

UNIVERSITY OF PUERTO RICO
MAYAGÜEZ CAMPUS
COLLEGE OF AGRICULTURAL SCIENCES
AGRICULTURAL EXPERIMENT STATION

ANNUAL REPORT OF ACCOMPLISHMENTS AND RESULTS

Planning Option: This Annual Report of Accomplishments and Results is prepared for our Institution's individual functions, just as our 1999-2004 Five Year Plan of Work and our FY 2005-2006 Plan of Work Update.

Reporting Period: October 1, 2005 to September 30, 2006.

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Agricultural Experiment Station

FY 2005-2006 ANNUAL REPORT OF ACCOMPLISHMENTS AND RESULTS
University of Puerto Rico
Mayagüez Campus
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General Overview

The University of Puerto Rico's Agricultural Experiment Station (AES) conducts basic and applied research to promote an economically viable agricultural sector and to stimulate rural development in Puerto Rico and in the region. Research also promotes the conservation and enhancement of natural resources and the environment, supports established and newly developed industries that process agricultural raw materials, and provides technical assistance to farmers and private and public institutions. The Agricultural Experiment Station coordinates its academic activities with the teaching and extension Faculty of the College of Agricultural Sciences (CAS) in an ongoing effort to implement the strategic plan that defines our programmatic goals. AES scientists also participate in several advisory boards of the Puerto Rico Department of Agriculture (PRDA), providing technical expertise for public policy decisions made by the PRDA. To advance regional goals, the AES participates in both Multistate research and Special Grants from USDA-CSREES that target agriculture in the Caribbean Basin of the United States.

Five goals, consonant with both federal and local priorities, drive our research program:

1. To develop technology for achieving sustainable agricultural production systems that are socioeconomically viable and competitive.
2. To develop technology for processing traditional and new agricultural products and for achieving a safe food and fiber system.
3. To provide direct services and technical expertise to farmers, agro industries, and public agencies that lack specialized personnel or research facilities present at AES-UPR.
4. To develop agricultural technology compatible with the preservation and enhancement of our natural resources and environment.
5. To provide the socioeconomic research needed to formulate alternatives that can potentially improve economic opportunities and the quality of life in rural areas.

Research efforts at the Agricultural Experiment Station are concentrated on goals one and four of the national goals, whereas other goals are covered by the Agricultural Extension Service of the College of Agricultural Sciences. In

2005 the AES began an internal and external evaluation process to identify other critical issues that should be targeted by our research program, and to incorporate stakeholders input on the setting of research priorities. This process culminated in our current Plan of Work, in which five programs and their priorities were described. Commodity groups are still active and constitute an important link with our stakeholders, but they are no longer the basic unit structuring our research program.

Core funding for the Agricultural Experiment Station's research program is provided by various sources. State funds are primarily used to cover salaries of academic and support personnel. USDA funding is crucial for directly financing the research program and supplementing salaries of faculty and staff. Formula-funds include Hatch Regular, Hatch Regional, McIntire-Stennis and Animal Health, although during FY 2006 we had no active Animal Health project. Special Grants such as the Tropical and Subtropical Agriculture Research (T-STAR) support targeted areas of research important for Puerto Rico, Florida and the Virgin Islands. Along with federal and state funding, there are extramural research grants and contracts such as those with the Natural Resources Conservation Service, Environmental Protection Agency, and USDA-ARS, Puerto Rico's Department of Agriculture, Puerto Rico's Department of Natural Resources and other agreements with US-Universities.

Executive Summary

Goal I. An agricultural system that is highly competitive in the global economy

Overview: Agriculture is of strategic importance to Puerto Rico both in terms of its present and its potential contribution to the economy. Although it is the smallest of the primary economic sectors its broader economic impact is significant, given the high multiplier effect of its activities. Puerto Rico has a large food import bill, much of which could be competitively produced locally if appropriate technology and marketing strategies were devised, disseminated among farmers and processors, and emerging problems are researched to formulate viable solutions. Moreover, through its research and extension programs the island's land grant system could also make a significant contribution towards stabilizing and expanding our current agricultural exports. Approximately 45% of our federally funded research projects are ascribed to this goal. These projects are in line with the furtherance of agricultural production, the long-term critical issue targeted by this goal.

Plant breeding research and maintenance of plant genetic resources continues to be an important component of the AES and CAS program. Recent evaluations show that the CAS already has the expertise, facilities, germplasm and breeding lines needed to develop improved cultivars of many traditional crops such as pigeonpeas, tropical pumpkin, selected roots and tubers, and green shelled beans. Breeding programs for many of these crops do not exist in the private sector or in neighboring countries.

Field germplasm maintenance of clonally propagated crops is vital for the preservation of important genetic material which might otherwise be lost. The UPR/AES keeps germplasm collections of traditional, new, and underutilized crops critical for the development of programs to improve the competitiveness of local agriculture. This year our program included the evaluation of cultivars of promising specialty crops such as *Quenepa* (*Melicoccus bijigatus*) and guava (*Psidium guajava*), of traditional root crops such as yam and taniar, and genetic improvement of ornamental crops, among others. By providing local farmers a reliable source of seed of many of the crop varieties developed by the AES, this program is strengthening the capacity of local growers to successfully compete in local and global markets.

