*) false coriander (*Eryngium foetidium*) and pineapple (*Ananas comosus*) by avoiding trade restrictions due to phytosanitary concerns.

DESCRIPTION OF PPG ACTIVITIES

UNDERSTANDING THE PHYTOSANITARY SITUATION OF COSTA RICAN EXPORTATION CROPS

In order to better understand the phytosanitary issues involved and focus producer training and participatory research, baseline information from Costa Rican growers, APHIS, and Costa Rican Ministry of Agriculture's Phytosanitary and Exportation Services (SFE) was gathered. Interception databases from Costa Rica and the USA were analyzed to identify key crops and pests, and their quarantine situation. Workshops and meetings were conducted for producers as well as governmental, university, and non-governmental professionals associated with the sector on the phytosanitary conditions of the key crops.

A pest interception database was provided by SFE with official data from APHIS, The information was analyzed from 2007 to 2009. The ten most intercepted crops and pests were selected (Figure 1) and explored to determine the most important pests associated for each cropping system. Once the information was compiled, different meetings were held with governmental officers from SFE. The objectives of the **first meeting** were to present the initial approaches of the project preparation grant to SFE, as well as to discuss the results of the database analysis. SFE agreed on the importance of the project for Costa Rica, and they expressed their support for the proposal.

The list of the 10 most intercepted crops and pests were used as a baseline to select the target crops and pests for the project (Figure 1). SFE suggested the following seven crops,

based on their phytosanitary sensibility and economic importance at the national level: *Dracaena* sp., *Codiaeum* sp., *Schefflera* sp., *Alpinia* sp., *Cordyline* sp. (all ornamental crops), *Ananas comosus* and *Eryingium foetidum*.

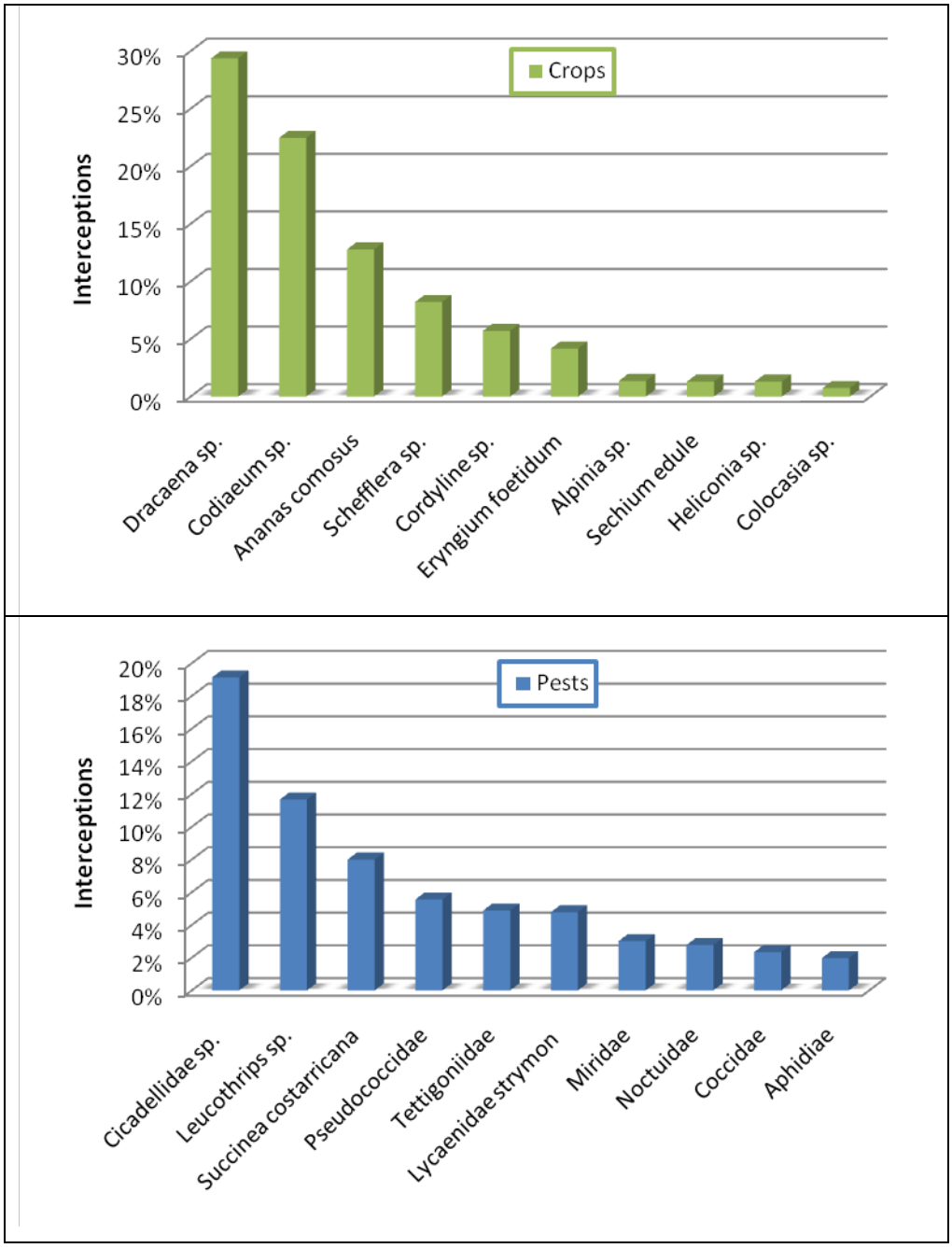

Figure 1. The ten most intercepted crops (top) and pests (bottom) being exported into the USA based on the APHIS pest interception database from 2007-2009.

They also recommended continuing the training and validation of the Clean Stock Program (CSP) in *Dracaena* and considered it necessary to train all the Dracaena producers. This crop continues to maintain the highest level of interceptions, and the CSP will soon be a

mandatory requirement for continued export to USA markets. SFE agreed on sending the list of producers and packers for the selection of a subset of representatives for the planning of the next PPG activities.

A **second meeting** was held with the governmental supervisors from SFE. The objectives of the meetings were:

1) Define the procedure to formalize the project proposal as a strategy for Costa Rica to the USA authorities for the reduction of quarantine pests on export crops.
2) Define the thematic areas and project goals.
3) Review the list of producers and packers to select a subset for the next project proposal activities.
4) Define SFE participation in training and traceability activities.

SFE officers emphasized the importance of the execution of this project taking into account that the Plant Protection and Quarantine program (PPQ) from APHIS has expressed a concern about the high level of pest interceptions associated with the importation of some crops from Costa Rica. APHIS has advised the government of Costa Rica to take measures to avoid more severe regulatory actions and expressed its willingness to provide some technical assistance to SFE to develop a pest management plan. It was established that the project proposal can be presented to APHIS authorities as an action aimed at reducing quarantine pests on export crops.

The SFE recommended emphasizing two strategies to implement the BMPRS project proposal:

a. Pest harmonization: to maintain access to international markets and raise phytosanitary barriers. Pests such as Leucothrips sp. in Croton, Mealybugs in Alpinia and others should be included in this issue.
b. Development of management protocols for agricultural production systems: to reduce the country´s phytosanitary interceptions.

SFE provided us with the database of growers and packers for the target crops. It was agreed that subsequent meetings would be held with the inspectors in charge of each of these crops. The aim would be to define the subset of producers and growers or packers qualified to participate and collaborate in the research process.

Although we have demonstrated that traceability is critical to a successful Clean Stock Program, SFE has determined that the producers have different traceability systems. It was agreed that these systems should be assessed during project implementation to determine their effectiveness and try to find standardization to facilitate its use over the

export production systems (from producer to U.S. port of entry). SFE indicated that they could be in charge of this process.

A **third meeting** was held with SFE to define further actions that are needed in order to develop a solid strategy for the project's articulation. The objectives of the meeting were:

1. Identify the key contacts at SFE for each of the crops included in the project and define the way of getting more detailed information on these groups of producers.
2. Explore possible collaborators for scaling up the training activities.
3. Define the best way to approach the False Coriander growers
4. Discuss the possibility of including Guatemala as a second country participating in the project.

A list of SFE inspectors was provided for each crop and it was agreed to ask them for an updated list of producer and to participate in future meetings.

SFE suggested asking the International Regional Organization for Plant and Animal Health (*OIRSA*) for help with the training program. Jimmy Ruiz was mentioned as the possible contact at this organization. It also was suggested that the training program could be executed by the National Learning Institute (INA) since they already have a network of training centers throughout the country.

The exportation of False Coriander is carried out by six companies, the same ones that own the packing houses. In order to include all points of view and interests from this sector, SFE was asked to choose and invite participants to the project planning workshop.

Some constraints were pointed out if we were to include Guatemala in the project. One of the most important was the lack of information at the governmental level about interceptions. The following steps were proposed in order to define if it was possible to include Guatemala in the project:

1. Establish contact with governmental and representatives from CATIE in Guatemala.
2. Find the name of the APHIS representative in Guatemala to gain access to their interceptions data base in order to define the priorities for this country.
3. Define the working structure and budget.

The objective of the **fourth meeting** was to establish contact with SFE inspectors for the target crops within the project. In this meeting we defined the contacts and strategy to approach growers of pineapple, *Alpinia* sp., and ornamentals.

The association of pineapple growers (Proagroin) was mentioned as a potentially good partner for the project since they work with small producers which grow pineapple using

both organic and conventional systems. However, bigger organizations like CODAP and CANAPEP were mentioned as indispensable to be incorporated in the process to ensure participation by the sector.

For foliage ornamentals and Alpinia, it was suggested to work with the National Plant Export Chamber (CANEPLANTA) and the Association for Flower Exportation (ACOFLOR). Contact names were provided for each organization.

CHARACTERIZING THE AGROECOLOGICAL AND SOCIOECONOMIC ASPECTS OF THE PRODUCTION SYSTEMS

In order to describe the agroecology and socioeconomic issues involved in the production systems and their market chains; workshops, meetings with producers and experts, and fields trips were carried out.

Two workshops for producers as well as government, university and non-government professionals associated with the target agricultural sectors were conducted. The objective of the first three day workshop (July 2^{nd} – 4^{th}) was to discuss the phytosanitary status of the target exportation crops (*Dracaena* sp., *Codiaeum* sp., *Schefflera* sp., *Alpinia* sp., *Cordyline* sp., *Ananas comosus* and *Eryingium foetidum)* with the sector involved, and to define the research lines of the project.

The agenda for the workshop included:

- ✓ Day 1: Activity with representatives of the productive sector, researchers (CATIE-Purdue University, EARTH University), governmental authorities (SFE-MAG) and regulatory authorities (APHIS).
- ✓ Day 2: Field trip with the researcher group.
- ✓ Day 3: Working group (CATIE-Purdue University-EARTH University) to define research lines.

The first day of the workshop brought together 32 participants among ornamental and pineapple producers, government representatives, chamber of exporters, APHIS and plant health experts (Annex 1). An invitation and agenda for this workshop are provided in Annex 2. The working session initiated by giving a presentation of the project background, thematic areas and goals. Additionally, SFE and APHIS authorities explained the current phytosanitary situation of Costa Rica in the USA market, and stressed the importance of these initiatives.

Activities with producers included focal groups to discuss the main problems for the selected crops in order to define the goals and strategies for the project. Three groups

were identified: ornamental group (including *Cordyline*, *Codiaeum*, *Dracaena* and *Schefflera*), pineapple group and *Alpinia* group. The ornamental group included the four foliage crops due to their similarity in terms of production systems. Twenty two surveys were conducted in the workshop. Each producer individually filled in the first form describing agricultural problems or special needs in their production system related to any of the following categories: pests, diseases, weeds, nutritional issues, chemical dependency, crop management, harvest management, marketing and commercialization, training opportunities, access to technical information, organizational management, among others. Once the forms were filled in, producers were asked to prioritize the top five problems or needs from their own list. After finishing the prioritization, each grower filled in a second form describing their prior experiences and knowledge about the top five issues selected. Additionally, they expressed their expectations of the new project and brought their own suggestions to solve those problems through research. Results were discussed inside each group, and a table summarizing the results of each focal group was presented as a workshop conclusion. Workshop results on prioritization of crop problems, grower's prior experiences on their management and their expectations for the new project are in Annex 3. As a complement to the information obtained during the workshop 48 producers, including all of the crops, were surveyed in their farms.

On the second day a field trip was coordinated to allow the experts from CATIE and Purdue University to better understand the production systems and be able to propose integrated strategies to solve the pest and disease problems. Representative farms in the Atlantic zone of Costa Rica, where most of the production systems are located, were visited. In each farm, where possible, samples of insects and diseases were collected to identify some problems described in the workshop with producers. The field trip included the following farms:

1. Turriplantas (Pavones-Turrialba, Ornamental farm with *Codiaeum*)
2. False coriander farm (Pavones-Turrialba)
3. Lucha Ornamental (Pacuarito-Siquírres, Ornamental farm with *Cordyline* and *Codiaeum*)
4. Trópica del Atlántico (Guácimo, Ornamental farms with *Schefflera* and *Codiaeum*)
5. Pinneaple farms (Guácimo)
6. Hermanos Castillo (Cariari-Guápiles, Ornamental farms with *Alpinia*).

