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, 2004 to September 30, 2005

Due Date: April 1, 2006

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FY 2004-2005 ANNUAL REPORT OF ACCOMPLISHMENTS AND RESULTS
University of Puerto Rico
Mayagüez Campus
College of Agricultural Sciences
Agricultural Experiment Station

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 on 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 enchantment 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.

Last year 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 stakeholder input in the setting of research priorities. Our research is still organized following commodity lines, but we now have nine commodities and one program area[1] instead of the original eleven commodities. Since FY 2002 the sugarcane commodity has been eliminated from our program, given the practical disappearance of sugar plantings in Puerto Rico and the retirement of researchers with expertise in that commodity.

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 2005 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 import bill for food, much of which could be competitively produced locally if appropriate technology and marketing strategies were devised, disseminated among farmers and processors, and if emerging problems were 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

[1] Current commodity groups are: dairy, coffee, plantains and bananas, vegetable crops, fruit crops, ornamentals, meat production, roots and tubers, basic grains and the environment and natural resources program.

current agricultural exports. Approximately 50% 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 continues to be an important component of the AES and CAS programs. 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 pigeon peas, tropical pumpkin, sweet potatoes, and green shelled beans. Breeding programs for many of these crops do not exist in the private sector or in neighboring countries. During this fiscal year some of our long-term projects have culminated and have either been terminated or renewed with different objectives. Plant breeders have been successful in developing lines with local adaptation and enhanced resistance to diseases or emerging pest problems.

Three common bean (*Phaseolus vulgaris* L.) lines resistant to the bean golden yellow mosaic virus (BGYMV) were developed and released collaboratively by the Puerto Rico Agricultural Experiment Station and the USDA-ARS, Tropical Agriculture Research Station (TARS). BGYMV, a whitefly [*Bemisia tabaci* (Gennadius)]-transmitted Begomovirus, can cause significant yield losses in beans. These three bean germplasm lines are susceptible to common bacterial blight and resistant to endemic races of rust. The release of these germplasm lines is a great achievement for the future of bean breeding research in the tropics.

Among vegetable crops, tropical pumpkin or *calabaza* (*Cucurbita moschata*) occupies second place both in terms of revenue generated and physical production. Although it is very important in the growing Hispanic market of the United States, as well as throughout the Caribbean and Latin America, currently US production is limited to Puerto Rico and subtropical areas of Florida. New cultivars developed from an effective breeding program can add value for both growers and consumers of tropical pumpkin. Two such new cultivars, PRShortvine1 and PRLongvineSLR, were developed with fruit quality superior in color and texture to that of the most commonly grown cultivar in Puerto Rico. Their improved flesh color provides the consumer with additional health benefits, since darker orange color is associated with higher levels of beta-carotene, an important antioxidant. For the grower, PRShortvine1 can be more easily managed than traditional vine types because of its semi bush growth habit. PRLongvineSLR, on the other hand, is a more traditional long vine variety with more insect resistance than the commonly grown cultivar. These traits will benefit the grower by reducing costs of pest control.

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 has declined by more than 12%. Faced with insufficient land for feed production, farmers are increasingly relying on imported feed sources for their lactating cows. The development of supplementation strategies to optimize productivity and efficiency of dairy cows grazing tropical forages is therefore an important priority in our research program. Results from two trials to evaluate the effect of level of concentrate supplementation on productive performance and forage intake, of early and late lactation cows consuming tropical grass hays, showed that the high level of supplementation resulted in $0.35/cow/day more income over feed costs than the low level for cows in early lactation. If further confirmed, these results indicate that the traditional recommendations for dairy cattle of high forage/low supplementation diets are not adequate for the local dairy industry at present.

Finally, 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 and quality of our tropical crops. During this fiscal year one of our long term projects in weed control was terminated, as the program shifted its focus from an umbrella approach covering general problems in several crops, to more specifically targeted research problems. Under this project weed management strategies were developed for several crops—beans and coffee, among others--that could help farmers to increase production and reduce imports into Puerto Rico. Results also showed that suppression of weeds by living mulches may be adapted as an alternative practice to reduce herbicide applications and reduce chemical contamination in upland agro-ecosystems.

Hatch funds under this goal:	$1,918,971	SY FTE: 20.1
State matching funds:	$2,508,208	

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 with 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 on alternative food production, alternative marketing, and food accessibility.

