ANNUAL REPORT FOR ACCOMPLISHMENTS AND RESULTS

GUAM FY-2003

Location

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Executive Summary

Guam, an unincorporated Territory of the United States, is located in the Western Pacific at 13 degrees north latitude and 144.4 degrees east longitude. It is the largest of 16 islands in the Mariana archipelago. It is approximately 3,600 miles west-southwest of the Hawaiian Islands and about 1,500 miles due east of Manila, Philippines. According to the 2000 census, Guam's population is 154,805. About forty percent of the population is under 20 years old. Twenty-three percent of the population lives in poverty. The ethnic background of the island includes: Chamorro (native islanders), Filipinos, Caucasians (including members of the U.S. Armed Forces and their dependents), other islanders (Micronesians and Palauans) and Asians (Koreans, Japanese and Chinese). The ethnic composition includes 37% Chamorro, 27% Filipino, 6.8% Caucasian and 29.9% other (i.e., Pacific Islanders other than Chamorros and Asians).

On June 22, 1972, the U.S. Congress passed Public Law 92-318, which designated the University of Guam as a member of the 1862 Land Grant institutions. In recognition of the University of Guam's land grant status, the Guam Legislature, through Public Law 13-47, assented to the federal provisions dealing with the research and extension functions of a land grant institution. In March 1974, the University of Guam Board of Regents created the College of Agriculture and Life Sciences (CALS) to facilitate the tripartite functions of the college: research, extension and teaching. On August 1, 2003, the University executed a major reorganization, which included consolidating five colleges into three major colleges. CALS was merged with mathematics and science disciplines from the former College of Arts and Sciences to form the College of Natural and Applied Sciences (CNAS). The Dean of CNAS retained the Directorship of the Agriculture Experiment Station, while the Vice President of University and Community Engagement reassumed his appointment as Director of Cooperative Extension Service. The land grant mission of CNAS and of CES, in partnership with public and private sectors, remains the improvement of economic, environmental, and social conditions of the people of Guam and the Western Pacific by providing creative and integrated research, education and extension programs in agriculture and life sciences.

The Agriculture Experiment Station (AES) conducts research for the development of the island's agriculture and related fields. The University of Guam Cooperative Extension Service translates and delivers technical information and conducts informal education programs for farmers, homemakers, families, youth and the community. The primary mission of AES is to conduct applied, adaptive and basic research in agriculture and on issues pertaining to family well-being, youth development, human health/nutrition, consumer science, human resource development and the environment. The Extension mission enables the multicultural community of Guam to make informed decisions through non-formal education programs based on research and identified local needs.

It is important that both AES and CES implement programs to help Guam's people cope with the extraordinary social stresses they have suffered over the last seven years. Recent natural disasters have battered the community, and Asia's economic downturn and the events of September 11 have weakened the local economy. The President has declared Guam a

federal disaster area three times since 2001 — after an October 2001 earthquake and after two typhoons in 2002. Damage from the two typhoons forced businesses to close, left families homeless, and destroyed schools. Islanders suffered months without basic services such as water, electricity and telephone service. Some schools shut down for weeks, while other schools closed permanently, adding to already overcrowded classrooms. According to the *Pacific Daily News*, Guam's unemployment rate has been in double-digits since 1999, when 15.2 percent of job seekers couldn't find jobs. Bankruptcy filings in 2001 posted a nearly 100-percent increase from 155 in 2000 to 287 as of Dec. 26, 2001.

While some evidence of economic recovery exists, the impact of renewed tourism and increased military spending on Guam has not offset the economic hardships described above. A freeze on salary increases of government and university personnel remain in effect, as do the elimination of many holidays, and the retention of many austerity measures designed to reduce government spending in the face of reduced tax and tourism revenues. Jobs continue to be lost and many have moved to the US mainland or joined the swelling welfare rolls.

A. Planned Programs

National Goal 1: An agricultural system that is highly competitive in the global economy.

Executive Summary

Growers of fresh local produce face severe competition from the U.S. mainland. Local fruits and vegetables account for about 80 percent of the value of the agricultural industry on Guam, but more than 90 percent of Guam's food supply continues to be imported from U.S. West Coast wholesale markets. Imported produce has several advantages over locally grown produce. The supply of imported produce is reliable, the product is graded and consistent in maturity and quality, and importers can receive the produce directly when it arrives on island. Locally grown produce, however, offers benefits imported food does not. Local produce is often fresher than imported produce; there are little or no shipping costs. Many of the local fruits and vegetables are cultivars or crops that are not commonly available on the U.S. mainland and are tailored to the tastes of Guam's Asian and Pacific Islander population. In addition, local produce does not generate extra packaging material that will be to the island's waste stream. A three-pronged strategy to encourage local agriculture on Guam is under way. First, researchers continue to investigate new cultivars and crops for a variety of uses. Second, researchers are finding and implementing disease and insect control in crop and ornamental plants which has the potential to reduce pesticide inputs when implemented by farmers at large. Third, extension agents target their efforts on stakeholder needs, which range from education on agricultural developments to finding out about financial assistance opportunities.

Highlight (1):
Disease survey and marketing prospects for specific pathogen free shrimp production on Guam

Because of Guam's geographic isolation, the absence of wild stocks of penaeid shrimp, and the government's strict importation laws, the University of Guam's Guam Aquaculture Development Training Center is ideally suited to maintain SPF broodstock and to supply shrimp both to local farms and for export. The immediate impact of the proposed work is to allow Guam to begin production of SPF PLs for stocking local farms. This will reduce or eliminate the importation of post-larval shrimp as is currently practiced. In addition, early studies identified the Guam's potential as a producer of SPF shrimp for export (Iverson and Brown, 1993). At that time the recommendation was for Guam to produce black tiger prawn (*P. monodon*) for marketing in Asia, as this was the main species of interest in that region. Also, in Asia, interest in the culture of white shrimp (*L. vannamei*) has been growing exponentially. Thus, the opportunity for Guam to sell SPF shrimp in Asian markets has blossomed. This project will set the stage for Guam to take advantage of this engaging opportunity.

In the first on farm survey, the University of Arizona Shrimp Pathology Laboratory found White Spot Syndrome Virus (WSSV) on a Guam shrimp farm. While this result is preliminary, if verified, it would represent the first report of this pathogen in the United States in a number of years. What is troubling is that the source of the infection appears to have been a shrimp hatchery in Hawaii where the virus is as yet unreported. We are working with authorities in

Hawaii to identify the source farm and to check it for the virus.

Highlight (2):
Commercial aquaculture development

Aquaculture of foodfish has been the mainstay for Guam. Growth of the industry has been limited by the lack of diversity in foodfish and available local sources of seedstock. Producers have been reliant on foreign sources of fish fry and shrimp postlarvae. Local production of seedstock has been limited to marine shrimp postlarvae. Diversification has been sought in Guam's aquaculture industry. Tilapia producers have been forced to import seedstock to stock their ponds. This constant importation places the industry at risk for the introduction of diseases that may harm the industry and natural environment.

Development of a new training program has started. The “Aquaculture Professional Certification" (AQUAPRO) is a seven-module curriculum designed to provide knowledge and experiential training in various areas of aquaculture, including (1) General Principles of Commercial Aquaculture Production, (2) The Business of Aquaculture – Business Planning and Economics, (3) Large Scale Commercial Aquaculture Production (4) Aquaculture in Recirculating Tank Systems, (5) Hatchery Production of High Quality Tilapia Fry, (6) Ornamental Aquaculture – Production of Freshwater Aquarium Fishes, (7) Alternative Aquaculture Opportunities.

To date the first module has been completed and implemented. This training seeks to provide links between funding agencies and knowledgeable or experienced applicants. A total of nine participants completed the 80-hour module “General principles of commercial aquaculture production”. The core of these participants is youth residents of Sanctuary, Inc. a home for troubled teens. These participants and others have expressed interest in completing many or all of the modules for certification as an Aquaculture Professional. Two more modules will be completed in the next year.

Highlight (3):
A model integrated small farm for the U.S. Caribbean and Pacific Islands

The project was initiated to create a model farm to illustrate successful sustainable agriculture under Guam’s limited resource constraints. The project to establish the foundation of the farm operation is in its second year. We conducted a consumer survey on production of lei flowers on the farm and on other possible branches of the farming enterprise. Specific objectives then were set to produce profitable local fruit and vegetable crops, to produce ornamental plants used in local mwarmwar and lei making, and to raise goats to illustrate rotational grazing techniques. It is hoped the demonstration farm will be a site of education in tropical island agriculture.

During the second year of the project, rooted cuttings of karamansi (X *Citrofortunella mitis*) and barbado cherry (*Malpighia punicifolia*) and seedlings of star fruits (*Averrhoa carambola*) were planted in the orchard. Ti (*Cordyline terminalis*) and plumeria (*Plumeria* spp.) were also planted for production of lei flowers and forage. In the rotational operation for vegetable and goat production, stargrass (*Cynodon nlemfuensis* var. *nlemfuensis*) and pangola grass (*Digitaria eriantha*) were planted in mother beds to increase the number of both plants. Some materials for fencing goat in the farm were purchased.

Water catchments and compost bins are planned for the site. A draft of main farm structures is being finalized. Windbreaks (*Casuarina equisetifolia* and *Leucaena leucocephala* K636) and hedge plants (*Hibiscus* spp.) were planted or replaced as needed.

The model farm will be educational tool to the community on how to recycle resources, improve crop production and protect the environment.

Key issues addressed in Fiscal 2003 were:
Small Farm Viability
Niche Markets
Agricultural Competitiveness
Animal Production Efficiency
Sustainable Agriculture
Agriculture competitiveness
Adding value to new and old agricultural products
Aquaculture
Plant Production Efficiency
Urban Gardening
Plant health/ plant production efficiency
Agricultural Profitability
Plant health
New uses for Agricultural Products
Plant Production
Agricultural Profitability
Animal Production Efficiency
Invasive Species

Key theme: Small Farm Viability

Farmers participate in organizing producer cooperatives training

a. Brief description

The back-to-back supertyphoons in 2002 (Chata'an and Pongsona) underscored the importance of organizing farm groups for accuracy in farm reporting and documenting the extent of damages and processing of farm benefits and disaster assistance. The ability of both the Cooperative Extension and the Department of Agriculture to service farmers is limited based on the one-to-one approach employed. This need to organize producers became a focus of the essential agricultural issues aligned to organizational efforts, data collection and coordinated marketing. The University of Guam Cooperative Extension Service and the Department of Agriculture work closely together to sustain a viable agricultural industry.

Based on the 1998 Guam Agricultural Census, 201 farms on a total acreage of 2,144 representing a total market value of $4.3 million agricultural products sold on Guam produced agricultural commodities. Of the 201 farms, 74 farmers reported $10,000 or more of market value of agricultural products sold. To date, the only existing organized extractive industry group is the Guam Fisherman's Cooperative. Other organized farm groups use the structure of associations which is less formal than a cooperative, i.e., Guam Nurserymen's Association. The last Producer Cooperative existed in the 1960s and has since faltered. Much of the technical

expertise and training in organizing cooperatives were limited. This need was revisited in the many outreach forums co-sponsored by the Guam Department of Agriculture and the University of Guam Cooperative Extension Service with farm groups. A mail-out campaign was initiated with coordinated efforts between the Department of Agriculture and the University of Guam Cooperative Extension Service. The leadership of the programs of Agricultural and Natural Resources and the Economics and Community Systems initialized the campaign via a technical request to USDA Rural Business Cooperative Service. A total of 50 participants attended a May 2003 training session. As a result of this effort, a farm clientele listing was formalized and serves as the most credible and formal attempt to update Guam's agriculture clientele list.

b. Impact/accomplishment

As a result of this effort, dialogue with the Guam Fishermen's Cooperative and the USDA Rural Development provided a benchmark for creating a producer group umbrella initiative for organizing all producers (fishermen, agriculture, and aquaculture). The technical packet produced in this effort gives farmers a comprehensive resource guide to organizing a cooperative. The technical knowledge base for organizing a cooperative was a much-needed educational piece for producers and government workers. Many participants recognized the importance of organizing as a cooperative, the requirements, and value of the training. To date 15 farmers signed a petition to initialize the process of organizing a Producer Cooperative under a producer association as a first step. Through the producer association initializing efforts, the focus of a "hands-on" approach to co-op development assistance aligns resources and efforts. The next planned level is to review and encourage the establishment of a regional cooperative development technical center for the Pacific.

c. Source of funding — Smith-Lever and USDA Cooperative Development
d. Scope of impact – State specific

Key theme: Niche Markets

Awareness of freshwater ornamental aquaculture

a. Brief description

The aquaculture industry in Guam has undergone extreme fluctuations. Based on production of food-fish alone, the industry has required large capital and land investment to be an economical participant. Other areas of aquaculture can be profitable and do not require as large an investment. One of these is the production of freshwater ornamental fish. This market is predominantly for export, with small domestic markets. Major competitors are from Asia. However, there are advantages to locating in Guam. As a U.S. territory, there are fewer restrictions to shipping to the U.S. Guam's proximity to Asia also allows for exports to Asia and establishes Guam as a transshipment point for fish from Asia. The world ornamental fish market is a multi-billion dollar market. In 1998, the U.S. alone imported over $67 million. The Internet has opened a new avenue for marketing on a small scale as well as large scale.

University Cooperative Extension Service has initiated collaborative efforts with two private businesses to heighten the awareness of the ornamental fish industry beyond the pet store experience. Forty-two hobbyists and small-scale aquaculturists worked together with the Cooperative Extension Service to present a one-day inaugural Guam Ornamental Fish Show and

Competition. The event reached two thousand people, and more have heard about it through information distributed through sponsors, newspaper notices and articles. Thirty-five participants registered and 200 requests have been made for information on ornamental aquaculture and the fish show. Five extension publications were prepared for distribution during the show.

b. Impact/accomplishment

Guam's aquaculture industry is diversified through ornamental aquaculture. Ornamental aquaculture also provides a proven business enterprise that is suitable for small operations. Collaborative work with pet stores and aquaculture hobbyists to establish marketing linkages and cooperatives is planned. A committee has been established with five people as a core group to plan for next year's event.

c. Source of funding — Smith-Lever
d. Scope of impact — State Specific

Key theme: Agricultural Competitiveness

Commercial foodfish aquaculture development

a. Brief description

Aquaculture of foodfish has been the mainstay for Guam. The lack of diversity in foodfish and available local sources of seedstock have limited growth of the industry. Producers have been reliant on foreign sources of fish fry and shrimp postlarvae. Local production of seedstock has been limited to marine shrimp postlarvae. Recent destruction of facilities by two supertyphoons in 2002 limited production of shrimp. Production is now approaching pre-storm levels.

Diversification has been sought in Guam's aquaculture industry. Tilapia producers have been forced to import seedstock to stock their ponds. This constant importation places the industry at risk for the introduction of diseases that may harm the industry and natural environment.

Work has been started to establish a tilapia breeding and fry production area at the hatchery. A project was initiated to evaluate growth and fecundity of five strains of tilapia in Guam's aquaculture environment. The fish have been undergoing growth studies in replicated trials and have also been placed in commercial ponds for evaluation in local commercial situations. A second year of funding for the fecundity has been sent to Washington DC for final approval.

Development of a new training program has started. The "Aquaculture Professional Certification" (AQUAPRO) is a seven-module curriculum designed to provide knowledge and experiential training in various areas of aquaculture, including (1) General Principles of Commercial Aquaculture Production, (2) The Business of Aquaculture – Business Planning and Economics, (3) Large Scale Commercial Aquaculture Production (4) Aquaculture in Recirculating Tank Systems, (5) Hatchery Production of High Quality Tilapia Fry, (6) Ornamental Aquaculture – Production of Freshwater Aquarium Fishes, (7) Alternative Aquaculture Opportunities.