The objective for third day was to define the research lines for the new project. Experts from different areas including agroecology, entomology, pathology, socio-economy, rural development and production participated in this working group. Based on the results of the workshop with producers and the field trip it was possible to characterize agroecologically the production systems, from the phytosanitary point of view; as well as

to describe socioeconomically their market chains. Agroecology results are summarized in Annex 3. From a socioeconomic perspective production systems can be characterized as follows:

1. There is an institutional lack of research and training capacity to better promote the cooperation between market chain operators of the different products or crops. This could reduce the benefits from Clean Stock Programs or harmonization programs. Also, it could negatively influence the search for a less expensive technology transfer process. Additionally, there is a diminished capacity to respond to new issues affecting trade such as the new regulations developed as a response to the implementation of new programs.
2. To improve the ultimate benefits of new technologies and to describe marketing strategies that farmers could implement to improve product demand and sales over the course of the year, three group of producers were identified inside the different production systems:

    - *Group 1*: Growers with an unknown cost structure, little product diversification (everyone sells the same product) and a high cost for adopting new new technologies.
    - *Group 2*: Producers perceived as opportunists sacrificing fidelity to the producer group for short term gain. For example organic pineapple growers facing lower prices; or some ornamental growers selling their products cheaper because they avoid legal payments such as social security and other taxes.
    - *Group 3*: Growers do not have knowledge about seasonal fluctuation in market prices, costs and, likelihood of pest interception.

The main outputs of this workshop were the definition of research approaches and a first draft of the logical framework of the project. Research approaches were identified as follow:

1. Harmonization of *Leucothrips* in *Codiaeum* and mealybugs in *Schefflera* and *Codiaeum*.
2. Identification and management of quarantine weeds in pineapple.
3. Development of Best Management Practices (BMP) protocols in quarantine pests for the target crops.
4. Development of Best Management Practices (BMP) protocols for main diseases: “Mal morado” in *Dracaena* and Stunting in Alpinia.
5. Training and result validation programs.

The logical framework was circulated electronically among people involved in the project including producers, government inspection workers, researchers, and others to receive feedback. Additional field trips and interviews with producers were carried out to contribute to the development of the project work plan and expected activities.

A second workshop was held with False coriander growers, which brought together 22 producers and a governmental inspector (Annex 5). This group is characterized for having rudimentary proction practices, and poor record of investment in human and social capital. These issues have become a bridge between these producers and those of ornamental and pineapple. The objective of this workshop was the same as the previous one, but the methodology changed slightly to accommodate a illiterate growers.

The work session started out by giving a presentation of the background and major approaches to be established under the project goals. In order to define the goals and strategies for False Coriander in the new project, producers were asked to describe agricultural problems or special needs in their production system related to any of the following categories: pests, diseases, weeds, nutritional issues, chemical dependency, crops management, harvest management, marketing and commercialization, training and technical access, productive organization, and others. Information was then hand written in paper sheets of a flip chart including figures and charts. After that, producers were asked to prioritize the top five problems or needs discuss previously. After they reached an agreement an open discussion started, allowing growers to express their expectations for the new project and to bring their own suggestions to solve those problems through research. Workshop results on prioritization of False coriander problems, grower's prior experiences on their management and expectations for the new project are in Annex 3. When required, additional field trips and interviews with producers were carried out to contribute with the results of the workshop. Agroecology and socioeconomic information obtained was then included in the logical frame and work plan. Photos showing workshop and meeting with Flase Coriander growers and exporters, and field diagnostic trips with experts from CATIE and Purdue are shown in annex 6.

PROPOSAL DEVELOPMENT

All documentation, including literature, governmental information and databases, that justified and elucidated the quarantine problems of the target crops were reviewed to define the project's background and justification. Using the logical framework draft as a base, a preliminary budget and activities timeline were created and circulated thorough the working group to be updated.

A third workshop was carried out from August 18th to 22nd in order to prepare the final draft proposal to be submitted to the STDF-WTO. Workshop brought together 12 participants among researchers from CATIE, Purdue University and EARTH University; government representatives and chamber of exporters (Annex 7).

Activities in this workshop included:

1. Definition of the project's work plan. Research lines, objectives and activities were discuss and defined to have a final version of the work plan. Experts from different areas including agroecology, entomology, pathology, socio-economy, rural development, landscape ecology, agricultural extension, physiology and Geographic Information Systems participated in this working group. Working groups were identified according to the four objectives established. Each group reviewed the activities, expected results, means of verification and means of verification to complete the logframe matrix and describe the workplan.
2. Proposal budget and activities timeline. Once the workplan was approved, the whole group reviewed and adjusted the budget and activities timeline to fulfill with the objectives and goal of the project. Distribution of responsibilities and timetable for research activities was also defined.
3. Compilation of the draft proposal.
4. A meeting with people involved with the project including representative of producer chambers, government inspection workers, USDA personnel, researchers, and others to receive feedback on the proposal were arranged. A presentation was realized to discuss the main approaches and goals of the project. The project was well received by participants and was also approved by SFE-MAG.

Since it was not possible to bring together all the possible collaborators to the project on the third workshop, additional meetings were held to explain the scope of project. Meetings were held with the Ministerio de Comercio Exterior de Costa Rica (COMEX), Ornamental chambers (Federación de Productores y Exportadores de Plantas Floresy Follajes de Costa Ricas), growers cooperatives and associations (Asoproagroin) and growers. As a result of this, project acceptance letters of support were received.

Finally the proposal titled **Best Management Practices to Reduce Interception of Quarantined Pest Species (BMPRS)** was submitted to the Standards and Trade Development Facility Secretary.

FINANCIAL REPORT

PERIOD

May 15, to September 30, 2009

SOURCE: World Trade Organization

PROJECT: "Accesing new ornamental plant markets by reducing phytonsanitary issues through participatory research and extension: the Clean Stock Program".

TROPICAL AGRICULTURE RESEARCH AND HIGHER EDUCATION CENTER CATIE

OCTOBER 2009

Finnancial report
(From May 15, to September 30, 2009)
Amounts expressed in U.S. dollars

Cost Type	Budget	Expenditure Incurred	Balance
Personnel Services	18.000,00	18.000,00	-
Travel	10.500,00	7.443,13	3.056,87
Workshops	1.000,00	999,17	0,83
General Operating Expenses	500,00	499,63	0,37
TOTAL	**30.000,00**	**26.941,93**	**3.058,07**

Código Contable **CC. E897**

Remittances received

Date	US DOLARES
Mayo 16, 2009	15.000,00
Bank commission	(20,00)
TOTAL	**14.980,00**

Finnancial position

	US DOLARES
Funds received	14.980,00
Costs incurred	26.941,93
BALANCE	**(11.961,93)**

The undersigned certify that the information provided
is true and correct to the best knowledge and belief

Francisco Jamienson F.
Contralor

Tamara Benjamin
Project Responsible WTO/CATIE

SUMMARY OF THE RESULTANT PROJECT

Best Management Practices to Reduce Interception of Quarantined Pest Species (BMPRS)

Interceptions of pests and rejection of crops at ports of entry are costly to exporting business who must pay the costs of fumigation or for the consequences of delayed shipments. Use of fumigants may also reduce the quality of the crops and the environment and can have an impact on an exporting country's image. The importing country is also affected by the introduction of unwanted pests and higher costs of the crops themselves. From 2006 to 2009, more than the 80% of reported interceptions from Costa Rica were the ornamentals *Dracaena* sp., *Codiaeum* sp. (Croton), *Schefflera* sp., *Cordyline* sp. and *Alpinia* sp. (Ginger), as well as false coriander (*Eryngium foetidum*) and pineapple (APHIS 2009).

Ornamental exports account for more than US $180 million or approximately 10% of all agricultural exports from Costa Rica. Nearly 50% of total ornamental exports are shipped to North America, mainly to the USA, which represents more than US $80 million (PROCOMER, Banco Central de Costa Rica 2006). Costa Rica, like many Central and South American countries, has historically been vulnerable to large swings in the demand and profitability of commodities like coffee. Diversification of agricultural enterprises can buffer the agronomic sector from market extremes and provide a more stable source of income for rural communities and surrounding urban areas with low socioeconomic indices. Ensuring continued access of ornamentals and other plants to U.S. consumers is therefore a critical component of national development strategies and policies.

To avoid bans imposed on frequently intercepted plants, programs must be developed that reduce interceptions. We have developed a model system for such an approach for the ornamental plant, *Dracaena*, in Costa Rica, the first country in the world to implement such a program. The Clean Stock Program was a highly successful venture that resulted in participating growers tripling their exports, while reducing the number of plants intercepted at US ports to near zero. As a result of their research that documented levels of risk posed by plants of a particular size class, the Costa Rican Ministry of Agriculture has initiated a process with USDA APHIS to relax size restrictions on this crop. These changes are likely to greatly increase markets for this plant in the US.

Our experience with *Dracaena* has highlighted the need to better understand pest-crop interactions, to develop solutions at the farm system level, and to involve producers in project activities in order to effectively develop and transfer knowledge. We propose a three phase process to expand our success with *Dracaena* to other ornamental species

and to false coriander and pineapple. First, we will use questionnaires and on-farm sampling of pests to identify management systems that reduce pest abundance. Pests collected in this effort will be used determine whether unidentifiable life stages of specific pests detected in these crops at ports of entry are likely to be of quarantine importance. We will also use economic analyses to quantify benefits and costs of identified systems and practices so that we can provide producers with practical management options. Second, we will use participatory research methods to test the effectiveness of management systems identified in the first phase at reducing pest abundances. Specifically, we will use our experience working with *Dracaena* produces to design a prototype validation and training program for use in other crops. We will create educational materials with producer input to insure that the materials are relevant and useful to target audiences during this phase and develop training workshops for the producers. Finally, we will initiate a program to communicate the results of our research to producers and stakeholders through a series of workshops, releases of bulletins, pest identification guides, and a website.

The goal of the project will be to promote trade and increase new market opportunities in the US for cut flowers, (*Alpinia* sp.),: ornamental crops (*Dracaena* sp*., Codiaeum* sp., *Schefflera* sp., *Cordyline*) false coriander (*Eryngium foetidium*) and pineapple (*Ananas comosus*) by avoiding trade restrictions due to phytosanitary concerns.

FUNDING

The elaboration of this project proposal was 100% granted by the Standards and Trade Facility 286 granting program of the World Trade Organization.

We expect to receive up to 40% of funds from the STDF-OMC to execute the project. An application for complementary funding sources had been made to the USDA 2008 Farm Bill (H.R. 6124), which has a goal of safeguarding nursery production from exotic invasive pests and diseases. According to this bill the Commodity Credit Corporation must fund this effort by over $45/million per year from 2010 through 2013.

Agricultural sector, governmental, and research institutions involved with the project are willing to provide in kind contribution as was stated in the support letters submitted with the proposal.

CONCLUSIONS AND RECOMMENDATIONS

According to the information collected at the workshops and in the interviews with government representatives, growers, packers and exporters, the pest problems and associated crop management incompatibilities with the export market are very clear:

1-Percieved market demand for perfect looking, pest free products, induce some of the producers to use excessive amounts of chemical products, that are sometimes not allowed or registered for their crop, ending up with pesticide residue problems.

2- The lack of knowledge on pest identification, biology and ecology makes it difficult to make the correct decisions for their control.

3-Even though research has been carried out in the past on some of the problems they are facing, very little of this information has been made available in appropriate ways to the growers leaving them without the necessary decision making tools to improve crop management.

4-Without an organized initiative to gather the available information, develop complementary research and state an effective process for validation and training, it will be difficult to lower the interception rate for these crops, jeopardizing these productive activities which represent the way of living for thousands of families in Costa Rica.

Funding is recommended to provide resources needed to implement the proposed project that will serve as a starting point to reduce the risk of pests on agricultural export products and maintain access to international markets.

Annex 1. List of partipants of the first wokshop held from July 2nd to 4th, Heredia, CR.

Registro de participación.

Taller

"Proyecto Mejoramiento del acceso de productos ornamentales y no tradicionales a mercados externos".

	Nombre	Organización o Empresa	Teléfono	Correo electrónico o fax
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5	Julio Arroyo	Flovica	2453 7020	[illegible]
6	William Vásquez	Dpto. La Cima	2453 6563	lacima@xce.co.cr
7	[illegible] Peña (Sto)	SFE	2260-6721	[illegible]
8	Armando Vargas M.	FED. ORNAM.	2291.5232	[illegible]
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11	José Luis Hernández O.	SFE. M.A.G.	2474-42-53	[illegible]
12	Juan Diego Barrantes V.	AEROEXP. (BW) SA	2761 11-22	[illegible]
13	Juan Arroyo Guzmán	AEROEXP (BW) SA	2761 0293	[illegible]
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18	Magela Padilla	SFE - Cartucho	22608300	[illegible]
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20	Luis Echeverría	SFE - CIN	22608300	centro de información
21	[illegible]	USDA/APHIS-IS	2290-4548	[illegible]
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27	José Ricardo Guzmán S.	M.A.G.	8479-9158	[illegible]
28	Mildred Linkimer	CATIE	25582533	linkimer@catie.ac.cr
29	Gerardo Pérez L.		83146353	
30	Heiner Castillo	EARTH	27130000	hcastillo@earth.ac.cr
31	Grace Montenegro	SFE	2260-6721	gmontenegro@protecnet.go.cr
32	Wilkin Gutiérrez	CATIE	2558-2456	[illegible]
33				
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Annex 2. Invitation and agenda for the workshop held on July 2nd, Heredia, CR.

