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, 2000 to September 30, 2001.

*Due Date:* March 1, 2002.

*Certification:* Dr. Ernesto O. Riquelme

Acting Dean and Director
College of Agricultural Sciences

University of Puerto Rico
Agricultural Experiment Station

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ANNUAL REPORT OF ACCOMPLISHMENTS AND RESULTS

University of Puerto Rico

Agricultural Experiment Station

**General Overview**

The University of Puerto Rico's Agricultural Experiment Station (AES - UPR) conducts basic and applied research needed to achieve an economically viable agricultural sector in Puerto Rico. Research is conducted to strengthen the industries that process agricultural raw materials and to stimulate rural development, while conserving our natural resources and environment. AES - UPR coordinates academic activities with the Faculty of the College of Agricultural Sciences and the Agricultural Extension Service in the ongoing development of a strategic plan defining our programmatic efforts.

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

1. To develop technology for achieving a sustainable agricultural production system that is 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, agroindustries, and public agencies that lack specialized personnel or research facilities present at AES - UPR.
4. To develop agricultural technology compatible with the preservation 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 are concentrated in goals one and four of the national goals.. The research program is organized in eleven commodities: vegetable crops, fruit crops, root and tuber crops, plantains and bananas, coffee, basic grains, sugarcane, ornamental crops, meat production, dairy and environment and natural resources. Funding for AES - UPR research is provided by various sources. USDA funding is crucial to the overall research program. Formula - funds include Hatch Regular, Hatch

Regional, McIntire-Stennis and Special Grants. Special Grants such as the Tropical and Subtropical Agriculture Research (T-STAR) support targeted research areas of our research program. Along with federal funding, State funds contribute significantly to our funding. Extramural research grants and contracts, such as those from the Natural Resources Conservation Service, Environmental Protection Agency, USDA-ARS, SARE-ACE, Puerto Rico Department of Agriculture, Puerto Rico Department of Natural Resources, and other of US - Universities complement funding.

**Executive Summary**

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

Overview: Agriculture is a sector of strategic importance to Puerto Rico both in terms of its present and its potential contribution to the economy. While its one of the smallest of the major economic sectors its broader economic impact is significant, given the ripple 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 are devised and disseminated among farmers, and, if emerging problems are investigated to formulate viable solutions.

National Goals I and IV utilize the majority of both human and financial resources of AES-UPR. Around 70% of our research projects (both federally and otherwise funded) are ascribed to these goals. These projects are in line with the furtherance of agricultural production; the long-term critical issue is targeted by this goal.

An illustration of achievements for goal one is research projects which are conducted to improve animal production efficiency. After three breeding seasons when Senepol x Charbray (SxCh), Senepol (S), and Charbray (Ch) cows mated to S and Ch bulls, the calving intervals were shortened, birth weights of both male and female calves increased for some crosses. Higher calving rates, survival rates, and weaning rates can be achieved by introducing into the island's breeding herds crossbred cows that are well adapted to their production environment. An increase of only 5 percent in weaning rate in a population of 50,000 breeding cows represents an estimated cash value of $792,000 and an increase in beef production of 1,567,500 lb with a cash value of $ 1.4 million

In another study concerning animal production efficiency Senepol purebred and crossbred bull calves were put to graze on guinea grass immediately after weaning. Animals were supplemented for 104 days with either soybean meal or molasses + urea. Estimated conversion of pounds of supplement to pounds of additional gain favored the animals consuming soybean meal compared to those on non-supplemented groups. If 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 percent. The 20 percent increase is equivalent to a total of 8, 000,000 lbs of beef (carcass weight) with a cash value of $7.2 million. In addition, a decrease of the slaughtering age should be accompanied by an improvement in beef tenderness, the most important quality trait.

Minor crops account for 100% of Puerto Rico's crops. Six magnitudes of residue and one residue decline GLP (Good Laboratory Practices) trials were established. Performance and magnitude of residue data are needed to register pest control and resistance management alternatives and to establish the most effective control schedules for an economically feasible production of tropical crops. Under Hatch financing, trials on pesticide efficacy were conducted for tropical crops including avocado, yam-seed, banana, mango, pigeon pea, tanier, apio, cilantro, recao, coffee, papaya and cassava.

