

UNIVERSITY OF PUERTO RICO  
MAYAGUEZ 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.

*Reporting Period:* October 1, 2001 to September 30, 2002.

*Due Date:* March 1, 2003.

*Certification:* Dr. John Fernandez Van Cleve  
Dean and Director  
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Agricultural Experiment Station  
 University of Puerto Rico  
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# 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, hereafter Agricultural Experiment Station, 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 environment and supports established and newly developed industries that process agricultural raw materials. The Agricultural Experiment Station provides technical assistance and promotes collaboration among state, federal and private intuitions. The Agricultural Experiment Station coordinates its academic activities with the teaching and extension Faculty of the College of Agricultural Sciences in the ongoing effort to implement the strategic plan that defines our programmatic goals. To advance regional goals, the Agricultural Experiment Station participates in both multistate research and Special Grants from USDA-CSREES that target the agriculture in the Caribbean Basin of the United States.

The Agricultural Experiment Station's main goals are consonant with both federal and local priorities:

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. The research program is organized in ten commodities: vegetable crops, fruit crops, root and tuber crops, plantains and bananas, coffee, basic grains, ornamental crops, meat production, dairy, and environment and natural resources.

Core funding for the Agricultural Experiment Station's research program is provided by various sources. State funds are primarily to cover salaries of academic and support personnel. USDA funding is crucial for directly financing the research program. Formula-funds include Hatch Regular, Hatch Regional, McIntire-Stennis and Animal Health. Special Grants such as the Tropical and Subtropical Agriculture Research (T-STAR) support targeted areas of research. Along with federal and state funding, there are extramural research grants and contracts such as those from the Natural Resources Conservation Service, Environmental Protection Agency, USDA-ARS, SARE-ACE, Puerto Rico's Department of Agriculture, Puerto Rico's Department of Natural Resources and other of US-Universities complement core funding.

## **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 one of the smallest of the primary economic sectors, its broader economic impact is significant, given the multiplying effects of its activities. Puerto Rico has a high import bill for food, much of which could be competitively produced locally if appropriate technology and marketing strategies were devised, disseminated and adopted among farmers, processors and consumers. Approximately 35% of our research projects (both federally and otherwise funded) 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.

Work conducted to improve our agricultural competitiveness is illustrated by studies on supplemental feeding of cattle. In recent years supplemental feeding has been studied as a way to ameliorate beef production costs and to increase efficiency and enhance the quality of the beef produced within the island. Research demonstrates that under the conditions of Puerto Rico the time required to take a bull to processing weight can be reduced from 28-34 to 20-24 months. Economical efficiencies of beef production could be increased by at least 20%. An increase of 20% in the beef production rate is equivalent to a total of 8,000,000 lb of beef (carcass weight). A reduction of beef imports is estimated in 5 to 8% resulting in the infusion of \$7.2 million into the local economy.

Plant germplasm management and incorporation into breeding programs has increased the competitiveness of local vegetable producers. The Agricultural Experiment Station has maintained a modest pumpkin research program for many years. In recent years research has focused on work modification of growth habit by selecting compact plant types. Semi-bush types of tropical pumpkin have been developed with fruit quality superior in color and texture to that of the traditional varieties grown in Puerto Rico. Variety 'Soler' released from this program has been developed and adopted by local farmers. Local acreage of tropical pumpkin is estimated at 2,000/year about 85% of which is planted by using 'Soler' or 'Soler' -type varieties. Production is estimated at 34,100,000 lb with a farmgate value of about \$ 9.0 million. High quality of the local tropical pumpkin is preferred to that of the imports.

Small farm viability is an important issue locally because the majority of farms in Puerto Rico are considered small. 'Cabezona', a triploid variety of pineapple, is grown without irrigation or mechanization by a group of small acreage farmers located in the Lajas municipality in southwestern Puerto Rico. Meteorological and edaphic conditions needed for 'Cabezona' pineapple restrict cultivation of this crop to the Lajas area. Decrease in production appears to be related to deterioration of the variety. Agricultural Experiment Station's researchers reintroduced original 'Cabezona' from the USDA-clonal

Repository in Hawaii and selected true-type ‘Cabezona’ from commercial fields. Availability of true type propagation material of the ‘Cabezona’ variety of pineapple has improved dramatically with a joint effort between the State Department of Agriculture and the Agricultural Experiment Station. A total of 400,000 plantlets have been obtained by using micropropagation and will be made available to farmers of Lajas. It is estimated that 100 acres of Cabezona pineapple will be newly planted by using selected material for a gross income estimated at \$7,500 per acre.