Las intercepciones por plagas cuarentenarias en cultivos agrícolas de exportación han sido un tema constante que afecta a toda la agrocadena productiva. Esta situación ha provocado reacciones por parte de las autoridades reguladoras en temas fitosanitarios de los Estados Unidos quienes han optado por estimular a sus homólogos en nuestro país para tomar medidas correctivas al respecto. Como parte de los múltiples esfuerzos de las autoridades fitosanitarias de Costa Rica, en conjunto con Instituciones de investigación y enseñanza (CATIE y Purdue University), y la colaboración de otras instancias gubernamentales, se apuntó recientemente un éxito en cuanto al desarrollo de una estrategia de manejo de cultivo, basada en el conocimiento científico del sistema, el cual ha demostrado ser eficaz para el manejo de poblaciones de plagas cuarentenarias. Este esfuerzo ha sido reconocido y aplaudido por las autoridades de los Estados Unidos abriendo la oportunidad para extender esta experiencia a otros cultivos de exportación que requieren de investigación para superar problemas con plagas específicas. Con esta visión, estamos proponiendo el desarrollo de un nuevo proyecto que incluye productos agrícolas sensibles fitosanitariamente a fin de generar soluciones basadas en la generación de conocimiento, alternativas de control, homologación de plagas, capacitación y fortalecimiento de capacidades productivas. Dada la relevancia y perfil de este proyecto, es fundamental tener la participación de todos los actores en el sector productivo. Para esto se propone desarrollar el presente taller que tiene como objetivo definir los ejes temáticos y líneas de investigación del proyecto. Para nosotros es imprescindible contar con su experiencia y participación en esta etapa que brindará las bases para la elaboración y futuro éxito del proyecto.

Fecha: Jueves 02 de julio 2009

Hora: 8:45 a.m.

Lugar: Auditorio del Servicio Fitosanitario del Estado, Barreal de Heredia.

AGENDA

9:00 a.m. – 9:15 a.m.	Bienvenida: Situación fitosanitaria de las Agroexportaciones en CR *Servicio Fitosanitario del Estado*
9:15 a.m. –9:40 a.m.	Presentación de logros y resultados del Proyecto de Material Propagativo Sano (CSP) *CATIE*
9:40 a.m. – 10:00 a.m.	Presentación del Nuevo Proyecto *CATIE*
10:00 a.m. – 10:15 a.m.	Refrigerio
10:15 a.m. – 11:45 a.m.	Trabajo en grupo: Discusión de la problemática de los cultivos en cuestión y definición de ejes temáticos para ser incluidos en las líneas de investigación
11:45 a.m.– 12:15 m.d.	Presentación y síntesis de resultados del trabajo en grupo
12:30 m.d.	Cierre de la actividad

SERVICIO FITOSANITARIO DEL ESTADO, CENTRO AGRONÓMICO DE INVESTIGACIÓN Y ENSEÑANZA (CATIE) Y PURDUE UNIVERSITY

Favor confirmar a:
2558-2314
2558-2533
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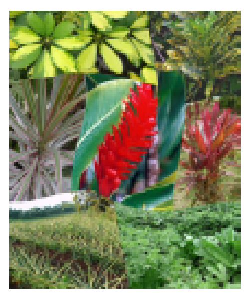
Correo: ehidalgo@catie.ac.cr

SERVICIO FITOSANITARIO DEL ESTADO, CENTRO AGRONÓMICO DE INVESTIGACIÓN Y ENSEÑANZA (CATIE) Y PURDUE UNIVERSITY



Le invitan al taller: Proyecto Mejoramiento del Acceso de Productos Ornamentales y no Tradicionales a Mercados Externos

Annex 3. Workshop results on prioritization of crop problems, grower's prior experiences on their management and their expectations for the new project. Includes information from the two first workshops.

Crop	Problem	Priority given by growers (1:High, 2:Medium, 3:Low)	Grower´s experience and knowledge	Expectations from the new project
Alpinia sp.	Mealy bugs	1	They wash the flowers with pressurized water and have also tried soaps but the interceptions for mealy bug persist. They argue about a seasonal increase on interceptions (*when the market is high in the USA the # of interceptions is low and vice verse*). They've heard of a thermal treatment but feel the it would be too expensive for the volume of product they'd have to treat	Pest harmonization and development of better control practices at the field level
	Tettigoniidae	3	Occasional damage to foliage and flowers, is not relevant since it is not frequent	None
	Ants	2	They make the control them with chemicals for its relation with mealy bug spreading (they use nematicides to control them)	More research and better control practices
	Coleoptera	3	Minor damages caused by weevils on the flower. Is not frequent.	None
	Stunting	1	There have been many attempts to identify the causal agent but the growers have never received the results nor an strategy to control it. Is a growing problem and they think it might be caused by a virus or probably by degeneration of the genetic material since they've been using propagating the same material over many years.	They want a proper identification as for the origin of the problem and strategies to control it.
	Spots on stem and flowers	3	Spots on the stem are not a real problem and they only appear on extra large flowers (the oldest flowers). The can control using fungicides if necessary	None
	Drainage	3	They don't see it as a problem but some of them feel that good drainage systems give strength to the plant.	None
	Crop waste management	3	They divide into two waste types: 1- packing house waste and 2- field/pruning waste. The packing house waste is disposed in stacks nearby and the pruning waist is left inside the plantation. This helps on weed control although they know there is a potential problem with mealy bugs.	None

Crop	Problem	Priority given by growers (1:High, 2:Medium, 3:Low)	Grower´s experience and knowledge	Expectations from the new project
	Access to information and training	1	They feel that there is not enough information on crop management since it is relatively new and rustic. There is not literature available, nor access for training.	They would like the existent information to be made public and to develop new research and training programs according to their needs (including sampling techniques and estimation of populations, absorption curves, alternatives for pest control, etc.)
	Market /commercialization	2	It is a market based in trust where the absence of contracts, uneven prices, seasonal increase of interceptions and strong measures taken by the USA authorities traduce into high losses for exporters and producers.	They believe that homologating the mealy bugs will reduce their market problems significantly.
	General prioritization : Growers defined from the highest to the lowest priority the following 5 problems: 1- Mealy bugs and stunting, 2- Market /commercialization, 3-Periodicity/seasonality of interceptions,4- Lack of technical information, 5- Need for training			
Cordyline sp.	Scale insects Snails Mites Leafhoppers Grasshoppers	1	Major problem due to interceptions and fumigations, they feel that there are not identification tools; they do not know what to do when they find a pest. There is a lack of information about recognized laboratories in Costa Rica and outside the country to identify the pests.	They expect protocols to identify and control pests, they are willing to apply alternative pest control instead of pesticides. They expect more research to identify and control snails.
	Market /commercialization	2	There is an unknown of the cost structure, they don´t know how to diversify their products, costs are high in "formal" farmers. They depend on fluctuation prices. Lack of loyalty in the small producers. They feel there is a lack of support from the government (Procomer) to promote their products outside the country. They feel there is a lack of organization in the ornamental market.	They expect to understand the market and cost structure. They expect to know the costs of implementing the new technologies. They need to open new markets.
	Nutritional problems	3	They feel there is a relation between nutritional problems and pests. In the last years they have abandoned the fertilization due to economics costs.	They would like more research in alternative fertilizers. They expect to know the quality of the products available in the country. They expect more technical assistance in this issue
	Training	2	In general, they think there is a lack of knowledge in different issues, mainly pests, because they feel they have	They expect to have access to the research results in short time. They

Crop	Problem	Priority given by growers (1:High, 2:Medium, 3:Low)	Grower´s experience and knowledge	Expectations from the new project
			not had a good training program. They feel they do not have access to research or technical information.	would like to have a training program which includes all the market processes. They expect manuals, workshops, and they are willing to be included in a participatory research. They expect to have decision tools to identify pests and disease, as well as to control the problems (protocols)
	Diseases	3	Minor problems due to diseases	They expect protocols to identify and control diseases. They expect more training in this area.
	General prioritization : Growers defined from the highest to the lowest priority the following 5 problems: 1- Insects, 2- Market/Commercialization, 3- Nutritional problems, 4- Need for Training, 5- Diseases.			
Codiaeum sp	Scale insects Snails Mites Nematodes Snails	1	Major problem due to interceptions and fumigations, they feel that there are not identification tools; they do not know what to do when they find a pest. There is a lack of information about recognized laboratories in Costa Rica and outside the country to identify the pests.	They expect protocols to identify and control pests, they are willing to apply alternative pest control instead of pesticides. They expect more research to identify and control snails
	Leucothrips	1	They feel the priority is the Pest harmonization of leucothrips (sampling in *Theobroma* cacao and *Sechium* edule and send samples to USDA).	Pest harmonization and development of better control practices at the field level
	Market /commercialization	2	There is an unknown of the cost structure, they don´t know how to diversify their products, costs are high in "formal" farmers. Lack of loyalty in the small producers. They feel there is a lack of support from the government (Procomer) to promote their products outside the country. They feel there is a lack of organization in the ornamental market.	They expect to understand the market and cost structure. They expect to know the costs of implementing the new technologies.
	Anthracnose Xanthomonas	3	Growers feel the main problems are caused by Anthracnose and *Xanthomonas*, but there are not sure I they identify these disease correctly. They feel they do not have tools to identify and manage these diseases.	They expect protocols to identify and control diseases. They expect more training in this area.
	Training	2	In general, they think there is a lack of knowledge in	They expect to have access to the

Crop	Problem	Priority given by growers (1:High, 2:Medium, 3:Low)	Grower´s experience and knowledge	Expectations from the new project
			different issues, mainly pests, because they feel they have not had a good training program. They feel they do not have access to research or technical information.	research results in short time. They would like to have a training program which includes all the market processes. They expect manuals, workshops, and they are willing to be included in a participatory research. They expect to have decision tools to identify pests and disease, as well as to control the problems (protocols)
	Nutritional problems	3	They feel there is a relation between nutritional problems and pests. Some relate bad nutrition with higher susceptibility to Thrips. In the last years they have abandoned the fertilization due to economics costs..	They would like more research in alternative fertilizers. They expect to know the quality of the products available in the country. They expect more technical assistance in this issue.
	Soil		Compaction and poor drainage are the main problems	
	Market /commercialization	2	There is an unknown of the cost structure, they don´t know how to diversify their products, costs are high in "formal" farmers. Lack of loyalty in the small producers. They feel there is a lack of support from the government (Procomer) to promote their products outside the country. They feel there is a lack of organization in the ornamental market.	They expect to understand the market and cost structure. They expect to know the costs of implementing the new technologies.
	General prioritization : Growers defined from the highest to the lowest priority the following 5 problems: 1- Insects, 2- Market/Commercialization, 3- Nutritional problems, 4- Need for Training, 5- Diseases.			
Schefflera sp.	Scale insects (star scale)	1	Major problem due to interceptions and fumigations, they feel that there are not identification tools; they do not know what to do when they find a pest. There is a lack of information about recognized laboratories in Costa Rica and outside the country to identify the pests. They feel the main solution for *Leucothrips*, mealy bugs and snails is the Pest harmonization .	They expect protocols to identify and control pests, they are willing to apply alternative pest control instead of pesticides. They expect more research to identify and control snails Pest harmonization and development of better control practices at the field level
	Mealy bugs			
	Leucothrips			
	Snails			
	Diseases	3	Minor problems due to diseases	They expect protocols to identify and control diseases. They expect more

Crop	Problem	Priority given by growers (1:High, 2:Medium, 3:Low)	Grower´s experience and knowledge	Expectations from the new project
				training in this area.
	Training	2	In general, they think there is a lack of knowledge in different issues, mainly pests, because they feel they have not had a good training program. They feel they do not have access to research or technical information.	They expect to have access to the research results in short time. They would like to have a training program which includes all the market processes. They expect manuals, workshops, and they are willing to be included in a participatory research. They expect to have decision tools to identify pests and disease, as well as to control the problems (protocols)
	Nutritional problems	3	They feel there is a relation between nutritional problems and pests. In the last years they have abandoned the fertilization due to economics costs.	They would like more research in alternative fertilizers. They expect to know the quality of the products available in the country. They expect more technical assistance in this issue
	Market /commercialization	2	There is an unknown of the cost structure, they don´t know how to diversify their products, costs are high in "formal" farmers. Lack of loyalty in the small producers. They feel there is a lack of support from the government (Procomer) to promote their products outside the country. They feel there is a lack of organization in the ornamental market.	They expect to understand the market and cost structure. They expect to know the costs of implementing the new technologies.
	General prioritization : Growers defined from the highest to the lowest priority the following 5 problems: 1- Insects, 2- Market/Commercialization, 3- Nutritional problems, 4- Need for Training, 5- Diseases.			
Ananas comosus	Tecla (*Strymon megarus* (Godart) (LEP.Lycanidae) *Metamazius hemipterus*	1	Growers say that these 2 pests live primarily in the forest and move from there into the crop. The main hosts identified by the growers for these pests are *Musa* spp., *Heliconia* spp. and palms.	Growers expect to get better control agents and management strategies. They propose to investigate the use of trap crops and barriers such as Vetiver and King grass.
	Mealy bugs	3	I wasn't perceived as a limiting problem. They associate it with the presence of ants. They say that farms that succeed on controlling ants also control the mealy bug. Some indicate that *Cecropia* trees important hosts for	Studies to better understand the ant/mealy bug relation and a management strategy to prevent population growth