The introduction of new crops in Puerto Rico, and changes in the region of production of traditional ones, underscore the need to evaluate appropriate fertilizer sources, placement methods, and timing of applications in crops of economic importance. Revision of fertilizer recommendations for major crops of Puerto Rico is a critical component in the development of best management practices (BMPs) for the island's crops. Experiments conducted with *Carica papaya* and root crops in different regions of the island suggest that current nitrogen application practices are above these crops needs for optimum production in the soils tested. Results from this project are being used to inform educational campaigns for farmers on the benefits that optimal use of fertilizers can have on their farm income and on the environment.

The dairy industry has been the principal agricultural enterprise in Puerto Rico over the past two decades contributing more than 20% of the island's Gross Agricultural Income. In the last decade, however, the number of acres dedicated to forage production declined by more than 12%. During that period beef production has also been steadily declining. There is an urgent need to identify potential new grasses and legumes to support the dairy, beef, and small ruminant industry. In the past, *Brachiaria decumbens* cv. Basilisk, although of very low nutritive value, has been promoted as potential forage on acid soils and humid areas. Recently, *B. brizantha* cv. Marandú and the hybrid cv. Mulato were introduced for evaluation on acid

soils and as a potential replacement of cv. Basilisk. Studies to assess yield, nutritive value and mob-grazing effects of cvs. Mulato, Marandú and Toledo grasses were conducted. While further studies are needed, results suggest that pasture renovation strategies which incorporate new cultivars with high nutritive value and good digestibility, such as Mulato, may enhance milk production of dairy cows in Puerto Rico and reduce the farm level investment in feed supplements.

Another important component of our research program under this goal is the continued evaluation and development of management practices that could help farmers improve the productivity of our tropical crops and protect our natural resources. Microirrigation technologies and management strategies can be important tools for natural resource protection and optimal crop production. The UPR has been conducting research on microirrigation for close to two decades, and the government has promoted and financially supported the adoption of this technology. Although microirrigation has been adopted by many local farmers, uncertainty remains with regard to the problem of when and how much water to apply to their crops. As part of a Multi-state effort researchers in Puerto Rico have been investigating both soil-based and ET-based methods to schedule irrigation. A new procedure has been recently developed to estimate ET and crop coefficients for various crops. Estimates of crop coefficient values are readily available to the public through a computer program developed by collaborators of this project which can be downloaded from the following website:

<http://academic.uprm.edu/abe/PRAGWATER>.

The program currently includes crop coefficient data for fifteen vegetable crops. Results from ongoing research have been instrumental for improving irrigation scheduling techniques and efficiency in water application for avocado, orange, tanager and beans in Puerto Rico.

Hatch funds under this goal:	\$2,058,973	SY FTE: 20.0
State matching funds:	\$2,362,569	

Goal II. A safe and secure food and fiber system

Overview: When our current Plan of Work was originally prepared research efforts under this goal were concentrated in the areas of food safety (analysis of pesticide residues) and post-harvest storage and processing of crops. Most of these activities were carried out in the Food Technology Laboratory located in the AES facilities at Río Piedras. In recent years research activities have been limited by the retirement of the majority of food scientists associated to this laboratory, and by the transfer of remaining projects and facilities to the Mayagüez Campus, where the program's

emphasis has shifted away from research to the formal training of students in food science. At the AES new activities are being developed in the areas of emerging plant and animal protection issues, and food system research with an emphasis in alternative food production, alternative marketing, and food security.

Under the activities of a Multi-state Hatch project, information was collected on how new organizational forms, such as "alternative" farming and farmer's markets are emerging in Puerto Rico, and on their potential contribution to the stability of crop markets, food security, and local economic development. Local results and lessons learned are being summarized and compared to the ones achieved by mainland participants. Pooling the outcomes of similar initiatives in diverse localities will provide us with more systematic knowledge on how communities generate, support and benefit from more localized food systems, one of the objectives of this Multi-state effort.

Hatch funds under this goal:	\$19,732	FTE: 0.4
State Matching funds:	\$22,342	

Goal III. A healthy, well nourished population

The current Plan of Work of the AES did not contemplate any research activities under this goal and no project have been developed in this area during this period. The Agricultural Extension Service conducts all the work performed in the CAS under this goal.

Goal IV. Greater harmony between agriculture and the environment

The principal objective of the Natural Resources and Environment Program-- under which most the projects contributing to this goal are administered-- has been since its inception to develop and support the scientific research carried out in the CAS on the interface of agriculture, natural resources and environment. During the past fiscal year Program priorities were revised to include the following areas that better reflect the desired research direction we expect the program to follow in the future: (1) Developing detection techniques and management strategies to deal with the different sources of pollution of the island's major watersheds (2) Examining the transport of contaminants and nutrient losses with an emphasis on the evaluation of management practices and strategies, (3) Developing integrated pest management systems for different crops, and (4) Regeneration of secondary forests and management of land for the production of forest-related crops.