Under the activities of a Multistate 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. Stakeholder input collected through project activities continues to be used in the delineation of research priorities for the local Agricultural Experiment Station. This year a new Hatch project was approved on the basis of these revised priorities, on alternative methods of weed control in transitional organic systems—one of the information needs identified by sustainable agriculture producers interviewed under this project.

Hatch funds under this goal:	$16,861	FTE: 0.3
State Matching funds:	$19,734	

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 projects 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 of 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 this fiscal year Program priorities have been 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 (IPM) 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 held yearly 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.

Development of locally validated IPM technology for our crops is one of the top priorities of our program. At present, vegetable producers have only one of such programs (for peppers) and rely mainly on the application of broad spectrum insecticides on a calendar basis to control insect pests. This practice is detrimental to the survival of natural enemies, particularly those regulating leafminer population increases. A population dynamics study of *Liriomyza* spp. in cucumber, tomato and eggplant revealed that, on the southern plains of Puerto Rico, serpentive and vegetable leafminers (*Liriomyza trifolii* and *Liriomyza sativa*) are secondary pests triggered to primary pest status by inadequate management practices, solely dependent on sprays of broad spectrum insecticides. Approximately $1,700/acre could be saved in production costs by reducing the number of insecticide applications with proper insect pest monitoring and timely application of control measures.

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 for monitoring 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. In Puerto Rico, project cooperators developed a field-portable solid phase extractor, by using PVC pipes and connectors. The extractor performance was excellent and the recovery percentage was similar to those from samples collected and extracted in the laboratory. We expect that the fulfillment of project objectives will improve the analytical techniques available for examining crop protection chemicals and ultimately will aid in the management of local natural resources.

Agroforestry systems combining the growing of trees with agricultural crops is a fairly common practice in the tropics. An overstory of trees is often used to provide shade for agricultural crops. In Puerto Rico, many forests have developed where coffee was once grown with this system. Although higher yields can be obtained without shade, the longevity of the plantation is enhanced by shading. Moreover, shading trees on coffee plantations may enhance the adaptability of the crop to acid soil conditions through the accumulation of soil organic matter. The species *Pithecellobium carbonarium* is a leguminous tree that has good potential as a shading species for coffee because of its fast growing habits, low density canopy and its capacity to fix nitrogen. Results of field experiments suggest that addition and incorporation of coffee leaf litter to acid soils can significantly reduce toxic levels of exchangeable aluminum, thus contributing to a better environment for root development. A better root system will result in a healthier coffee plant that will produce higher yields and last longer. Management practices to promote the accumulation of leaf litter under coffee trees should be promoted to maximize the litter's beneficial effects.

Hatch funds under this goal:	$1,758,742	SY FTE: 16
State matching funds:	$2,421,391	

McIntire-Stennis funds under this goal:	$ 90,402	SY FTE: 0.9
State matching funds:	$151,353	

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. Compared to nutritional subsidies, welfare payments are small in Puerto Rico, but little is known on the impact that reforms in the program's administration may bring to rural families on the island.

To examine the impact of the Personal Responsibilities Work Opportunities Act (PRWORA) on rural women, 37 women participating in job readiness training programs sponsored by the Work Investment Act (WIA) were interviewed in five non-metro municipalities. Interviews yielded information regarding their socioeconomic characteristics, previous labor history, and

perceived constraints for past and future job market opportunities. Results showed that for those attending a high school equivalency course the perceived main barrier was the lack of a high school diploma, followed by lack of transportation from their rural residences as an expected future constraint. For those attending agricultural skills training programs, some of whom had a secondary school diploma, the perceived main constraint--past and present--against gainful employment was the lack of jobs in their local areas. Project outcomes further suggest that, besides infrastructure, larger social investments will be needed to mitigate the inequality that fosters more poverty in rural areas.