After a four-year study under a Special Grant, two varieties of tropical type sweet potato were selected for commercial production. These will be released next fiscal year. Both have improved physical characteristics of the roots for marketability purposes. A 10 to 15 percent increase in yield and marketability is expected under commercial situations by the use of selected varieties. This increase in yield represents approximately an additional $40.00 per acre at the farm-gate price.

Under another Special Grant, the effects of nitrogen levels and evapotranspiration replenishment treatments were evaluated for four turfgrasses: Bermuda, Centipedegrass; Zoysia manila and Zoysia meyer. Previous information on commercial turfgrasses under nitrogen levels and diverse environmental conditions was not available to local turfgrass producers nor to landscape developers. The results provided a quantitative base for their respective commercial operations. In addition, results indicate that N fertilizer rates traditionally used for sod production can be reduced substantially by using appropriate fertilizer management guidelines.

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| Hatch funds under this goal: | $2,281,523 | FTE: 19.4 |
| Special Grant funds: | $121,534 | FTE: 1.7 |
| Animal Health: | $30, 208 | FTE: 0.5 |

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

Overview: Research efforts concerning Goal II at the AES-UPR have been reduced in the last years because of retirement of the majority of food scientist 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 unde r a Special Grant, *Modified Atmosphere Packaging for a Tropical Fruit*. Research on the prolongation of the shelf -life of plantains using modified atmosphere packaging (MAP) was completed. The shelf -life of the green whole plantain was successfully exten ded 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 organizati on 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: $11,424 FTE: 0.0 (researcher was not a AES -UPR faculty)

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

AES-UPR had not project under this goal.

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

Overview: AES commodity of Natural Resources and Environment has as its purpose to further agricultural production and competitiveness while promoting 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. In the central mountain range, farming activities and urban developments have been associated with soil erosion and reduction in quality and quantity of water supply.

Plantain and banana production plays an i mportant socioeconomic role in numerous regions of the Caribbean and Pacific Basins areas of the US. A project under a Special Grant corroborated the importance of magnesium nutrition on plantain performance. Magnesium nutrition increased the overall productivity. Soil analyses performed at different depths revealed a significant downward movement of magnesium in this soil. In consultation with Agricultural Extension Service personnel, soil and plant tissue analyses were conducted on different banana f arms of two of the major production zones of the island. Results supported the contention that initial soil exchangeable Mg levels constitute the most important limiting factor controlling Mg nutrition in plantains and bananas. Diagnostic criteria for a -priori

identification of soil conditions and management practices most likely to result in Mg deficiencies in plantains and bananas have been established. A preventive Mg management program for plantains and bananas on highly weathered soils was developed .

Underground water quality of wells located on the south coast of Puerto Rico was assessed. For a period of four years, six water wells, located on farms in three municipalities on the south coast, were sampled each month. Water was tested for $NO_3$-N, $NH_4$-N, $PO_4$, Ca, Mg, K, pH and conductivity. $NO_3$-N levels found in the six underground wells exceeded the level of 10 mg/L (critical level) in at least two of the samplings of each well. These findings indicate that nitrogen is leaching to groundwater from fertilizers or from other sources such as septic tanks or from a combination. Our findings indicate that nitrate is leaching and affecting groundwater quality.

Integrated pest management experiments were established to determine the effect of crop association systems in the population dynamics of *Empoasca papayae*, scale insects and aphids on papaya plantations in Puerto Rico. In plots with highly reflective plastic mulch, the incidence of papaya virosis decreased as compared to the other evaluated crop systems. Results showed that the insecticides did not significantly reduced the incidence of virosis disease in papaya. The use of a cover association system, conversely, will reduce the incidence of papaya virus diseases and will provide sufficient weed control at a lower cost than the traditional system.