Close linkages have been maintained with personnel from the Natural Resources Conservation Service (NRCS), USDA Forest Service International Institute of Tropical Forestry, the Department of Agriculture, the Environmental Quality Board, Animal and Plant Health Inspection Service and the Department of Natural Resources. Interviews and meetings with officials from these organizations are yearly held to gather their input on our research priorities, and to guarantee that research results contributing to sound management practices are included within these agencies' programs.

Although increasing scientific understanding of sustainable agricultural systems and promoting management practices that conserve natural resources is part of our institutional mission, studies focusing in organic agriculture have been practically absent from our research agenda. Organic production is, nonetheless, a small yet promising emerging sector in Puerto Rico. Pest management in organic tropical systems provides challenges beyond those of conventional production. Many products have been advertised for disease and insect control in organic production systems, but most have not been adequately evaluated in independent replicated trials. As part of a project seeking alternatives to pesticides for weed and insect control in watermelon in a transitional organic system, researchers are currently evaluating twelve alternative products, within two weed management systems, for pest control, yield, and postharvest quality of organic watermelons (cv. Crimson Sweet). Although none of the products tested in these trials should be relied upon as the sole means of managing pests, those with efficacy could be integrated into organic management programs. This is a new research area for our local AES and it is expected to contribute to achieving a more sustainable production system for watermelon, and to enhancing tropical organic research.

Tropical dry forests in Puerto Rico are facing new environments related to the introduction of exotic species that change disturbance regimes and patterns of forest succession, particularly when recovering on abandoned farm land. The introduction of non-native grass species in pasture systems has changed fire dynamics in forest ecosystems. Also, the introduction of non-native tree species may have important effects on interspecific competition among tree species and on dispersal mechanisms for plants and wildlife. Any of these changes have the potential to alter regeneration of native species in dry forests. Forest management practices may need to be modified to meet the challenges of a new ecosystem. Part of the outcomes of research in this forest dynamics is the development of interpretive material to educate the public about the effects of fire in dry forests and about dry forest ecology and management.

Development of locally-validated IPM technology for our crops is one of the top priorities of our program. New key pests, weeds and diseases are introduced each year, frequently threatening the integrity of the island's fragile agricultural economy. Research on new biological and chemical pesticides, used alone or in combination with other control measures, is crucial for sustaining the productivity and profitability of agriculture in Puerto Rico. Under our crop protection program several projects are screening the efficacy of new biological and chemical insecticides for controlling pests. Also, surveys of natural enemies such as parasitoids and entomopathogens have been conducted. The correct identification of the species attacking our crops, the continuous evaluation of insecticides, and the search for alternatives for pest control are all necessary to reduce the damage caused by insects. Results from many of these studies suggest that parasitoids and entomopathogenic fungi are good alternatives for insect control, or for complementing chemical control, thus for reducing the costs of production of many local crops threatened by pests.

Nevertheless, given the significant reliance of local producers on crop management chemicals to control diseases and pests, the continuous improvement in the methodology used for the extraction and analysis of these chemicals is vital to monitor water quality standards and for general ecosystem management. In collaboration with other Southern states participating in a regional project, new solid phase extraction (SPE) matrices have been developed which might result in better extraction procedures. The water quality methodology for crop protection chemicals developed under this project has been used in Puerto Rico to detect other toxic anthropogenic chemicals such as acetophenone (AC), phenanthrene (PH), camphor (CA), 1,2,3,4,5,6 hexachlorocyclohexane (CH), 3-(4-chlorophenyl-1,1,1dimethyl), urea (U) and ortho phenyl phenol (PP). The development of an easy and relatively inexpensive method for measuring other xenobiotics besides pesticides is an important contribution of this project, and could help regulatory agencies in monitoring compliance, thus improving water quality.

Hatch funds under this goal:	\$1,603,798	SY FTE: 13.3
State matching funds:	\$1,841,174	
McIntire-Stennis funds under this goal:	\$ 91,848	SY FTE: .9
State matching funds:	\$154,670	

Goal V. *Enhanced economic opportunity and quality of life for Americans*

Overview: High unemployment rates and chronic poverty are long term critical issues affecting Puerto Rico's population, particularly in rural areas. Changes in the global economy since the 1990s, with the concomitant restructuring of major local economic sectors, have exacerbated these adverse conditions. Official statistics confirm that nutritional subsidies are highly important for the livelihood strategies of more than half of the island's families. Although the contribution of agriculture to the Gross Domestic Product is stagnant or declining, because of its high multiplier effect, the continued viability of farming is critical for maintaining and improving the quality of life in the island, particularly in the central mountainous region where alternative employment opportunities do not abound.