To date the first module has been completed and implemented. This training links with funding agencies criteria for knowledgeable or experienced applicants in the field that they are applying for funds.

b. Impact/accomplishment

A total of nine participants completed the 80-hour module "General principles of commercial aquaculture production". A core of these participants is youth residents of Sanctuary, Inc. a home for troubled teens. These participants and others have expressed interest in completing many or all of the modules for certification as an Aquaculture Professional. Two more modules will be completed in the next year.

c. Source of funding — Smith-Lever
d. Scope of impact — State Specific

Key theme: Animal Production Efficiency

Use of Local Feedstuff for Swine Feeding in the American Pacific

a. Brief description

The American Pacific region has an abundance of local foodstuff such as breadfruit, bananas, copra and fish by-products. During harvest season, these feedstuff are readily available for swine feeding. The primary reason these feedstuff are not utilized is the lack of information on the nutritional contents and the absence of a demonstrative study of these resources for swine feeding. Hog producers feed their pigs different local feedstuff, but they have no records on how they perform under such feeding conditions. Feeding trials were conducted to compare the growth rate of grower pigs using commercial feeds and local feedstuff like bananas, coconuts or combination of this feedstuff with commercial feeds. Trials were conducted in Pohnpei, Tinian and Mangilao Hog Farm on Guam.

a. Pohnpei: A high school pig farm was used to compare the growth rate of grower pigs fed with 100% commercial feeds and 100% coconut. This trial was conducted to gather hard data on how grower pigs would perform on this kind of feeding. The feeding trial demonstrated how grower pigs perform on pure feeding of coconut. The results showed that growth rate is severely affected and other feed materials should be added to their daily ration.

b. Tinian: On-site feeding trials were conducted on two producers' farms. Grower pigs were fed 100% commercial feed for control while the experimental group were fed 30% commercial and 70% local resources such as papaya, coconuts, tapioca and breadfruit).

c. Mangilao Hog Farm: Three batches of grower pigs were fed to determine the best ratio of mixing commercial feeds and bananas. Grower pigs fed with 50% commercial and 50% bananas gained as much weight as those fed with 100% commercial. Another initial finding was grower pigs fed with 33% commercial feeds, 33% bananas and 33% coconut gave a reasonable growth rate.

b. Impact/accomplishment

These feeding trials were conducted directly with producers to allow them to observe the actual effects of feeding local feedstuff. Although there were 4 producers involved in the first phase of feeding trials, these producers shared their experiences with other hog producers and

their farms were open for other producers to see. At the Mangilao Hog Farm, the farm manager calculated that he could save 50% of the feed cost for his grower population by feeding the 50% commercial and 50% bananas. He was convinced that the growth rate at this ration would still be profitable and fits to the market situation of hogs on Guam.

c. Source of funding — Sustainable Agriculture and Research Education (SARE)
d. Scope of impact – Multi-state integrated research and extension — FM GU NM

Key theme: Animal Production Efficiency

Alternative Housing for Livestock and Poultry for Guam and Micronesia

a. Brief description

A typical livestock and poultry house in Micronesia is made up of light materials of wood and galvanized iron sheets that are easily blown away by typhoons. With an average of 2.5 typhoons hitting the region, typhoon damages to animal housing has become too costly to the producers. Due to frequency of typhoons, producers provide minimum accommodations to livestock and poultry. Insufficient housing causes low productivity and inhumane conditions to the animals. Used container vans are being evaluated for animal housing. These massive, heavy metal vans can withstand typhoon winds as long as they are secured to the ground.

What Has Been Done:

1. Twenty-five four-week-old broilers were raised in an elevated wire / wooden brooder placed inside a 20-foot container van. The broilers were raised inside the container van for a period of 4 weeks. To increase ventilation, 2 rectangular openings were made at the closed end of the container van. Growth rate and behavior patterns were observed for 4 weeks.

2. Twenty-five two-week old Brown Nick layer chicks were raised in an elevated wire/wooden brooder. The brooder was placed inside a 20-foot container van. Chicks were raised in the brooder until 8 weeks of age. Grower chicks are now out of the brooder and are now raised on the floor using grass trimmings as bedding materials. A divider made up of wire was installed 4 feet from the container door. These growing pullets will be housed in the container until the laying period.

b. Impact/accomplishment

This project demonstrates that Guam farmers can produce eggs in container vans in their own backyards. This is the first year of the project. Initial results show that the performance of both broiler and layer chicks raised inside the container van is similar to the control chicks raised at a nearby brooding facility. There were no significant differences in terms of mortality, behavioral problems, body conditions and growth rate. Brown Nick pullets should start laying by March 2004. A workshop will be conducted by that time and will be attended by agricultural workers and producers in the region.

c. Source of funding — Sustainable Agriculture and Research Education (SARE)
d. Scope of impact – State Specific

Key theme: Agriculture Competitiveness

Plant Diagnostics Herbarium Collect

a. Brief description

To improve the viability of Guam's agriculture, renewed efforts were made to increase the proficiency of farmers and agriculture students in plant disease identification. A herbarium collection of plant diseases was initiated last year. This collection will supplement our current instructional tools: fact sheets, workshops, and farm and office visits. This collection provides a means to document new diseases and offers clients and researcher an opportunity to study actual samples.

b. Impact/accomplishment

Members of the public have been trained in plant diagnostics which included collecting and identifying specimens with plant abnormalities. These specimens constitute the start of a collection of herbarium diagnostic materials that will be used for extension in years to come.

c. Source of funding — Smith Lever 3(d) — Integrated Pesticides Management
d. Scope of impact — State Specific

Key theme: Sustainable Agriculture

Decreasing the need for man-made fertilizers through the incorporation of chicken manure and crop sunn hemp, a green manure crop

a. Brief description

Nearly 60% soil on Guam is shallow (4-8 inches), rocky, high in pH (6-8) and low in organic matter. The ability of these soils to produce crops without the addition of man-made fertilizers has decreased over the years; largely due to erosion and the loss of soil organic matter. A field trial was conducted in 2003 to determine if it is possible to improve sweet corn production on Guam northern soil through the replacement of man-made fertilizers (inorganic fertilizer) with enriched chicken mature and through the incorporation of a green manure crop. The project had two objectives: one to provide producers with a cost effective means of improving the health of their farms' soil and the other to provide agricultural researchers with information regarding the benefits of adding organic matter to Guam's shallow, limestone soils.

b. Impact/accomplishment

Because of the impressive strand of corn that was produced in the trial, many farmers have expressed interest in adding organic matter to their soil. The use of sunn hemp as a green manure generated interest among thirty-five farmers. This interest prompted the Northern Guam Soil &Water Conservation District Board and Extension Agent Robert Schlub to apply for a two-year, $68,462 WSARE Competitive Research & Education Program Grant in October to provide farmers access to low-cost sunn hemp seed.

c. Source of funding — Sustainable Agriculture and Research Education (SARE)
d. Scope of impact — State Specific

Key theme: Agriculture competitiveness

Education in general food and agricultural sciences to develop a tropical agricultural product market on Guam and other Micronesia.

a. Brief description

Guam and other Micronesian islands are located in the Western Pacific. Although more than 20 varieties of tropical crops can be commercially grown on Guam, 90% of foods consumed on Guam are imported from the U.S. mainland or from other Asian countries. Only 0.6% of the population on Guam works in the agricultural industry. Less than 2% of the current students at the University of Guam are enrolled in the agriculture discipline. Higher education opportunity in the food and agricultural sciences, especially in modern technology or crop production and processing, would help develop a tropical agricultural product market on Guam and other Micronesian islands.

Scholars have been selected in the Higher Education Multicultural Scholars Program based on their career interests, academic records, recommendation letters, and interviews. Each of five scholars has received $2,625 scholarship in the Fall semester, 2003. One sophomore scholar dropped from this program after one semester due to non-food and agriculture career goals. One scholar was recruited in Fall semester, 2003. Each of five scholars received $2,625 scholarship in Spring semester, 2004. These scholars are: one freshman, two sophomores, and three juniors. Their ethnicities are three Chamorro, one Asian/Caucasian, and Asian/Eurasian. One junior scholar has started undergraduate research in developing Tilapia jerky products. The other junior scholar is doing research in pepper production and pepper sauce processing. In the Spring, 2004, two more scholars will be recruited in this program as required in the project.

b. Impact/accomplishment

Through education and knowledge, the project will help empower the agricultural system with knowledge that will improve its competitive advantage in domestic production, processing and marketing. The project will support seven Scholars at the University of Guam to complete their undergraduate studies in the discipline of general food and agricultural sciences. This multicultural education program will enhance the recruitment of students in the discipline of food and agricultural sciences, promote undergraduate research in the development of tropical foods and agricultural crops, and prepare students for their career in the area of agricultural food production and food processing enterprises on Guam and in the Western Pacific islands.

c. Source of funding — USDA Higher Education Multicultural Scholars Program Grant - USDA Higher Education Challenge Grant
d. Scope of impact — State Specific

Key theme: Agriculture competitiveness

Instrumentation in food and agricultural sciences may enhance agricultural research and education capacity at the University of Guam.

a. Brief description

Tropical agricultural resources on Guam are not well-utilized and thoroughly explored to benefit people. Initiating education and research programs in food science and technology will generate additional value in tropical agriculture products, promote food and agriculture enterprises, and provide job opportunities on Guam. The University of Guam (UOG) is a land-grant institution with about 80% minority students from the Western Pacific. The College of Natural and Applied Sciences at UOG is well positioned to undertake such education. However, the college currently lacks laboratory facilities to support comprehensive studies in food science. The objectives of this acquisition of instrumentation are to enhance scientific training in food chemistry, food processing, and food safety and to enhance the research programs in food science to utilize the unique tropical resources of Guam and the Western Pacific.

Instruments proposed in the project proposal are being purchased and installed in the College of Natural and Applied Sciences at the University of Guam. These include a ProStar 230 Gradient HPLC System, a Cary 50 UV-Vis Spectrophotometer, a Cary Eclipse Fluorescence Spectrophotometer, a Photochem Texture Analyzer, Universal Centrifuges, a Brookfield Viscometer, and other items..

b. Impact/accomplishment

The acquisition of these instruments will be significant to education and research programs at the College of Natural and Applied Sciences because they will enhance teaching and research capabilities, strengthen the competitiveness of academic degree programs; improve the education quality, and increase student recruitment and graduation in food and agricultural sciences. The requested equipment will also be expected to promote research projects to understand valuable components in tropical crops that could benefit the health of people. Furthermore, the instrumentation will increase opportunities for UOG faculty to collaborate with armed forces personnel on projects of food and agricultural sciences on Guam.

c. Source of funding — Department of Defense
d. Scope of impact — State Specific

Key theme: Adding value to new and old agricultural products

Evaluation of processing and storage may improve the quality of commercial noni products.

a. Brief description of activity

Noni (*Morinda citrifolia L*) is a tropical plant that traditionally treats various diseases in the Pacific Islands. Noni extract is now taken by cancer patients to control cancer. Novel glycosides from noni juice exhibit free radical scavenging activity and demonstrate anti-cancer effects. Noni fruit are now commercially processed into juice or powders for disease prevention and therapies. However, it is unknown how processing and storage conditions affect the bioavailability of bioactive components and the shelf life of noni products. The objective of this research is to determine how the bioactive compounds of noni products degrade during processing and storage.

The research project is just beginning. Instruments, chemicals, and supplies are being purchased, installed, and prepared for research. A full-time and a part-time research assistant were recruited and are doing experiments in making noni juices with fermentation and boiling methods and noni powders with hot air and freezing dry methods. We observed that freezing

dried noni powders are white and hot air dehydrated noni powders are brown. Temperatures above 50°C can cause browning of noni powders during hot air dehydration.

b. Impact/ accomplishment statement

Research outcomes will benefit noni product processors in the Pacific Islands. Noni product processors will be provided a guideline to process high quality noni products in which bioactive components will be significantly available for effective disease prevention and therapies. The improvement of noni product quality will also benefit noni markets for millions of tourists that visit Pacific Islands, and promote agronomic activity in the Pacific Islands. In addition, the proposed research will contribute to broader understanding of how nutraceuticals change during processing and storage in functional food products. Finally, the data obtained in this research will provide useful information for FDA in evaluating health claims of noni products.

c. Source of funding - Smith-Lever and USDA CSREES Special Project TSTAR
d. Scope of impact – State Specific

Key theme: Aquaculture

Guam Aquaculture Development and Training Center

a. Brief description of activity

Guam has a small but viable aquaculture industry that produces tilapia, shrimp, milkfish and catfish for local consumption. The Guam Aquaculture Development and Training Center was transferred to the University of Guam on 1 October 2001. The University then placed the facility in the Agricultural Experiment Station where it has become our fourth off-campus facility. The role of the facility traditionally has been to produce shrimp and fish seedstock for the local farmers, to develop new products and techniques for the industry and to train local farmers in aquaculture.

Primary efforts over the past year have been to rehabilitate the facility from years of neglected maintenance and the impact of Typhoons Chata'an and Pongsona. Shrimp larvae production resumed on a regular basis in September and has been fairly consistent since then. We have imported four new strains of genetically selected tilapia of use by the industry: Chitralata, and Philippine Select from the Asian Institute of Technology, the GIFT strain from the Philippines and the GMT pearl strain from Louisiana. The hatchery is hosting three federally funded projects that are reported upon elsewhere in this document: one to develop a tilapia hatchery and two to work on different aspects of producing Specific Pathogen Free (SPF) shrimp.

b. Impact/accomplishment statement

Local production of aquaculture seedstocks provides farmers a reliable source of quality product and reduces the likelihood of importing aquatic diseases and invasive aquatic organism and insects.

c. Source of funding – Local government and sales revenue
d. Scope of impact – State Specific

Key theme: Aquaculture

Disease survey and marketing prospects for specific pathogen free shrimp production on Guam

a. Brief description of activity

Because of Guam's geographic isolation, the absence of wild stocks of penaeid shrimp, and the government's strict importation laws, the University of Guam's GADTC is ideally suited to maintain SPF broodstock and to supply shrimp both to local farms and for export. The immediate impact of the proposed work is to allow Guam to begin production of SPF PLs for stocking local farms. This will reduce or eliminate the importation of post-larval shrimp as is currently practiced. In addition, early studies identified the Guam's potential as a producer of SPF shrimp for export (Iverson and Brown, 1993). At that time the recommendation was for Guam to produce black tiger prawn (*P. monodon*) for marketing in Asia as this was the main species of interest in that region. Also, in Asia, interest in the culture of white shrimp (*L. vannamei*) has been growing exponentially. Thus, the opportunity for Guam to sell SPF shrimp in Asian markets has blossomed. This project will set the stage for Guam to take advantage of this engaging opportunity.

In the first on farm survey, the University of Arizona Shrimp Pathology Laboratory found White Spot Syndrome Virus (WSSV) on a Guam shrimp farm. While this result is preliminary, if verified, it would represent the first report of this pathogen in the United States in a number of years. What is troubling is that the source of the infection appears to have been a shrimp hatchery in Hawaii where the virus is as yet unreported. We are working with authorities in Hawaii to identify the source farm and to check it for the virus.

b. Impact/accomplishment statement

Production of SPF shrimp would allow the export of a Guam aquacultural product for the first time. This would release the industry from the restrictions of the limited size of the local market.

c. Source of funding — USDA CSREES Special Project TSTAR
d. Scope of impact — state specific

Key theme: Aquaculture

Specific-pathogen free (SPF) marine shrimp culture on Guam

a. Brief description of activity

The focus of the proposed project is to revitalize the aquaculture center on Guam by establishing stock of specific-pathogen free (SPF) marine shrimp. Though post-larval shrimp have been produced at the center for many years, much of the shrimp stock had to be destroyed because of an outbreak of infectious hypodermal and hematopoietic necrosis virus (IHHNV), one of several viral diseases that have seriously impacted shrimp production worldwide (Lightner 1983). While the stocks of white shrimp (Penaeus vannamei) that remain have not shown signs of disease, larval production has declined, growth rates are lower, and they are thought to suffer from a lack of genetic diversity or in-breeding depression.

The first health survey of the GADTC shrimp has been completed. The results were that the hatchery was clean of all viruses of interest. A bio-sanitation workshop was held for the hatchery workers, extension personnel and farmers on-island.

b. Impact/accomplishment statement

The production of high health SPF shrimp fry by the University of Guam's GADTC hatchery would reduce the risk of disease importation by the local farmers. Thus, it would allow them to operate in a lower production risk environment and reduce their losses due to disease events.

b. Source of funding — US DOC, NOAA, NMFS, S-K Grant
c. Scope of impact — State specific

Key theme: Plant Production Efficiency

Regulation of photosynthetic processes

a. Brief description of activity

Photosynthesis is the single process on earth, which converts radiant energy to biomass by fixing atmospheric carbon dioxide into carbohydrates. Understanding its regulation is fundamental in designing strategies to develop improved crop systems that are environmentally sound. This project is designed to determine the limitations on photosynthesis of tropical species, and how development and physiological characteristics may be deployed to optimize yields during times of environmental limitations.