Hatch funds under this goal:	$45,586	SY FTE: 0.9
State matching funds:	$53,409	

Planned Programs:

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

I. Key Theme – Plant Production Efficiency

A. (Under Hatch and State Funds). Resistance to diseases is a primary aspect of bean breeding research. Yield, pest resistance and food value are important and necessary qualities of bean breeding lines. Some white-seeded and pinto lines selected combine resistance to bean golden yellow mosaic virus (BGYMV), bean common mosaic necrotic virus (BCMNV) and rust. Another group of white-seeded lines has resistance to BGYMV and resistance to common bacterial blight both in the leaves and pods. Breeding line 04SH-8730 was found to be resistant to a local isolate of ashy stem blight. During the year, 2979 bean breeding lines from three universities and the USDA-ARS were advanced one generation in a winter nursery. Three bean germplasm lines, PR 9771-3-2, PR 0247-49 and PR 0157-4-1, were released in collaboration with the USDA-ARS.

B. Impact – BGYMV-resistant common bean (*Phaseolus vulgaris* L.) germplasm lines PR 9771-3-2, PR 0247-49 and PR 0157-4-1 were developed and released collaboratively by the Puerto Rico Agricultural Experiment Station and the USDA-ARS, Tropical Agriculture Research Station (TARS). BGYMV, a whitefly [*Bemisia tabaci* (Gennadius)]-transmitted Begomovirus, can cause significant yield losses in beans. These three bean germplasm lines are susceptible to common bacterial blight [caused by *Xanthomonas*

campestris pv. *phaseoli* (Smith) Dye] and resistant to endemic races of rust [caused by *Uromyces appendiculatus* (Pers.) Unger]. The release of these three germplasm lines is a great achievement for the future of bean breeding research in the tropics.

C. Source of Federal Funds: Hatch (Multistate): $ 159,692 SY FTE: 2.0
State Match: $167,533

D. Scope of Impact: Multistate: PR, FL, NY, MI

II. Key Theme – Plant Germplasm

A. (Under Hatch and State Funds). Tropical pumpkin or calabaza (*Cucurbita moschata*) is one of the most important vegetable crops in Puerto Rico, occupying second place in terms of revenue generated by vegetable crops. New tropical pumpkin cultivars developed during the past four years were tested in a variety of environments (locations and planting seasons). Two cultivars, PRShortvine1 and PRLongvineSLR, showed a superior performance to that of other materials, and were similar in yield to that of the standard cultivar 'Soler.' Furthermore, the cultivar PRLongvineSLR carries resistance to silverleaf, a whitefly-induced physiological disease. Formal release of these cultivars is expected during 2006. In addition, studies to better understand genetic relationships between tropical pumpkin (*Cucurbita moschata*) and its closely related species, *C. argyrosperma* and *C. sororia*, showed a high level of compatibility between *sororia* and *argyrosperma*, no matter the direction of the cross. There was a high degree of compatibility between either *argyrosperma* or *sororia* with *moschata* when the former species were used as the female parent. The high level of compatibility observed should make it easy to move traits of interest from one species to another.

B. Impact – Two new tropical pumpkin cultivars, PRShortvine1 and PRLongvineSLR, were developed with fruit quality superior in color and texture to that of the most commonly grown cultivar in Puerto Rico. Their improved flesh color provides the consumer with additional health benefits, since darker orange color is associated with higher levels of beta-carotene, an important antioxidant. For the grower, PRShortvine1 can be more easily managed than traditional vine types because of its semi bush growth habit. PRLongvineSLR, on the other hand, is a more traditional long vine cultivar with more insect resistance than the commonly grown cultivar. These traits will benefit the grower by reducing costs of pest control. Moreover, the high level of compatibility between species studied will allow breeders to move traits of interest, such as better resistance, from one species to another.

Nevertheless, undesirable genes from one species, including genetically engineered ones, are able to move to another species with relative ease. This knowledge is useful when growing various tropical species in the same area.

C. Source of Federal Funds: Hatch Funds $93,038 SY FTE: 0.6
State Match: $128,667

D. Scope of Impact: Multistate: PR and Southern United States

III. Key Theme - Animal Production Efficiency

A. (Under Hatch Funds). In the Caribbean tropics, traditional recommendations to farmers for efficient milk production have been to limit concentrate supplementation and to maximize pasture forage intake. Two trials to evaluate the effect of level of concentrate supplementation, high (1:1.5 kg concentrate: milk) and low (1:2.5), on productive performance and forage intake of early and late lactation cows consuming tropical grass hays, were conducted at the Lajas dairy farm. Whole milk production of cows in early and late lactation was influenced in a positive manner by increasing the level of supplementation, with cows in early lactation producing 2.9 kg/d more milk at the higher level of supplementation. In another experiment, dairy replacements under grazing conditions were evaluated for 623 days at the Gurabo dairy. Treatments evaluated were 1) no supplementation and grazing at 3.75 head/ha; 2) concentrate supplementation and grazing at 7.6 head/ha. Heifers receiving no supplement had lower average and total bodyweights and calving bodyweight than heifers receiving supplementation (0.375 vs. 0.528 kg/d; 265 vs. 339 kg/heifer, and 463 vs. 528 kg at calving, respectively).