Hatch funds under this goal:	\$1,856,258	FTE: 17.9
Special Grant funds under this goal:	\$151,083	FTE: 3.9
Animal Health funds under this goal:	\$2,474	FTE: 1.0

***Goal II. A safe and secure food and fiber system***

Overview: Research efforts concerning Goal II at the Agricultural Experiment Station have been reduced in the last years because of retirement of the majority of food scientists at our institution. The Food Technology Laboratory has been transferred to the main Campus at Mayaguez. During this fiscal year, research under this goal was limited to a project under a Special Grant, *Modified Atmosphere Packaging for a Tropical Fruit*. Research on the prolongation of the shelf-life of plantains using modified atmosphere packaging was completed. The shelf-life of the whole green plantain was successfully extended from 3 days to 45 days. Increasing the shelf-life of tropical fruits helps to insure a more extended supply of this fruit, makes exportation feasible and increases the geographic and economic market for this crop. C.A.T.P.I., Inc., a local organization that trains handicapped persons so that they can enter the work field, will utilize the results of this study to increase the plantain business they already have going.

Special Grant funds under this goal: \$16,500 FTE: 0.25

***Goal III. A healthy, well nourished population***

The Agricultural Experiment Station had no project under this goal. Work has been reported by the Agricultural Extension Service of the College of Agricultural Sciences.

***Goal IV. Greater harmony between agriculture and the environment***

Overview: The Natural Resources and Environment Research commodity of the Agricultural Experiment Station has the primary purpose to further agricultural production and competitiveness while keeping a balance among agriculture, environment and community needs. Puerto Rico is a highly populated island with limited natural resources. Potential problems of underground water, air and soil pollution have been identified.

Research has been conducted to develop strategies to reduce use of synthetic pesticides. Species of *Liriomyza* spp. and leafminers attack vegetables and reduce yields. An integrated pest management approach was developed to managing *Liriomyza* in vegetable agroecosystems by using natural parasitoids. The utilization of herb crops like basil, marjoram and rosemary as companion crops in commercial onion fields reduced populations of thrips and leafminers, thus facilitating the effect of parasitoids and predators. In vegetables accompanied by herbs, pesticide applications were reduced from a standard number of 24 applications per cycle to nine applications. Cost of controlling both thrips and leafminers estimated at \$2,700 per field was reduced to an estimated \$1,129, more than a 50% reduction.

A project under a Special Grant corroborated the importance of magnesium nutrition on plantain performance. Farm gate value of plantain averaged \$60 million, representing about 7.5% of the local gross agricultural income. Field experiments were conducted on highly weathered soils to investigate response of plantain to magnesium fertilization. Plantain planted in Ultisols responded dramatically to magnesium application, with a 25% relative yield increase. On the basis of the results, a preventive magnesium management program was developed for plantain in highly weathered soils. Information has been forwarded to officials of the State Department of Agriculture, who are considering implementing the recommended magnesium management for both plantain and banana. If 20 to 25% yield increase is obtained in about 10,000 acres of



plantain and 2,500 acres of banana, there is potential to increase gross income of these crops by \$5 to \$7 million.

Hatch funds under this goal:	\$1,578,846	FTE: 17.0
Special Grants funds under this goal:	\$169,521	FTE: 3.2
McIntire-Stennis funds under this goal:	\$66,994	FTE: 1.1

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

Overview: The rapid economic and social transformation that Puerto Rico underwent from 1940 until the early 70s –from an agricultural to an industrial-based society – brought about improved standards of living in terms of life expectancy, education and housing, but reduced progress in terms of unemployment. Changes in the global economy since the mid-seventies, with the concomitant restructuring of major local economic sectors, have exacerbated these adverse conditions, particularly in rural areas. Although the contribution of agriculture to the gross domestic product has diminished in recent years, the continued viability of farming is critical for maintaining and improving the quality of life in Puerto Rico. The economic well-being of individuals, families and communities is an important component of what has been conceptualized as “quality of life”. Our program is directed toward providing the socioeconomic research required to formulate alternatives that can potentially enhance the economic well-being and the quality of life in rural areas.