Crop	Problem	Priority given by growers (1:High, 2:Medium, 3:Low)	Grower´s experience and knowledge	Expectations from the new project
			ants which are also related to mealy bugs. Cyperaceous plants and Mimosa sp. are known host weeds but no control measures are carried out.	
	Scale insects	3	Are recognized as a potential problem for their spreading capacity.	None
	Snails	3	Are present in the crop but are not a problem.	None
	Elaphria moth	3	The larvae of *Elaphria* appear occasionally causing damage but is not a serious pest.	None
	Phytophthora *Fusarium* *Pseudomonas* stem rot *Erwinia*	3	Growers associate this diseases to crop management and do not see them as economically important	None
	Management of crop residues		Post harvest residues cause an important problem for cattle since this is the main reproduction media for *Stomoxys* fly. Growers have used biocontrol agents, sticky traps and sterile male releases to control this problem. It seems to increase in certain periods of the year. There is a concern about a restriction posed by the EU on the use of Paraquat for post harvest control of plant residues in the field.	Need to work on effective IPM strategies
	Weeds	1	There is a list of 16 quarantine weed but in the field they are easily confused with other non quarantine species (ea. *Mecania* & Tuete (*Vernonia patens*) in the North Zone of CR., *Espermacose* & *Ricardia*, *Penicetum setosum* & *P. purpureum*). Mistletoe is causing problems as well as some shrubs from the Asteraceae family. *Rotboellia* seeds are not efficiently killed with methyl bromide. Weed control is expensive.	They propose to explore the use cover crops for weed control.
	General prioritization : Growers defined from the highest to the lowest priority the following 5 problems:			

Crop	Problem	Priority given by growers (1:High, 2:Medium, 3:Low)	Grower´s experience and knowledge	Expectations from the new project
Eryingium foetidum	"White spot" *Halticus bracteatus*	1	They are conscious that they can control the pests with chemicals but risking to be intercepted for residues on the product. There is a lack of knowledge about the biology and ecology of the insect. They think all the previous researches have not been concluded and they have not had access to them.	Explore the possibility of Pest harmonization . Develop management practices to control pest population. They expect to have access to the information.
	Lepidopteran Nematodes Snails Grasshoppers	2		
	Dependency and availability of chemical insecticides	1	Heavy dependency of chemicals to control pests. This put them in a delicate position respect residues on the product.	Learn about insect biology to find IPM practices to reduce chemical dependency.
	Diseases	1	Rotting (*Sclerotinia* sp.), *Erwinia*, *Cercospora*, and a virus like disease. They do not have the means to identify diseases.	Proper identification of diseases and definition of best management practices.
	Market/commercialization	2	Small market and lack of loyalty. There is no synchrony between offer and demand, so there are periods of overproduction affecting the price.	Look for new markets. Learn the market fluctuations. Look for alternative to give aggregated value to the product, and extend the shelf life.
	Access to information and training	2	There is no information available for the growers.	They expect access to information and training to all previous investigation, and to have faster access to the new research.
	Weeds	3	Many are problematic for crop establishment and their control represent a high cost. They relate some weeds to pest abundance.	Study relation with pest and diseases. Look for control alternatives.
	Crop waste management	3	The waste varies depending on the quality of the management and can go from 20% in a well managed crop to 50% in a poorly managed.	None
	Seed	3	Seed quality and methods of selection is not considered a problem among the growers, but most of them use poor quality seed (coming from the weakened plants after 3 to 4 cuts). There is no protocol for seed storage and viability testing. There is no a standard of the amount of seed by area for crop establishment.	None
	General prioritization : Growers defined from the highest to the lowest priority the following 5 problems: 1- Pests, 2- Dependency on chemical insecticides, 3- Diseases, 4- Market/commercialization and Access to information and training, 5- Crop waste management			

Crop	Problem	Priority given by growers (1:High, 2:Medium, 3:Low)	Grower´s experience and knowledge	Expectations from the new project
Dracaena sp.	Pests	1	Leafhoppers, tettigoniids, snails and scale insects are still a problem in the field.	Need to validate research results and establish management and mitigations protocols
	Training	1	Growers on the CSP 1 received all the information but the regulation will be for all of them	Need to train all the growers
	Flecking	3	Is a common problem without diagnostic	Determine the cause and possible corrective measures
	Fusarium sp.	3	Not very important. Probably due to management	Determine best management practices
	Phytium sp.	3		
	Erwinia sp.	3		
	General prioritization : Growers defined from the highest to the lowest priority the following 5 problems: 1- Pests, 2- Training, 3-Diseases, 4- Market/commercialization and Access to information and training, 5- Dependency on chemical insecticides			

Annex 4. Workshop and field trip for ornamental crops and pineapple, July 2009. Photographic records of workshop with ornamental and pineapple producers, government representatives, chamber of exporters, APHIS and plant health experts. The main problems for the selected crops were exposed and discussed in groups by crop, in order to define the goals and strategies for the project. A field trip was then carried out to allow the experts to understand the production systems and be able to propose integrated strategies to solve the pest and disease problems. Photos of the meetings and phytosanitary problems observed during the field trip are shown bellow.

Annex 5. List of participant of False Coriander workshop held on July 8th, Linda Vista, CR.

Registro de participación. 8/07/09

Taller Culantro coyote
Linda vista.

"Proyecto Mejoramiento del acceso de productos ornamentales y no tradicionales a mercados externos".

	Nombre	Organización o Empresa	Teléfono	Correo electrónico o fax
1	Mario Cordero Contreras		8820-0949	— 3 X
2	Victor Mario F	empacadora chitari	8888 7626	2554 15 12
3	Marco Julio Gomez R	finca mia 25541308		Chitaria
4	Cristian Obando Rojas	Chitaria	25-54 12 23	Santa Marta
5	Victor Brenes Araya	chitaria	8915 1213	
6	Carlos Jiménez Alvarado		8375 5988	
7	Alfredo Alvarado A		8308-5864	
8	M A A		8760-2036	
9	Guillermo Fuster Aguilar	Juan Fuster	83577235	2554-16-12 - Linda Vista
10	Dennis Camacho Chavés	Green Rojas y Chapetes S.A.	8843-27-18	
11	Luis Gago Soto	Gustavo	83580557 — 61 501	
12	Juan Gago Soto	Denis	3-378-796	
13	Carlos Ramírez Bodik	empacadora 3X	88477627 — 3 X centro 25541718	
14	Walter Andrade Jiménez	Macadamia La Flor	25561078 25541878	2556-10-70 Fax - Global
15	Anthony Loaiza Mora		2554 1587	Lomas C.R
16	Jorge Camacho T.	Jorge Camacho T.	25544396	m
17	Esaú Miranda	MAGFSF		miranda@pgr.go.cr
18	Eduardo Hidalgo	CATIE	25582583	ehidalgo@catie.ac.cr
19	Mildred Linkimer N.	CATIE	25582533	linkimer@catie.ac.cr
20	Gerardo Pérez	Tarde		gperez@catie.ac.cr
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22		(A) Jueves luego	de las 2pm	
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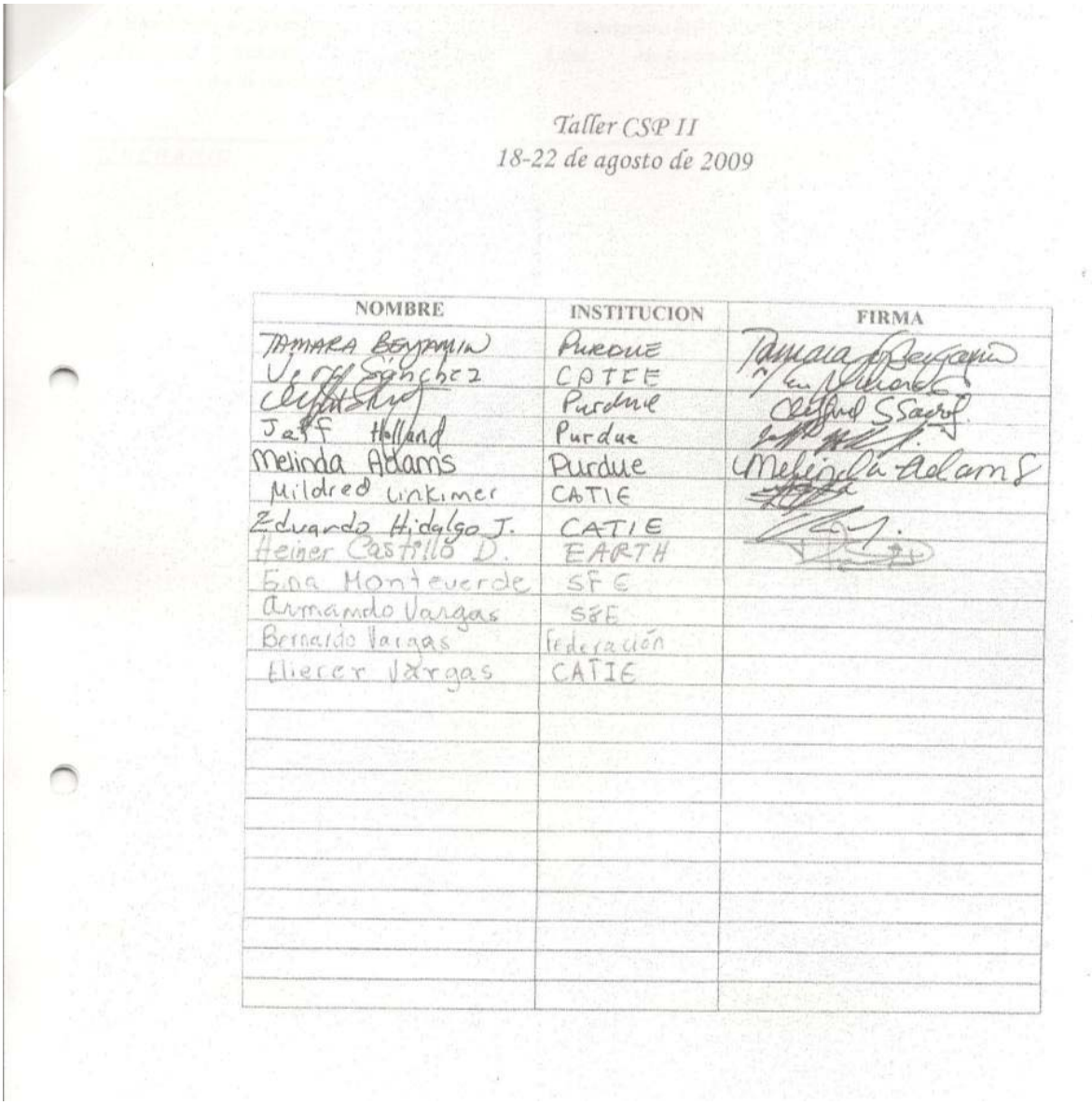
Annex 6. Workshop and field trip for False Coriander, July 2009. Photos showing meetings with Flase Coriander growers and exporters, and field diagnostic trips with experts from CATIE and Purdue: symptoms showed are due to different phytosanitary problems such as root knots and leave yellowing caused by nematodes (top left), Cercospora leaf spots (top right) , Sclerotinia rot (bottom left).

Annex 7. Lists of participants of third workshop held from August 18th to 22nd, Turrialba-SanJosé, CR.



Taller CSP II
18-22 de agosto de 2009

NOMBRE	INSTITUCION	FIRMA
TAMARA BENJAMIN	PURDUE	
[illegible]	CATIE	
[illegible]	Purdue	
Jeff Holland	Purdue	
Melinda Adams	Purdue	
Mildred Linkimer	CATIE	
Eduardo Hidalgo J.	CATIE	
Heiner Castillo D.	EARTH	
Ena Monteverde	SFE	
Armando Vargas	SSE	
Bernaldo Vargas	Federación	
Eliecer Vargas	CATIE	

Annex 8. Workshop, August 2009. Photos showing working group of researcher from CATIE, EARTH University and Purdue University during the last workshop. Turrialba, CR.

Annex 9. Reference cited

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USDA 2004. Proposed Rule change for Nursery Stock Regulations. US. Federal Register. 7 CFR Part 319 Docket 03-069-1.

Annex 10. Sustainable fully-costed project proposal submitted to STDF Secretary, WTO

STDF-286 PROJECT GRANT

APPLICATION FORM

1. Project title	**Best Management Practices to Reduce Interception of Quarantined Pest Species (BMPRS)**
2. Themes 2 and 3	The project will improve the capacity of horticultural producers to grow crops that meet export standards through: • Research activities that identify the most efficacious practices for growers (Theme 2) • Development of a training program to share information with producers (Theme 3).
3. Starting date	January 10, 2010
4. Completion date	January 9, 2012
5. Requesting organization(s)	Ing. Ana Gabrieala Zúñiga Valerín Director Servicio Fitosanitario del Estado MAG- Costa Rica Apdo. 70-3006 Barreal, Heredia Protecnet.net.go.cr Request letter in **Appendix 2**.
6. Implementing organization(s)	Clifford S. Sadof Purdue University Department of Entomology 901 W. State Street West Lafayette, IN 47907-2089 (765) 494-5983 (765) 494-2152 (FAX) csadof@purdue.edu http://www.entm.purdue.edu/Entomology/research/cs/. Letter in **Appendix 2.**
7. Project background and rationale	The rationale and background for this project are explained in the attached **Appendix 3**.
8. Project management	The organizational structure of the project is explained in the attached **Appendix 4**.
9. Project objectives	**Overarching Development Goal:** Promote trade and increase new market opportunities in the US for cut flowers, (*Alpinia* sp.),: ornamental crops (*Dracaena* sp., *Codiaeum* sp., *Schefflera* sp., *Cordyline*) false coriander (*Eryngium foetidium*) and pineapple (*Ananas comosus*) by avoiding trade restrictions due to phytosanitary concerns. **Objective 1.** Develop strategies to reduce phytosanitary risks (insects, pathogens, weeds) for the following crops: cut flowers, false coriander, ornamentals, and pineapple.