B. Impact – The high level of supplementation resulted in $0.35/cow/day more income over feed costs than the low level for cows in early lactation. Results indicate that the traditional recommendations for dairy cattle of high forage/ low supplementation diets are not adequate for the local dairy industry at present. With dairy replacements, the reduced time to reach breeding weight and first lactations justifies the cost of supplementation. Locally reared heifers are about $700 to $1,000 less expensive than imported heifers even with supplementations. Thus, the need for large cash expenditures to buy imported replacements is reduced.

C. Source of Federal Funds: Hatch $707,233 FTE: 5.8

D. Scope of Impact: State Specific, PR

IV. Key Theme – Plant Health

A. (Under Hatch Funds). Weed control is among the top priorities in field management to improve yield and quality of tropical crops. Although data are not available for total weed losses in Puerto Rico, researchers estimate that weed management accounts for up to 40% of total production expenses. In this project different weed management strategies were evaluated and developed in basic grains, coffee, root crops and vegetable crops. Best weed control strategies for green-shelled and dry beans were trifluralin preplant incorporated and metachlor preemergence, both followed by bentazon and sethoxydim. Bean yields were improved from 69 to 88%. Root exudates from *Echinochloa colona* promoted root nodulation. In coffee production, trimming living mulches every 4, 6, 8 and 12 months after coffee was established reduced weed cover from 41 to 56% the third year. In root crops, plastic mulch plus paraquat controlled 100% weeds in sweet potato, better than preemergence ametryn, clomazone, and dimethenamid followed by clethodim. In vegetables, disc incorporation of mature plant residues of *Mucuna deeringiana, Cajanus cajan, Sorghum bicolor* and *Cucurbita moschata* suppressed nutsedges more than removal of residues from the soil surface. Oxyfluorfen was safe and effective for weed suppression in onion.

B. Impact – Weed management strategies were developed and are available to increase bean production and reduce imports into Puerto Rico. Suppression of weeds by living mulches may be adapted as an alternative practice to reduce herbicide applications and reduce chemical contamination in upland agro-ecosystems. Oxyfluorfen at 10 days after onion emergence could be integrated as a new tactic to reduce early weed interference more than conventional application at 15 days.

C. Source of Federal Funds: Hatch $472,535 FTE: 3.6

D. Scope of Impact: State Specific, PR

Goal II. A safe and secure food and fiber system

I. Key Theme – Food Accessibility and Affordability

A. (Under Hatch and State Funds) Information was collected on how new organizational forms, such as "alternative" farming and farmers' markets are emerging in Puerto Rico, and on their potential contribution to the stability of crop markets, food security, and local economic development. The

information needs of farmers and community projects working towards sustainable agriculture and community-based economic development have been identified and disseminated through this project's activities. Overall results suggest that the success of any future community agriculture initiative will be associated with the development of a strong educational component. Part of the expected outcomes of the presentations made is to increase the awareness of researchers, administrators and public at large of the benefits that can be derived from a stronger agro-food system, and of the alternatives now being forged to facilitate this process.

B. Impact - Research on food retail restructuring, alternative farming and farmers' 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. Stakeholder input collected through projects' activities continues to be used in the delineation of research priorities for the local Agricultural Experiment Station. This year a new Hatch project was approved, based on these revised priorities, on alternative methods of weed control in transitional organic systems—one of the information needs identified by sustainable agriculture producers interviewed in our field work.