Coffee production is vital for the economy of the central region of Puerto Rico. It generates over 6,000 direct jobs, accounting for 26% of total agricultural employment. Labor scarcity, particularly during harvest, however, is, a major constraint faced by farm operators. It has been largely responsible for a decline in the sector's farm income since 1998, and has prompted a downsizing in the scale of operations from medium to smaller farms. To explore potential solutions to the mismatch between coffee growers' labor demands and the available labor supply a mail survey of 126 growers was conducted. Also, 102 potential agricultural laborers attending Work Investment Act programs were personally interviewed. This study provides alternatives, recommended by both workers and growers, on how to improve the labor market situation in the coffee region. If linkages can be established between the needs of growers and demands of workers, an expansion in employment and in the size of coffee plantations could be achieved, all of which would have a measurable multiplier effect in many rural areas of Puerto Rico. Results have been presented at the local Legislature Agricultural Commission's hearings on the status of the coffee sector in Puerto Rico

Hatch funds under this goal:	\$8,965	SY FTE: .10
State matching funds:	\$10,151	

Planned Programs:

Goal I. An agricultural system that is highly competitive in the global economy

I. Key Theme – Plant Germplasm

A. (Under Hatch and State Funds). Field germplasm maintenance of clonally propagated crops is vital for the preservation of important genetic material which might otherwise be lost. The UPR/AES keeps germplasm collections of traditional, new, and underutilized crops critical for the development of programs to improve the competitiveness of local agriculture. Quenepa (*Melicoccus bijigatus*) and guava (*Psidium guajava*) are two specialty crops with potential for increased fruit production and greater use in processed products, for which cultivars are being selected and evaluated. Also, germplasm consisting of 28 yam, 22 cassava, 16 sweet potato and 75 tanager clones were field-maintained and evaluated at Corozal. Excellent yield was obtained with the yam cultivar 'Mapuey' (*Dioscorea trifida*). Genetic improvement of three ornamental crops, *Caesalpinia pulcherrima*, *Leandra krugii* and ornamental *Musa sp.*, is under way at Lajas. *Caesalpinia pulcherrima* is being bred for triploidy, *Leandra krugii* is being characterized and selected in the wild, and seven ornamental *Musa* species are being hybridized. Other crops being evaluated under this program include "Mayagüezano" type mango clones, sweet cherry peppers, "Cabezona" pineapple, orange, tomato, and "Mayorbela" maize.

B. Impact – The plant genetic resources introduced and evaluated through this project have contributed to the development of pest-and disease-resistant crops adapted to local conditions and with greater yield potential. Mapuey yam cultivar produced a maximum yield of 11,250 kg/ha when planting material of 112 g was used, compared with 6,704 kg/ha when planting material of 56 g was used. Seed for 'Mayorbela', 'Chulo' and 'Suresweet' maize, selected for improved agronomic and commercial seed traits, are currently available for sale at the Isabela Experiment Station. By providing local farmers a reliable source of seed of crop varieties developed by the AES, this project is strengthening the capacity of local growers to successfully compete in local and global markets.

C. Source of Federal Funds: Hatch (Multi-State) \$395,861 SY FTE: 6.2

D. Scope of Impact: Multi-State, PR, NC, HAW, FLA, VI

II. Key Theme – Plant Production Efficiency

A. (Under Hatch and State Funds). Fertilizers are essential for increasing agricultural productivity, but their improper use can be counterproductive. If applied in excess of crop intake, fertilizers can reduce crop yields and

contribute to surface and groundwater contamination. The introduction of new crops in Puerto Rico, along with changes in the region of production of traditional ones, underscores the need to evaluate appropriate fertilizer sources, placement methods, and timing of applications in crops of economic importance. Experiments with *Carica papaya*, conducted in the northern region of the island (Oxisol) to evaluate current nitrogen fertilizer recommendations and their effect on fruit quality and yield, concluded that the current nitrogen recommendation is excessive for this crop in this soil. The application of 224 and 448 kg N/ha resulted in yield values of 32.3 and 27.9 kg/tree, compared to a yield of 31.7 kg/tree with the recommended amount of 896 to 1120 kg N/ha. Fruit quality parameters such as sugar content and fruit size were not significantly affected by nitrogen treatments. In the case of root crops traditionally grown in the central region of the island where acid Ultisols predominate, new plantings in the fertile loamy soils of the south semiarid coast required that a revision be made of fertilizer recommendations. Results from an experiment established in the southern region (Mollisol) to determine the effect of nitrogen treatments, plant density, and harvest date on tanager (*Xanthosoma spp.*) indicate a significantly higher number of first rate cormels, and a higher total yield, with a higher plant density. Waiting up to 12 months for harvest significantly increased tanager yield without affecting crop quality. No significant differences were observed in yield between the treatment of the recommended N rate (135 kg N/ha) and the treatment where the nitrate in the soil and irrigation water were subtracted from the recommended N rate. These results suggest that the present N rate recommendation for this soil is more than what the crop needs for optimum production.

B. Impact – Revision of fertilizer recommendations for major crops of Puerto Rico is a critical component in the development of best management practices (BMPs) for the island's crops. Results from this project are being used to inform educational campaigns for farmers on the benefits that optimal use of fertilizers can have on their farm income and on the environment. The development of more accurate fertilizer application rates is expected to contribute to a reduction in the non-point source pollution of water resources.