	Objective 2. Determine if intercepted species are correctly identified as invasive threats to the United States. **Objective 3.** Clarify socioeconomic costs and benefits for adoption of BMPs to reduce quarantine pests in targeted crops. Identify information networks to optimize delivery of our educational materials. **Objective 4**. Promote adoption of best management practices (BMPs) to reduce abundance of quarantined pests on Costa Rican farms.
10. Project outputs	The **specific project outputs**, relating to each of the objectives, will be: 1.*Best Management Practices (BMPs) for targeted horticultural crops.* Through a combination of studying current management practices and experimental testing, we will identify the practices most likely to improve crop quality and reduce the likelihood that exported shipments will be intercepted at ports of entry. 2.*Increased transparency of phytosanitary regulations to US and Costa Rican producers and regulatory agencies.* Current inspection procedures exclude crops when any unidentifiable immature life stage of thrips, mealybugs, or weed seeds are detected, Through implementation of survey protocols acceptable to USDA APHIS PPQ NIS, we will determine which of these crops (if any) are likely to contain pests of true concern. 3.*Identification of opportunities most likely to result in lasting improvement of grower practices.* Through socioeconomic study of the supply chain for each targeted crop system we will identify the sets of practices most likely to benefit producers, and how to best transfer the information to them. 4.*Reduced proportion of exported crops intercepted at borders with quarantined pests.* Validated BMPs made available via training workshops, manuals and other socioeconomically relevant delivery systems will be adopted a substantial proportion of growers. The background to the project and the rationale underpinning these objectives are attached as Appendix 3.
11. Project activities	The main project activities are listed here and described in more detail in the work plan Appendix 6 (attached). Numbering corresponds to the project objectives above. 1.*Best Management Practices (BMPs) for targeted horticultural crops cut flowers, false coriander, ornamentals and pineapple.* • Conduct survey to determine existing management practices, economic conditions, and sizes of farms producing these crops. • Geo-referencing of farms and surrounding landscape.

	• Identify insects, pathogens and weeds and collect information on pest abundance. • Multivariate analysis conducted to identify management factors contributing to low pest populations and rates of interception. • Experimental tests conducted to determine capacity of management tactics to reduce populations. • Publication of results in refereed academic journals. 2.*Increased transparency of phytosanitary regulations to US and Costa Rican producers and regulatory agencies.* • Proposal will be submitted to USDA APHIS PPQ NIS to survey thrips, mealybugs and weed seeds to determine the risk of transporting invasive species in crop exports. • Surveys will be conducted and pests will be identified by recognized taxonomic experts. • Petition for regulatory changes with APHIS as appropriate 3.*Identification of opportunities most likely to result in lasting improvement of grower practices.* • Extract economic data from grower survey (Objective 1) and participatory research plots (Objective 4) to test efficacy and determine costs and benefits of BMPs • Analyze market and institutional networks to identify nodes of opportunity for information exchange and technology transfer 4.*Reduced proportion of exported crops intercepted at borders with quarantined pests.* • Establish participatory research and validation studies. • Generate producer-reviewed manuals, and websites describing BMPs to capitalize on opportunities for information transfer identified in Objective 3. • Conduct pilot workshops with growers, crop consultants, and other stakeholders to test their capacity to transfer technology. • Publish education materials in print and on the web to facilitate sustained technology transfer. These activities are explained in the context of a logical framework matrix in **Appendix 5.** The detailed Work Plan (**Appendix 6**), is attached.
12. Timetable	A detailed time table is attached (**Appendix 7**)
13. Private/public sector co-operation	Project research teams will meet yearly with stakeholders that include representatives of the Costa Rican and the US regulatory community, trade associations and growers. Letters of support (Appendix 1) attest to the willingness of growers to participate in

	survey, participatory research and survey activities.
14. Budget	The total cost of this 2 year project is expected to be US $1,172,720.00. Details of the budget are specified in **Appendix 8**. Much of the budget is used to pay personnel and travel expenses needed to execute activities specified in the proposal to meet each of the 4 objectives. Funds are requested to renovate a conference room to facilitate communication between research groups and key stake holders via internet conferencing. Terms of Reference (**Appendix 9**) for project co-directors C. Sadof and T. Benjamin are attached. List of necessary equipment (**Appendix 10**).
15. Evidence of past success working with phytosanitary issues.	Purdue and CATIE have been working together since 2004 on phytosanitary issues for the horticulture industry. Their collaborations have been supported by a grant from USDA FAS ($14K), to work on red ginger flowers, and by a grant ($1 million) from the Reconversion Productive Program in Costa Rica to develop a Clean Stock Program for *Dracaena marginata*, a nursery ornamental. The Clean Stock Program was a highly successful venture that resulted in participating growers tripling their exports, while reducing the number of plants intercepted at US ports to near zero. As a result of their research that documented levels of risk posed by plants of a particular size class, the Costa Rican Ministry of Agriculture has initiated a process with USDA APHIS to relax size restrictions on this crop. These changes are likely to greatly increase markets for this plant in the US. A summary report to the US Nursery Industry detailing the program philosophy and the degree of cooperation with regulatory agencies and producers is attached in **Appendix 11.**

Appendix 1: Supporting letters (submitted)

Appendix 2: Endorsement of implementing organizations (submitted)

Appendix 3: Description of the project background and rationale

Within the context of globalization, international trade represents a phytosanitary risk due to the possible translocation of pests to importing countries. The opening of markets and new trade agreements has forced countries to apply a series of sanitary and phytosanitary measures to protect human health as well as the health of natural and agricultural ecosystems, which can be threatened by the introduction of animals, plants, pathogens, residuals, and contaminants through imports. Under the specific case of CAFTA-DR (Central America and Dominican Republic Free Trade Agreement with the United States of America (USA)), the existing norms under the Sanitary and Phytosanitary Measures Agreement and the Technical Trade Obstacles Agreement of the World Trade Organization (WTO) have been ratified. Concern about invasive species has caused substantial pressure to revise international standards for the protection of plants due to problems caused by invasive species (Mack *et al*. 2000, Campbell and Schlarbaum 2002, USDA 2004).

Interceptions affect agricultural supply chain economics through rejections at the port of entry or by forcing the company to pay the costs of fumigation. The use of fumigation also reduces plant quality, has an environmental cost due to the chemicals that are used, and can have an impact on an exporting country's image. The importing country is also affected, not just from the introduction of unwanted pests, but also economically because the interception cost is passed on to the importer. For example, in the USA only 2% of all goods that enter the ports of entry are inspected but shipments contaminated with quarantined pests constitute an annual loss of $350 billion dollars (GAO 2006).

From 2006 to 2009, more than the 80% of reported interceptions from Costa Rica were the ornamentals *Dracaena* sp., *Codiaeum* sp. (Croton), *Schefflera* sp., *Cordyline* sp. and *Alpinia* sp. (Ginger), as well as false coriander (*Eryngium foetidum*) and pineapple (APHIS 2009). From October 2006 to September 2007 alone, there were more than 1500 interceptions of plants from Costa Rica, according to the Animal and Plant Inspection Service (APHIS). Ornamental exports account for more than US $180 million or approximately 10% of all agricultural exports from Costa Rica. Nearly 50% of total ornamental exports are shipped to North America, mainly to the USA, which represents more than US $80 million (PROCOMER, Banco Central de Costa Rica

2006). Costa Rica, like many Central and South American countries, has historically been vulnerable to large swings in the demand and profitability of commodities like coffee. Diversification of agricultural enterprises can buffer the agronomic sector from market extremes and provide a more stable source of income for rural communities and surrounding urban areas with low socioeconomic indices. Ensuring continued access of ornamentals and other plants to U.S. consumers is therefore a critical component of national development strategies and policies.

Solutions and Alternatives

The continued economic development of exporter countries in Latin America, like Costa Rica, depends in part on access to U.S. markets; this access is currently endangered by high rates of interceptions. To avoid bans imposed on frequently intercepted plants, programs must be developed that reduce interceptions. These programs will produce the added advantage of strengthening economic relationships by lowering the potential costs to importers of Latin American products. This could be accomplished by developing science-based management systems that reduce pest populations in the field before harvesting and by encouraging growers to commit to using these improved phytosanitary management practices. This would allow importers to distinguish between high and low risk producers; membership in a recognized phytosanitary program could allow growers to avoid a ban by importer countries. We have developed a model system for such an approach for the ornamental plant, *Dracaena*, in Costa Rica, the first country in the world to implement such a program. For three years an interdisciplinary and inter-institutional team from the Ministry of Agriculture (SFE-MAG), National Production Council (CNP), Ministry of Foreign Trade (COMEX), the United States Department of Agriculture (USDA/APHIS), local ornamental growers, as well as two university and research institutions (CATIE and Purdue University) has worked to reduce interceptions, decrease the abundance of intercepted pests in grower fields, and to develop a network of producers using practices developed by the program. Participation by producers has been strong and many are now trained to identify problems without having an agronomist come to their farm. Some have also been trained in participatory research and are able to conduct their own small trials on their farms. In conjunction with the government, producers have substantially reduced interceptions on *Dracaena* plants coming from farms associated with the program and lowered the phytosanitary risks. *As a result, the number of exported Dracaena plants from growers in the program has tripled since its inception*.

The potential of clearly defined phytosanitary programs, such as The Cantaloupe and Watermelon Inspection and Certification Programs, to lower trade barriers is substantial. For

example, the Customs and Protection Division of the new Homeland Security Department of the USA decided to include the cantaloupe and watermelon program in a system that speeds up importation. The percentage of inspections on these fruit is only 0.5% due to low interception levels. Similar results have been obtained for chayote and litchi. The development of phytosanitary programs for plant species currently intercepted at high rates could lead to a similar reduction in both interceptions and inspections. These programs will require adequate research and development plans to ensure that the technological innovations can be inserted into the rural economy in markets with high levels of competition (Barrio 2006, Chiriboga 2003, FAO 1997, Mora 2007, Sepúlveda 2005).

Although increased inspections at the packing house level can reduce interceptions at the U.S. border, this approach imposes additional costs on the packing house and simply moves the point of interception from the U.S. to Costa Rica. A more sustainable approach is to adopt phytosanitary practices that reduce pest abundance in producer fields and thus the number of interceptions. Our experience with *Dracaena* has highlighted the need to better understand pest-crop interactions, to develop solutions at the farm system level, and to involve producers in project activities in order to effectively develop and transfer knowledge. We propose a three phase process to expand our success with *Dracaena* to other ornamental species and to false coriander and pineapple. First, we will use questionnaires and on-farm sampling of pests to identify management systems that reduce pest abundance. Pests collected in this effort will be used determine whether unidentifiable life stages of specific pests detected in these crops at ports of entry are likely to be of quarantine importance. We will also use economic analyses to quantify benefits and costs of identified systems and practices so that we can provide producers with practical management options. Second, we will use participatory research methods to test the effectiveness of management systems identified in the first phase at reducing pest abundances. Specifically, we will use our experience working with *Dracaena* produces to design a prototype validation and training program for use in other crops. We will create educational materials with producer input to insure that the materials are relevant and useful to target audiences during this phase and develop training workshops for the producers. Finally, we will initiate a program to communicate the results of our research to producers and stakeholders through a series of workshops, releases of bulletins, pest identification guides, and a website.

Institutional Support

The combined action between different key stakeholders including the Costa Rican government, the US Department of Agriculture/APHIS, the civil society, the private sector, and research and extension institutions has been recognized as an effective mechanism to achieve technological advances and incorporate these advances into agricultural supply chains (Alburquerque 2004). This along with the eventual free trade agreement with the United States and the eventual negotiation with the European Union provides the impulse needed to join efforts between a variety of Costa Rican institutions including the Ministry of Foreign Trade (COMEX) and the Phytosanitary Services of the State (MAG-SFE), as well as others including the Animal and Plant Health Inspection Service of the United States of America Department of Agriculture (USDA/APHIS), the Tropical Agriculture Center for Higher Education and Research (CATIE), and Purdue University.

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Appendix 4: Description of the project management structure

Drs. Clifford Sadof and Dr. Tamara Benjamin will serve as co-directors for the project. Dr. Sadof will have primary responsibility for activities and personnel at Purdue University and Dr. Benjamin will have primary responsibility for activities and personnel in Costa Rica. They will share responsibility for coordinating logistics related to travel, in-country transportation, and supervision of technicians. They will also have primary responsibility for budget management and reporting.