C. Source of Federal Funds: Hatch $16,861 FTE: 0.3
State Match: $19,734

D. Scope of Impact: Multistate: PR, NY, CA, IA, MN, WI, WV

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 projects 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 – Pesticide Application

A. *(Under Hatch Funds)* – In Puerto Rico, vegetable producers rely mainly on the application of broad spectrum insecticides on a calendar basis to control insect pests. The continuous application of nonselective insecticides is a practice detrimental to the survival of natural enemies, particularly those regulating leafminer population increases. A population dynamics study of

Liriomyza spp. in cucumber, tomato and eggplant was conducted using plastic as well as cover crops. On the southern plains of Puerto Rico, serpentive and vegetable leafminers (*Liriomyza trifolii* and *Liriomyza sativa*) are secondary pests triggered to primary pest status by inadequate management practices solely dependent on sprays of broad spectrum insecticides. Under conditions of non-insecticide sprays, *Liriomyza* species are kept below damaging levels by at least four parasitoid species. Timely monitoring of these insect species combined with strip planting of companion herbs reduced the number of insecticide applications from 24 to nine (62.5% reduction). In commercial corn plantings, *Helicoverpa zea* eggs and larvae had peak numbers in winter and spring, but egg and larval populations resurged in autumn in continuous corn and tomato plantings.

B. Impact – *Liriomyza trifolii*, *L. sativae*, *Thrips tabaci* and *Helicoverpa zea* are presently considered major pests of vegetable crops in southern Puerto Rico. Reduction of broad spectrum insecticide applications will reduce production costs and the adverse impact that these products have on the environment and human well-being. It will also allow for the recovery of naturally regulating organisms, such as parasitoids. Some vegetables, such as eggplant and cucumber, may be produced without spraying for *Liriomyza*, whereas others, such as onion, may be produced with significant reduction in amount of insecticide sprays, particularly if strip planting of herbs is incorporated in the production system. Approximately $1,700/acre could be saved in production costs by reducing the number of insecticide applications with proper insect pest monitoring and timely application of control measures.

C. Source of Federal Funds: Hatch $182,477 FTE: 1.5

D. Scope of Impact: State Specific, PR

II. Key Theme – Water Quality

A. (Under Hatch and State Funds) - Field extraction is a significant advance in water quality analysis because it eliminates problems in sample handling and degradation of some unstable organic compounds. New solid phase extraction (SPE) matrices are being developed which might result in better extraction procedures and eliminate the problem of realignment of disks. A field portable solid phase extractor was prepared by using PVC pipes and connectors. Water samples were collected from a pond in the Botanical Garden of the University of Puerto Rico, Río Piedras. They were spiked with a cocktail of pesticide stock solution consisting of eight pesticides: atrazine (ATR), ametryne (AME), carbofuran (CAR), tebuconazole (TEB), diazinon

(DIA), metolachlor (MET), chlorpyrifos (CHL) and fenamiphos (FEN). The extraction was conducted with Speedisk® C18, coupled to the in-house extractor. Mean recovery percentages were 85 (ATR), 81 (AME), 78 CAR), 78 (TEB), 81 (DIA), 75 (MET), 69 (CHL) and 100 (FEN). The extractor performance was excellent and the recovery percentages were similar to those from samples collected and extracted in the laboratory. This equipment will be used to fulfill project objectives.

B. Impact – The use of pesticides in agriculture demands continued improvement in the methodology for extraction and analysis of chemical pesticides. This research will improve the analytical techniques for the analysis of crop protection chemicals. These analyses are important to water resource conservation, natural resource and ecosystem management, environmental policies and regulations, risk management and assessment in agricultural systems, and agriculture-related social and consumer concerns.

C. Source of Federal Funds: Hatch $21,115 FTE: 0.4
State Match: $24,773

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

III. Key Theme – Soil quality

A. (Under McIntire-Stennis Funds and State Funds). Coffee is grown on highly weathered soils in Puerto Rico, where production and accumulation of organic matter is essential for maintaining soil fertility and productive crop environment. Shading trees on coffee plantations may enhance the adaptability of the crop to acid soil conditions through the accumulation of soil organic matter. A field experiment was established on Alonso clay (Oxic Dystrudepts) to evaluate the effect of *Pithecellobium carbonarium*, a shading species for coffee, on soil organic matter content, soil pH, exchangeable Al^{3+}, available P and exchangeable basic cations. The treatments included a full sunlight plot, a low shade density plot, and a high shade density plot. Soil samples were collected at 0- to 20-cm and 20- to 40-cm depths. Available P was higher in the high density shade plot and decreased sharply in the 20- to 40-cm depth in all plots. The lowest soil organic matter content was observed in the full sunlight plot at the depth of 20 to 40 cm. The lowest Al^{3+} content (1.83 $cmol_c\ kg^{-1}$) was observed at 0 to 20 cm in the low shade density plot. This plot showed the highest organic matter content. The highest Al^{3+} content (9.23 $cmol_c\ kg^{-1}$) was observed at 20 to 40 cm in the high shade density plot, which showed the lowest pH. The Effective Cation Exchange Capacity (ECEC) in the low shade density plot was about 50% of the ECEC in the other two plots. Exchangeable Al^{3+} in the high