C. Source of Federal Funds: Hatch: \$193,654 SY FTE: 1.6

D. Scope of Impact: State Specific, PR

III. Key Theme - Rangeland and Pasture Management

A. (Under Hatch and State Funds). In Puerto Rico there is an urgent need to

identify potential new grasses and legumes to support the dairy, beef, and small ruminant industry. Annual imports of alfalfa hay amounted nearly one million dollars in 2004. In the past, *Brachiaria decumbens* cv. Basilisk, although of very low nutritive value, has been promoted as potential forage on acid soils and humid areas. Recently, *B. brizantha* cv. Marandú and the hybrid cv. Mulato were introduced for evaluation on acid soils and as a potential replacement of cv. Basilisk. Yield, nutritive value and mob-grazing effects of cvs. Mulato, Marandú and Toledo grasses were assessed under this study. All pastures were mob-grazed for 15 grazing cycles to determine changes in yield over time. Mean yield of Mulato (1,207 kg/ha), Marandú (1,094 kg /ha) and Toledo (1,271 kg/ha) were different, but there were no differences in crude protein (6.8%). There was a cv. effect on neutral detergent fiber (NDF) and acid detergent fiber (ADF), with a lower NDF (64.6%) and ADF (33.6) for Mulato. There was a grazing cycle date effect on yield consistent with rainfall patterns and day length. After 1.5 years of grazing, it is evident that all three cultivars persisted, but that grazing management is needed (longer regrowth) during the dry periods.

B. Impact – The assessment of potential legumes and new grass resources for incorporation in pasture-based systems is one of the priorities of the local milk and meat production program. Pasture renovation strategies which incorporate new cultivars with high nutritive value and good digestibility, such as Mulato, may enhance milk production of dairy cows in Puerto Rico and reduce the farm level investment in feed supplements.

C. Source of Federal Funds: Hatch: \$191,989 SY FTE: 1.8

D. Scope of Impact: State Specific, PR

IV. Key Theme – Innovative Farming Techniques

A. (Under Hatch, State and External Funds). Microirrigation technologies and management strategies can be important tools for natural resource protection and optimal crop production. The UPR has been conducting research on microirrigation for close to two decades, and the government has promoted and financially supported the adoption of this technology. Although microirrigation has been adopted by many local farmers, uncertainty remains with regard to the problem of when and how much water to apply to their crops. This issue is more complex in tropical conditions where the variety of crops grown, as well as climatic and soil variation, is great. Microirrigation management depends on consumptive water use (ET), which in turn depends on soil type, crop stage development and climatic conditions. Under this project researchers have been

investigating both soil-based and ET-based methods to schedule irrigation. A new procedure has been recently developed to estimate ET and crop coefficients for various crops. Results from these studies form part of a regional effort to collect, share, and together evaluate the weather data related to evaporative demand and ET and the applied irrigation water data for each experiment. This will allow researchers to determine how close an ET schedule comes to various alternative irrigation scheduling methods such as tensiometers and pan evaporation.

B. Impact – Results from ongoing research have been instrumental for improving irrigation scheduling techniques and efficiency in water application for avocado, orange, tanager and beans in Puerto Rico. Estimates of crop coefficient values are readily available to the public through a computer program developed by collaborators of this project that can be downloaded from the following website: <http://academic.uprm.edu/abe/PRAGWATER> . The "Puerto Rico EvapoTranspiration Estimation Computer Program" Version 1.03 calculates the mean daily crop evapotranspiration at any location in Puerto Rico. With only the site latitude and elevation, and specification of the Climate Division, the program calculates all the climate data necessary as input to the Penman-Monteith reference evapotranspiration method. Alternatively, the user can enter mean monthly climate data manually into the Windows-based computer program. In this mode the program can be used anywhere in the world. The program currently includes crop coefficient data for fifteen vegetable crops.

C. Source of Federal Funds: Hatch (Multi-State) \$28,197 SY FTE: .3

D. Scope of Impact: Multi-State, PR, OH, IA, FL, VI, AZ, CA, CO, TX

Goal II. A safe and secure food and fiber system

I. Key Theme – Food Security

A. (Under Hatch and State Funds). New farmers' markets have recently been established in Puerto Rico with the hope of creating more direct connections between producers and consumers. By cutting out the intermediate sector, farmers' markets hold great promise for making fresh, local produce available to consumers at affordable prices, thus improving food security for vulnerable populations, while offering farmers a new and more favorable market. Understanding the different kinds of farmers' markets in Puerto Rico and the different possibilities and limitations they face is critical for assessing the key challenges in this process. Working together with researchers in a multi-regional project, we are summarizing

local results and lessons learned and comparing them to the ones arrived at by mainland participants. Pooling the outcomes of similar initiatives in diverse localities will provide us with more systematic knowledge on how communities generate, support and benefit from more localized food systems, one of the objectives of this Multi-State effort.

B. Impact – Research on food retail restructuring and farmer’s markets is expected to contribute to our understanding of the forces that motivate the formation of place-based food systems and of the impact these forces are having in communities nationwide. Results from this project suggest that in Puerto Rico the new farmers’ markets are promising but fragile, depending on the abiding commitment of a small number of organizers and, for most, the WIC coupons that subsidize market purchases. To nurture this type of direct marketing effort, public entities should pay more attention to ways of supporting farmers and food entrepreneurs’ needs, particularly in the areas of infrastructure and human resources.

C. Source of Federal Funds: Hatch (Multi-State) \$19,732 SY FTE: .4

D. Scope of Impact: Multi-State, PR, NY, CA, IA, MN, PA, WI, WV, WA

Goal III. A healthy, well nourished population

The current Plan of Work of the AES did not contemplate any research activities under this goal and no project have been developed in this area during this period. The Agricultural Extension Service conducts all the work performed in the CAS under this goal.