We will form three teams charged with management of key program components. First, Dr. Gibson and Eduardo Hidalgo (MSc.) will lead the research team which will be comprised of faculty PIs and key researchers with expertise in the areas of Agricultural Economics, Agronomy, Entomology, Horticulture, Landscape Ecology, Plant Pathology, Statistics, and Weed Science. This team will meet quarterly to ensure that research goals are being met, to oversee and facilitate progress by graduate students on research projects, and to facilitate publication of results in peer-reviewed journals and presentations given at conferences. This team will also oversee the inclusion of five undergraduates at EARTH in research projects. Undergraduates at EARTH are required to work on a research project as part of the requirements for graduation. EARTH faculty will provide additional mentoring for EARTH student research projects and serve as a liason to organic pineapple growers. Second, Dr. Roberto Lopez and Dr. Vera Sanchez will lead an educational/outreach team, comprised of team members with backgrounds in extension. This team will have primary responsibility for interacting with participating growers and for the development of extension materials such as IPM manuals, bulletins, and field guides. They will

also be responsible for development and maintenance of a bilingual website for the project. Third, Dr. Jeff Holland and Dr. Mildred Linkimer will oversee the development and implementation of a shared database so that information will be collected systematically and according to established protocols. This will facilitate the sharing of information and our ability to communicate and make progress toward our research and education goals. We anticipate that most meetings will be conducted using distance technology such as Adobe Connect and/or Skype in existing conference rooms at Purdue and in a renovated conference room in Costa Rica. Minutes will be kept for each team meeting and made accessible to team members through the project website. Team leaders will report at least quarterly to the co-directors. To further ensure collaboration, transparency, and communication, the project team will meet annually in Costa Rica with industry and government stakeholders to assess our progress and to make any necessary adjustments.

Appendix 5: Logframe matrix (attached)

Appendix 5

PROJECT DESCRIPTION	MEASURABLE INDICATORS	SOURCES OF VERIFICATION	ASSUMPTIONS AND RISKS
Project Goal: Minimize the phytosanitary risk from ornamental crops (*Dracaena* sp., *Codiaeum* sp., *Schefflera* sp., *Cordyline* sp., *Alpinia* sp.), false coriander (*Eryngium foetidium*) and pineapple (*Ananas comosus*) to avoid trade restrictions and increase new market opportunities in the US.	A reduction in the number of interceptions for target crops after pest management practices have been adopted Trade with the US for these products continues and new markets have been developed for products certified under the best management practice system	Reports from United States Department of Agriculture-APHIS interception database. Export data for these products show an increase in market diversification, due to a phytosanitary certification system (Costa Rican Ministry of Foreign Trade)	Growers, packing houses, and exporters are willing to adopt pest management practices. Resources are available to make technological changes. Demand for these products in US markets increases. Costa Rican government offers a phytosanitary certification system for growers, packing houses, and exporters.
General objective 1. Develop strategies to reduce phytosanitary risks (insects, pathogens, weeds) for the following crops: cut flowers, false coriander, ornamentals, and pineapple.	Best management practices for the target crops identified by end of project	Summary report will be prepared and submitted	Best management practices will reduce the number of pests in fields and interception rates at ports.
Specific objective 1.1. Characterize systems and identify associated pests (invertebrates, pathogens,	At least 20% of farms will be surveyed to identify management	Database of information collected	Growers will be willing to complete survey

PROJECT DESCRIPTION	MEASURABLE INDICATORS	SOURCES OF VERIFICATION	ASSUMPTIONS AND RISKS
and weeds) and factors that contribute to interceptions in target crops.	practices and characterize pest abundance and diversity	Reports and publications	Researchers will have access to fields of surveyed farms
Expected result 1.1. These activities will provide us with a clear picture of which management systems and practices are effective at reducing quarantine pest abundance. This will allow us to identify best management practices and to develop experiments to test specific practices.	Data (surveys, pest sampling) will be collected from approximately 100 farms by trained personnel during the first year of the project.	Information on management systems will come directly from growers. Information on pests will come from field sampling.	Grower cooperation and our ability to sample a large number of farms (project logistics) are the primary constraints that must be managed
Activity 1. Develop and administer a survey to determine current management systems used in target crops. The survey will provide information on pest management practices, economics, and general farm management	Survey will be developed by January 2010 with team members contributing questions related to their specific disciplines. Surveys will be collected from growers for approximately six months. Survey development costs are minimal but survey collection will require team members to visit each farm.	Progress will be measured by completing the survey and by collecting completed surveys from growers.	Identifying growers to participate in the survey, their willingness to participate, and arranging visits to administer the surveys are the primary factors outside project control that must be met to obtain results.
Activity 2. Sample farms participating in the survey for insects, pathogens, and weeds. Develop taxonomic lists of pests for comparison with quarantine list.	Sampling protocols for each pest will be developed by January 2010. Fields sampling will begin when growers complete the survey and continue for at least one year.	Progress will be measured by completion of sampling protocols and by development of database on pests.	Permission to visit farms several times and sample for pests. Communication with growers regarding farm management practices, particularly harvest schedules.
Activity 3. Use univariate and multivariate statistical analyses to classify farms into management systems based on grower responses to the survey. Relate pest abundances and species	Data analysis will be initiated on surveys when all completed surveys are returned. We anticipate approximately three	Completion of survey and pest collections. A list of pest species collectedand managed for each crop.	Supervision of graduate students and of data analyses must be sufficient to ensure that activities are

PROJECT DESCRIPTION	MEASURABLE INDICATORS	SOURCES OF VERIFICATION	ASSUMPTIONS AND RISKS
composition to farm management systems. This will allow us to identify management systems and practices that result in fewer pest problems, particularly fewer pest species on the intercept list.	months for these analyses. Pest lists will be developed and updated throughout the project. Data analyses relating pests to management factors will be completed in the second year of the grant.	Reports to be prepared and submitted about survey and pest data. (Theses, papers and/or technical reports).	accomplished in timely fashion. Communication among researchers in Costa Rica and Purdue must be sufficient to facilitate analyses and preparation of reports and publications
Specific objective 1.2 Determine influence of surrounding landscape composition and configuration on populations of pests and their natural enemies	Relative impacts of field management and surrounding landscape determined	Effects of landscape patterns on pests and natural enemies reported	Variation at relevant spatial scales might obscure meaningful inferences
Expected result 1.2. Both management and landscape influence pests and natural enemies, with the landscape influence altered by management	Relative influence of landscape, management, and combined, determined for all farms	Relative influences published (Theses, papers and/or technical reports).	Quality of land use covers already classified from aerial photographs will determine time to produce useful maps
Activity 1. Geo-reference the 100 surveyed farms included in the project and create baseline maps of surrounding land use for each	Reports produced from database information.	Maps with farms and packing houses located, and land use data in database.	GIS layers and aerial photos available
Activity 2. Evaluate landscape patterns and the effect on pest and natural enemy abundance and distribution in the crops.	Influence of landscape pattern on pests and natural enemies are determined for the observational trials for each crop, reviewed, and reported on in annual reports	Results of the effect of landscape on key pest populations and their natural enemies are analyzed and published. (Theses, papers and/or technical reports).	Growers are willing to cooperate. Variation at relevant spatial scales might obscure meaningful inferences

PROJECT DESCRIPTION	MEASURABLE INDICATORS	SOURCES OF VERIFICATION	ASSUMPTIONS AND RISKS
Specific objective 1.3. Test management practices to reduce key pest abundance.	Hypotheses about management practices and pest abundance for the target crops will be experimentally tested within the time allotted for the project	Reports prepared and submitted (Theses, papers and/or technical reports).	Management practices affect pest abundance
Expected result 1.3. Management practices to control key pests are available to be used in IPM strategies.	Number of effective strategies identified.		
Activity 1. Construct experiments to compare effectiveness of management strategies identified from the grower survey and those showing potential based on the scientific literature about key pests.	At least one experiment conducted per target crop for target pests and pathogens.	Results are analyzed and published. (Theses, papers and/or technical reports	Effective management practices can be identified and tested.
Specific objective 1.4. Develop a set of best management practices (BMP) for key quarantine pests in target crops to reduce interception rates and to improve production quality.	BMPs developed for each target crop	BMP manuals, technical bulletins, journal publications and student theses	Pest populations can be reduced through selected management practices
Expected result 1.4 BMPs for target crops will be developed and made ready for grower adoption.	Number of target crops managed with BMPs	Research results published in reports and incorporated into BMP manuals for growers.	BMPs can be identified to reduce pest abundance.
Activity 1. Choose strategies to be included in the BMP program	BMP program developed for each target crop	BMP manuals available for each crop	BMPs can be identified to reduce pest abundance.

PROJECT DESCRIPTION	MEASURABLE INDICATORS	SOURCES OF VERIFICATION	ASSUMPTIONS AND RISKS
General objective 2. Determine if intercepted species are correctly identified as invasive threats to the United States.	Surveys of pests conducted and results compared with lists of invasive species provided by USDA-APHIS specialists	Reports submitted to USDA APHIS PPQ NIS	USDA APHIS PPQ NIS approves protocols for unidentifiable immature organisms (UIO)
Specific objective 2.1. Determine if the intercepted species of mealybugs and leucothrips in *Alpinia*, croton, *Schefflera*, and pineapple are invasive threats to US agriculture.	Surveys of mealybugs and leucothrips conducted in accordance with USDA APHIS PPQ NIS approved UIO guidelines	Reports submitted USDA PPQ APHIS NIS	Insect samples sent can be identified and processed in a timely manner
Expected result 2.1 Official communication from USDA authorities determining if immature stages of these pests need to be identified to species to determine if they pose an invasive threat.	Status of the pests are modified according to USDA resolution	Official communication from USDA APHIS PPQ NIS received by SFE.	Species of mealybugs and/or leucothrips identified in survey do not pose a threat.
Activity 1. Development of an Unidentifiable Immature Organism (UIO) proposal to send to the USDA APHIS NIS that details sampling method and identifies taxonomic expertise for leucothrips and mealybugs.	Proposal submitted and accepted to NIS USDA	Official communication with Joe Cavey USDA APHIS PPQ National Identification Services, Permits and Risk Assessments (NIS)	Proposal is accepted by NIS
Activity 2. Execute protocol described in UIO proposal and prepare manuscripts for submission to a refereed journal	Journal article submitted	Official communication with journal	Access is granted to farms to collect information.
Specific objective 2.2. Determine if the intercepted species of weeds in pineapple are invasive threats to US agriculture.	Weed seeds identified by species and compared to USDA APHIS PPQ invasive weed species lists	Reports submitted to USDA APHIS PPQ	Seed found in pineapple is a mixture of invasive and non-invasive plant species

PROJECT DESCRIPTION	MEASURABLE INDICATORS	SOURCES OF VERIFICATION	ASSUMPTIONS AND RISKS
Expected result 2.2. List of weed species found in pineapple fruit. Guide to identify weeds and their seed provided to growers and inspectors. We anticipate that a majority of seed found in pineapple fruit will not be on quarantine list.	Actual counts of seed found in pineapple. Completion of weed identification handout.	Data will be obtained from field samples of pineapple fruit. Weed identification guides will be constructed using team expertise.	Grower participation. Sample size will be adequate to characterize species composition of weed seed in pineapple
Activity 1. Use information from sampling pineapple farms to determine which weed species are present in pineapple fruit.	Sample pineapple fruit (20 plants per farm, 20 farms) for weed seed. Analyze results.	Database from sampling published (Theses, papers and/or technical reports).	Grower participation. Sample size will be adequate to characterize species composition of weed seed in pineapple
Activity 2. Develop identification guide for major weed species and their seeds. The guide will help growers and inspectors distinguish between quarantine and non-quarantine species	Photographs and taxonomic criteria for identification Easy to use guide developed.	Seed images, expertise of team members.	Guides must be considered useful to growers and inspectors.
Specific Objective 2.3. Use Mal Morado a form of *Fusarium oxysporum* that causes foliar disease of Dracaena will be identified to *forma speciales* species and used as a model to develop best management practices for diseases.	The *forma speciales* will be compared with known disease lists to determine if present in the US.	Official communication from USDA APHIS PPQ NIS received by SFE.	Mal Morado can be collected and identified to species.
Expected Result 2.3. A model for BMPs will be developed for a leaf disease that can be applied to other diseases.	The status of Mal Morado will be determined by USDA APHIS PPQ as exotic or endemic.	Reports submitted to USDA APHIS PPQ NIS	Molecular techniques (PCR) can be developed for rapid identification to species.
Activity 1. Mal Morado in Dracaena fields will be identified to species and a PCR identification tool will be developed to determine critical buffer zones of no harvest to prevent spread of diseases.	Photographs with key symptoms and signs for field identification Easy to use guide developed.	Disease images, Expertise of team members.	Guides must be considered useful to growers and inspectors.