The following project is an example of the research work concerning rural communities conducted in a collaborative effort between the Agricultural Experiment Station, Agricultural Extension Service and SARE Program of USDA. Under Hatch funds the food system profile of the Barranquitas municipality (located in the center of the island of Puerto Rico) was completed. This work was performed in conjunction with the activities of a Southern SARE project on Community Agricultural Development. The project was conducted to entail formation of community partnerships and community stakeholders working in collaboration with multidisciplinary academic teams to implement a

Community Agricultural Development model. Educational activities were carried out in collaboration with the Agricultural Extension Service and a local cooperator. Surveys were conducted among participants to obtain information needed to promote the local Farmers Market. Results from this project provided baseline data useful to local community groups, extension personnel and local government officials in the development of policies and programs promoting sustainable agricultural development and local food and agriculture entrepreneurship. With involvement in the project, Puerto Rico's Department of Agriculture has begun the process of bringing the WIC Farmers' Market Nutrition Program to Puerto Rico and has coordinated activities with the Farmers Market organizers in Barranquitas.

Hatch funds under this goal:	\$106,417	FTE: 2.1
Competitive Grant funds:	\$19,678	FTE: 0.1

**Planned Programs:**

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

I. Key Theme -- Agricultural Competitiveness

A. (Under Hatch and State Funds): Performance level of grazing animals and the concurrent beef production in the tropics is limited by the low digestible energy and protein content of tropical grasses and seasonal variations that affects the quality and quantity of pasture. During the decades of the 70s and 80s research conducted at the Agricultural Experiment Station was directed to intensify beef production emphasizing the applications of fertilizer to grass pastures managed under rotational grazing. These management practices had little acceptance among beef producers. The lack of implementation of this technology appeared to be related to high costs of fertilizer and weak prices for local beef. Supplemental feeding has been tested in recent years as a way to ameliorate beef production costs and to

increase efficiency and quality of the beef produced on the island. Senepol purebred and crossbred bull calves have been evaluated for performance in grazing and grazing plus supplemented diets. Animal diets were supplemented with either soybean meal or molasses plus urea. Supplements provided 75% of the crude protein requirements. Average daily gains were from 0.96 to 1.37 lb/head/ depending on the type of supplement. Estimated conversion of pounds of supplement to pounds of additional gain favored the animals consuming soybean meal. In the season when the dry matter availability of the pasture is low (winter), supplemented animals have been offered a mixture of corn grain and soybean meal providing also 75% of the crude protein requirement, achieving average daily gains up to 2.0 lb/day.

B. Impact: Research demonstrates that under the conditions of Puerto Rico the time required to take a bull to processing weight can be reduced from 28-34 to 20-24 months. The biological and economical efficiencies of beef production could be increased by at least 20%. In addition, a decrease of the slaughtering age should be accompanied by an improvement in beef tenderness, the most important quality trait, and thus by a greater demand for the local product. An increase of 20% in the beef production rate is equivalent to a total of 8,000,000 lb of beef (carcass weight). A reduction of beef imports is estimated in 5 to 8% resulting in the infusion into the local economy of \$7.2 million that would otherwise be used to purchase beef from other countries.

C. Source of Federal Funds: Hatch \$196,005 FTE: 1.4

D. Scope of Impact: State Specific (Puerto Rico).

II. Key Theme - Home Lawn and Gardening

- A. (Under Special Grant and State Funds): The effects of nitrogen fertilization on the quality and quantity of turfgrass were tested under contrasting ecological conditions by using turfgrass species of common use in lawns in Puerto Rico: Centipedegrass, Bermuda, *Zoysia matrella* and *Zoysia japonica*. During establishment no differences for nitrogen levels in percentage of ground cover nor in turf quality color, shoot density or uniformity of stand were observed among turfgrasses. Results suggest that nitrogen fertilizer rates used in turf can be reduced substantially because higher rates did not provide significant quality or growth attributes. In general, nitrogen in Mollisols soils is sufficient for the establishment of turf. Mollisols are common on the southern and southwestern coasts of Puerto Rico.
- B. Impact: There are discussions in southern Puerto Rico concerning possible negative effects on water quality of fertilization practices for crops and lawns. Fertilization practices for lawns will be reviewed. New management guidelines fertilizer input will be considered. Implementation of newly developed nitrogen management in lawns reduces chances for negative environmental impact of misuse of nitrogen fertilization in the environment.
- C. Source of Federal Funds: Special grants \$30,923 FTE: 1.4
- D. Scope of Impact: State Specific (Puerto Rico)