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| Hatch funds under this goal: | $2,145,344 | FTE: 1.8 |
| Special grants: | $312,307 | FTE: 2.2 |
| McIntire-Stennis | $154,100 | FTE: 1.2 |

**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 exacerb ated 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 AES-UPR concerning rural communities. Under Hatch funds the profile of the Barranquitas Municipality (located in the center of the island of Puerto Rico) food system, was completed. This work was performed in conjunction with the activities performed under a Southern SARE project on Community Agricultural Development. Interviews with farmers and community leaders showed that one of the most important obstacles to the development of local agriculture is the lack of new marketing channels for farm produce, particularly at peak harvesting time. A monthly local Farmers' Market was organized in an effort to address this problem. Results from the study were shared with the community in presentation at the *Festival del Apio,* a local agricultural fair, in a workshop on sustainable agriculture offered to 4-H youth from the targeted municipality. A leaflet summarizing the project's highlights was distributed. 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.

Hatch funds under this goal: $138,762 FTE: 2.3

**Planned Programs:**

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

I. Key Theme - Animal Production Efficiency

A. (Under Hatch funds PR-H380) After three breeding seasons Senepol x Charbray (SxCh), Senepol (S), and Charbray (Ch) cows mated to S and Ch bulls showed the pregnancy and calving rates, 92.3-81.17, 87.8-87.6 and 83.04-77.7 percent respectively. The SxCh weaned 91.69% of their calves; the Senepol, 90.36 percent; the Charbray, 81.53 percent. Calving intervals were shorter for the SxCh (355.3 days) and Ch dams (358.2 days) than for the S (390.9 days). As expected, weight loss during lactation was greater in the SxCh and S groups than the Ch (-27.3 and -18.08 vs.

+41.25 lb/cow/lactation period). Birth weights of male and female calves were higher in the SxCh and S than in the Ch groups (male calves 80.5, 79.4 vs. 73.6 lb; female calves 71.4, 72.2 vs. 68.9 lb, respectively). Efficiency ratios of calf 205 days adjusted weaning weight/dam weight (CAWW/DW) and CAWW/DW x weaning rate favored the SxCh crossbred dams over the Ch and S (50.65; 45.0 vs. 47.4; 37.7 and 44.1; 38.7 percent, respectively). Male calves 240 days adjusted weaning weights were higher in the SxCh (505.5 lb) and Ch (501.0 lb) than in the S (451.7 lb) cows. Female calves 240 days adjusted weaning weights were also lower for the Senepol cows. Male calves Ch(SxCh), SxCh, and S(ChxS), and female calves SxCh, Ch and Ch(SxCh) were the heaviest of all breed of sire and breed of cow combinations.

B. Impact - Higher calving rates, survival rates, and weaning rates can be achieved by introducing into the island's breeding herds crossbred cows that are well adapted to their production environment, and that have outstanding characteristics for fertility, mothering, and milking ability. An increase of only 5 percent (from 60 to 65 percent) in weaning rate in a population of 50,000 breeding cows would represent: i) an increase of 8 percent (+2,500) in the production of weaner calves with an estimated cash value of $792,000 (assumptions: average weight 450 lb; price per pound of live-weight for male and female calves of $0.70). ii) an increase in beef production of 1,567,500 lb with a cash value of 1.4 million dollars (assumptions: 90 percent of the 2,500 male/female feeder calves are taken to a slaughter weight of 1,100 lb., 56 percent dressing percentage and $.90/lb hot carcass weight).

C. Source of Federal Funds: Hatch $34,607 FTE: 0.3.

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

II Key Theme - Grazing:

A. (Under Hatch funds PR-H392): Forty-eight Senepol purebred and crossbred bull calves were put to graze on 32.76 acres of guinea grass (*Panicum maximum* Jacq.) pastures immediately after weaning. Animals were supplemented for 104 days, with either soybean meal (T2; n=16) or molasses + urea (T3; n=16) in a Complete Randomized Block Design (4 blocks; 3 treatments). Supplements provided 75 percent

of crude protein (CP) requirements (500 lb medium frame bull calf gaining 1.5 lb/day) and similar amounts of net energy for gain (NEg). Animals were fed an average of 2.07 lb/head/day of soybean meal (SM) and 3.84 lb of molasses + urea (MU). Average daily gains (ADG) were 0.96, 1.74 and 1.37 lb/head/day for the calves grazing alone (T1) and for the SM and MU fed groups, respectively. Estimated conversion of pounds of supplement to pounds of additional gain favored the animals consuming the SM over the MU-fed groups (2.65 vs. 9.36 lb of supplement/lb additional gain). In a second grazing trial, the effect of supplementing young bulls during seasonal restrictions on pasture growth, with a low or high level of CP, is under evaluation. Supplements are expected to provide 35 (T2) and 85 (T3) percent of CP requirements (900 lb medium frame bull gaining 2.0 lb/day), and similar amounts of NEg. After 42 days of grazing, the animals in T3 are showing the highest ADG (0.832 lb/head/day) followed by those in T2 (0.354 lb/head/day). Non-supplemented groups are losing -0.154 lb/head/day.