Goal IV. Greater harmony between agriculture and the environment

I. Key Theme – Sustainable Agriculture

A. (Under Hatch and State Funds). Despite the fact that the body of organic farming research continues to grow, little has focused on tropical systems. Pest management in tropical systems provides challenges beyond those of conventional production. Because of differences in temperature, daylength, rainfall, and humidity versus those factors in a temperate climate, organic producers in the tropics face year-round pest pressure. Organically grown watermelon from Puerto Rico offers good prospects for filling seasonal niches in the US market. Weed management is essential for the production of high quality watermelons but can be difficult when herbicides are not permitted. Weeds also serve as a source of inoculum for disease organisms and a

habitat for insects. Many products have been advertised for disease and insect control in organic production systems, but most have not been adequately evaluated in independent, replicated trials. This project is currently evaluating twelve alternative products, within two weed management systems (grass mulch and no mulch), for pest control, yield, and postharvest quality of organic watermelons (cv. Crimson Sweet). The alternative products included a traditional copper-based fungicide, biological control agents, potassium bicarbonate, hydrogen dioxide, milk, and garlic, neem, tea tree, and combinations of rosemary, wintergreen, peppermint, clove, and thyme oils.

B. Impact – Organic production is a small, yet promising emerging sector in Puerto Rico. Results from this project are providing much needed alternatives for growers interested in making the transition from a conventional to an organic production system. Although none of the products tested in these trials should be relied upon as the sole means of managing pests, those with efficacy could be integrated into organic management programs. This is a new research area for our local AES and it is expected to contribute to both achieving a more sustainable production system for watermelon, and towards enhancing tropical organic research.

C. Source of Federal Funds: Hatch: \$ 30,100 SY FTE: .2

D. Scope of Impact: State Specific, PR

II. Key Theme – Wildfire Science and Management

A. (Under McIntire-Stennis Funds and State Funds). Tropical dry forests in Puerto Rico are facing new environments related to the introduction of exotic species that change disturbance regimes and patterns of forest succession, particularly when recovering on abandoned farm land. First, the introduction of non-native grass species in pasture systems has changed fire dynamics in forest ecosystems. The understory of mature Puerto Rican dry forest is typically sparse and not amenable to fire, but secondary forests and mature forests near old pastures are subject to frequent and intense burning due to high fuel loads provided by exotic grasses. Second, non-native tree species have been introduced into Puerto Rico and some of them now dominate secondary forests but their influence on the succession of dry forests is not yet understood. These non-native species may have important effects on interspecific competition among tree species and on dispersal mechanisms for plants and wildlife. In addition, these dry forests naturally experience hurricanes, but storm intensity or frequency may be changing as a result of global warming. This project is evaluating how exotic grass and tree

species, and the perturbations they create, influence the community dynamics of native dry forest species.

B. Impact – Any of the changes described above has the potential to alter regeneration of native species in dry forests. Together, these perturbations could strongly influence the survival, structure, and composition of native dry forests. As a result, forest management practices may need to be modified to meet the challenges of a new ecosystem. Part of the outcome of this project is the development of interpretive material to educate the public about the effects of fire in dry forests and about dry forest ecology and management.

C. Source of Federal Funds: McIntire-Stennis \$27,790 FTE: 0.2
State Match: 23,222

D. Scope of Impact: State Specific, PR

III. Key Theme – Pesticide Application

A. (Under Hatch and State Funds). Agricultural production is under a constant threat by insects. The introduction of new pests, the development of resistance to insecticides, and the resurgence of old and secondary pests undermine the viability of many crops. Moreover, regulations on insecticide use in specialty crops –the majority of Puerto Rico's products- limit the options open for managing insect populations. Research on new biological and chemical pesticides, used alone or in combination with other control measures, is crucial for sustaining the productivity and profitability of agriculture in Puerto Rico. Under our crop protection program several projects are screening the efficacy of new biological and chemical insecticides for controlling pests. Also, surveys of natural enemies such as parasitoids and entomopathogens have been conducted. The correct identification of the species attacking our crops, the continuous evaluation of insecticides, and the search of alternatives for pest control are all necessary to reduce the damage caused by insects.

B. Impact – From an economic point of view, plantains and bananas are the most important crops of Puerto Rico. Nematodes and the banana root borer are the most serious pests that attack these crops locally. There are only two pesticides registered in Puerto Rico for these pests and they are at risk of being cancelled. In trials conducted since 2005, Fosthiazate 10G (15 gr/plant) a new insecticide-nematicide, showed a high degree of efficacy against the banana corm borer and nematodes in plantain. Data from these trials will be used to support a new pesticide registration for the control of

these pests in Puerto Rico. Pigeon pea is also an important crop in the island, highly cherished by locals particularly during the Christmas season. Since 2000, the pigeonpea pod fly (*Melanagromyza obtusa*) has become the most serious pest of the crop. Experiments with insecticides indoxacarb, fenpropathrin, lambda cyalothrin, bifenthrin, esfenvalerate, and cyfluthrin showed they were efficient at controlling *M. obtusa* and reducing pod damage. Puerto Rico is currently conducting a project to introduce natural enemies of *M. obtusa*. *Ormyrus orientalis*, a parasitoid of the pupa, was imported, reared and released in the island. It was recovered from pigeon pea, up to 31% of parasitism. Overall, the use of parasitoids and entomopathogenic fungi are good alternatives for insect control, or for complementing chemical control, thus for reducing the costs of production of many local crops threatened by pests.