Fluctuations in non-structural carbohydrates were studied in papaya plants following manipulation of source-sink balance by leaf removal. Starch pools were minimal and unchanged following defoliation. Lateral roots had higher concentration than taproots or stems, but maximum levels were only 5 mg/g. Glucose and fructose concentration was similar for taproot and stem tissue, but was lower in lateral root tissue. Alternatively, sucrose concentration was similar for lateral root, taproot, and stem tissue. Other saccharides were minimal or undetectable in papaya tissues. The increased need for carbohydrates for reconstructing source leaves following foliage injury was not apparently met by mobilization of soluble carbohydrates from stem or root tissue.

b. Impact/accomplishment statement

Source-sink relationships play a key role in plant recovery from any environmental stress, especially one that severely impairs source size or function. Source-sink dynamics of herbaceous plants may not apply to the arborescent papaya species, since organ and non-structural carbohydrate pool size are much greater than other herbaceous species. Alternatively, source-sink dynamics of tree species may not apply to papaya, since the species is herbaceous and plants are comprised entirely of living tissue that is more expensive to maintain than woody tissues. A greater understanding of source-sink balance in papaya is needed to understand mechanisms that control phenological processes, and may lead to improved management strategies to optimize productivity.

c. Source of funding — Multi-Regional Hatch

d. Scope of impact — integrated research and extension

Key theme: Urban Gardening

Home Gardening Extension Program

a. Brief description of activity

This program is geared toward publishing extension publications for improving home gardening. The venue for this during the past year was through the local newspaper. Thirteen extension publications were produced in the form of newspaper articles and proceedings from a seminar that reach all readers in the region.

Extension publications:

Golabi, M.H., T. E. Marler, E. Smith, F. Cruz, J.H. Lawrence. 2003. Sustainable soil management techniques for crop productivity and environmental quality for Guam. p. 25-35. Proc. International Seminar on Farmers' Use of Diagnostic Systems for Plant Nutrient Management. 11-15 August 2003. Suwon, Korea.

Marler, T. 22 Nov. 2003. Converting waste to resource. *Pacific Daily News*. p. 20-21.

Marler,T. 27 Sept. 2003. Solving the south's water woes. *Pacific Daily News*. p. 18.

Marler, T. 6 Sept. 2003. Butterfly attacking Guam's banana plants *Pacific Daily News*. p. 16.

Marler,T. 12 July 2003. Prune now for the good of all. *Pacific Daily News*. p. 16,17.

Marler, T. 14 June 2003. Avocado trees for Guam. *Pacific Daily News*, p. 20, 21.

Marler, T. 31 May 2003. Getting to the root of irrigation. *Pacific Daily News*, p. 16.

Marler, T. 10 May 2003. Lasting flower power. *Pacific Daily News*, p. 22, 26.

Marler,T. 4 May 2003. Surprise Mom with the exotic. *Pacific Sunday News*, p. 17.

Marler, T. 3 May 2003. Improving Micronesian bananas. *Pacific Daily News*, p. 16, 18.

Marler, T. and J. Lawrence. 29 March 2003. Save money: plant a tree. *Pacific Daily News*, p. 18-19.

Marler, T. and J. Lawrence. 15 Feb. 2003. Empowering yourself in the garden. *Pacific Daily News*, p.16-17.

Marler, T. and J. Lawrence. 8 Feb. 2003. Bending in the wind. *Pacific Daily News*, p. 14.

b. Impact/accomplishment statement

These publications reach residents in the region on a large scale. The primary audience is homeowners who do not take the initiative to seek out help.

c. Source of funding — State matching funds

d. Scope of impact — State Specific

Key theme: Plant health/ plant production efficiency

Photosynthetic recovery rates of Ifit

a. Brief description of activity

This project is designed to determine the limitations on photosynthetic rates at the canopy level, and how the rate of foliar development and specific physiological characteristics help optimize yields during times of environmental limitations.

b. Impacts/accomplishments.

We studied post-defoliation leaf expansion and photosynthetic functioning in *Intsia bijuga* plants. The species is Guam's official territorial tree, and it is highly susceptible to defoliation during typhoons. Defoliation is the essential reason the species recovered rapidly from typhoon damage: It allows wind forces to pass through the canopy without them being transferred to the stems and trunk. The rebuilding of leaves is rapid following defoliation, and photosynthetic capacity reaches mature levels in about three weeks after leaf expansion begins. Rapid development of photosynthetic capacity explains the general ability of this species to tolerate typhoon damage.

b. Impact/ accomplishment statement

This project increases understanding of how native ecosystem responds to periodic tropical storm systems.

c. Source of funding — Multi-state Hatch
d. Scope of impact — State specific

Key theme: Agricultural Profitability

A model integrated small farm for the U.S. Caribbean and Pacific Islands

a. Brief description of activity

The project was initiated to create a model farm to illustrate successful sustainable agriculture with Guam's limited resources. The project to establish the foundation of the farm operation is in its second year. We conducted a consumer survey on production of lei flowers on the farm and on other possible branches of the farming enterprise. Specific objectives then were set to produce profitable local fruit and vegetable crops, to produce ornamental plants used in local mwarmwar and lei making, and to raise goats to illustrate rotational grazing techniques. It is hoped the demonstration farm will be a site of education in tropical island agriculture. During the second year of the project, rooted cuttings of karamansi (X *Citrofortunella mitis*) and barbado cherry (*Malpighia punicifolia*) and seedlings of star fruits (*Averrhoa carambola*) were planted in the orchard. Ti (*Cordyline terminalis*) and plumeria (*Plumeria* spp.) were also planted for production of lei flowers and forage. In the rotational operation for vegetable and goat production, stargrass (*Cynodon nlemfuensis* var. *nlemfuensis*) and pangola grass (*Digitaria eriantha*) were planted in mother beds to increase the number of both plants. Some materials for fencing goat in the farm were purchased. Water catchments and compost bins are planned for the site. A draft of main farm structures is being finalized. Windbreaks (*Casuarina equisetifolia* and *Leucaena leucocephala* K636) and hedge plants (*Hibiscus* spp.) were planted or replaced as needed.

b. Impact/ accomplishment statement

The model farm will be educational tool to the community on how to recycle resources, improve crop production and protect the environment.

c. Source of funding — IFAFS
d. Scope of impact — Multi-state integrated research and extension - VI PR GU

Key theme: Plant health

Study of Coconut Tinangaja Disease and possible modes of transmission

a. Brief description of activity

Cocos nucifera L, the coconut palm, is a very important tree species in the Western Pacific region. Coconut Tinangaja is the most significant disease occurring throughout Guam and possibly in other Mariana Islands. The disease poses a threat to all other coconut growing areas in the world. We found different DNA/RNA ratios in coconut tissues from Tinangaja-infected and healthy tissues. We then designed an experiment to determine if this ratio could be used as a faster and cheaper diagnostic tool instead of the previous molecular methods we have been using. Our results showed that even though the difference between healthy and Tinangaja-infected trees is statistically demonstrable, it is not consistent enough to be used as a diagnostic tool. We incorporated most molecular techniques used in this project to one graduate course in environmental microbiology and some of these techniques to an undergraduate (lab) course in plant pathology. During the past year, students were able to use these techniques in lab exercises in both courses mentioned above.

Although we were twice completely devastated by 2 typhoons in a period of 6 months, we are again gearing up to continue our research on Tinangaja. We had hoped to already have some results on pollen and insect transmission studies, but those will have to wait for this next year. Damage compensation took a long time; funds have only recently been made available. Furthermore, in the few attempts made at extracting RNA during 2003, we had numerous contamination problems related to storm damage. Our water purification system in the building does not produce water clean enough for molecular studies; we did not have access to a fume hood in our lab until February 2004. Pollen studies were not possible during the year because of lack of specimens from infected trees. We hope this year trees will have recovered sufficiently from storm damage. Inoculated seedlings are still being monitored to study the developing symptoms and overall effects of the Tinangaja viroid on immature coconut palms. This is an entirely new field for us, as we never had the opportunity to study infected seedlings before.

b. Impact/ accomplishment statement

More detailed studies of Tinangaja viroid are now possible because of our achievements from research completed in 2001 and new instruments obtained in 2002. Our new technique developed in 2001 (RT-PCR) and the new instruments obtained in 2002 will make our work more accurate, and will lead to a better understanding of the disease and its modes of spread; this will eventually lead to the development of better management practices. It is hoped that we can finally get the work done this year. There is an advantage, however, because of all the delays; we now have access to better RT-PCR kits that are not as perishable and do not require refrigeration of all components. Our landscapers, grounds maintenance people and homeowners will become more familiar with Tinangaja and what to do about it

c. Source of funding — USDA CSREES Special Project TSTAR
d. Scope of impact — Multi-state research - GU NM FM

Key theme: Plant health

Research on diseases of traditional Pacific Island crop plants

a. Brief description of activity

Coconut, banana and taro are important traditional crops in Pacific islands. The most important diseases of these crops on Guam are Coconut Tinangaja, Banana Bunchy Top, Black Leaf Streak and Panama Wilt, and Taro Leaf Blight (TLB), respectively. The aim of this project is to facilitate ways to develop control measures for these important diseases. A state-of-the-art technique has been developed and fine-tuned for early detection of CTiVd. An extension publication on Coconut Tinangaja was prepared and circulated among interested parties. We successfully applied for a grant to search for resistance to PW in bananas for Guam and Kosrae, and have started on that work this year. A banana cultivar similar to local cultivar Manila was imported in tissue culture and is being propagated for testing. We hope that it will show resistance to Panama Wilt, unlike Manila, which is very susceptible. This is currently being addressed via a second T-STAR grant whose objectives are also to study the possible existence of disease and insect resistance in taro germplasm. Work is still ongoing. Taro germplasm (77 cultivars) were propagated in tissue culture and given to the entomologist for insect resistance testing. Some of this work is already complete and comprises a M.S. thesis for a graduate student. Resistance to Taro Leaf Blight has not been tested further because of lack of the pathogen after the 2 storms last year. Furthermore, all these cultivars were characterized by making descriptions of them according to the IPGRI Taro Descriptors, and by color photographs. It is hoped that this information will be useful for the entire region and help in keeping taro cultivar names straight. When comparing cultivars from one island to the next, taros with different names may actually be the same, and vice-versa.

b. Impact/accomplishment statement

Control of any of the diseases of coconut, taro or banana will have significant economic impact in the Western Pacific region.

c. Source of funding — Hatch
d. Scope of impact — Multi-state research - AS FM GU HI NM

Key theme: Plant health

Development of PRV resistance for the West Pacific and assay of PRV variability

a. Brief description of activity

Papaya Ringspot Virus (PRV) is the main production constraint of papaya in Hawaii, Guam, and the Western Pacific. No papaya available on Guam is resistant to the local strain of PRV. Transgenic resistance has been shown to work in Hawaii, but existing plants are resistant only to the Hawaii strain of the virus. Last year our field plots were totally devastated twice in a 6-month period. We started from scratch for a third time. We successfully self-pollinated some local papaya plants to produce homozygous seed for transgenic conversion. The seeds have been planted and we are currently waiting for them to germinate. They will be sent to UH for transformation. We have learned the technique for identifying the Gus gene and therefore are

able to detect transgenic plants. We observed 2 different transgenic lines from UH. Our other papaya cultivars have been tested for the Gus gene to insure that we do not inadvertently transfer the transgenic UH genome to our local cultivars. UH has obtained permission to import papaya seed and leaf samples from Guam to do the above work.

b. Impact/ accomplishment statement

By developing resistance in local papaya to PRV, researchers hope to favor papaya production and increase yields for the local market. This resistance, however, can also be used in other islands of the region as well. Researchers will look at the variability of the virus with respect to its coat protein gene to determine if there is a potential new strain that could pose a threat to the entire region.

c. Source of funding — USDA CSREES Special Project TSTAR
d. Scope of impact — Multi-state research - AS FM GU HI AS

Key Theme: Adding Value to Old Agricultural Products

Increasing market of traditional root crops of Guam

a. Brief description of activity

The research project focuses to promote post-harvest activities to increase marketability of traditional root crops on Guam. The study was designed to conduct field evaluation of sweetpotato (*Ipomoea batatas*), and a market study of sweetpotato, taro (*Colocasia esculenta* and *Xanthosoma* sp.), cassava (*Manihot esculenta*). This study also included sweetpotato preference test and taste test of selected sweetpotato accessions.

Sweet potato accessions grown in calcareous soil on Guam revealed a diverse phenotypic characters and field performance. The concept test showed that people of Guam consumed sweet potato, taro, cassava and yam in both traditional dishes and as new processed foods. Taro and cassava tamales were still popular forms among Chamorro, and a variety of processed root crops were available at local market. Chips and breads of sweet potato and taro have a great potential to be processed foods made in Guam for local consumption as well as for export. From the survey, it was found that sweet potato with purple skin and flesh color was preferred type. Purple sweet potato chips were also preferred over yellow chips. Ratings of two orange flesh accessions, SW-394 and SW-113B, in the taste test of baked sweet potato were evaluated as equal as SW- G2 (local, purple) sweet potato.

b. Impact/accomplishment statement

The research suggests that the development of processed products made from traditional root crops would be a possible agri-business on Guam and other tropical islands of this region. Results indicated that chips and breads made from taro and sweet potato could be sold to local venders and at gift shops on Guam. The administration of concept tests and sensory evaluation tests on traditional crops was a new attempt on Guam. This procedure can now be applied to many other agricultural food items produced in this tropical region.

c. Source of funding – USDA CSREES Special Project TSTAR

d. Scope of impact – State specific

Key theme: New uses for Agricultural Products

Commercial production of tropical mushrooms grown organically

a. Brief description of activity

Organic waste products can be used to generate more food for the local community. We previously have developed techniques for tropical mushroom production *with Pleurotus ostreatus sajor-caju* and *Volvariella volvacea*. Despite several delays, a part-time technician was hired and trained to work with mushroom cultures. He is now working with 2 different tropical species and starting a third one. Although we haven't been able to recover our facilities, which were damaged during the last storm, we did set up shop in a different location at the Yigo Experiment Station, where we have to share space with non-biological workers. In spite of this great inconvenience, which jeopardizes our culture work, we have been making progress. We are now testing various methods of mushroom production to find optimal techniques. All this work has been possible because he have salvaged whatever we could from the damaged equipment and are making do with what we have. We are still maintaining our mushroom cultures.

b. Impact/ accomplishment statement

We still hope to develop a large-scale production system that is profitable. If we succeed, the region will benefit from having mushrooms locally produced. This would benefit those involved in growing the mushrooms, any intermediaries marketing the produce, and consumers enjoying fresh, delicious and exotic tropical mushrooms.

c. Source of funding — SARE
d. Scope of impact — State specific

Key Theme: Plant Health

In vitro breeding to develop Fusarium wilt-resistant bananas (*Musa* sp.)

a. Brief description of activity

The banana is an important staple food in the Western Pacific. Panama wilt is a limiting factor in its production. This is particularly true today in Kosrae, where production is worth $100,000 annually. The disease is also important on Guam, where banana production reaches annual values of $121,000. Cultivar Saba is the most popular in Kosrae, and among the most important on Guam as well. This cultivar has already been established in tissue culture, and methods for micro-propagation have been developed. We developed a memorandum of understanding between UOG and COM to govern the activities described in this joint venture. Some funds were transferred in order to hire a research assistant in Kosrae to help with the plan of work. One has been hired already. Banana cell cultures have already been initiated. Protocols are still being developed. A liquid culture shaker is being ordered. On Guam, cultivar Kufwafwa

was imported and was tested for 5 different banana viruses via ELISA. It is being propagated in vitro for testing against Panama Wilt disease in the field.

b. Impact/ accomplishment statement

Many farmers have expressed concern about Panama wilt of bananas, both on Guam and Kosrae. It is only right to try to address this problem by seeking to develop resistant plants from popular cultivars.

c. Source of funding — USDA CSREES Special Project TSTAR
d. Scope of impact — Multi-state research - GU NM FM

Key theme: Plant Production

Improving crop production and water use efficiency

a. Brief description of activity

This project seeks to improve crop production and water-use efficiency by using switching tensiometers as part of micro-irrigation management practice, and to increase grower use of switching tensiometers through instruction publications and workshops. Field experiments have shown that switching tensiometers when properly maintained and set to the proper soil matric potential for a particular crop perform better than timers in both crop yield and water-use efficiency in micro-irrigation systems. Irrigation management series publications were distributed at a workshop conducted at the end of a watermelon experiment. The use of floating row covers to protect the crop from insects, fertigation and irrigation scheduling of watermelons and other production issues were discussed and presented at the workshop.

b. Impact/ accomplishment statement

Farmers on Guam use water from the public distribution mains for irrigation. Any savings of water through micro-irrigation techniques will cut the cost for the farmers and save on the public subsidies used for the distribution system.

c. Source of funding — Hatch multi-state
d. Scope of impact — State specific

Key theme: Agricultural Profitability

New cultivars increase local demand for heliconias

a. Brief description of activity

There is a limited availability of heliconia cultivars in Guam. Since this project was initiated, heliconia rhizomes cannot be imported. Heliconias are in demand as a cut flower and as a landscape plant. Making new cultivars available will increase local growers to meet the demand of florists in Guam.