B. Impact - If 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 percent. In addition, a decrease of the slaughtering age should be accompanied by an improvement in beef tenderness, the most important quality trait, and by a greater demand for the local product. An increase of 20 percent in the beef production rate. This 20 percent increase is equivalent to a total of 8,000,000 lbs of beef (carcass weight) with a cash value of $7.2 million (assumptions: final slaughter weight 1,100 lb; dressing percentage 56 percent; carcass price/lb $0.90). A reduction of beef imports (5-8 percent) resulting in the infusion of $7.2 million into the local economy that would otherwise be used to purchased beef from other countries.

C. Source of Federal Funds: Hatch $63,840.00 FTE: 0.5.

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

II Key Theme - Ornamentals

A. (Under Special Grant funds, T-STAR 73) The effect of nitrogen levels on the performance of turfgrasses was evaluated. Turfgrasses were Bermuda: Centipedegrass; Zoysia manila; Zoysia meyer. Spreading ability of Bermudagrass was significantly

greater than that of the other varieties. Maintenance requirement order determined by the amount of dry matter per square meter collected during clipping operations were Bermuda; Centipedegrass; Zoysia manila; Zoysia meyer for all N levels and locations studied. Evaluation indicated that turfgrass varieties under four evapotranspiration replenishments differed in drought resistance and persistence under variable irrigation regimes.

B. Impact - Previous information on commercial turfgrasses under nitrogen levels and diverse environmental conditions was not available to local turfgrass producers nor to landscape developers. The results provided a quantitative base for their respective commercial operations. In addition results indicate that N fertilizer rates traditionally used for sod production can be reduced substantially by using appropriate fertilizer management guidelines.

C. Source of Federal Funds: Special Grants $31,449 FTE: 0.63

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

IV Key Theme - Plant Production Efficiency

A. (Under Special Grant funds, T - STAR - 65) Three tropical type varieties and one substaple type variety of sweet potato were harvested 126, 141 and 162 days after planting. The fresh weight distribution for individual roots was evaluated for normality by using the Kolmogorov - Smirnov test. None of the varieties showed a normal distribution. Roots between 150 - 450 g harvested at 141 and 162 days after planting were subjected to three treatments: raw, boiled and microwaved. They were dried and ground into flour. Sugar was extracted from flour. Glucose, fructose, sucrose and maltose concentrations were determined by liquid chromatography. Maltose was the most concentrated after cooking. Sugar concentrations and relative sweetness varied among varieties. When evaluated raw, tropical - types had concentrations of glucose and fructose higher than the substaple type. Two new accessions of the tropical type have been selected for commercial production. Both have improved physical characteristics

of the roots for marketability purposes. A 10 percent increase in yield and marketability is expected under commercial situations.

B. Impact - A quantitative selection index for sweetness in tropical type sweet potato will be developed from data obtained from this study. Two varieties of tropical type sweet potato were selected for commercial production. These will be released next fiscal year. Both have improved physical characteristics of the roots for marketability purposes. A 10 to 15 percent increase in yield and marketability is expected under commercial situations by the use of selected varieties. This increase in yield represents approximately an additional $40.00 per acre at the farm-gate price.