C. Source of Federal Funds: Hatch \$811,647

FTE: 7.5

D. Scope of Impact: State Specific, PR

IV. Key Theme – Water Quality

A. (Under Hatch and State Funds). The use of pesticides in agriculture demands continued improvement in the methodology for the extraction and analysis of chemical pesticides. The water quality methodology for crop protection chemicals developed under this project has been used to detect other toxic anthropogenic chemicals such as acetophenone (AC), phenanthrene (PH), camphor (CA), 1,2,3,4,5,6 hexachlorocyclohexane (CH), 3-(4-chlorophenyl-1,1,1dimethyl) urea (U) and ortho phenyl phenol (PP). The above mentioned chemicals have been detected in some environmentally sensitive areas of Puerto Rico by the use of the C18-Empore disk™ technique. A field portable solid phase extractor constructed by using PVC pipes (Speedisk® C18-PVC), as described by Mattice for this regional project, was also used. Mean recovery percentages of above mentioned compounds in Speedisk® C18-PVC field extractor were 25 (AC), 72 (PH), non detectable (CA), 81 (CH), 63 (U) and 87% (PP). Camphor was not detected probably because it was adsorbed over the PVC housing of the field extractor. No significant differences were found between the use of Speedisk® C18-PVC and that of Speedisk® C18 for above mentioned compounds, except for CA and PP. These results suggest that careful studies must be done before the PVC field extractor is used for water quality monitoring in the field.

B. Impact – This research is improving the analytical techniques for the analysis of crop protection chemicals. The development of an easy and

relatively inexpensive method to measure other xenobiotics besides pesticides is an important contribution of this project, and could help regulatory agencies in monitoring compliance, thus improving water quality. This project's results are consequently of paramount importance to water resource conservation, natural resource and ecosystem management, environmental policies and regulations, for risk management and assessment in agricultural systems, as well as for agriculture-related social and consumer concerns.

C. Source of Federal Funds: Hatch \$18,240 FTE: 0.4
State Match: \$20,653

D. Scope of Impact: Multistate: PR, AR, MS, SC, TN, TX, VA

Goal V. Enhanced economic opportunity and quality of life for Americans

I. Key Theme – Jobs/Employment

A. (Under Hatch and State Funds). Coffee is the crop with the greatest socio-economic and environmental importance in Puerto Rico. It generates over 6,000 direct jobs, accounting for 26% of total agricultural employment. Labor scarcity, particularly during harvest, however, is a major constraint faced by farm operators. It has been largely responsible for a decline in the sector's farm income since 1998, and has prompted a downsizing in the scale of operations from medium to smaller farms. To explore potential solutions to the mismatch between coffee growers' labor demands and the available labor supply we conducted a mail survey of 126 growers. We personally interviewed 102 potential agricultural laborers attending Work Investment Act programs. Nineteen municipalities were represented. Results from the growers' study showed that the average farm land under production was 27 acres, the average value of coffee sold was \$17,969 (median \$7,850), and the average number of hired farmworkers was three. Fifty-five percent said they would have needed more workers during the entire year; 83% believed more laborers are needed only during the coffee harvest. Responses from the workers interviews showed that prospective workers were on the average 50 years old had 8.5 years of schooling, and all were participants of the Nutritional Assistance Program. The most important aspect considered at the time of selecting a job was "to be treated with respect" and flexibility. Having an employer with a good attitude towards laborers was considered more important by the majority of interviewees than having a higher wage.

B. Impact – Maintaining a vital coffee industry in Puerto Rico is important from an environmental perspective, given that farm owners are still custodians of a significant part of the natural resources of the region, and important from a social point of view because the industry includes more than 50% of the farmers of the island and employs the majority of agricultural laborers. If linkages can be established between the needs of growers and demands of workers, an expansion in employment and in the size of coffee plantations could be achieved, all of which would have a measurable multiplier effect in many rural areas of Puerto Rico. This study provides alternatives, recommended by both workers and growers, on how to improve the labor market situation in the coffee region. Results have been presented at the local Legislature Agricultural Commission's hearings on the status of the coffee sector in Puerto Rico.