Thirty-five heliconia cultivars were collected and established in 3 field plantings at three different sites in Guam. Many of the cultivars in the plantings are hybrids with H. bihai. Other

species included *H. psittacorum, H. spathocircinata, H. angusta, H. wagneriana, H. caribaea, H. stricta, H. chartacea,* and *H. hirsuta*. One of the objectives was to survey for the incidence of *Cylindricladium*. This disease was not observed in the plantings. *Marasmius* was identified in established plantings. Sanitation must be emphasized in reducing the spread of this disease. Due to the growth habit of having underground rhizomes, heliconias were found to successfully reestablish within months after severe typhoon damage. There is however, a delay and shift in time of flowering as a result of shoot damage.

The cultivars which were identified to be productive through most of the year are: 'Irish Banshee', 'Firebird', 'Lobster Claw I', 'Lobster Claw II', 'Purpurea', 'Dwarf Jamaican', 'St. Vincent Red' and 'Richmond Red'. Other cultivars did not produce as many flowers but were considered to be attractive included: 'Garden of Eden', 'Imperial', 'Eden Pink', 'Temptress' and 'Sexy Pink'.

b. Impact/accomplishment statement

Several flower shops in Guam have on-going orders with heliconia growers. The addition of new cultivars has increased the demand for heliconias as a cut flower and as a landscape plant. Being an herbaceous perennial, recovery following severe typhoon damage required little input and flowering began three to 6 months following the typhoon making it a feasible horticultural crop in a typhoon-prone area.

c. Source of funding — USDA CSREES Special Project TSTAR
d. Scope of impact — State specific

Key theme: Animal Production Efficiency

Specialty Poultry Production

a. Brief description of activity

To examine cost and return of small-scale production of brown table eggs, capons, and turkeys in small pilot projects that could easily be adopted by small poultry producers to supplement their farm income.

b. Impact/accomplishment statement.

The project was approved for funding in October of 2003. Preparation to start the project is underway. Technical advice was provided to several potential clients.

c. Source of funding — Hatch Project
d. Scope of impact — State Specific

Key theme: Invasive Species

Invasive Insects of Micronesia

a. Brief description of activity

Invasive arthropod pests pose a continuous and serious threat to agricultural, urban and natural ecosystems on Guam and in Micronesia at large. The majority of insect and mite pests on Guam are alien species accidentally introduced from Asia, from adjacent islands, or from the

US mainland. These arthropod pests infest crops, vector plant and animal diseases, lead to quarantine of plant produce, destroy houses and wood structures, and threaten the island's biodiversity. Similarly, introduced arthropod pests comprise the majority of serious crop pests in the other islands of Micronesia. With increased air and ship travel between the islands of Micronesia, and with increasing demand for products from Asia, the US mainland and from other continents and island ecosystems comes an increasing threat for the introduction and establishment of additional pests. Approximately one new arthropod pest is introduced annually into Guam. Records from other islands within Micronesia are less comprehensive. Although previous workers have sought to catalogue the insects of Guam and other Micronesia islands, there have been no comprehensive insect surveys in Micronesia for many years. As a result, pest records do not accurately reflect the fauna, nor describe the animal/plant – arthropod relationship existing within Micronesia.

Biological control has been employed to mitigate alien invasive arthropods on Guam and in Micronesia. However, the number of successful biocontrol introductions made to date does not come close to matching the number of alien pest introductions. Hence, farmers are forced to rely on expensive pesticides that are becoming increasingly restricted in their use due to environmental and health concerns. Part of the reason for the relatively limited biocontrol activities in the region is the lack of knowledge on which natural enemies would be best suited for release in the humid tropical islands of Micronesia. A systematic evaluation of the invasive pests present in Micronesia, coupled with a survey of possible biocontrol agents with an estimations of the risk/benefit associated with the particular host – natural enemy will allow better use the limited funds available for pest mitigation by targeting systems with the highest possibility for success.

A research associate for this project, Dr. Aubrey Moore, was recruited and began work in October 2003. A project Website (http://frontpage2000.family-net.org/amoore/Micronesian%20Invasives%20Web/) has been established to facilitate coordination with collaborators and dissemination of information generated by the project. This site has already proven useful as a repository for up-to-date information on a recently introduced scale insect attacking cycads on Guam. A database containing information on the entire arthropod fauna of Micronesia is being built using the BioLink software package developed by the CSIRO in Australia. This database will be used to compile information on distribution and dates of introduction of invasive species. It will also store specimen data and photographs of arthropods collected within Micronesia. Arrangements are being made to provide project collaborators with access to the CABI Crop Protection Compendium. This tool will help to improve pest identification skills within Micronesia.

b. Impact/accomplishment statement

We have trained PPQ personnel on the importance of invasive species, and how to recognize them during their inspections. The trainees in their work assignments are using these techniques. Workers and other interested parties are able to access information regarding invasive species in the region by accessing the web site.

c. Source of funding — USDA CSREES Special Project TSTAR
d. Scope of impact — Multi-state integrated research and extension GU ROP NM FM RMI

National Goal 2: A safe and secure food system.

Executive Summary

Food safety issues continue to play an important role in extension training. Data from the Guam Department of Public Health showed there were 599 outbreaks and 1,658 cases of food-borne illness on Guam from 1983 to 2001 due to incorrect food preparation and handling. Food safety was especially critical in the aftermath of a supertyphoon that destroyed Guam in December 2002. Residents were left without telephone, electrical, sewer and water services. With no power for refrigeration or ability to make ice, people were exposed to spoiled foods, and food preparation was difficult with little or no potable water.

Key issues addressed in Fiscal 2003 were:
Foodborne Pathogen Protection
HACCP

Key theme: Foodborne Pathogen Protection

Food safety education may prevent and reduce foodborne illness on Guam

a. Brief description

Every year at least 50 outbreaks and 150 cases of foodborne diseases are reported to the Guam Public Health Department. The frequency of foodborne illnesses on Guam is much higher than the United States mainland. The tropical climate and variety of ethnic foods enhance the risk of foodborne illness. Lack of food safety knowledge and poor food handling practices are the major reasons for the high rate of foodborne disease on Guam. The goal of the project is to provide food safety education to Guam communities and reduce the risk of foodborne illness on Guam

A bridge grant from CSREES-USDA National Integrated Food Safety Initiative Program Grant funded this project to enhance collaboration institutions and states, revise the submitted proposal, and enhance the food safety program capacity at the University of Guam. The purpose of the funded bridge project is to develop a stronger food safety proposal, collaborate with food safety education and extension specialists, promote food safety education program on Guam, and effectively prevent and reduce foodborne diseases in Guam communities.

To enhance collaboration among institutions and states as requested in the bridge grant, six professors from Washington State University, University of California (Davis), Oregon State University, and the University of Hawaii were invited as consultants to review and revise the previous 2003 food safety proposal, plan and support food safety programs on Guam. The revised proposal “Food Safety Education and Traditional Food ‘Kelaguen’ Modification for Consumers and Children in the U.S. Territory of Guam” was submitted in December 2003 to USDA/CSREES National Integrated Food Safety Initiative Program to apply for the FY2004 program grant. A research associate was recruited and is working for the project to develop food safety education and training programs for consumers and food establishments.

b. Impact/accomplishment

The project will significantly promote food safety education on Guam communities. The new proposed project will not only provide the food safety knowledge but also produce significant changes in food safety behaviors. Such outcome will effectively prevent foodborne disease and reduce the number of foodborne illnesses on Guam. This project will also create a model of food safety educational system systems that will benefit many other Western Pacific islands. In addition, this proposed project would provide useful information of foodborne illness control in the tropical climate area for CSREES research, education, and extension database.

c. Source of funding — Smith-Lever and CSREES-USDA National Integrated Food Safety Initiative Program Grant
d. Scope of impact — State specific

Key theme: HACCP

Food safety training helps prevents foodborne illnesses

a. Brief description

Costly foodborne illnesses are caused by poor personal hygiene and lack of food safety practical knowledge. Other causes of food- related illnesses are related to frequent power and water outages. Power shortages leave refrigerated and frozen foods contaminated and spoiled. Infrequent water supply is unsatisfactory, unsafe, and undesirable. For the most part, the water supply is either out completely or pressure is low. These problems are caused by people, facilities, equipment, or natural disaster. These are but a few island problems that warrant training and education workshops.

Safe food handling HACCP practices in food safety education is necessary for the consumers. They need to know what to do to prepare wholesome food for consumption and how to prevent costly medical care caused by foodborne illnesses.

b. Impact/accomplishment

Sixteen (16) restaurant food service managers and training trainers participated in twenty (20) hours of food sanitation and health certification training and HACCP workshop conducted by the University of Guam Cooperative Extension Service. Ten food safety workshops were attended by a total of 81 participants.

The 16 foodservice managers all successfully passed their examination and have trained their workers. Their establishments awarded them with raised salaries. Also, customer service had improved.

Eighty-one (81) participated in other food safety workshop. Seventy-nine (79) participants passed, and two failed. The participants with passing scores showed improved food safety skills. They have adopted safe food handling and HACCP practices, and have improved their personal hygiene. Hand washing before food preparation became second nature for them.

c. Source of funding — Smith-Lever
d. Scope of impact — State specific

National Goal 3: A healthy, well-nourished population.

Executive Summary

Chronic diseases such as diabetes, cardiovascular disease and cancer have been primary causes of death for people on Guam for over 30 years. According to recent data from the Guam Department of Public Health and Social Services — Vital Statistics Office, six out of the ten leading causes of death on Guam are preventable by healthful lifestyle habits, especially in diet and exercise.

Infant mortality and low birth weight rates on Guam are increasing. Smoking and inadequate prenatal care are both known to contribute to these negative birth outcomes. Furthermore, adolescent pregnancy rates are also increasing. Many of these adolescents and adult women do not have insurance coverage, and therefore do not have prenatal care. Guam's recent welfare reform has made access to health care difficult. Guam's performance plan addresses the following areas of concern: (a) the need to increase objective data regarding nutrient intake in the region, (b) the need to improve nutritional education materials and methodologies for pregnant and lactating women, teens, adults and children at risk of chronic and communicable disease, and (c) the need to train more professionals in the fields of human nutrition and consumer family sciences.

Highlight:
Expanded Food and Nutrition Education Program (EFNEP)

EFNEP is a federally funded program conducted through the U.S. Department of Agriculture. EFNEP has been on Guam for more than 20 years helping local families and children learn how to eat healthier meals and snacks, stretch food dollars and reduce the risk of food-borne illness. The goal of this extension program is to teach children and families how to choose healthful foods, how to stretch food dollars, and to reduce the risk of food-borne illnesses. The Guam EFNEP program reached one hundred and seventy-four families and 1,795 elementary school-aged children, who completed five lessons of the non-formal nutrition education program to improve dietary habits, food safety practices, and food resource management skills.

Out of one hundred seventy-four (57 men and 117 women) participants in the Adult Guam EFNEP program, forty-nine percent showed improvement in two or more nutrition practices including planning meals, making healthy food choices, reading nutrition labels, or feeding children breakfast. Forty-three percent of the participants reported they thought about healthy food choices when deciding what to feed their families, 49 percent reported using the 'Nutrition Facts' on food labels, and 39 percent reported their children ate breakfast more often. Fifty-two percent of participants showed improvement in one or more of the food safety practices such as thawing and storing foods properly.

Eighty-eight percent of the 1,276 children completing the 5-lesson EFNEP curriculum increased their knowledge of the essentials of human nutrition.

Key issues addressed in Fiscal 2003 were:
Human Health

Human Nutrition
Food Resource Management

Key theme: Human Health

Multidisciplinary strategies with community partners promotes healthy living among Pacific Islanders

a. Brief description

Advances in quality of life for Pacific Islanders are restricted by excess health care costs to treat disease, increased non-communicable diseases (chronic diseases), poor living conditions and a decrease in food security. The Healthy Living in the Pacific Islands (HLPI) initiative is the latest Extension Health program among the Agriculture Development in the American Pacific (ADAP) partners that assists to improve the quality of life of Pacific Islanders. Through the HLPI strategy, collaboration and community- based strategic planning help utilize scarce resources and promote self-sufficiency. Similar and matching projects are being implemented in the ADAP coalition. We view this as a long-term initiative, no shorter than 10 years, seeking long-term sustainable change. In Fiscal 2002, Guam and other ADAP partners conducted focus group needs assessments studies with their respective target communities. Health need issues identified by the Guam study are: unhealthy lifestyles (smoking, unhealthy diets, not enough exercise); access to good medical care and medical insurance; environmental health (cleanliness & trash, stray animals, disposal of toxic materials, safe drinking water, and illegal burning-air pollution).

Emphasis is placed on the preparation of information and workshop supplements. Work areas include developing a Guam Health Resource directory that is aligned to pilot a "first call" strategy to promote Extension's role as a resource center for collaborators, educators and community planners. This also includes developing a series of complementing Healthy Living typhoon resource supplements for consumers. A Guam progress report was presented in FY 2003 as well as the inclusion of this program area in a conference on sustainable food systems session (poster submission).

b. Impact/accomplishment

The HLPI projects strive to balance the values of Pacific Islanders influenced by modern practices. Pacific Islanders learn healthy living behaviors through projects aimed at incorporating community-based, holistic, collaborative and sustainable approaches. One thousand health-related brochures were published and continue to be disseminated with the various EFNEP and nutrition-related workshops sponsored by 4H youth mentors and Extension Faculty.

c. Source of Funding — Smith-Lever and ADAP Program funds
d. Scope of Impact — State Specific

Key theme: Human health

Nutrition classes teach benefits of preparing home-cooked meals

a. Brief description

Guam is a fast-food community resulting in obesity. Consequently, the generations are at high risk of chronic illnesses such as diabetes, hypertension, heart problems, and cancer which were unheard of before 1950. Eating out, or buying pre-prepared meals (i.e. fast food restaurants, home-delivery, take out, drive-through, dining out, and deli) have replaced cooking healthful and balance meals at home. High fatty and high salty canned meats and fish are also commonly eaten in place of home cooking meals. The meals are not only high in fats, salt, and rich in animal products but also are low or lacking fruit and vegetables. Serving portions and calories have tripled compared to meals usually prepared and served at home. Portion sizes of meals are generous, and at the same time, obesity has increased. By gradually reducing the portion sizes, most people can lose weight, and reduce the on-set of chronic diseases. By preparing home-cooked meals individuals can fully be in charge of living healthy lives. They can easily reduce saturated fats and triglycerides while preparing the meals. Salt intake can be monitored. Five or more fruits and vegetables can easily be served. Beans and other plant-based protein rich foods can reduce or replace animal-based protein consumption. Healthy home-cooked meals can again replace buying pre-prepared meals. Nutritious meals can be adequate and serving sizes can be corrected for life.