C. Source of Federal Funds: Special Grants $12,225.00 FTE: 0.42

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

V. Key Theme - Rangeland and Pasture Management

A. (Under Special Grant funds, T-STAR 78). The study at the Corozal Substation was established May 23, 2001, as planned, utilizing *Brachiaria decumbens* cv. Basilisk. The area selected for the experiment was overgrazed and covered with *Paspalum millegrana* (common name: Cortadera) over 60% of its surface. This grass species is rejected by the bovine. Seven treatments were installed following the study's protocol. Variables such as plants/m2, surface coverage percentage and weed percentage were recorded once a month. November (5.5 months after establishment), data indicated that treatments 1 (one superficial harrow disc pass only), 6 (non-tillage, one application of a mixture of Round-up and Tordon) and 7 (conventional planting) were the most successful with *Bracchiaria decumbens* plants/m2 were 13, 12 and 14% respectively. In the same order, surface coverage with the introduced grass was 35, 31 and 49%. Plots were already wired for mob-grazing by the end of January 2002. Cows and heifers will graze at a rate equivalent to 40 heads of 800 lb-liveweight/acre. Grass recovery after mob-grazing and trampling will be evaluated. At Lajas Substation, the study was installed for the second time September 28, 2001. *Andropogon annulatus*

(common name: Pajon) was the predominant weed in the selected area. The first attempt in October 2000 failed in this semiarid location because of lack of rain at the time of study establishment and the unsuccessful irrigation by flooding. Furthermore, *Cenchrus ciliaris* cv. Texas was not aggressive enough to compete with native species such as Pajon. *Brachiaria decumbens* was selected as the grass to be introduced in the pasture in this second attempt study at the Lajas Experiment Substation.

B. Impact - Recovery of pastures degraded because of overgrazing with the introduction of productive grass species with minimum tillage will have beneficial effects in the local beef industry. If minimum tillage proves to be effective, costs to recuperate degraded pastures will be reduced and cattlemen may be willing to incorporate this technique on their farms. The improvement of cattle nutrition is fundamental for a successful animal production operation.

C. Source of Federal Funds: Special Grants $25,180* FTE: 0**

*Special grant. **Dr. Danilo Cianzio, director for this progect, is ascribed to the Faculty of Agriculture, thus FTE is zero for the AES purposes.

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

VI Key Theme - Tropical Agriculture:

A. (Under Hatch funds PR - H372): Six magnitudes of residue and one Residue Decline GLP (Good Laboratory Practices) trials were established or completed for: imidacloprid in avocado sucking insects; fludioxonil in yam storage rot; difenoconazole in yam seed rot; and imidacloprid for the control of banana corm borer. In a performance study for the control of anthracnose in mango, the azoxystrobin treatment resulted in the highest number of fruits retained and harvested, and strobilurin compounds were more effective in protecting the fruit after harvest. In another performance trial, strobilurin compounds were effective in controlling anthracnose in yams. Other performance trials were coordinated and in various stages of completion for avocado (sucking insects);

pigeon pea (pod fly, pod borer, leafhoppers); and tanier (mal seco). IR -4 Pesticide Clearance Requests were submitted for mango (anthracnose, sucking insects); avocado (mites, thrips, sucking insects); yam (anthracnose); apio (seed rot); pigeon pea (pod fly, pod borer, leafhoppers); cilantro (alternaria); recao (cercospora); coffee (leafminer); papaya (anthracnose, powdery mildew); cassava (mites); and greenhouse vegetables (botrytis). Tropical crop research needs for 2001 -2002 were prioritized.

B. Impact - Minor crops account for 100% of Puerto Rico's crops. There are very few, and in some cases, no alternatives for the control of pests and diseases in tropical crops. Performance and magnitude of residue data are needed to register pest control an d resistance management alternatives and to establish the most effective control schedules for an economically feasible production of tropical crops.

C. Source of Federal Funds: Hatch $97,989.00 FTE: 1.4

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, T -STAR 72). Experiments on the prolongation of the shelf-life of Maricongo plantains using modified atmosphere packaging (MAP) were completed. The shelf -life of the green whole plantain was successfully extended the from 3 days to 45 days. This is the second project to be completed with the fundi ng for the Modified Atmosphere Packaging for a Tropical Fruit Mixture project in four years. The shelf life for cubed mangoes and pineapples was extended from 5 to 25 days using MAP.

B. Impact - Increasing the shelf -life of tropical fruits i nsures extended supply of this fruit, makes exportation feasible and increases the geographic and economic market for these projects. C.A.T.P.I., Inc., an organization that trains handicapped persons so that they can enter the work field, identified the p lantain project as something they would like to

see done. They will utilize the results of this study to increase the plantain business they already have going.