shade density plot accounted for 57% of ECEC at 0- to 20 cm depth and 79% of ECEC at 20- to 40-cm depth. In the full sunlight plot, exchangeable Al^{3+} accounted for 58% at the 0- to 20-cm depth and 68% at the 20- to 40-cm depth. At the low shade density plot, exchangeable Al^{3+} accounted for only 26% of ECEC at 0 to 20 cm, and 64% at the 20- to 40-cm depth. Inactivation of exchange sites in organic matter by Al^{3+} and the blocking of exchange sites at clay surfaces by Al^{3+}-organic matter complexes are suggested as possible causes of the decrease in ECEC.

B. Impact – Addition and incorporation of coffee leaf litter to acid soils can significantly reduce toxic levels of exchangeable aluminum, thus contributing to a better environment for root development. A better root system will result in a healthier coffee plant that will produce higher yields and last longer. Management practices to promote the accumulation of leaf litter under coffee trees should be promoted to maximize the litter beneficial effect on reducing levels of exchangeable aluminum.

C. Source of Federal Funds: McIntire-Stennis $36,375 FTE: 0.5
State Match: 65,954

D. Scope of Impact: State Specific, PR

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

I. Key Theme – Workforce Preparation-Youth and Adult

A. (Under Hatch and State Funds). To examine the impact of the Personal Responsibilities Work Opportunities Act (PRWORA) in rural women, 37 women participating in job readiness training programs sponsored by the Work Investment Act (WIA) were interviewed in five non-metro municipalities. Interviews yielded information regarding their socioeconomic characteristics, previous labor history, and perceived constraints for past and future job market opportunities. Results showed that for those attending a high school equivalency course the perceived main barrier was the lack of a high school diploma, followed by lack of transportation from their rural residences as an expected future constraint. For those attending agricultural skills training programs, some of whom had a secondary school diploma, the perceived main constraint--past and present--against gainful employment was the lack of jobs in their local areas. Lack of child care was not a main constraint for those interviewed. Compared to 58% in the U.S., only about a third (34%) of females over 16 participated in the labor force in 2000. This “forced exclusion” can have detrimental results particularly for female-

headed households under poverty levels (27% of all families in 2002). Whereas, in general, poverty rates dropped from 1998 to 2003, 75% of children in non-metro municipalities are still considered living in poverty.

B. Impact – Results of this study offer information to those with decision making power in public policy about the special needs of sub-studied populations in rural areas, such as unemployed women trying to become more self-dependent. Project outcomes further suggest that besides infrastructure, larger social investments will be needed to mitigate the inequality that fosters more poverty in rural areas.

C. Source of Federal Funds: Multistate Hatch: $20,330 FTE: 0.3
State Match: $23,849

D. Scope of Impact: State Specific, PR

STAKEHOLDER INPUT PROCESS

The internal and external evaluation process begun by the AES in the context of the current two-year Plan of Work (POW) update has continued during this past year. As before, 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 stakeholder 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 where 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 definition for our new 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 were submitted. Last year, 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 on the basis of said 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 Chair[2], 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:

[2] 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 Biosystems and Agricultural Education.

a) Commonwealth Research Funds:

Proposals are submitted to the Assistant Dean for Research with the pre-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 review 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 three to four 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 programs.

Evaluation of the Success of Multi and Joint Activities:

The Agricultural Experiment Station of the University of Puerto Rico actively participates in Multistate Research. There were eight projects conducting Multistate Research last fiscal year. Research covers disciplines such as plant breeding, pesticide detection and assessment, irrigation management, water quality, and rural sociology. Whereas 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 annual meetings have contributed to the improvement of our research program.