C. Source of Federal Funds: Multi-State Hatch	\$8,965	FTE: .1
State matching funds:	\$10,151	

D. Scope of Impact: State Specific, PR

STAKEHOLDER INPUT PROCESS

Two types of meetings have been held in different locations of Puerto Rico to identify critical issues that should be targeted by our research program, and to incorporate stakeholders input on these issues and on the setting of research priorities. First, we have continued to celebrate an annual meeting with all the researchers, extension faculty, farmers and other public interested in the work performed under each commodity area. In these meetings the progress of currently active projects is discussed, preliminary results are shared and further input is sought for updating the commodity's research needs and priorities. The meeting is usually celebrated in the Research Center or Substation closest to where the main nucleus of the commodity producers are located, and coordinated with the Agricultural Extension Service commodity specialist and agricultural agents of the region. Both the commodity leader and the extension personnel identify and invite interested stakeholders from producers associations, individual farmers, faculty and students, government officials, and community organizations with an interest in the commodity's work. The input received in these meetings from all the stakeholders present is summarized, evaluated and presented in a concluding meeting of commodity leaders and research administrators, where final decisions are taken. The list of priorities assembled through this process guides the year's call for proposals for new Hatch and Special projects.

Second, several commodity leaders and directors of integrated academic departments have organized thematic workshops, seminars, or field days in which research results on particular topics have been shared and alternative views on the subject--including further research and extension needs, or public policy determinations--have been discussed. The feedback received in these activities was incorporated into the revised statement of issues prepared under each goal for the FY 2004-2006 POW update and continues to inform the current process of program assessment for our rolling five-year POW.

PROGRAM REVIEW PROCESS

There has been no significant change in our Program Review Process since our Five-Year POW and Two-Year update was submitted. In 2005, however, we changed the way in which our Hatch funded research proposals are initially granted. In response to internal and external evaluations requesting that a portion of Hatch funds be allocated to projects on the basis of an annual call for proposals with the year's revised priorities, part of our formula-funded research is now competitively granted based on such proposals.

Every AES proposal or request for extension, formula funded or otherwise, goes through a thorough merit review process following the *Administrative Manual for the Hatch (Experiment Station) Act as Amended* (see section C.3, page 7, Projects Supported with Regional Research Funds). The review committee includes the AES Associate Dean and Assistant Dean for Research, the concerned Department Chair¹, a local peer and an external peer reviewer and, in some cases, the concerned commodity Leader. Each individual evaluates and rates the various proposals before a final decision is taken. If any of the members of the review committee are collaborating in the proposal being submitted, they do not participate in the evaluation process, but send the proposal to another qualified scientist.

More specifically, the scientific peer review process of proposals according to the source of funding is the following:

a) Commonwealth Research Funds:

Proposals are submitted to the Assistant Dean for Research with the pre-

¹ The College of Agricultural Sciences is made up of seven Integrated Departments: Animal Industry, Horticulture, Crop Protection, Agronomy and Soils, Agricultural Economics and Rural Sociology, Agricultural Engineering and Agricultural Education.

approval of the respective Department Head and Commodity Leader. The Assistant Dean for Research discusses and evaluates the proposals in a meeting with the concerned commodity leader. Once the proposal goes through this process and is accepted, the project is included in the AES research program.

b) Hatch-Formula Research Funds:

An annual call for proposals which includes the year's revised research priorities is prepared and distributed by the AES Research Office. Proposals are submitted to the Assistant Dean for Research with the preliminary endorsement of the respective Department Head. The Assistant Dean for Research sends the proposal again to the corresponding department head, to a local peer reviewer and to an external reviewer for their written comments on the scientific merit of the proposed research and compliance with the AES strategic plan. Proposals and their reviewers' input are discussed and evaluated by the CAS Associate and Assistant Deans for Research, and a final decision is taken by the administration. Project directors of the selected proposals are given the opportunity to incorporate reviewers' suggestions and make adjustments as appropriate. These proposals are then sent to the USDA-CSREES Office of the Administrator, where the respective national program leaders review them. Once the proposals are approved in Washington, the new or revised projects are included in the AES research program.

c) Special Grant Research Funds:

A letter of intent with an abstract of the proposed project is submitted to the Assistant Dean for Research and to the Manager of the Special Grants Program in the University of Florida, with the pre-approval of the respective Department Head and Commodity Leader. Full proposals are submitted to the Assistant Dean for Research and are forwarded, after reviewing them for compliance with local and federal procedures, to the program manager. The program manager sends them out for external review to the pre-arranged panels. These panels of 3 to 4 reviewers rank each proposal and make written comments on the scientific merit, scientific preparation of the principal investigator, and the potential success and impact of the research. This information is then gathered, distributed, and discussed among the technical committee members of the special grant fund at an annual spring meeting in Washington. This committee is composed of representatives of the universities of Florida, Puerto Rico, and the US Virgin Islands (Dean and Director, Associate Dean and/or Assistant Dean for Research), CSREES staff, and USDA-ARS representative. This group and the Program Manager decide which proposals will be accepted for funding and included in each of the

participating universities research program.

Evaluation of the Success of Multi and Joint Activities:

The Agricultural Experiment Station of the University of Puerto Rico actively participates in Multi-State Research. There were eight projects conducting Multi-State Research last fiscal year. Research covers disciplines such as plant breeding, animal reproduction, pesticide detection and assessment, irrigation management, water quality, and rural sociology. While the impact of some of these studies appears to be state specific, when results from the participant states are put together, conclusions about the impact of a particular program and nationwide variations can be reached. This has been the case with MultiState projects in the area of rural sociology and water quality, for example. The exchange of information and disciplinary discussions taking place in these projects annual meetings have contributed to the improvement of our research program.