A return to home cooked meals, once considered important and healthy, needs to be revisited, encouraged, and implemented. Healthy meals begin at home. Concern about health helps put people back in the kitchen. With planning, making few substitutions and a few shorts cuts, it isn't hard to prepare quick, easy meals that put individuals in charge of what and how much they eat. There is a turning point in life where individuals need to cook and eat healthy meals. Meals that feature 5-10 servings of vegetables and fruits per day can reduce chronic illnesses by 10% even before it is rounded out by whole grains and beans. Combine healthy diet with physical activities will reduce weight and the on-set of chronic illnesses by 30-40%.

The more scientists conduct research, the more they find that health is protected by eating plenty of vegetables, fruits, whole grains and beans --- plant-based foods. These plant-based foods are important sources of minerals, vitamins, phytonutrients and soluble fiber. Fiber is an important natural cleanser. Average American currently consumes 12 to 17 grams of fiber each day instead of the recommended daily intake of 20 to 30 grams of fiber (American Diabetic Association). According to the Journal of Cardiology, a supplemental 15 grams of fiber a day may significantly lower cholesterol levels in both men and women. The Health and Drug Administration (FDA) has approved a health claim stating that diets low in saturated fats and cholesterol and rich in fruits vegetables and grain products that contain some type of dietary fiber, may reduce the risk of heart disease. The New England Journal of Medicine confirms that some fiber can actually reduce insulin requirement by half. Some types of fiber can lower cholesterol, affect certain cancers, level out diabetics blood sugar, control hypoglycemia, or even headaches.

Eating a high-fiber diet -- 35 grams every day -- does indeed lower cancer risk and other chronic illnesses. Of more than half a million people studied across Europe, the ones who ate the most fiber had 40 percent less colon cancer than those who ate only 15 grams a day.

Teaching "Simple Healthy Steps" in promoting health is used by Food and Nutrition Extension Agent at the University of Guam Cooperative Extension Service (CES). These "Simple Healthy Steps" suggest everyday way to: choose a diet rich in a variety of plant-based foods; eat plenty vegetables and fruits; maintain a healthy weight and be physically active; drink alcohol only in moderation, if at all; select foods low in fat and salt; prepare and store food safely. And always remember to not use tobacco in any form. The Simple Healthy Steps teaching is also used for high-risk individuals and patients. This form of teaching will improve skills and knowledge. Individuals

will become proactive in the prevention, intervention, and maintenance of health. Obese and overweight individuals, high-risk individuals, and individuals with chronic illnesses will be more responsive in the improvement of health. Advice on living with non-communicable diseases, overcoming dietary problems, positive approach to treatment, and overcoming emotional strain such diseases bring will be offered.

Guidance on seeking second opinions and information about treatment options will be provided. Easy tips for healthy lifestyle were discussed. Those high-risk individuals will be challenged to improve their lifestyles through changed behavior.

b. Impact/accomplishment

There are four impacts for Goal 3 since four separate workshops where conducted for different audiences.

Impact No 1: Five Workshops on "Healthy Meals Begin at Home" were conducted. An average of ten (10) participants attended each workshop. A total of fifty (50) attendees participated at the intensive comprehensive lessons to initiate back-to-the-kitchen movement. They showed positive changed behaviors.

The result of the survey of the workshops showed: sixty percent (60%) of participants have changed their habitual pre-prepared meals (i.e. home-delivery, take out, drive-through, dining out, and deli) to preparing balance meals at home. High fat and high salt canned goods were replaced by sixty-seven percent (67%) to reduced fat and salt home cooked meals. Fifty-one percent (51%) of the participants said they enjoy preparing and eating meals at home but they occasionally eat out. Twenty percent (20%) prepared meals at home except for Sunday brunch, while the other twenty-nine percent (29%) said they prepare all meals at home except for very special occasion when they eat out. Hundred percent (100%) plan and prepare easy and quick healthy meals which put them in charge of their health care. Quick nutritious meals are prepared and served in right serving size. They see health is protected by eating plenty of vegetables, fruits, whole grains and beans. They see the positive results of dietary fiber which were missing prior to the "back-to-the-kitchen movement."

"Healthy Meals Begin at Home" workshops helped participants cut out saturated fats by ten percent. They reduced their salt intake now that they are preparing their meals at home. They aim to stay healthy. "Healthy Meals Begin at Home" workshops made participants eat five or more vegetables and fruits, beans and other plant-based foods and less animal products daily.

In addition to eating healthy meals, all the participants have added exercise activities. They are pleased with results of their efforts. They see weight reduction and they are working to get back to their ideal weight. About five percent (5%) of participants have reached their ideal weight. The others have succeeded in losing weight. Those individuals weighing 15 to 19 pounds overweight have reduced their weight to about 10 to 14 pounds. The seventy-nine (29%) obese individuals have lost around ten to fifteen pounds. Their report show positive proof of what behavior change can do for them. Twenty participants who lost three to five pounds were just as pleased with their small progress. Although nine participants are not losing weight, they are happy that they are loosing inches.

Food safety preparation and storage were adopted. Their visits to doctors after weekend parties and fiestas have reduced considerably.

The workshop participants marveled at how much cheaper it is to prepare meals at home. Thirty percent (30%) of participants saved between twenty to thirty dollars on foods. Sixty-one percent (61%) saved between ten to nineteen dollars.

Impact No. 2 - "Simple Steps" Workshops: Four "Simple Steps" workshops were conducted to a total of forty (40) chronic disease individuals: twenty-five (25) diabetics, five (5) cardiovascular victims and ten (10) cancer survivors. All these participants have high blood pressure and high cholesterol problems. Wanting to improve their health, the participants felt empowered to adopt healthier diet and more physical activity.

Furthermore, approximately two-thirds of the participants who are overweight or obese, which contributed to the high rate of cardiovascular disease, diabetes, and hypertension for this population said that they lacked nutrition and health related education. Similar patterns of increased prevalence of obesity that are associated with their health problem were their concern particularly. Their remarks were that there was little information given to them regarding the influence of diet and determinants of activity awareness prior to the workshop. They said it was during the workshop that they began to reflect on their past behaviors and when they began to make positive change. They saw the result of the most popular high sugar drinks and high-fat foods they frequently consumed have impacted their body size and health.

A variety of plant-based foods have replaced two-thirds of animal-based food. Thus they have replaced high fat, high sugar and high salt diet with a healthful diet. They are eating plenty of vegetables and fruits. They are beginning to experience the effect of healthy foods and physical activity.

Sixty percent of twenty drinking participants changed their alcohol drinking habits and are drinking in moderation. Forty percent rarely drink alcohol.

Eighty-four percent remove skin and visible fats from chicken. Seventy-eight percent replaced fried cooked foods with baking, boiling, and stir-frying cooking methods. Fifteen percent replaced high fat meat to low fat meats.

Impact No. 3: One-on-One Cancer Patients/Support People:

Direct one-on-one teaching contacts to cancer patients and support persons were made which made these individuals discover better understanding of cancer diseases. Consequently, they take informed and proactive role in cancer treatment. Having received advice about living with cancer, they became aware of dietary and environmental problems and how to overcome these problems. The cancer patients learn to cope with cancer, side effects from treatment, and the emotional strain this disease bring. These individuals have sought second opinions and information about treatment.

Having participated in twenty-five contact hours of teaching they have became empowered with positive attitude. Their dietary habits, daily activities and lifestyles have changed. These individuals are living normal life, are doing well, and are strongly supported by their families and friends.

Impact No. 4: Nutrition Education for the Elderly Impact:

Six nutrition education sessions for the elderly were conducted. The senior citizens were encouraged to eat healthy meals, exercise, and take care of their health. They all agreed that it is good to be reminded and that will apply what they learned about nutrition, health and exercise.

c. Source of Funding — Smith-Lever
d. Scope of Impact — State Specific

Key theme: Human nutrition

Expanded Food and Nutrition Education Program (EFNEP)

a. Brief description

According to recent data from the Guam Department of Public Health and Social Services — Vital Statistics Office, six out of the 10 leading causes of death on Guam are preventable by lifestyle habits, especially diet and exercise. Research from other studies, such as the Guam Youth Risk Behavior Survey, confirm that Guam's youth consume sub-optimal diets and are not very physically active. The Guam Behavior Risk Factor Survey, conducted by the Guam DPHSS, show that adults on Guam also have unhealthy diet and lifestyle behaviors. Given the statistics, there is a definite need for education and outreach in the area of nutrition, fitness, general health, and chronic disease prevention.

EFNEP is a federally funded program conducted through the U.S. Department of Agriculture. EFNEP has been on Guam for more than 20 years helping local families and children learn how to eat healthier meals and snacks, stretch food dollars and reduce the risk of food-borne illness. The goal of this extension program is to teach children and families how to choose healthful foods, how to stretch food dollars, and to reduce the risk of food-borne illnesses. The Guam EFNEP program reached one hundred and seventy-four families and 1,795 elementary school-aged children, who completed five lessons of the non-formal nutrition education program to improve dietary habits, food safety practices, and food resource management skills.

b. Impact/accomplishment

Impact of Adult program: Out of one hundred seventy-four (57 men and 117 women) participants in the Adult Guam EFNEP program, forty-nine percent showed improvement in two or more nutrition practices including planning meals, making healthy food choices, reading nutrition labels, or feeding children breakfast. Forty-three percent of the participants reported they thought about healthy food choices when deciding what to feed their families, 49 percent reported using the 'Nutrition Facts' on food labels, and 39 percent reported their children ate breakfast more often. Fifty-two percent of participants showed improvement in one or more of the food safety practices such as thawing and storing foods properly.

Impact of Youth program: Eighty-eight percent of the 1,276 children completing the 5-lesson EFNEP curriculum increased their knowledge of the essentials of human nutrition.

c. Source of Funding — Smith-Lever 3(d) — EFNEP
d. Scope of Impact — State Specific

Key Theme: Food Resource Management

a. Brief description

As the local, regional, and global economy continues to remain unstable, and as unemployment rates increase, consumers have less financial resources to purchase food and other basic life necessities. The Guam EFNEP program is addressing this current economic challenge by helping Guam residents to not only select and buy food that satisfies nutritional

needs, but to also effectively manage food resources such as limited income to purchase food, food stamps, and WIC vouchers.

b. Impact/accomplishment

Out of the one hundred seventy-four (57 men and 117 women) participants in the Guam EFNEP program, 71 percent showed improvement in one or more food resource management practices including planning meals, comparing prices, and using grocery lists. Seventy-two percent of the participants reported they intend to plan meals before shopping; 26 percent reported plans to shop from a list; 27 percent plan to compare food items to get the best buy; and 42 percent reported they plan to develop a family budget to ensure adequate expenditures for food until the end of the month.

Consumers who use good food shopping practices are more likely to be able to secure a healthy diet and reduce dependency on government for support.

c. Source of Funding — Smith-Lever 3(d) — EFNEP
d. Scope of Impact — State Specific

National Goal 4: Greater harmony between agriculture and the environment.

Executive Summary

Among several issues addressed in Fiscal 2003 were water quality, quantity, and biocontrol. The College of Natural and Applied Sciences continues to work toward solutions that will help protect the island's most precious resources, Guam's sole-source aquifer and the people who depend on this resource not only for their physical health but economic livelihood. Eighty percent of Guam's drinking water resource sits under Guam's industrial, urban and agricultural districts.

The College conducted several projects to help farmers raise disease-resistant crops. Guam's year-round tropical conditions make the island a natural haven for agricultural pests. Unlike weather in temperate areas with cold periods that naturally "check" pest populations, Guam's weather only makes for prolific pest growth and recurrence of insects of diseases. During the past year, AES and CES faculty continued to develop a multi-faceted plant protection and urban entomology program, as well as a plant pathology research program for Guam and the region. In developing an integrated pest management awareness program for Guam and the region, much work has been centered on reducing chemical pesticide usage.

Highlight (1):

Biological control of ivy gourd, *Coccinia grandis*

a. Brief description of activity

Ivy gourd is a perennial vine native to Africa that thrives in warm, humid tropical regions. In its native habitat, it presents little or no threat to cultivated crop land or native vegetation because it is kept in check by competing plants and effective natural enemies. However, in recent years, it has become a serious pest in the Hawaiian and Mariana Islands, by out competing native plants, suppressing roadside vegetation, forest plantations, and ornamental and fruit farms. It was accidentally introduced to the Marianas in the 1980's and is a serious problem in Saipan and Guam. This weed is a problem for the following reasons: (1) Interferes with cultivation of plantation crops. Ivy gourd vines smother cultivated ornamental plants and fruit crops including mango, guava, banana, breadfruit, citrus and coconut, (2) Invasive: Ivy gourd infests vacant lots, roadsides pastures, forests, natural resources and power poles. (3) Results in negative effects on the ecosystem. Ivy gourd climbs on natural vegetation in forests and natural reserves and disinfects them. (4) Serves as a host for pests of melons. Several pests of cucurbitaceous crops multiply on ivy gourd. Suppression of ivy gourd is a prerequisite for starting a program to eradicate melon fly in the Marianas. It has been estimated that over 15,000 acres in Saipan, 500 acres in Guam and 5 acres in Rota are now infested and infestations continue to spread. There is a need for a host-specific, self-perpetuating, biological control agent for this invasive species. Successful control of this weed has occurred in the Hawaiian Islands by releasing *Acythopeus cocciniae* (Coleoptera: Curculionidae), *Melittia oedipus* (Lepidoptera: Sessidae) and *Acythopeus burkhartorum* (Coleoptera: Curculionidae).

The leaf mining weevil, *Acythopeus cocciniae* of East African origin imported from Hawaii was host specificity tested against the endemic melon plant, *Zehnaria guamenis*, an

Environmental Impact statement was prepared and published in the Federal Register. A permit to field release *A. cociniae* obtained in May 2003 and it was released and established in Saipan and Guam in May 2003.In November 2003, a culture of *A. burkhartorum* was brought from the Hawaii Department of Agriculture to the Quarantine Laboratory at the University of Guam. In communication between the University of Guam, Department of Land and Natural Resources of Northern Marianas, and the Northern Marianas College, Fish and Wildlife - Hawaii and the APHIS, it was decided that the best specificity test for *A. burkhartorum* was to test it on the endemic species *Z. guamensis*. It is being awaited for permission from APHIS to field release.

Acythopeus coccinae has been defoliating the ivy gourd in the release sites. It will take another year or two to notice the decline of the ivy gourd. When *A. burkhartorum* is released, it will complement the effects of *A. cocciniae*.

Highlight (2):

Genetics of *Aphis gossypii*

Aphis gossypii Glover is an extremely cosmopolitan and polyphagous pest of crops and ornamental plants in the tropical Pacific Basin and worldwide. While confined primarily to glasshouses in cooler climates, in the tropics and subtropics *A. gossypii* is a major pest of cotton and cucurbits, where its high reproductive rate allows it to rapidly build up high populations and kill otherwise healthy plants by direct feeding or through the transmission of over 50 virus species. Despite the abundance of past work on *A. gossypii*, its taxonomic status is still poorly understood. The lack of certainty in identifying *A. gossypii* renders interpretation of biological information, including host plant-herbivore-natural enemy relationships, questionable. Lack of understanding about the specific identity of *A. gossypii* populations lessens the chance for successful natural enemy introductions against them in classical biological control programs. Similar taxonomic confusion may also exist among the aphid's aphidiid parasitoid complex, further reducing the chances of successfully establishing an introduced parasitoid on a specific target host while avoiding unanticipated and undesirable nontarget activity.

Aphis gossypii was collected from a range of crop and non-crop plant hosts and at various times during the year on Guam. *A. gossypii* was also collected from a range of crop and non-crop plant hosts in the Commonwealth of the Northern Marianas islands of Saipan, Tinian and Rota, and from the Republic of Palau islands of Koror and Babeldaup. In addition, *A. gossypii* collections were obtained from five of the Hawaiian Islands, Japan, Canada, the USA, Syria, and the Republic of the Marshall Islands. Plant hosts were determined and ant/aphis associations described. Aphid collected were morphometrically analyzed from slide mounted specimens using principal components analysis. These analyses suggested that aphid variation was most closely related to geographic provenance, followed by host plant. Results from microsatellite flanking region analysis (MFRA) performed on aphids from these same collections, but which had been preserved in 95% ethanol, suggested that the majority of genetic variation observed among aphid samples was most closely related to the host plant they had been collected from. Field observations made on Guam suggest that the physical appearance of aphids in subsequent generations may be altered by altering the host plant upon which the aphids develop. Aphid collections from various sites continue, as does refinement of both morphometric techniques, DNA sequencing and data analysis.