PROJECT DESCRIPTION	MEASURABLE INDICATORS	SOURCES OF VERIFICATION	ASSUMPTIONS AND RISKS
General objective 3. Clarify socioeconomic costs and benefits for adoption of BMPs to reduce quarantine pests in targeted crops. Identify information networks to optimize delivery of our educational materials.	Costs and benefits associated with BMPs identified throughout the project	Reports and bulletin prepared and submitted (Theses, papers and/or technical reports).	Growers are willing to engage in participatory research and share cost information Ability to estimate benefits
Specific objective 3.1. Determine an economic optimum for the implementation of BMPs in target crops that account for price vulnerability, market size, and interception rates to provide effective cost estimates of the program.	A benefit-cost ratio has been determined	Project report	Growers are willing to engage in participatory research and share cost information
Expected result 3.1. Growers in target crops increase adoption rates of BMPs motivated by economic retribution estimates	Number of growers that have adopted BMPs due to economic information	Internal report	Growers are willing to engage in participatory research and share cost information
Activity 1. Analysis of costs associated with current practices and BMPs recommended for each target crop	Each target crop has been analyzed	Internal report	Growers are willing to engage in participatory research and share cost information
Activity 2. Estimation of benefit-cost ratios for current practices and BMPs for each target crop	Benefit-cost ratios have been determined	Reports and bulletin prepared and submitted (Theses, papers and/or technical reports)	Growers are willing to engage in participatory research and share cost information
Activity 3. Evaluation of the economic optimum's sensitivity to different price scenarios, interception rates, and potential markets	Sensitivity analyses have been analyzed	Reports and bulletin prepared and submitted (Theses, papers and/or technical reports).	Price data accessible and lengthen enough.

PROJECT DESCRIPTION	MEASURABLE INDICATORS	SOURCES OF VERIFICATION	ASSUMPTIONS AND RISKS
Specific objective 3.2. Identify socioeconomic factors that affect adoption of risk reduction strategies.	Completion of survey and analysis of socioeconomic components	Internal report	Growers can provide meaningful socioeconomic information
Expected result 3.2. Growers will gain knowledge about how socioeconomic factors affect their benefits by increasing adoption of BMPs in target crops	Growers will be more aware of BMPS and have a greater rate of adoption	Internal report	Growers can provide meaningful socioeconomic information
Activity 1. Map network of markets and institutions.	Market chain maps Network maps	Internal report	Growers can provide meaningful socioeconomic information
Activity 2. Analysis of critical points in the networks that affect delivery of relevant research, market and price information, technical services, and business development services to stakeholder in the target crops	A list of points critical to the effective flow of information has been determined	Reports and bulletin prepared and submitted (Theses, papers and/or technical reports).	Growers can provide meaningful socioeconomic information
General objective 4. Promote adoption of best management practices (BMPs) to reduce abundance of quarantined pests on Costa Rican farms.	Numbers of workshops per target crop and rates at which proposed practices are adopted Rate of dissemination of available materials	Surveys of practices by workshop attendees before and after workshop. Evaluation of quality of materials. Reports and bulletin prepared and submitted (Theses, papers and/or technical reports).	Growers are willing to participate in training and evaluation activities. Educational materials are effective in changing behavior

PROJECT DESCRIPTION	MEASURABLE INDICATORS	SOURCES OF VERIFICATION	ASSUMPTIONS AND RISKS
Specific objective 4.1. Design a prototype validation and training program critical points in delivery network (Objective 3.2) based on existing research results for *Dracaena marginata*.	Effectiveness of proposed BMPs validated experimentally. *Dracaena* education model is adapted for delivering information at critical points of information network of other target crops.	Internal report	Growers are willing to participate Educational materials are effective in changing behavior
Expected result 4.1 *Dracaena* producers receive training and adopt validated protocols.	Effectiveness of proposed management strategies and rate of grower adoption.	Reports of validation studies and post workshop surveys	Growers are willing to participate
Activity 1. Validation of the research results in reduced quarantined pests on *Dracaena* sp. through participatory research.	At least 10% of stakeholders conduct validation trials through participatory research program.	Reports from farms conducting validation studies	Growers are willing to participate
Activity 2. Implement and evaluate training program for *Dracaena* producers	At least 75% of growers participate in some form of training and change their growing practices.	Reports from post-training grower survey	Growers are motivated to change behavior
Specific objective 4.2. Involve key stakeholders in development of educational programs and materials program for ornamentals, false coriander, and pineapple based on *Dracaena* model	Number of growers per target crop involved in beta testing of educational material	Educational materials are produced Internal reports	Growers are willing to participate and contribute to educational materials
Expected result 4.2. Relevant educational materials will be produced that has incorporated grower knowledge and participation	Numbers of key pests targeted by educational materials	Educational materials counted Internal reports of post training results	Information will be given in a manner that is understandable and convincing to growers.

PROJECT DESCRIPTION	MEASURABLE INDICATORS	SOURCES OF VERIFICATION	ASSUMPTIONS AND RISKS
Activity 1. Grower workshops will be conducted during which the format of educational materials will be designed and evaluated	At least two workshops per target crop will be delivered in the second year	Internal reports	Growers are willing to participate
Activity 2. Participatory research program set up in accordance with guidelines derived from *Dracaena* validation	At least two growers per target crop are enrolled in participatory research	Internal reports	Growers are willing to participate
Activity 3. Educational materials are assembled and published	Publication of educational materials	Internal reports	Knowledge transfer to growers is effective
Specific objective 4.3. Ensure stakeholder access to educational programs and materials generated from the project about target crops.	Number of workshops per target crop in second year of project Number of educational materials distributed for four target crops (ornamentals, cilantro, pineapple, Alpinia)	Internal reports Requests for educational materials Attendance at workshops	Growers are interested in obtaining information
Expected result 4.3. Producers will participate in education programs and will follow BMPs for target crops.	Proportion of growers adopting BMPs for target crops	List of participants from workshops	Growers are willing to participate
Activity 1. Workshops will be held to train growers about BMPs	Workshops held in the second year	List of participants. Workshops reports	Growers willing to participate

PROJECT DESCRIPTION	MEASURABLE INDICATORS	SOURCES OF VERIFICATION	ASSUMPTIONS AND RISKS
Activity 2. Build and maintain a project website to efficiently disseminate information	Working website established	Internet address established and number of hits recorded	Grower access to internet

Appendix 6: Work Plan

Objective 1. Develop strategies to reduce phytosanitary risks (insects, pathogens, weeds) for the following crops: cut flowers, false coriander, ornamentals, and pineapple.

We will collect information on management practices and on the abundance of pest species from 160 farms (forty farms per crop) in 2010. Data on management practices, including economic information, will be gathered through interviews with growers. Data on pest abundance will be collected through on-farm sampling. We anticipate that farms will be sampled at least twice in 2010. Multivariate statistical techniques will be used to identify farm management systems based on key characteristics. For example, small sized farms may have different management systems (more labor, less mechanization) than larger-sized farms. The management systems objectively identified in our analyses will then be used to determine if management systems vary in their association with quarantined pests. We anticipate that some management systems will be more effective at reducing pest abundance than other systems. Additional analyses will be conducted to determine if specific management practices are highly associated with pests. Cumulatively, this information will provide us with detailed information on pests in these four crops and will help us to identify management systems and practices to reduce quarantine pests. We will use this information to develop experimental approaches to better understand causality and test specific management practices. These experiments will further advance our understanding of pest-management relationships and increase our ability to deliver science-based recommendations to stakeholders. We will also use this information to develop recommendations for best management practices (BMPs) manuals and bulletins.

To determine the impact of the surrounding landscape on the abundance of pests and their natural enemies in crop fields we will use the data on pests of concern from the surveys of crop fields. All field surveys will be geo-referenced with a geographical position system (GPS). We will create landscape maps from digitized aerial photographs with several land use classes (e.g., forest, pasture, pineapple, ornamental crop, residential/urban) in ArcGIS (Geographical Information System). Within each landscape map, we will determine the importance of land use classes and the pattern they form (e.g., connectivity of forests) for predicting pest abundances. These results will be combined with the management analyses to allow us to determine the degree to which pest and natural enemy populations are determined by landscape, by management, and by combined landscape-management.

Objective 2. Determine if intercepted species are correctly identified as invasive threats to the United States.

We will use data collected in Activity 1 to determine which quarantined species are actually present in grower fields. Pest species can be difficult to identify by species and we hypothesize that some interceptions, particularly mealybugs and leucothrips in ornamentals and weed seeds in pineapple, are actually misidentified non-invasive species. We will identify pests to the species level for each crop and compare field data to quarantine lists used by the USDA. We will develop and execute proposals with USDA APHIS NIS to survey growing regions to determine if pests of quarantine importance are present in the growing region. Results from these surveys will be submitted to USDA APHIS PPQ National Identification Services (NIS) to determine if they merit changes in the inspection criteria for each crop.

Objective 3. Clarify socioeconomic costs and benefits for adoption of BMPs to reduce quarantine pests in targeted crops. Identify information networks to optimize delivery of our educational materials.

Economic data collected from the survey described in Objective 1 and from participatory research plots will be analyzed for each crop to determine costs of current and new BMPs. Cost/benefit ratios will be determined and sensitivity analyses conducted to determine how the ratios vary with price changes and interception rates. Market and institutional networks for each crop (networks may overlap for some crops) will be mapped using data collected from the survey, participatory research, and team expertise. Points (nodes) in the network that are critical to information flow will be identified. This information will allow us to both identify economically viable BMPs and to ensure that our management recommendations can be efficiently distributed through the institutional network.

Objective 4. Promote adoption of best management practices (BMPs) to reduce abundance of quarantined pests on Costa Rican farms.

We will ensure that educational materials developed during this project are relevant and coherent to growers through two primary approaches. First we will directly include growers in the development of information through participatory research and validation efforts. Second, we will ask key growers to review all educational materials before distributing materials to the general public (i.e., growers will serve as beta testers). Educational materials will include bulletins on BMPs, posters, pest identification guides, and a dedicated web site (we recognize that individual growers may not have Internet access but this is an efficient method to deliver information to

organizations such as farmer cooperatives for distribution). We will also deliver information through a series of training workshops that focus on pest identification and best management practices (BMPs). In the first year of the project we will develop the model for delivering BMP information using research results from our previously conducted work on *Dracaena*. In the second year of the grant we will expand the scope of the effort to include transfer of new information about BMPs for cut flowers, other ornamentals, false coriander and pineapple.

Appendix 7. Project timeline from January, 2010 to December, 2011.

Activities/Milestones	**Year One**				**Year Two**			
First Month of Quarter	**Jan**	**Apr**	**Jul**	**Oct**	**Jan**	**Apr**	**Jul**	**Oct**
1. Set up communications and establish regular meetings with PIs, cooperator and stakeholders								
2. Recruit Students and Growers								
3. Conduct BMP surveys and geo-reference farms (Obj.1.)								
4. Sample pest abundance, ID insects, diseases and weeds on BMP farms and conduct analysis (Obj.1)								
5. Conduct experimental trials of promising BMPs for insects, diseases, and weeds. (Obj. 1)								
6. Develop proposal with APHIS to survey region for presence of quarantine insects, pathogens, and weeds.(Obj 2)								
7. Implement quarantine pest surveys (Obj. 2)								
8. Prepare petitions to USDA APHIS (Obj. 2)								
9. Conduct Cost/benefit and information network analyses (Obj. 3)								
10. Establish participatory research and validation studies (Obj. 4)								
11. Produce manuals and web materials (Obj 4)								
12. Conduct validations and trial workshops with Dracaena (Obj. 4)								
13. Conduct workshops for other targeted crops. (Obj. 4)								
14. Conduct evaluation of project for WTO STDF (Obj 4).								
15. Submit scholarly manuscripts to support regulatory changes (Obj.1-4)								

Appendix 8- Budget

OBJECTIVE 1. Carry out farm and pest survey	
Personnel	
Field Assistants (2)50% of time Survey fields for pests, assist in data collection and data input	$28,800.00
Professional Services of Purdue and CATIE Faculty (30% of effort) 11 total to design field survey methods for pest and economic data. See list of Professional Personnel and responsibilities.	$129,000.00
Student tuition and stipend of 4 CATIE and 4 Purdue Students over 2 years (30% of effort) Will be assigned discipline specific aspects of farm and field surveys and will work with technicians	$87,000.00
Administration services	$5,000.00
Programming services (databases) Holland, Casanoves, and student staff	$15,000.00
Secretary	$2,500.00
Travel	
Domestic including vehicle rental and per diem for technicians and graduate students	$30,000.00
International	
8 trips between US and Costa Rica	$16,000.00
OBJECTIVE 2. Identify invasive pest threat	
Personnel	
Field Assistants (15)% of time	$8,640.00
Professional Services of Purdue and CATIE Faculty (20% of effort) Sadof, Hidalgo- Insects Beckerman, Sanchez- Diseases Gibson- Weeds	$86,000.00
Student tuition and stipend of 4 CATIE and 4 Purdue Students over 2 years (30% of effort)	$87,000.00
Administration services	$5,000.00
Secretary	$2,500.00
Taxonomic Identification Services (Will identify individuals after agreement with USDA APHIS PPQ NIS)	$10,000.00
Travel	
Domestic including vehicle rental and per diem for technicians and graduate students	$15,000.00
International	
4 trips between US and Costa Rica	$8,000.00
Shipping	
Shipment of specimens to US for identification (DHL)	$4,000.00