### III. Key Theme - Plant Germplasm

- A. (Under Hatch and Special Grant Funds) Vegetable crops contribute approximately \$ 28.0 million to the annual gross agricultural income in Puerto Rico. Tropical pumpkin or calabaza (*Cucurbita moschata*) occupy the second place among vegetables in terms of the amount of revenue generated from vegetables. The Agricultural Experiment Station has maintained a

modest pumpkin research program for many years. In recent years research has focused on germplasm enhancement and cultivar development, screening for resistance to diseases and insects, as well as modification of growth habit by selecting for compact plant types. Half sib recurrent selection in two breeding populations of tropical pumpkin (a semi-bush and a long vine population) has been conducted. Research has yielded varieties adapted for commercial production in Puerto Rico.

B. Impact - Semi-bush types of tropical pumpkin have been developed with fruit quality superior in color and texture to that of the traditional varieties grown in Puerto Rico. For the grower, short vined tropical pumpkin can be more easily managed. This research program has been the basis for the change in variety among local producers. Variety 'Soler' released from this program has been adopted by local farmers. Local acreage of tropical pumpkin is estimated at 2,000/year, about 85% of which is planted with 'Soler' or 'Soler' -type varieties. Production is estimated at 34,100,000 lb with a farmgate value of about \$9.0 million. Quality of the local tropical pumpkin is preferred to that of the imports. This effort has also lead to the development of an applied Station-wide project to produce high quality seed of calabaza for farmers.

C. Source of Federal Funds: Hatch \$192,155 and Special Grants \$35,000FTE:25.

D. Scope of Impact: MultiState: Puerto Rico and Florida.

#### IV. Key Theme - Plant Production Efficiency

A. (Under Hatch and Special Grant Funds). Interspecific crosses among cultivated species of beans can be used to broaden the genetic base of common beans and increase production efficiency. The identification of new

resistance genes is needed to develop breeding lines with greater or more durable levels of disease resistance. In Puerto Rico, blights are among the most important diseases limiting production of green-shelled bean planted during the warm and wet summer months. Under certain conditions, blights can cause rapid defoliation that can result in a total loss of the bean crop. Also recently developed are white-seeded bean breeding lines that combine resistance to common bacterial blight and to bean golden yellow mosaic, and tropically adapted pinto bean lines that combine the genes for resistance to rust and to bean golden yellow mosaic. PR9920-171, a light red kidney line that combines bean golden yellow mosaic resistance and heat tolerance, will be released as variety 'Rosada Mocana'.

- B. Variety 'Rosada Mocana', which shows resistance yellow mosaic and is tolerant to heat, will be released for farmer use. The use of this variety will provide small holders opportunity for better yields of green shelled bean planted during the hot wet months when disease pressure is high. The majority of the beans planted in Puerto Rico for green-shell production are the recently-released varieties 'Arroyo Loro' and 'Morales'. During the past year, we sold at the Isabela Substation of the Agricultural Experiment Station more than 6,000 lb of 'Morales' and 'Arroyo Loro'. This amount should be sufficient to plant 120 acres of beans, resulting in an on-farm income of at least \$250,000. The demand for seed at the Isabela Substation of the Agricultural Experiment Station is much greater than the supply. After purchasing seed of improved varieties, many farmers keep seed to plant on their farm.
  
- C. Source of Federal Funds: Hatch (Multistate) \$109,904; Special Grants \$35,000  
FTE: 1.45.

D. Scope of Impact: Multistate Puerto Rico, Florida.

V. Key Theme - Rangeland/Pasture Management

A. (Under Special Grant and State Funds) There are about 232,000 ha of pasture and rangeland in Puerto Rico, 49% of which is estimated to be improved pastures, 19% natural and 32% unimproved rangelands. High stocking rates and poor management, in combination with below average rainfall in some geographical areas, have caused accelerated pasture deterioration. In Puerto Rico beef production relies almost exclusively on overgrazed pastures and unimproved rangelands. Researchers at the Agricultural Experiment Station have been conducting studies to improve strategies to reduce the high costs of pasture establishment. The conventional system of pasture establishment is by plating stem sections. This system is too costly for the local beef industry. A study utilizing *Brachiaria decumbens* showed that superficial harrow with applications of registered herbicides were as good as conventional planting to recuperate pastures. In recuperated pastures, cows and heifers grazed at a rate equivalent to 40 head of 800 lb liveweight each per acre. Average dry matter offered after four grazings was 11.6 to 7.6 ton/ha. Estimated cost of planting per acre for those treatments was \$70.50 to \$137.80 per acre, depending on the treatment and the deterioration of the field.