We have increased our understanding of the relationship between phenotype and genotype in *A. gossypii.* We have also raised new questions regarding the nature of reproduction in *A. gossypii* in the tropics, and of its rate of evolution in Micronesia.

Highlight (3):

Restoring and Conserving Soil Quality in Degraded Lands of the Pacific Islands

Accelerated erosion as a consequence of poor soil quality threatens both the soil resource base and downstream environment in the island of Guam. These threats are manifested more seriously in the southern part of the island. The challenge facing soil and agricultural scientists therefore is to develop conservation strategies that restore the soil and improve their quality for crop production and environmental quality.

Similar challenges are facing the island of Hawaii and therefore this research project is also being conducted at the University of Hawaii by our collaborators as part of this grant. In this investigation the extent of soil erosion and its effect on soil physical and chemical properties is being evaluated. By using rainfall simulators the parameters of erosion and sediment losses will be measured and determined for further assessment of the environmental impact of erosion and the effectiveness of the applied conservation techniques on these soils. In this regard, we are evaluating the plant residue management such as no-till and reduced till planting as soil erosion control techniques on typical degraded soils in southern Guam. We also use sunnhemp in rotation to the corn crop to maintain surface cover between planting and also improve the quality of soils under study. The principal method of controlling soil erosion and its accompanying rapid water runoff is to maintain adequate vegetative cover at all times which is the main objective of this project.

An integrated approach is designed to evaluate the effect of conservation tillage, crop rotation with leguminous plant for organic matter build up, and residue management for soil re-habilitation and restoration of severely eroded soils of southern Guam. We anticipate that the results of these studies not only provide good database for assessing the extent of soil erosion but the data will provide information on effectiveness of restoration techniques being applied to conserve soils and prevent water erosion in Guam and the other islands of Western Pacific with similar climatic conditions.

The educational impact of this project already have proven to be of a great value since some farmers started to consider rotating their corn crop with sunnhemp and use sunnhemp as green manure and cover crop during the rainy seasons. The educational impact of this investigation will prove to be of great value not only to farmers but also the other members of the communities of the Pacific islanders whom are concerned about the degradation of soils and the impact of water erosion on natural resources of these islands.

Key issues addressed in Fiscal 2003 were:
Rangeland/Pasture Management
Integrated Pest Management
Biological control
Forest Resource Management
Plant germplasm

Nutrient Management
Biodiversity
Agricultural Waste Management
Sustainable agriculture
Invasive species
Water Quality
Weather and climate
Soil erosion
Soil Improvement
Sustainable agriculture
Natural Resource Management

Key theme: Rangeland/Pasture Management

Use of composted organic waste to enhance soil quality of the rangelands in Southern Guam

a. Brief description of activity

Rangeland soils of southern Guam are severely eroded mainly due to lack of organic matter content and poor soil quality. In this extension project we have applied composted organic waste as an amendment to improve the quality of these soils hence, reducing the risk of erosion by water. This project produces composted organic waste mostly from is from typhoon debris, animal manure, and other organic wastes available at the University of Guam Agricultural Experiment Stations and near-by ranches. The composting and the application of compost on farm and rangeland are documented for educational purposes. Composting facilities are used for class activities as part of lab project for graduate and undergraduate students of Soil and Environmental Science courses at the University of Guam. Also, an extension bulletin is being developed on composting and the effect of compost application on farm and rangelands of southern Guam. Presently about an acre of land that is being used as research plots will be impacted by this project. However, the result of this research/extension project will be implemented throughout the Island of Guam and other islands of the Western Pacific affecting many acres of farms, rangelands, and public and recreational areas. The result of this project is being disseminated at educational events and workshops that are conducted as part of the outreach program of the project.

b. Impact/ accomplishment statement

Soil quality has degraded to an alarming stage in most regions of Guam, most especially in southern Guam where most rangelands are located. A humid tropical climate causes rapid decomposition, thus depleting the organic content of soils. Compost is more than a fertilizer and more than a soil conditioner. Using compost can help build good soil texture, structure and qualities that enable soil to retain nutrients, moisture and air for the support of healthy crop growth. Compost is also used to protect the surface of the eroded soils and as organic amendments for enhancement of rangeland productivity, sustainability and maintenance of soil productivity. Compost also helps control erosion that otherwise would wash topsoil into waterways. This benefits farmers and ranchers, landowners as well as the general public who use ranches and other public lands as recreation areas.

c. Source of funding – Special Grants
d. Scope of impact – Multi-state extension- GU NM HI

Key theme: Integrated Pest Management

Integrated Pest Management

a. Brief description of activity

Farmers and home gardeners are becoming more aware of the dangers associated with the use of pesticides and are turning to the University of Guam Cooperative Extension Service for alternative methods of controlling pests. Floating row covers are currently being used to control pumpkin beetle, *Aulacophora similes*, on a watermelon fertigation/irrigation watermelon experiment. Preliminary results indicate that row covers should be added as part of our IPM recommendations to watermelon growers. Currently a fact sheet on results of that project is being prepared. An education program promoting the planting of sunn hemp has been ongoing for a number of years. Sunn hemp has been uses on the farm and new uses are being explored. An article was published in Integrated Pest Management (IPM) Annual Report (www.pprs.info).

b. Impact/ accomplishment statement

Currently no commercial grower is using row covers. The added cost associated with the row cover and the labor necessary for instillation are only offset by the insecticide application savings if beetle populations are moderate to heavy. Another drawback is the development of weeds under the row cover. Sunn hemp is now routinely used by researcher at UOG to increase soil fertility and reduce weeds in research plots.

c. Source of funding — Smith Lever 3(d) — Integrated Pest Management
d. Scope of impact – State Specific

Key theme: Biological control

Biological control of ivy gourd, *Coccinia grandis*

a. Brief description of activity

Ivy gourd is a perennial vine native to Africa that thrives in warm, humid tropical regions. In its native habitat, it presents little or no threat to cultivated crop land or native vegetation because it is kept in check by competing plants and effective natural enemies. However, in recent years, it has become a serious pest in the Hawaiian and Mariana Islands, by out competing native plants, suppressing roadside vegetation, forest plantations, and ornamental and fruit farms. It was accidentally introduced to the Marianas in the 1980's and is a serious problem in Saipan and Guam. This weed is a problem for the following reasons: (1) Interferes with cultivation of plantation crops. Ivy gourd vines smother cultivated ornamental plants and fruit crops including mango, guava, banana, breadfruit, citrus and coconut, (2) Invasive: Ivy gourd infests vacant lots, roadsides pastures, forests, natural resources and power poles. (3) Results in negative effects on the ecosystem. Ivy gourd climbs on natural vegetation in forests and natural reserves and disinfects them. (4) Serves as a host for pests of melons. Several pests of cucurbitaceous crop

multiply on ivy gourd. Suppression of ivy gourd is a prerequisite for starting a program to eradicate melon fly in the Marianas. It has been estimated that over 15,000 acres in Saipan, 500 acres in Guam and 5 acres in Rota are now infested and infestations continue to spread. There is a need for a host-specific, self-perpetuating, biological control agent for this invasive species. Successful control of this weed has occurred in the Hawaiian Islands by releasing *Acythopeus cocciniae* (Coleoptera: Curculionidae), *Melittia oedipus* (Lepidoptera: Sessidae) and *Acythopeus burkhartorum* (Coleoptera: Curculionidae).

The leaf mining weevil, *Acythopeus cocciniae* of East African origin imported from Hawaii was host specificity tested against the endemic melon plant, *Zehnaria guamenis*, an Environmental Impact statement was prepared and published in the Federal Register. A permit to field release *A. cociniae* obtained in May 2003 and it was released and established in Saipan and Guam in May 2003.In November 2003, a culture of *A. burkhartorum* was brought from the Hawaii Department of Agriculture to the Quarantine Laboratory at the University of Guam. In communication between the University of Guam, Department of Land and Natural Resources of Northern Marianas, and the Northern Marianas College, Fish and Wildlife - Hawaii and the APHIS, it was decided that the best specificity test for *A. burkhartorum* was to test it on the endemic species *Z. guamensis*. It is being awaited for permission from APHIS to field release.

b. Impact/accomplishment statement

Acythopeus coccinae has been defoliating the ivy gourd in the release sites. It will take another year or two to notice the decline of the ivy gourd. When *A. burkhartorum* is released, it will complement the effects of *A. cocciniae*.

c. Source of funding – USDA CSREES Special Project TSTAR
d. Scope of impact – Multi-state research and extension

Key theme: Biological control

Management of the New Guinea sugarcane weevil, *Rhabdoscelus obscurus* in Guam.

a. Brief description of activity

New Guinea sugarcane weevil (NGSW) is an introduced pest to Guam. It attacks sugarcane, coconut, betel nut and other ornamental palms. A survey of palms in Guam revealed that this weevil causes serious damage to Pitchardia and Champaign palms. Another survey conducted using aggregation pheromone indicated that this weevil population is greater in Dededo and Tumon than other parts of the island. This directly coincides with the concentration of ornamental nurseries in these areas.

A laboratory rearing of the New Guinea sugarcane weevil *Rhabdoscelus obscurus* has been developed. Population density of the weevils in different parts of the island was assessed and it was found that there was a high concentration of the weevils in the villages Tamuning and Dededo corresponding with the commercial nursery business. Lures of aggregation pheromones of the Australian and Hawaiian populations of New Guinea sugarcane weevil, with other semiochemicals were used to clarify the identity of the weevil population in Guam. In a field experiment at eight different locations (Dededo, Tumon, Yigo, Hagåtña, Mangilao, Yona, Agat and Malesso), plastic bucket traps baited with the lure of the Australian *R. obscurus* population in combination with a food volatile compound (ethyl acetate) and cut sugarcane captured

significantly more weevils (total of 348) than traps baited with pheromone lure of the Hawaiian *R. obscurus* population in combination with food volatile and cut sugarcane which caught a total of 128 weevils. Traps baited with lure containing only the food volatile and cut sugarcane or only cut sugarcane captured significantly fewer weevils (total of 36 and 30, respectively) than those baited with pheromone compounds. Data from trap catches indicate that the Guam population of *R. obscurus* responded significantly more to the pheromone lure of the Australian population than to pheromone lure of the Hawaiian population, indicating that the Guam *R. obscurus* population is related more closely to the Australian population. Trap catches at the Tumon and Dededo locations were greater than those in Yigo, Yona, Mangilao, Hagåtña, Agat, and Malesso. Rainfall had a low correlation with trap catches at all locations except at Yigo where it positively correlated to the Australian population lure treatment.

b. Impact/accomplishment statement

A technique for rearing NGSW in the laboratory has been developed. An APHIS, USDA permit to import the parasitoid, *Lixophaga sphenophori* was obtained. Pheromones are being used to trap the weevils in the commercial nurseries. Development of the rearing and trapping techniques will aid in rearing and release of the parasitoids that have been planned for importation from Hawaii.

c. Source of funding — USDA CSREES Special Project TSTAR
d. Scope of impact — State specific

Key theme: Forest Resource Management

Selected cultivars of the native tree *Eleaocarpus joga* can be vegetatively propagated for use in the landscape and for reforestation.

a. Brief description of activity

Due to increased clearing of forested areas and typhoon damage, the population of *Elaeocarpus joga* Merr. has reduced in numbers. *E. joga* is an attractive tree which is indigenous to the region. Yoga has great potential for use as a specimen landscape plant and for reforestation. Variation in leaf shape, color and texture as well as variation in canopy characteristics makes it necessary to vegetaively propagate selections. Previously trees were only successfully propagated from seed.

Hardwood, semihardwood and softwood cuttings were treated with acid and salt forms of IBA and/or NAA at several concentrations. The cuttings were treated with one of the following: acid form at 05 mL IBA/L + 0.25 mL NAA/L, 1 mL IBA/L + 0.5 mL NAA, 2mL IBA/L + 1 mL NAA/L; salt form at 1, 3, or 8 g IBA/kg. Rooting was compared after 8 weeks. The best rooting (occurred with the salt form of IBA at 3 g•kg-1. The acid form containing both IBA and NAA produced poorer results.

b. Impact/accomplishment statement

Selected plants are being propagated for use in the landscape and in tree planting ceremonies.

c. Source of funding — McIntire-Stennis

d. Scope of impact — State specific

Key theme:

New *Scaevola sericea* cultivars are available for use in Guam landscape

a. Brief description of activity

There is a need to identify a greater variety of plant material for use in Guam's landscape. Methods for optimal propagation and production of the selected plant material must be determined. Vegetative propagation of selected *Scaevola sericea* Vahl. cultivars was evaluated as a means of increasing selected cultivars. Cultivars of Scaevola were selected from naturally occurring variation for bicolor white and purple flower color instead of the common solid white flower. Floral fragrance was another selection factor. The selections need to be propagated vegetatively to maintain uniformity for these selected characteristics. Terminal cuttings were propagated using intermittent mist with treatments of IBA. It was determined that the selected cultivars propagated easily without any growth regulator treatment when intermittent mist is used.

b. Impact/accomplishment statement

Scaevola is used heavily in the landscape. Much of the plants used were imported from Hawaii. These new cultivars add variety to landscapers. Growers in Guam can easily produce these plants.

c. Source of funding – Hatch
d. Scope of impact – State specific

Key theme: Plant germplasm

Plant germplasm collection for improvement of local crop production.

a. Brief description of activity

The project was initiated in Jan. 2001 to collect local and international plant germplasm and to propagate selected cultivars by seed and tissue culture. The project will improve plant acquisition and management system for germplasm and plant propagation program by advancing technology of the Guam AES Horticulture Laboratory.

Activities for this year included (1) to collect local and international plant germplasm and propagate selected cultivars by seed production and in-vitro propagation for conservation of germlines and distribution, (2) to evaluate field performance of collected germplasm for tropical climate adaptation, pest resistance, and other desirable characters for consumers in Guam, and (3) to improve a plant acquisition and management system for germplasm collection and plant propagation program by advancing technology. A crop evaluated in 2003 was hot pepper (Capsicum annuum) in Guam cobbly clay soil. Two field experiments were terminated due to plant damage by slugs. Currently the third trial is being conduced including 7 germlines. Two sweet potato accessions of the University of Guam were deposited to USDA-ARS, PSI-FL Plant Germplasm Quarantine in Beltsville, MD on April 30, 2002. They were *Ipomoea batatas* cv. OTerlaje[1] originated from Guam, and cv. OKuri[1] of Saipan

origin. Those cultivars will be kept in the quarantine until 2005, and will be distributed to the Tuskegee University. A workshop on local white corn was offered to conserve Guam's own line of corn on June 28, 2003. More than 30 participants attended the workshop. Seeds of local white corn were distributed to participants.

b. Impact/accomplishment statement

Conservation of local white corn was the main effort for this year. Production of its seeds was achieved, and distribution of seeds to growers was done at the workshop. A local newspaper article on traditional uses of corn and the workshop conducted successfully drew people's attention on this corn.

c. Source of funding – Hatch multi-state research
d. Scope of impact – State specific

Key theme: Nutrient Management

Mycorrhizal fungus shows potential to enhance crop production on Guam

a. Brief description of activity

Guam cobbly clay soil is commonly cultivated for agricultural crop production. Important plant nutrients such as nitrogen, phosphorus, and potassium in Guam cobbly clay soil are often unavailable or inaccessible. Plants grown in this soil often display deficient symptoms due to limited nutrient availability, high pH, fluctuations of water supply, and scarceness of microbial activity. As a result, common farming practices include application of chemical fertilizers and supplemental irrigation.