C. Source of Federal Funds: Special Grants $11,424.00. FTE=0.0*

*Dr. Carolyn Harper, director for this progect, is ascribed to the Faculty of Agriculture, thus FTE is zero for the AES purposes.

D. Scope of Impact: Puerto Rico and other tropical and subtropical regions of the United States.

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

AES of the UPR had no research projects under this goal.

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

I. Key Theme - Biological Control:

A. (Under Special Grants, T - STAR 74) The effect of poultry litter was evaluated in two separate field experiments for the management of plant - parasitic nematodes on plantain (*Musa acuminata* X *M. balbisiana*) cv. Maricongo and pumpkin ( *Cucurbita moschata* cv. Soler) at Corozal and Isabela Substations, respectively. The pumpkin experiment was established on a root - knot infested soil during May 2001. The amendment was applied at rates of 0 (absolute control), 16.5, and 32.9 kg/plant, alone or with phenamipho s (1.5 g a.i/plant). Also a treatment with phenamiphos at 1.5 g a i/plant was included (chemical control). Plots treated with poultry litter at 16.5 and 32.9 kg/plant yielded almost 2.5 times more fruit weight than those from absolute control and chemical control. Also, the use of poultry litter reduced root damage caused by M. incognita. A total of 4 genuses of fungi belonging to 17 isolates were found in soil before amendment treatment. The most common fungi found were *Trichoderma*, *Penicillium*, *Fusarium* and *Aspergillus*. The plantain experiment was established in April 2001.

Amendment rates used in this study were 7.3 and 14.5 kg/plant. Also an untreated control (0 kg amendment/plant) and a chemical control (phenamiphos 3.0 g a i/plant) were used to compar e with amendment treatments. Plant development has been favored in plots treated with poultry litter. Nematode population from plots treated with poultry litter remained lower than in plots treated with phenamiphos (standard nematicide for plantain product ion in the Caribbean). Isolation of microorganisms (fungi and bacteria) from rhizospheres of pumpkin and plantain continues in progress. We are in the process of growing most isolated fungi and bacteria on chitin -amended media to test for chitinolytic acti vity in these groups of microorganisms.

B. Impact - Results from this project will help with the proper use and disposal of poultry litter in agricultural soils. Microorganisms promoted by the amendment as sources of biological control agents for plant - parasitic nematodes, thus reducing the dependence on synthetic.

C. Source of Federal Funds: Special Grants $22,696. FTE:0.05.

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

II Key Theme - Integrated Pest Management

A. (Under Special Grant, T - STAR 80) Experiments were established to determine the effect of crop association systems in the population dynamics of *Empoasca papayae*, scale insects and aphids on papaya plantations in Puerto Rico. The fields were divided into four treatments, which included cover crop plots with *Wedelia trilobata*, highly reflective plastic mulch, black plastic mulch and bare soil. In plots with highly reflective plastic mulch, the incidence of papaya virosis continued to decrease as compared to the other evaluated crop sys tems. No effects were observed on the incidence of papaya bunchy top disease. A new mite infesting papaya in Puerto Rico was identified as *Eotetranychus lewisi* and a new record for the scale insect *Paracoccus marginatus* was also reported. Ten aphid species were identified in the water pan traps in papaya fields. Many of them had been reported as vector of papaya virosis and virosis in other

crops. More aphids were captured in Isabela than in the Corozal plantation but leafhoppers were more abundant in Coro zal than in Isabela. Aphids were more abundant in May in both localities but were captured almost all year. The abundance of these insects also affected the diseases present in both areas. The bunchy top was more common in Corozal and the virosis was more common in Isabela. An additional experiment was established in Isabela to determine the effect of insecticide treatments on the *dispersion* of bunchy top and virosis diseases in papaya. The insecticide malathion, and orchard oil solution, alone or in comb ination were sprayed two times per month for 8 months. The results showed that the insecticides did not significantly reduce the incidence of virosis disease in papaya.

B. Impact - The movement of pests and natural enemy population between crops and cover association systems was documented. The use of a cover association system will reduce the incidence of papaya virus diseases and will provide sufficient weed control at a lower cost than the traditional system.