B. Impact - The beef industry presently contributes approximately \$30 million (4.5%) to the annual gross agricultural income, and the local product represents 25% of the beef consumed in Puerto Rico. The conventional method to recover overgrazed pasture stands, which requires extensive soil preparation and planting of vegetative material (stem sections), is considered expensive (about \$650 per acre). Results of research demonstrated that the recovery of degraded pastures at a competitive cost per acre is possible by

using no-tillage in combination with herbicides. Cost of planting was found to be from \$71 to \$138 per acre. The amount of herbicide, however, and therefore total costs for pasture recovery will vary depending on the specific conditions of the field. The use of this method for recovery represents an estimated saving of at least \$100 per acre as compared to cost of conventional planting.

C. Source of Federal Funds: Special Grants \$25,180 FTE: 0.35.

D. Scope of Impact: State Specific (Puerto Rico).

#### VI. Key Theme – Small Farm Viability

A. (Under Hatch and State funds): ‘Cabezona’, a triploid variety of pineapple, is grown without irrigation or mechanization by a group of small acreage farmers located in the Lajas municipality in southwestern Puerto Rico. Meteorological and edaphic conditions restrict this crop to this location. During the decade of the 90s acreage was reduced from about 300 to 100, whereas fruit weight decreased from an average 7 kg per fruit to a 3 to 4 kg per fruit. Decrease in production appears to be associated with low market prices, absence of market plans and phenotypical deterioration of the variety. Researchers at Agricultural Experiment Station reintroduced the original ‘Cabezona’ pineapple from the USDA Plant Reservoir in Hawaii and selected true-type ‘Cabezona’ from commercial fields. Plants were propagated by tissue culture.

B. Impact: Availability of true type propagation material of the ‘Cabezona’ variety of pineapple has improved dramatically with a joint effort between the State Department of Agriculture and the Agricultural Experiment Station. Plants produced in the Tissue Culture Laboratory of the Agricultural



Experiment Station were sent to the State Department of Agriculture, which contracted micropropagation of the selected materials. A total of 400,000 plantlets have been obtained and will be made available to 'Cabezona' pineapple farmers. It is estimated that promptly 100 acres of 'Cabezona' pineapple will be planted with selected material. An acre represents a gross income of \$7,500. This work was also the basis for a collaborative agreement between the Agricultural Experiment Station and a local small corporative farm to determine cost of production of pineapple plantlets through tissue culture.

- C. Source of Federal Funds: Hatch \$46,629                      FTE: 0.4.
  
- D. Scope of Impact: State Specific (Puerto Rico).

**Goal II. A safe and secure food and fiber system**

I. Key Theme - Food Handling

- A. (Under Special Grant funds): Research efforts concerning Goal II at the Agricultural Experiment Station have been reduced in the last years because of retirement of the majority of food scientists at our institution. The Food Technology Laboratory has been transferred to the main Campus at Mayaguez. During this fiscal year, research under this goal was limited to a project under a Special Grant, *Modified Atmosphere Packaging for a Tropical Fruit*. Research on the prolongation of the shelf-life of plantains using modified atmosphere packaging was completed. The shelf-life of the whole green plantain was successfully extended from 3 days to 45 days. Increasing the shelf-life of tropical fruits helps to insure a more extended supply of this fruit, makes exportation feasible and increases the geographic and economic market for this crop.

- B. Impact - C.A.T.P.I., Inc., a local organization that trains handicapped persons so that they can enter the work field, will utilize the results of this study to increase the plantain business they already have going.
- C. Source of Federal Funds: Special Grant: \$16,500 FTE: 0.25
- D. Scope of Impact: State Specific (Puerto Rico)

### **Goal III. A healthy, well nourished population**

The Agricultural Experiment Station had no project under this goal. Work has been reported by the Agricultural Extension Service of the College of Agricultural Sciences.