Mycorrhiza is a mutualistic association existing between a group of soil fungi and higher plants. In this symbiotic relationship, plant roots provide a growing environment for mycorrhizal fungi, while these fungi develop extended hyphae that absorb important plant nutrients from the soil, and thus translocate these nutrients to roots of the plant. The effects of low soil fertility due to the immobilization of nutrients (phosphorus, zinc, and copper) and drought conditions can be reduced through the formation of mycorrhizae. Experiments were conducted to evaluate the influence of Glomus aggregatum, an arbuscular-mycorrhizal fungus, on the growth of corn, yardlong bean, and watermelon. Corn, yardlong bean, and watermelon were grown in either sterile or non-sterile Guam cobbly clay soil in pot cultures. Growth of all three plant species was significantly improved when inoculated with *G. aggregatum* regardless of soil type. A pot experiment with corn and G. aggregatum was conducted to investigate mycorrhizal corn versus non-mycorrhizal corn under water-stressed conditions. Mycorrhizal corn growth was again increased under well-irrigated and water-stressed conditions. In other pot experiments, G. aggregatum increased growth of okra, eggplant, and cucumber grown in Guam cobbly clay soil. In a field experiment, watermelon and eggplant were grown under optimum fertilizer treatments. Yields of both crops resulted in no significant difference. This may have occurred because mycorrhizal growth is hindered when high phosphorus is available in the soil. Nevertheless, the presence of G. aggregatum did not hinder production.

b. Impact/accomplishment statement

Positive effects of *G. aggregatum* inoculation include improved seedling growth and development, an increase in plant water stress tolerance, and reduction of chemical fertilizer usages. The study demonstrated benefits of the VAM fungus on corn, yardlong bean and watermelon grown in Guam cobbly clay soil in pot culture. Utilization of mycorrhiza in island agriculture may contribute to advances in sustainable agriculture.

c. Source of funding — USDA CSREES Special Project TSTAR
d. Scope of impact — State Specific

Key theme: Biodiversity

The impact of invasive weeds on the occurrence of Target Spot Pathogen

a. Brief description of activity

The introduction of new weeds, pests, and plant pathogens is a constant threat to Guam's agriculture. Early identification of these threats is the first step that needs to be taken before they can be controlled. A comprehensive guide of weeds in Guam with descriptions is that will make the agricultural community and the general public more aware of the threat that plant species currently present in Guam. A host range study on the target lead spot pathogen (*Corynespora cassiicola*) will provide information as to the degree of invasiveness of some weeds. Weeds that serve as a reservoir for important plant pathogens need to be identified.

A key for 100 major weeds on Guam is near completion. These weeds are now being photographed, herbarium samples prepared and growth habitat information collected. Over half of the weeds have been examined for the presence of *C. cassiicola. A* list of worldwide hosts of the pathogen is also being compiled.

b. Impact/accomplishment statement

The impact of the study is limited to the knowledge gained by the researcher working on the project. Their skills in weed identification and fungal pathogen identification have increases. Once the guide is completed, the impact will be extended to students and growers that will be using the resource material.

c. Source of funding — USDA CSREES Special Project TSTAR
d. Scope of impact — State Specific

Key Theme: Agricultural Waste Management

Animal Waste Utilization

a. Brief Description of Activity

Laying hen houses produce nutrient rich waste that if not properly managed can result in water pollution and overgrowth of tropical coral reefs by algal blooms. The purpose of our participation in this project is to reduce the phosphorus level in poultry wastes in tropical environments.

b. Impact/accomplishment

My participation in the project was approved for funding in October of 2003. Preparation to start the project will be made following regional meeting in April of 2004.

c. Source of funding — Hatch
d. Scope of impact — State Specific

Key theme: Integrated pest management

Integrated pest management of important Guam crops

a. Brief description of activity

Cucurbits are among the most important cash crops grown on Guam and in the Commonwealth of the Northern Mariana Islands (CNMI). Of the cucurbits, cucumbers and watermelons predominate and are produced in sufficient quantities to fill most of the local demand. A number of serious insect pests infest cucurbit crops on Guam and the Mariana Island archipelago. A truly integrated cucurbit pest management system must address the effect that controlling each pest might have on populations of other pests. Among the serious pests of cucurbits in the Mariana Islands are several species of whiteflies. The silverleaf whitefly, *Bemisia argentifolii*, was first observed on Guam in 1993 and rapidly became a serious pest of cucumber, watermelon and vegetables. It was also found infesting various farmland weeds. The sweetpotato whitefly, *Bemisia tabaci*, had been observed nearly 20 years earlier in farmers' fields but rarely attained pest status, probably due to population suppression by natural enemies. *B. tabaci* populations appeared to increase to economic pest status when insecticides were used against cucurbit pests, and decreased when sprays were not used (Schreiner *et al*. 1998). Cucurbits are preferred sites for oviposition by *B. argentifolii* (Blua *et al.* 1995, Chu *et al.* 1995). Among the Cucurbataceae, pumpkin, *Cucurbita maxima* Cuch cv. Ebisu was the most severely affected by *B. argentifolii*, while watermelon, *Citrullus lanatus* (Thunb.) Batsum et Nakai cv. Kodama, Karimori, cantaloupe, *Cucumis melo* L. var utilissimus Duthie et Fuller cv. Karimori and bittermelon, *Momordica charantia* L. displayed only a slight spotty chlorosis. Damage among cantaloupe cultivars was variable (Hokama et al. 1993). The major objective of the proposed research is to lay a foundation for developing and implementing IPM strategies, emphasizing non-chemical pest management techniques, for cucurbits on Guam.

Comprehensive aphid and ant surveys on Guam have been conducted on Guam, the CNMI and Palau. Surveys on other islands continue as opportunity arises to visit them, and in collaboration with PPQ and agriculturalists. Surveys of whiteflies and their associated natural enemies on Guam are conducted quarterly. No *Encarsia* parasites have been located in any sampling area for the past three years, contrasting with past surveys conducted on Guam where *Encarsia* sp. was abundant.

b. Impact/ accomplishment statement

Farmers, pest management advisors, and plant protection and quarantine personnel (PPQ) are using our keys to aphids and their natural enemies. They also are using management strategies that have been developed by our group in past years with our assistance rendered as needed.

c. Source of funding — Hatch
d. Scope of impact — State specific

Key theme: Biological control

Biological control in pest management systems in plants

a. Brief description of activity

The purpose of this project is ultimately to reduce the amounts of insecticides used against aphids on Guam and in Micronesia by introducing parasitoids that prey specifically on aphids. In a classical biocontrol program for beans, melons, and taro, the project integrates aphid biological control with crop management tactics used against other insect pests on the target. The project further identifies aphids and associated natural enemies in Micronesia by continuing comprehensive aphid and natural enemy surveys currently ongoing throughout the island. The project educates Guam's agricultural community on distinguishing aphids and associated natural enemies on crops, and recognizes the necessity of biorational pest management strategies.

Surveys of aphids, their host plants, and associated natural enemies continue in the Federated States of Micronesia, the Commonwealth of the Northern Marianas, Guam, and the Republic of the Marshall Islands. The primary focus of the surveys is the melon aphid, *Aphis gossypii* though all aphids from all host plants are considered. Colonies of *L. testaceipes* collected on Guam were reared in the University of Guam insectary on the UOG campus. These parasities were then released on *A. gossypii* and *T. citricida* at agricultural sites where they had not previously been observed on farms in northern and southern Guam. Follow-surveys were conducted on the islands of Babeldaub and Koror in the Republic of Palau where about 1000 *L. testaceipes* were released in 2001 on *A. gossypii* and *A. craccivora.* Studies on ant-aphid-parasitoid associations have begun in 2001 continue in Guam, the CNMI and in Palau. A collaborative network of ant/aphid/aphidiid taxonomists has been established to work on aphid-associated question of the Western Pacific Basin.

b. Impact/ accomplishment statement

The major host-aphid-natural enemy associations for the Mariana Islands, and the Republic of Palau have been described. We have generated further evidence that L. testaceipes populations have expanded during the past year on Rota despite a reduced agricultural area. About50 quarantine personnel on Guam, the CNMI, the Republic of Palau, the Republic of the Marshall Islands, and the Federated States of Micronesia were trained in aphid and aphid natural enemy collection and identification techniques as part of a Plant Protection and Quarantine Workshop held on Guam in April 2003. Joint survey and training activities with the Secretariat of the Pacific Community continue, which strengthens efforts to minimize the spread of noxious invasive species in Micronesia.

c. Source of funding — Hatch multi-state W-1185
d. Scope of impact — Multi-state research - FM GU NM

Key theme: Sustainable agriculture

Insect- and disease-resistant taro

a. Brief description of activity

Taro, *Colocasia esculenta* (L.), is a culturally important and profitable crop grown on Guam and throughout the tropical Pacific that is beset by insect pests and diseases that restrict its production in the Pacific, and impede expansion of its use elsewhere in the US.

The purpose of the research is to: Identify sources of resistance in regional taro cultivars to the aphid *A. gossypii* and taro leaf blight, *Phytophthora colocasiae* (TLB). In conjunction with this activity an insect/disease resistant taro germplasm collection will be assembled on Guam for use in on-island field trials and for eventual distribution to interested parties throughout the Pacific region.

1. Adapt and refine conventional aphid field screening techniques for use in screening for host resistance in taro cultivars for the serious homopteran pest, the taro planthopper, Tarophagus proserpina.
2. Create germplasm nurseries for future use in developing molecular markers for aphid resistance, and for evaluation of potential commercial cultivars.

Aphid and TLB resistant taro lines identified in this project will be made available to breeders and growers to hasten the development of commercially suitable taro varieties for US and Pacific region growers. Primary aphid and disease screenings and work on T. proserpina will be performed on Guam, while a taro nursery with differential aphid resistance will be created through collaboration with University of Hawaii-Maui.

Fifty-nine varieties of taro, Colocasia esculenta (L.), obtained from the Western Pacific and Hawaii have been screened for aphid resistance on Guam by evaluating the extent of naturally occurring infestation by Aphis gossypii Glover, by assessing survivorship and reproduction of A. gossypii caged on the leaves, and by assessing preference using leaf disks in laboratory choice trials. Significant differences were observed among taro varieties in the number of aphids naturally infesting plants in the field. Similarly, significant differences in reproductive rate and longevity were observed between taro varieties. Aphids also showed preferences for certain varieties of taro, as shown by controlled laboratory choice tests. Data have been analyzed and prepared for use by plant breeders seeking to improve the genetic resistance to aphids of commercial taro varieties.

b. Impact/ accomplishment statement

Resistant varieties identified in this study may be used as parents in crossing blocks designed to combine *A. gossypii* resistance with other desirable agronomic traits such as disease resistance and yield, and as a foundation for generating markers for molecular marker-assisted selection.

c. Source of funding — USDA CSREES Special Project TSTAR
d. Scope of impact — Multi-state research GU ROP NM HI

Key theme: Biocontrol

Genetics of *Aphis gossypii*

a. Brief description of activity

Aphis gossypii Glover is an extremely cosmopolitan and polyphagous pest of crops and ornamental plants in the tropical Pacific Basin and worldwide. While confined primarily to glasshouses in cooler climates, in the tropics and subtropics *A. gossypii* is a major pest of cotton

and cucurbits, where its high reproductive rate allows it to rapidly build up high populations and kill otherwise healthy plants by direct feeding or through the transmission of over 50 virus species. Despite the abundance of past work on *A. gossypii*, its taxonomic status is still poorly understood. The lack of certainty in identifying *A. gossypii* renders interpretation of biological information, including host plant-herbivore-natural enemy relationships, questionable. Lack of understanding about the specific identity of *A. gossypii* populations lessens the chance for successful natural enemy introductions against them in classical biological control programs. Similar taxonomic confusion may also exist among the aphid's aphidiid parasitoid complex, further reducing the chances of successfully establishing an introduced parasitoid on a specific target host while avoiding unanticipated and undesirable nontarget activity.

Aphis gossypii was collected from a range of crop and non-crop plant hosts and at various times during the year on Guam. *A. gossypii* was also collected from a range of crop and non-crop plant hosts in the Commonwealth of the Northern Mariana Islands of Saipan, Tinian and Rota, and from the Republic of Palau Islands of Koror and Babeldaup. In addition *A. gossypii* collections were obtained from five of the Hawaiian Islands, Japan, Canada, the USA, Syria, and the Republic of the Marshall Islands. Plant hosts were determined and ant/aphis associations described. Aphid collected were morphometrically analyzed from slide mounted specimens using principal components analysis. These analyses suggested that aphid variation was most closely related to geographic provenance, followed by host plant. Results from microsatellite flanking region analysis (MFRA) performed on aphids from these same collections, but which had been preserved in 95% ethanol, suggested that the majority of genetic variation observed among aphid samples was most closely related to the host plant they had been collected from. Field observations made on Guam suggest that the physical appearance of aphids in subsequent generations may be altered by altering the host plant upon which the aphids develop. Aphid collections from various sites continue, as does refinement of both morphometric techniques, DNA sequencing and data analysis.

b. Impact/ accomplishment statement

We have increased our understanding of the relationship between phenotype and genotype in *A. gossypii*. We have also raised new questions regarding the nature of reproduction in *A. gossypii* in the tropics, and of its rate of evolution in Micronesia..

c. Source of funding — USDA CSREES Special Project TSTAR
d. Scope of impact — Multi-state research GU HI AS ROP NM FM RMI

Key theme: Biocontrol

Effects of indigenous and exotic ants on Guam's native trees

a. Brief description of activity

A number of forest trees and ferns indigenous to Guam and the Marianas Islands are considered threatened or endangered. Suspect in the decline in recruitment has been the rise in the number and species of alien, invasive ants that have been introduced over the years into Guam, and that now have established extensive populations throughout its forests. While most ants are opportunistic foragers, some ant species feed on plant exudates or leaf and stem material, on arthropods infesting trees, and on seeds. A number of ant species have become widespread,

often associated with human activity. While most of these ants are most commonly encountered in urban environments, many are also found in disturbed areas and on oceanic islands where they area able to exploit vacant ecological niches. Invasive ants frequently have drastic disruptive effect on the native ant populations and upon the general ecology of the habitat they invade. Invasive ants may exclude competing native species from food resources and may raid their nests. Indigenous aboveground foraging ants are often the most severely affected, and established ant-plant interactions may be disrupted.

Ants were collected from a variety of habitats on Guam, with emphasis on the limestone forests of northern Guam and ants that were associated with aphids. Similarly, ants were collected from the islands of Koror and Babeldaup in the Republic of Palau, and ant-aphid-host plant relationships ascertained. Microslide mounts of selected ant species and aphids were made prior to their identification by Dr. Laurel Hansen, Spokane Community College and by Ms. Olivia Idechiil, University of Guam. Aphid identifications were made by University of Guam personnel, and verified by Dr. Keith Pike of Washington State University.

b. Impact/ accomplishment statement

Pest control operators on Guam have been informed of the ant species that are present on Guam, their behavior and possible control methods. Similar information has been made available to other workers involved in managing Guam's and Palau's natural resources, including forests.

c. Source of funding — McIntire-Stennis
d. Scope of impact — Multi-state integrated research and extension GU NM ROP

Key theme: Invasive species

The economics of invasive species

a. Brief description of activity

Alien, invasive plant and animal species pose one of the most serious threats to the fragile ecosystems of the insular environments of Micronesia. Combined with the impact of human-related urbanization and other development, invasive species pose a threat to endemic and indigenous species alike. Perhaps the foremost example of the potential for invasive species to wreak havoc on island ecosystems is the case of the brown tree snake, *Boiga irregularis*, which was introduced from Asian islands onto Guam in the late 1940's when WWII military equipment was being transited through Guam en route to the US mainland. Within 40 years the snake had spread throughout the islands, and ultimately caused the extirpation of 11 bird species, which had formerly been common. Cascading ecological effects of these extirpations continue today as some insect populations undergo periodic outbreak cycles since there are no longer predatory insectivorous birds to regulate their populations. Elevated population densities of spiders on Guam may also be related to the lack of bird predation. Other related effects to the Guam community include numerous power outages by snakes climbing across power lines, attacks on infants, depredations of chickens, etc. While the effect of the brown tree snake was not anticipated, there is a need to provide policy makers a mechanism whereby they can assess the cost of managing future invasive species introductions once they are detected as opposed to delaying mitigation efforts until they attain pest status. The development of such an economic

model is the object of this activity, conducted jointly with the University of Hawaii, the University of Florida and the University of Puerto Rico.