C. Source of Federal Funds: Special Grants $23,850 FTE: 0.47.

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

III Key Theme - Nutrient Management:

A. (Under Special Grant, T - STAR 70) Results from this project corroborated the importance of magnesium nutrition on plantain. As with the plant crop, results obtained from the first and second ratoon crops indicated that improved Mg nutrition increased the number of leaves available at flowering, as well as the bunch weight and overall productivity. A significant reduction in yield was observed with planting sequence, that is, plant crop > first ratoon > second ratoon. However, the drop was much more pronounced in Mg deficient plots. Only 32% of the control plants in the first ratoon crop reached flowering stage in contrast with close to 75% for the magnesium amended treatments. Soil analyses performed at different depths revealed a significant downward movement of magnesium in this soil. A year after the application of magne sium treatments an increase of 448% over control levels was observed at a depth of 30cm at

the highest magnesium level. Potassium remained relatively stable with time, exhibiting little movement within the soil profile. In consultation with Agricultural Extension Service personnel, soil and plant tissue analyses were conducted on different banana farms of two of the major production zones of the island. Results supported the contention that initial soil exchangeable Mg levels constitute the most important limiting factor controlling Mg nutrition in plantains and bananas. The estimated soil exchangeable Mg critical value varied significantly between soils of the two regions.

B. Impact - Plantain and banana production plays an important socio-economic role in numerous regions of the Caribbean and Pacific basins. Diagnostic criteria for a-priori identification of soil conditions and management practices most likely to result in Mg deficiencies in plantains and bananas have been established. A preventive Mg management program for plantains and bananas on highly weathered soils was developed.

C. Source of Federal Funds: Special Grants $36,987 FTE: 0.64

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

IV Key Theme - Soil Erosion

A. (Under McIntire-Stennis, MS-010) The adaptation of 10 trees, 27 grasses and 17 turf legumes was evaluated in three highly eroded landscapes of Puerto Rico. Species development was adequate at the Corozal site, intermediate at the Vega Baja site and poor at the Orocovis location. At Coro zal, tree species Albicia procera and Peltophorum inermes, grass species Brachiaria decumbens and the ground cover legume Desmodium heterophilum were significantly better in adaptation. At the Vega Baja location the tree species Leucaena leucocephala K636 was the best in adaptation. At the three locations, native tree species were significantly inferior in development and adaptation in comparison with the above-mentioned tree species. At the Corozal site, grasses and turf legumes were significantly better for reducing soil erosion and improving fertility than trees and bare ground. Development and adaptation of grasses and turf legumes was considerably inferior at the Vega Baja and Orocovis locations. At both

locations, the initial response of grasses and t urf legumes to the application of chemical fertilization was low, because of the advance loss in fertility of these locations. At the Vega Baja and Orocovis locations it is necessary to establish another research project to measure the response of bioferti lization and soil improving polymers. Soil dissolved organic carbon was an adequate parameter to determine differences in soil fertility between the different germplasm under evaluation.

B. Impact: The selection of soil transforming germplasm accelerate restoration of tropical soils in an advance stage of degradation while reduces the possibilities for erosion.

C. Source of Federal Funds McIntire-Stennis: $34,867 FTE:0.7

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

II. Key Theme - Water Quality

A. (Under Hatch funds H-362). Nitrogen sources (urea, ammonium sulfate, soluble fertilizer 33-0-0, and granular fertilizer 10-10-8) were evaluated in a pumpkin field in a Mollisol in order to study the concentration and movement of $NO_3$-N in the soil. Nitrogen was applied at a rate of 224 kg/ha via fertigation, except for the granular fertilizer. Soil samples were taken before planting, 40, 64 and 93 days after planting. Nitrate-N concentration in all treatments at the 0-20 cm depth was higher than that at the 20-40 or 40-60 cm, thus indicating slow movement of $NO_3$-N through the soil profile. At almost all sampling times and sampling depths the highest $NO_3$-N concentrations were observed when granular fertilizer was used, indicating inefficient use of the fertilizer by the plants. For a period of four years, six water wells, located on farms in three municipalities on the south coast of the island were sampled each month. Water was tested for $NO_3$-N, $NH_4$-N, $PO_4$, Ca, Mg, K, pH and conductivity. During the 4-year period, $NO_3$-N levels found in the six underground wells exceeded the maximum contaminant level (10 mg/L) in at least two of the samplings of each well. These findings indicate that nitrogen is leaching to groundwater either from fertilizers, from other sources (e.g., septic tanks) or from a combination. We took soil samples from two irrigation experiments at Lajas (Vertisol) and Juana Diaz (Mollisol) substations