### **Goal IV. Greater harmony between agriculture and the environment**

- I. Key Theme - Integrated Pest Management
  - A. (Under Hatch and State funds): In Puerto Rico vegetables contribute approximately \$28.0 million to the annual gross agricultural income in Puerto Rico. Scientists at the Agricultural Experiment Station studied the life cycle and population dynamics of *Liriomyza* spp. a thrip, and leafminer, insects that limits the production of vegetable crops in Puerto Rico. Two species of *Liriomyza* spp. (*sativa* and *trifolii*) attack vegetables, destroying the leaves and thus reducing yield. Commercial cultivars of tomato, cucumber and eggplant were planted under black plastic mulch or with *Arachis* spp. as a live cover crop to study the population dynamics of the insects and their hymenopterous parasitoids. The live cover crop (*Arachis* spp.) reduced leafminer populations and damage and increased the percentage of parasitism. Garden basil (*Ocimum basilicum*), purple basil (*O. sanctum*), southern marjoram (*Plectranthus amboinicus*), local marjoram (*Lippia micromere*) and rosemary (*Rosmarinus officinalis*) planted as companion crops along with experimental and commercial plots of onion proved to be

effective in reducing the number of thrips and leafminers. When insecticides (cypermethrin and avermectin) were applied in fields having companion crops, the number, and thus the damage, of these insect species was less than when companion crops were used alone.

B. Impact - Research has shown that continued application of broad spectrum insecticides must be avoided in vegetable agroecosystems to preclude outbreaks of *Liriomyza* spp. populations. An integrated pest management approach to handle *Liriomyza* in vegetable agroecosystems was developed by managing natural parasitoids. The utilization of herb crops like basil, marjoram and rosemary as companion crops in a commercial onion field will reduce populations of thrips and leafminers by facilitating the effect of parasitoids and predators. In vegetables accompanied by herbs, pesticide application were reduced from a standard number of 24 applications per cycle to nine. Cost of controlling both thrips and leafminers estimated at \$2,700 per field was reduced to an estimated \$1,129, more than a 50% reduction.

C. Source of Federal Funds: Hatch \$177,218 FTE: 1.7

D. Scope of Impact: State Specific (Puerto Rico).

## II. Key Theme -Nutrient Management

A. (Under Special Grant and State funds): Plantains (*Musa acuminata* x *M. balbisiana*,) rank first among crops of economic importance. Farm gate value of plantain averages \$60 million, representing about 7.5% of the local gross agricultural income. Field experiments were conducted on highly weathered soils to investigate response of plantain to magnesium fertilization. Treatments evaluated target levels of soil exchangeable

magnesium:potassium ratios. Magnesium level in the soil was observed to have significant effect on yields. Plantain crop responded dramatically to magnesium application in Ultisols, with a 25% relative yield increase in the first increment (0.6 to 2.0) in exchangeable magnesium:potassium ratio alone.

- B. Impact – About 80% of plantain and banana in Puerto Rico is produced on highly weathered soils. Therefore, there was a need to develop a preventive magnesium management program for plantain and banana. Information has been forwarded to officials of the Department of Agriculture of Puerto Rico, who are considering implementing the recommended magnesium management for both plantain and banana. If 20 to 25% yield increase is obtained on about 10,000 acres of plantain and 2,500 acres of banana, there is potential to increase gross income of these crops by \$5 to \$7 million .
- C. Source of Federal Funds: Special Grants \$32,536 FTE: 0.75.
- D. Scope of Impact: State Specific (Puerto Rico).

### III. Key Theme –Nutrient Management

- A. (Under Hatch and State funds). Based on the overall agricultural income of Puerto Rico, coffee (*Coffea arabica* L.) ranked first among the traditional crops. The 1997-98 crop was valued at nearly \$54 million representing 94% of the income generated these crops. The importance of coffee lies not only in its direct economic significance but also in its value as the principal agricultural enterprise in the mountainous region of Puerto Rico. Approximately 75,000 acres are devoted to coffee cultivation, sustaining 9% of the population of the Island. The coffee industry employs from 9 to 11 thousand laborers, thus providing gainful employment to workers in the rural areas. Researchers at AES are reevaluating the fertilization practices used in coffee nurseries.

Fertilizers have been incorporated into the traditional soil mixture used in coffee nurseries and different formulations have been evaluated for performance and cost. Treatments were granular fertilizer with minor elements, slow release fertilizer formulations, the recommended foliar fertilization and the absolute control. Monthly evaluations measured height, stem diameter, number of leaves, and incidence of diseases and overall development of the nursery plant.