OBJECTIVE 3. Economic and Network Analysis	
Field Assistants (15)% of time	$8,640.00
Professional Services of Purdue and CATIE Faculty (20% of effort) Vargas, Marshall, Casanoves	$86,000.00
Student tuition and stipend of 4 CATIE and 4 Purdue Students over 2 years (30% of effort)	$87,000.00
Administration services	$5,000.00
Secretary	$2,500.00
Travel	
Domestic including vehicle rental and per diem for technicians and graduate students	$10,000.00
International	
4 trips between US and Costa Rica	$8,000.00
OBJECTIVE 4: Technology Transfer	
Personnel	
Field Assistants (20)% of time	$11,340.00
Professional Services of Purdue and CATIE Faculty (20% of effort) All 11 in table.	$86,000.00
Student tuition and stipend of 4 CATIE and 4 Purdue Students over 2 years (10% of effort)	$28,800.00
Administration services	$5,000.00
Secretary	$2,500.00
Travel	
Domestic including vehicle rental and per diem	$5,000.00
Training	
Publications	$20,000.00
Web site development	$5,000.00
Workshops (8) 2 for each of 4 cropping systems	$48,000.00
Establishment of demonstration trials (Castillo- EARTH, Hidalgo, Sanchez, Linkimer car rental)	$30,000.00
Establishment of Participatory research Hidalgo, Linkimer, car rental	$30,000.00
Projector	$1,000.00
GENERAL OPERATING EXPENSES (All objectives)	
Communication	
Photocopier supplies	$4,000.00
Fax, telephone and other office equipment	$1,000.00

Printers	$2,000.00
Telephone, fax and internet	$3,000.00
Mail, DHL	$5,000.00
Expendable office supplies	$5,000.00
Internet Conference Room (Appendix 10)	$7,000.00
Laptop computers and supplies (Appendix10)	$10,000.00
Other laboratory supplies (Appendix 10)	$115,000.00
Total	**$1,172,720.00**

Professional Personnel and Responsibilities

Project Director and Coordinator of US Activities
Clifford Sadof, Professor, Entomologist (Purdue), Extension Specialist in Ornamental Pests
Project Co-Director and Coordinator of Costa Rica Activities
Tamara Benjamin, Research Scientist (Purdue), Plant Physiologist (Purdue)

BMPRS Team Members and Relevant Technical Expertise

Clifford Sadof, Professor, Purdue	Biology and management of insect and mite pests of ornamental and horticultural crops, Integrated pest management systems for native and exotic invasive species. Best Management Practices for insects. Outreach specialist.
Eduardo Hidalgo Jameson Research Scientist CATIE	Biology and management of insect and mite pests of ornamental and horticultural crops, Isolation and production of diseases for biological control of insects and mites. Testing of pest management tools, field plots, Integrated pest management systems, Best Management Practices for insects. Photographer
Janna Beckerman, Assistant Professor, Purdue	Biology and management of plant pathogens of ornamental and horticultural crops. Molecular identification of plant pathogens. Best Management Practices for diseases. Outreach specialist.
Vera Sanchez, Research Scientist CATIE	Biology and management of plant pathogens of ornamental and horticultural crops. Molecular identification of plant pathogens. Best Management Practices for diseases Outreach specialist.
Kevin Gibson, Associate Professor of Weed Science, Purdue	Biology and management of weeds in ornamental and horticultural crops. Integrated weed management systems and plant ecology. Best Management Practices for weeds. Multivariate statistical techniques.
Tamara Benjamin Research Scientist, Purdue/CATIE	Plant nutritional physiologist, Plant ecology, Systems analysis Best Management Practices for plant production.
Roberto Lopez, Assistant Professor, Purdue	Development of production systems for floricultural and ornamental crops. Best Management Practices for plant production. Outreach specialist.
Maria Marshall, Associate Professor, Purdue	Agriculture and Natural Resource Economist, International Regulation and Trade Barriers. Small business specialist

Eliecer Vargas, Research Scientist, CATIE	Agriculture and Natural Resource Economist, Social Network Analysis, survey design
Jeffrey D. Holland, Assistant Professor, Purdue	Effects of local patterns of land use and other landscape characteristics on patterns of insect, pathogen, and weed abundance.(Landscape Ecology) GIS specialists
Mildred Linkimer Abarca (Post Doc/ Purdue)	Validation of land use maps GIS, and coordination of georeferencing of data. Landscape Ecologist
Fernando Casanoves, Research Scientist CATIE	Biometrician, Statistician. Development of survey tools.
Heiner Castillo, EARTH	Agronomist, surpervision of students and research plots at EARTH, Development of participatory field plots

Appendix 9: TORs of key project staff To be filled out for Sadof and Benjamin

BMPR Team Responsibilities

Terms of Reference for Consultants

NAME: Clifford S. Sadof, Ph.D.

1. RATIONALE: Effective execution of the project requires a director to oversee activities in the US and in Costa Rica. Sadof has been working with Tamara Benjamin and the CATIE research group on the Dracaena Clean Stock Program since 2005. His past work on the Dracaena project included, maintaining contact with USDA APHIS PPQ officials, directing graduate student research, preparing peer reviewed publications, overseeing the development and editing of BMP guides for growers, and trade journal articles. His track record demonstrates his capacity to work effectively with a bilingual team of researchers. His responsibilities for developing pest management approaches or the Indiana nursery and floriculture industry will complement the proposed activities**.**

It is important in a project of this magnitude and being conducted in two separate countries to have two individuals making sure the project runs smoothly and efficiently. Dr. Sadof, along with Dr. Benjamin, will be in charge of making sure the objectives are completed in a timely fashion and done so within the budget that has been stipulated.

2. OBJECTIVES:

A. Objective 1. Develop strategies to reduce phytosanitary risks (insects, pathogens, weeds) for the following crops: cut flowers, false coriander, ornamentals, and pineapple.

B. Objective 2. Determine if intercepted species are correctly identified as invasive threats to the United States.

C. Objective 3. Clarify socioeconomic costs and benefits for adoption of BMPs to reduce quarantine pests in targeted crops. Identify information networks to optimize delivery of our educational materials.

D. Objective 4. Promote adoption of best management practices (BMPs) to reduce abundance of quarantined pests on Costa Rican farms.

3. OUTPUTS:

Through regular meetings described in Appendix 4, he will be involved with supervision of production all outputs. .

- **A.** *Best Management Practices (BMPs) for targeted horticultural crops.* Through a combination of studying current management practices and experimental testing, we wil identify practices most likely to improve crop quality and reduce the likelihood that exported shipments will be intercepted at ports of entry.
- **B.** *Increased transparency of phytosanitary regulations to US and Costa Rican producers and regulatory agencies.* Current inspection procedures exclude crops when any unidentifiable immature life stage of thrips, mealybugs, or weed seeds are detected, Through implementation of survey protocols acceptable to USDA APHIS PPQ NIS, we will determine which of these crops (if any) are likely to contain pests of true concern.
- **C.** *Identification of opportunities most likely to result in lasting improvement of grower practices.* Through socioeconomic study of the supply chain for each targeted crop system we will identify the sets of practices most likely to benefit producers, and how to best transfer the information to them.
- **D.** *Reduced proportion of exported crops intercepted at borders with quarantined pests.* Validated BMPs made available via training workshops, manuals and other socioeconomically relevant delivery systems will be adopted a substantial proportion of growers

4. SPECIFIC TASKS AND RESPONSIBILITIES:

A. Will be involved in regular meetings with the co-director (Benjamin) as outlined in the organizational structure (Appendix 4) to oversee project execution..
B. Will work with PI's, graduate students and technicians to elucidate relationships between pest abundance and grower practices.
C. Will utilize his contacts with USDA-APHIS-PPQ to develop proposals for Unidentifiable Immature Organisms that will be implemented to determine if changes in inspection protocols are warranted for each of the targeted crops.
D. Will help review and develop educational programs for producers.

5. QUALIFICATIONS REQUIRED

Experience in managing and conducting research projects. Expertise in pest management and outreach. Familiarity with regulatory issues.

6. TOTAL DURATION OF THE CONSULTANCY:

2010 and 2011.

Terms of Reference for Consultants

NAME: Tamara J. Benjamin, Ph.D.

RATIONALE:

Conducting research and extension between the USA and Costa Rica will take an inordinate amount of coordination between the key actors, particularly the producers in Costa Rica and the research institutions. Dr. Benjamin along with Dr. Sadof was able to manage the *Dracaena* Clean Stock Program successfully for three years. Without a constant support from Drs. Benjamin and Sadof the project would have failed due to the lack of coordination and communication between all parties. It is important in a project of this magnitude and being conducted in two separate countries to have two individuals making sure the project runs smoothly and efficiently. Dr. Benjamin, along with Dr. Sadof, will be in charge of making sure the objectives are completed in a timely fashion and done so within the budget that has been stipulated.

D. OBJECTIVES:

A. Develop strategies to reduce phytosanitary risks in associated plants

B. Clarify socioeconomic costs and benefits for adoption of BMPs to reduce quarantine pests in targeted crops

C. Promote adoption of best management practices (BMPs) to reduce abundance of quarantined pests on Costa Rican farms

D. Manage the project efficiently and coordinate the diverse actors to ensure project completion

E. OUTPUTS:

A. The activities involved with characterizing the management systems and practices within the farms will be coordinated and carried out efficiently including the identification of Best Management Practices (BMPs) that can be utilized to reduce phytosanitary risks within the specified plants.

B. Surveys and studies will be coordinated and carried out efficiently to provide growers with knowledge about socioeconomic factors important in the adoption of BMPs and adoption rates will be calculated based on economic retribution.

C. Growers will be trained and materials will be produced by the project and research will be validated through participatory research.

D. An efficient project, that has been coordinated within budget, will be maintained throughout the duration of the project.

F. SPECIFIC TASKS AND RESPONSIBILITIES:

A. Dr. Benjamin will be in charge of coordinating along with Dr. Sadof the activities listed in the logical framework (Appendix 5) to ensure the efficient and thorough completion of characterizing the farm management systems and practices.

B. Dr. Benjamin will coordinate the socioeconomic surveys and studies with members of the project and be responsible that the activities listed in the logical framework will be carried out in a timely fashion.
C. Dr. Benjamin will be in charge of the coordination of producer workshops, production of educational materials, and participatory research to effectively reach all producers involved in the project.
D. Dr. Benjamin along with Dr. Sadof will communicate weekly via telephone or Skype to ensure the efficient coordination of the project and continuously review important budget or proposal documents.

G. QUALIFICATIONS REQUIRED

Project management skills, including the establishment of a good communication system, organizational abilities, and managing the completion of tasks are needed to accomplish this consultancy and assure successful completion of project.

H. TOTAL DURATION OF THE CONSULTANCY

2010 and 2011

Appendix 10- Equipment

Laboratory Supplies (Objectives 1,2,4)	
Stereoscope	$5,000.00
Microscope with camera	$20,000.00
Fiber optic microscope lights	$1,500.00
Microscope slides, and mount preparations	$800.00
Tweezers, dissection equipment	$800.00
Field Research Supplies (Objectives 1,2,4)	
Motorized mist blower pesticide sprayer	$2,000.00
Weather stations (4)_	$4,000.00
Digital recorders (4)	$500.00
Malaise traps	$1,200.00
Sweep nets (6)	$200.00
Sticky traps pheromone	$2,000.00
Light sensor	$400.00
Communication radios	$200.00
Digital camera+macro lenses	$3,000.00
Software	$5,000.00
Current aerial photo updates	$5,000.00
GPS units	$2,000.00
Greenhouse Renovation Costa Rica	$5,000.00
Laboratory rental Costa Rica	$12,000.00
Greenhouse space rental/Purdue	$8,000.00
Equipment for PCR based Identification of Diseases (Objective 2.1)	
Thermocycler	$4,500.00
Gel Electrophoresis Tanks+power source	$2,100.00
Imaging: MiniBIS Pro D-transilluminator and software	$6,200.00
Consumables for PCR identification	
Reagents: Plasticware	$10,000.00
PCR reagents, including Taq polymerase	$6,000.00
Primer design	$1,600.00
Sequence analysis	$2,000.00
Misc. reagents (Agarose, dyes, buffers, etc)	$4,000.00
Communication (Objectives 1-4)	
5- Laptop Computers, hard drives, secure power sources, Skype head sets	$10,000.00
Large Monitors	$4,000.00
Dedicated desktop computer	$1,000.00
Audio	$1,500.00
Web camera	$500.00
Total	**$126,000.00**

Appendix 11- Related Projects completed by working group members.

Sadof, C. S., T. Benjamin, and E. Hidalgo 2008. The *Dracaena* Clean Stock Program brings new opportunities for Florida and Costa Rican growers. Ornamental Outlook. March 2008. http://www.entm.purdue.edu/Entomology/research/cs/pdf/dracaena.pdf

Prado, J., F. Casanoves, E. Jameson, T. Benjamin and C.S. Sadof. 2008. Effects of production practices on the abundance of quarantine pests in *Dracaena marginata* in Costa Rican production fields. J. Econ. Entomol. 101:1779-1785.

Hall, T.J., J.H. Dennis, R.G. Lopez, and M.I. Marshall. 2009. Factors Affecting Growers' Willingness to Adopt Sustainable Floriculture Practices.. *HortScience* 44(5):1346-1351.

Ostos, A., E. Hidalgo, T.Benjamin, F. Casanoves, and C. Sadof , 2007. Red Ginger Flowers: Looking for a plant free of mealybugs. http://www.entm.purdue.edu/Entomology/research/cs/pdf/boletinalpinia.pdf

Casanoves, F. and J. diRienzo 2006. Seqsam a program for elaborating sequential sampling programs. Manejo Integradas de Plagas y Agroecologia. 77:94-91. http://www.entm.purdue.edu/Entomology/research/cs/pdf/boletinalpinia.pdf

Marshall*, M.I. and T.L. Marsh. 2006. Endogenous Trade Protection in the Mexican Corn Market.. *Journal of International Agricultural Trade and Development* 2(2): 221-240.