to study nitrate movement through the soil profile. Pumpkin was drip irrigated at rates of 25, 50, 75 and 100 percent of the amount lost the previous week by evaporation. Nitrogen was applied, via fertigation, at the rate of 168 kg/ha. At Lajas, at all depths sampled after harvesting the crop, the highest levels of $NO_3$-N were observed in plots where 100 percent of the water lost by the crop was applied, indicating that $NO_3$-N moved with the water throughout the soil profile. However, at Juana Diaz the highest levels of $NO_3$-N at the 30-60 and 60-90 cm depths occurred where only 25 percent of the water lost by the crop was applied.

B. Impact - Findings indicate that nitrate is leaching and affecting groundwater quality. A possible source of contamination is the improper application of nitrogen fertilizer in the agricultural activities of the vegetable producing area, where drip irrigation is used.

C. Source of Federal Funds: Hatch $89,414 FTE:1.0

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

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

I. Key Theme - Change in Rural Communities

A. (Under Hatch funds H-388) During this year we conducted the data analysis and interviews needed to complete the profile of the Barranquitas food system, in conjunction with the activities performed under a Southern SARE project on Community Agricultural Development. Interviews with farmers and community leaders showed that one of the most important obstacles to the development of local agriculture, perceived by producers and leaders alike, is the lack of new marketing channels for farm produce, particularly at peak harvesting time. A monthly local Farmers' Market was organized this year to address this problem, but organizers felt that they needed more information on how to improve the operation of the market and on other direct marketing strategies that could be followed by producers. Accordingly, a seminar on alternative marketing strategies for small and mid-sized farmers was organized by the leaders of this project in collaboration with the local Agricultural Extension Service. At

the annual *Festival del Apio*, a local agricultural fair, we also conducted a small survey of consumers sponsoring a local Farmer's Market both to complement the data already gathered and to assess the Market's future perspectives. Results from the study were also shared with the community in a poster presentation at the *Festival del Apio,* at a workshop on sustainable agriculture offered to 4-H youth from Barranquitas, and by a leaflet summarizing the project's highlights distributed during the marketing seminar. At present, we are writing the food system profile of Barranquitas.

B. Impact - Results were 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. This year's alternative marketing seminar served to exchange ideas with the current Marketing Director of the local Department of Agriculture on ways in which public marketing policy could help the plight of highland producers.

C. Source of Federal Funds - Hatch: $15,107 FTE: 0.4.

D. Scope of Impact: State Specific PR.

**Stakeholder Input Process:**

Research program at the AES-UPR is divided into eleven research-commodities. Members of the commodities (primarily agricultural scientists) and the Deputy Director for Research meet at least once every year to summarize and analyze the research projects, to evaluate feasibility of new proposed research projects. The Commodity Strategic Plan that is updated annually, uses this input. At each of these meetings stakeholder representatives are invited and expected to participate actively in the discussions. Stakeholders include farmers, non AES-UPR scientists, government officials, extension agents and private individuals and groups who work with the particular commodity. Primary reasons for using stakeholder input are to learn from their experiences concerning on-farm and agroindustry research needs, and to promote better interpersonal relations with our clientele. The criteria for identifying the stakeholders were first, persons interested in the study and the utilization of the findings;

second, persons with power to implement the findings or who are able to influence those who have the power and those who have the commitment to attend the meetings and perform the required work.

**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:**

AES-UPR actively participates of Multi - State Research, projects within Multi - State Research average 10 per fiscal year. Results of the activities continue to help in the solution of research problems. As stated in the five year POW, each multi - state project has its specific short and intermediate term critical issue (s), which were reviewed in the co mmodity meetings.

Additional efforts by the AES - UPR should be made to incorporate under represented population as stakeholders. Small farmers and women are encouraged to participate in the annual commodity meetings. As stakeholders, women are frequently represented among government officials, private individuals or representatives of private groups.