B. Impact - Incorporation of fertilizer into the soil mix in the nursery is economically superior to the conventional 10 to 12 foliar applications of fertilizer. Superiority resides in the reduction of hand labor that is used for application of foliar fertilization. Application of this practice can be extended to coffee nurseries throughout Puerto Rico (about 55), which produce an estimated 7 million coffee plants each cycle. At only one cent per nursery plant, the saving to nurseries will be \$70,000 per cycle of production.

C. Source of Federal Funds: Hatch \$268,625                      FTE: 2.6

C. Scope of Impact: State Specific (Puerto Rico).

#### IV. Key Theme -Pesticide Application

A. (Under Hatch and State funds) Pigeon pea contributes approximately \$ 358,000 to the annual gross agricultural income in Puerto Rico. *Melanogramyza obtuse*, a pod borer, is a pest of recent introduction into Puerto Rico. In uncontrolled plots, average of grain damage is over 46%. Researchers have shown that pyrethroids bifenthrin, esfenvalerate and fenpropathrin have effective control over *Melanogramyza*. In Puerto Rico there is a renewed interest in reestablishing a pigeon-pea industry. The State

Department of Agriculture has built a processing plant for this legume, and over 500 new acres of this crop will be planted next year.

- B. Impact - Effective control of pod borers on pigeon pea increased production to over 270 kg per acre, with an additional farm income of more than \$600 per acre.
- C. Source of Federal Funds: Hatch \$295,823                      FTE: 3.8.
- D. Scope of Impact: State Specific (Puerto Rico).

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

I. Key Theme - Impact of Change in Rural Communities

- A. (Under Special Grant): Growers in Puerto Rico's mountainous central region have faced structural constraints that greatly hamper the practice of ecologically sound and economically sustainable farming. The municipality of Barranquitas, which in 1992 was the leading agricultural producer of the central region, is a typical central region community facing worsening structural conditions for agriculture. Twenty years earlier, farmers in Barranquitas made a successful transition from unprofitable tobacco production to coffee, food crops, livestock and ornamentals for both local and regional markets. A research project was conducted to form community partnerships and community stakeholders working in collaboration with multidisciplinary academic teams to implement a Community Agricultural Development model. Educational activities were carried out in collaboration with the Agricultural Extension Service and a local cooperator. The first activity was designed to share with the general public the results of the food system profile of the municipality. The second, a seminar targeted to farmers and agricultural professionals active in the central region, focused on

alternative marketing strategies for small and mid-sized farmers. The last activity was a one-day workshop on agroecology and sustainable farming targeted to the youth of the community. Surveys were conducted among participants to obtain information for the farmers market organizers.

- B. Impact: As a result of the information obtained, Farmers Market organizers are now considering freshness and quality for fresh fruits and vegetables offered to the public. Market organizers also increased the variety of products available and have emphasized local farming in their promotion. As a direct involvement in the project, Puerto Rico's Department of Agriculture has begun the process of bringing the WIC Farmers Market Nutrition Program to Puerto Rico and has coordinated activities with the Farmers Market organizers at the Barranquitas municipality.
- C. Source of Federal Funds: Hatch \$16,976 Competitive Grants \$19,678 FTE: 0.5
- D. Scope of Impact: State Specific (Puerto Rico)

**Stakeholder Input Process:**

The Agricultural Experiment Station's stakeholders include farmers, non Agricultural Experiment Station scientists, government officials, extension faculty and private individuals and groups who work with the particular commodity. As stakeholders, women are frequently represented among government officials, private individuals or representatives of private groups. As stated previously, the research program at the Agricultural Experiment Station includes ten commodities. Members of the commodities and the Associate Dean for Research and the Deputy Director for Research meet at least once every year to summarize and analyze progress of research projects. These meetings promote cooperation among the administrators, scientists, teaching and extension faculty

and stakeholders. Stakeholder representatives participate actively in the discussions and decision making process. Usually the commodity group and stakeholders evaluate feasibility of new proposed research projects and update the commodity strategic plan.

**Program Review Process:**

There have been no significant changes in our Program Review Processes since our Five-Year Plan of Work was submitted.

**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 within Multi-State Research last fiscal year. Research covers disciplines such as plant breeding, pesticide detection and assessment, and rural sociology. Our program has been expanded with two additional projects, one dealing with irrigation and the other with development of bioherbicides. Results of the activities continue to help in the solution of research problems.