Several species that are invasive and alien to Guam have been discussed for inclusion in case studies designed to provide baseline information for the economic model that is the ultimate objective of this project. We have narrowed the possible case studies to: 1) the brown tree snake - because of it well documented impact on the birds of Guam, its potential to infest and devastate other island ecosystems in the Pacific, and because of the less well know cascading effect its introduction to Guam has had on insect and other reptile populations; 2) the papaya mealybug - the successful introduction of three hymenopteran biocontrol agents successfully controlled this recent introduction to Guam from the Americas that had devastated Guam's papaya production capabilities and was of great concern in the tourist and home gardening industries because of its wide host range on a number of high profile ornamental plants; 3) the giant African snail - which was brought under control by a flatworm accidentally introduced to Guam, and which has been introduced to a number of Pacific islands threatened by the snail. This association continues to be controversial because of the threat the flatwork poses to indigenous snails on many islands; and 4) melon fly - a tephritid fruit fly that has been the object of an extensive and nearly successful sterile insect release program. Tephritid fruit flies are serious pests throughout the Pacific, including Hawaii and Micronesia. Case study subjects and protocols will be finalized at a workgroup meeting between PBAG and CBAG participants during the first year of the project.

b. Impact/accomplishment statement

The role of invasive species is beginning to be understood and appreciated by policy makers and researchers alike.

c. Source of funding —USDA CSREES Special Project TSTAR
d. Scope of impact — Multistate research GU HI FL PR

Key theme: Biocontrol

Biological control of papaya mealy bug, *Paracoccus marginatus* in Guam and Palau.

The papaya mealybug (PM), *Paracoccus marginatus*, a pest in the Central America and the Caribbean was noted to have established on Guam in April 2002 and was causing serious damage to papaya, plumeria, hibiscus and other plants. The recent establishment of PM in Guam was a serious concern for the Pacific Islands including Hawaii, Commonwealth of the Northern Marianas and Federated States of Micronesia. It became established in the Republic of Palau in April 2003. The serious damage caused by PM to papaya, plumeria, hibiscus and other plants in Guam and Palau warranted immediate attention as in the case of the countries in the Caribbean and Florida. Since the establishment of PM in Guam and Palau, farmers and home gardeners have been using some chemical and cultural control methods to control PM without much success.

The parasitoids *Anagyrus loecki*, *Pseudleptomastix mexicana* and *Acerophagous papayae* totaling 46,200 were imported from Puerto Rico and field released in Guam from June to October, 2002. Similarly, these parasitoids totaling 9,100 were released at various locations in the island of Palau from August to October, 2003. Releases and assessment sampling was

conducted on a monthly schedule. Notes were taken on other predators observed at each study site.

b. Impact/accomplishment statement

A reduction of over 99% of papaya mealybug was observed in less than a year after the introduction of these parasitoids. The risk of introduction of this mealybug to neighboring islands in the Pacific Region has been considerably reduced and a biological control technology tested and proven successful for implementation if necessary for other islands.

c. Source of funding – USDA CSREES Special Project TSTAR
d. Scope of impact – Multi-state research and extension GU ROP

Key theme: Biocontrol

Biological control of Chromolaena in the Federated States of Micronesia

a. Brief description of activity

Chromolaena is a scrambling weed that grows to a height of 5 m and forms monospecific thickets. It is highly allelopathic and invasive, posing a threat to indigenous vegetation. It is a short day length plant, flowering in December-January in the Northern Hemisphere and from April to June in the Southern Hemisphere. Seed production is prolific and the seeds are dispersed by wind. The shoots dry up during the dry season and become a fire hazard as the pithy dry stems burn readily. However, the stubbles remain alive and sprout immediately after the onset of the rainy season. Chromolaena is a problem weed in plantations of coffee, tea, teak, rambutan, mango, rubber, oil palm and coconut, pastures, disturbed forests, natural reserves, vacant lands and roadsides.

In November and December of 2002 *Pareuchaetes pseudoinsulata* reared on *Chromolaena odorata* in Pohnpei from December 2002 to December 2003 a total of 47,003 larva were produced in the laboratory and were released in Chuuk (26,383), Kosrae (5,471), Yap (200) and Pohnpei (14,949). In the second half of 2003 the production increased and continued to be high. Most of the larva was released in Chuuk, which is the target state for the project. At this stage it is difficult to confirm P. *pseudoinsulata* is in Chuuk. In October, 2003 one larva was found in the field. Although *P. pseudoinsulata* was reported to be established in Kosrae (1992), it was not found in the recent surveys. The project therefore decided to release *P. pseudoinsulata* in Kosrae. In Yap the situation is similar as in Kosrae, *P. pseudoinsulata* was released in 1988 and was reported to be established. During surveys in early 2000 *P. pseudoinsulata* was not found in Yap. In October 2003 the lab assistant went to Yap with 200 *P. pseudoinsulata* larva and 70 pupae were shipped to Yap to start a rearing colony. Several people from the College and Agriculture in Yap were trained in rearing techniques. Unfortunately the rearing of *P. pseudoinsulata* activities failed. Excess caterpillars reared in the laboratory were field released in Pohnpei. For 2004 rearing of *P. pseudoinsulata* will continue, first priority for release will be given to Chuuk but also Kosrae and Yap will be included in the release program. In August 24, 2003 the first shipment of adult flies of *Cecidochares connexa* were sent from the University of Guam to Pohnpei, FSM for host specificity testing on Kava. The testing started in August 25, 2003 and was completed in November 15, 2003. In this test, galls were found only on *C. odorata* plants in the control and choice treatments. The host specificity test with yam was started

November 2003. This trial needs to be repeated because some of the *C. odorata* plants did not have galls. It is planned to repeat this trial in early January 2004.

b. Impact/accomplishment statement

Establishment of the natural enemy *Pareuchaetes pseudoinsulata* (Arctidae) has resulted in marked suppression of the invasive weed in Pohnpei. Attempts are being made to achieve the same results in Chuuk, Yap and Kosrae. In addition, the natural enemy *Cecidochares connexais* being host specificity tested in Pohnpei for obtaining permission to field release in the Federal States of Micronesia.

c. Source of funding — USDA CSREES Special Project TSTAR
d. Scope of impact — Multi-state integrated research and extension FSM

Key theme: Biocontrol

Biological control of red coconut scale

a. Brief description of activity

Coconut is one of the important crops on Guam. Red coconut scale was introduced accidentally to Guam in the 1970s. It attacks coconut fronds and the nuts. In severe infestations, the whole tree appears red. It reduces vigor of the trees and yield of nuts. A parasitoid of red coconut scale was brought in from Ulithi Island in Yap State of the Federated States of Micronesia in 1987. This parasitoid has become established on Guam and it markedly reduced the red coconut scale population. However, reintroduction was necessary in late 2001 and was done. A survey was conducted to determine the extent of establishment and the results of the reintroduction were published.

b. Impact/ accomplishment statement

Red coconut scale is no longer a problem in Guam. The parasitoid introduction has saved people from spending thousands of dollars on insecticides. Also, it averted the possible environmental pollution caused by spraying insecticides. It increased the production of nuts and the aesthetic value of trees.

c. Source of funding — Special grants
d. Scope of impact — State specific

Key theme: Water Quality

Efficiency of drip irrigation alternatives in watermelon crops

a. Brief description of activity

Field experiments were conducted to evaluate drip system design parameters – drip spacing, and number of drip lines per row for watermelon crop. These are important parameters for very shallow soils (15 to 30 cm deep) of northern Guam situated over the sole-source fresh water lens which supplies potable water. One, two, three, and four drip lines per row with a 200 cm spacing were tested for yield and leachate. Based on in-situ soil moisture irrigation scheduling at 20

centibar, no differences in yield were observed and there was no leachate under any of the treatments. However, data indicated that the frequency of irrigation was inversely related to the number of drip lines per row.

Dissemination of information was done via a farmer's workshop at the field site just before final harvest. About 70 farmers, gardeners, teachers and entrepreneurs attended the workshop. An article in a local newspaper to reach a wider audience covered the workshop activities. There were 25 requests for information made at the time of the workshop.

One high school student received summer apprenticeship training during the summer of 2003, while the field experiments were in progress. In addition a legislative group, University of Guam students and High School students visited the experimental field and learned about the irrigation system, irrigation controllers, tensiometers, watermelon crop, and weather station.

b. Impact/ accomplishment statement

Drip irrigation systems will help conserve water, save money and increase crop yield.

c. Source of funding — USDA CSREES Special Project TSTAR

d. Scope of impact — State specific

Key theme: Weather and climate

Guam agricultural weather stations

a. Brief description of activity

Weather stations provide important climatic information to the agricultural community. The Guam Agricultural Climatic Data System (GACDS) has been created to assist scientists, students, golf course managers, farmers and gardeners.

Climatic data from two weather stations (northern and southern Guam) are collected on a daily basis. Rain, temperature, relative humidity, wind speed, wind direction, total solar radiation, photosynthetic radiation, pan evaporation, and estimated turf grass evapotranspiration are measured via sensors and a datalogger. Modems allow data to be collected at a central location. GACDS is to be initiated in four phases:

Phase 1: Install GACDS on an in-house shareware network.

Phase 2: Disseminate GACDS information through yearly technical bulletins

Phase 3: Create a GACDS web site for use by the local community

Phase 4: Add an additional estimated evapotranspiration measurement from a system similar to CIMIS.

The first two phases have been implemented. Phase three has been started, and will require seminars and workshops to instruct the community about accessing and using the information. Phase four is still being researched.

b. Impact/ accomplishment statement

This database has been used by USGS entity at Hawaii for simulation models for the operation of Fena Lake reservoir at Guam. Automated pan evaporation data was of particular significance to this work. This data is regularly used in agricultural engineering field research and there have been many requests for its use by the University of Guam research community.

c. Source of funding — Hatch
d. Scope of impact — State specific

Key theme: Agricultural Waste Management

Fate of Wastewater Effluent Used for Irrigation on Turfgrass Landscapes in the American Pacific.

a. Brief description of activity

Municipal wastewater or effluent is the partially treated wastewater from community or industry sewage. During treatment suspended solids are removed, however the effluent may still contain a host of potentially harmful substances including organic and inorganic compounds such as nitrates and phosphates, heavy metals, organic disinfection by-products viruses, bacteria and protozoan pathogens. Mobile nutrients such as nitrates may readily leach through the soil profile, contaminating underground aquifers.

Golf courses and other turfgrass landscapes are increasingly viewed as environmentally desirable disposal sites for wastewater effluent. Turfgrass areas on Guam and Hawaii are ideally suited for effluent irrigation as turfgrass grow year-round, providing a continuous supply of nutrients for plants. There is limited information available on Guam and Hawaii concerning the variability in effluent composition, and the effects of irrigating turfgrass landscapes with effluent water in regards to environmental factors related to water and soil quality and public safety. There is also little information concerning the biological and chemical composition of effluent water discharged from sewer treatment plants. On Guam, water discharged from a typical municipal sewage treatment plant was analyzed for inorganic ion concentrations, salinity, E. coli, and other basic chemical characteristics such as nitrates, phosphates, Na, K, Mg, Mn, B, Ca, and Fe. Water samples were taken twice a week over a period of 8 weeks during the rainy season. Results of the conducted analysis will be compared to the results from samples taken during the dry season in 2004.

To determine contaminant absorption and fate, non-absorbed contaminants in water discharged to deep (150 cm) parts of the soil profile were monitored with pressure/vacuum lysimeters and pen lysimeters. A field study was conducted during the rainy season in 2003 on common bermudagrass turf established over lysimeter units. Secondary treated municipal wastewater was applied twice a week at three different rates. Leachate was collected twice a week over the period of 8 weeks and analyzed for Escherichia coli, fecal coliforms, nitrates, phosphates, potassium, sodium, and magnesium. An identical study will be conducted in the peak of the dry season in 2004. Initial results indicate that collected leachate contained significantly lower nitrate concentrations at all rates of wastewater application. At the highest application rate, turf removed 52% of applied nitrates. At the lowest application rate, nitrate removal averaged 85%. Turf removed most of the water-soluble phosphorus at any application rate. Removal of potassium, magnesium, and sodium was modest and inconsistent. Turf removed more than 60% of Escherichia coli and less than 25% of fecal coliforms from wastewater regardless of the application rate.

b. Impact/accomplishment statement

Since the effects of turf wastewater irrigation on soil and the underground aquifer have been largely unknown, an accomplished portion of this project provided partial answer about

how to determine the application rates of municipal wastewater to turf areas without the danger of polluting the natural environment.

c. Source of funding – USDA CSREES Special Project TSTAR
d. Scope of impact – State specific

Key theme: Agricultural Waste Management

Application of effluent water on recreational turf in the American Pacific

a. Brief description of activity

The total potable water demand on Guam is approaching current estimates for a long-term sustainable yield. Currently, a smaller portion of aquifer potable water is being used for drinking purposes, and a larger part is being used for irrigation which usually does not require potability. The current practice of using municipal water for irrigation and the simultaneous practice of dumping wastewater (effluent) to the ocean is both environmentally unacceptable and wasteful. Recycled wastewater is a potentially valuable resource that could free-up potable water supplies for future human consumption.

Research began with a survey assessing the chemical composition of wastewater effluent discharged from sewage treatment plants that could be used for irrigation of turf and landscapes. After identifying the basic composition of effluents originating from different sources, a study to assess the long-term effects on major soil characteristics and turfgrass quality was conducted. Long-term effects (2 years) of wastewater effluents on soil parameters such as salinity, structure, permeability, saturated conductivity and turfgrass quality was evaluated. In the field study four lysimeter units $1m^2$ by 60 cm deep have been installed in the ground and filled to the top with topsoil. In addition, pressure/vacuum lysimeters were installed at two depths 6" and 12". The area was sodded with hybrid bermudagrass. Four treatments were applied including irrigation with potable water, irrigation with effluent, irrigation with potable water plus a standard level of nitrogen fertilization, and irrigation with effluent water plus a standard level of nitrogen fertilization.

Compared to tap water, turf quality, especially turf color, increased as a result of irrigation with wastewater. Conventionally fertilized plots had a similar quality to plots irrigated with effluent water and plots irrigated with effluent water but supplemented by fertilizer. Effluent water had a positive impact on turf rooting. The total amount of roots increased more than 20% in both treatments utilizing effluent water when compared to standard fertilization. The clipping yield was affected by nitrogen fertilization and the application of effluent water. The yield of clippings increased 23 percent as a result of effluent water application.

Twelve months of continuous application of effluent water had little effect on soil permeability and soil flocculation. No accumulation of sodium in the soil was found.

During the rainy season around 25 percent of applied N was recovered in leachate under treatments with supplemental fertilization, however, nitrate (NO_3) concentrations never exceed 10 ppm (current EPA limit). During the dry season less then 10 percent of applied N was recovered in the leachate with at most NO_3 concentration below 3 ppm. The concentration of phosphates in the recovered leachate was inconsistent across treatments and substantially varied at different sampling dates. The conducted soil analysis indicated a buildup of phosphates in the

upper 10 cm of soil probably as a result of phosphate precipitation in highly alkaline soil. The levels of other nutrients were not influenced by effluent water application.

b. Impact/accomplishment statement

Our research demonstrated that irrigation of turf with reclaimed water on Guam does not cause harm to the soil or to the natural environment. Effluent water disposal on turf reduces its discharge into streams, lakes or to the ocean. Through this research information was provided to the local government (Guam EPA) so that they may be able to use it for decision making processes.

c. Source of Funding — USDACSREES Special Project TSTAR
d. Scope of impact — State specific

Key theme: Soil erosion

Restoring and Conserving Soil Quality in Degraded Lands of the Pacific Islands

a. Brief description of activity

Accelerated erosion as a consequence of poor soil quality threatens both the soil resource base and downstream environment in the island of Guam. Theses threats are manifested more seriously in the southern part of the island. The challenge facing soil and agricultural scientists therefore is to develop conservation strategies that restore the soil and improve their quality for crop production and environmental quality.

Similar challenges are facing the island of Hawaii and therefore this research project is also being conducted at the University of Hawaii by our collaborators as part of this grant. In this investigation the extent of soil erosion and its effect on soil physical and chemical properties is being evaluated. By using rainfall simulators the parameters of erosion and sediment losses will be measured and determined for further assessment of the environmental impact of erosion and the effectiveness of the applied conservation techniques on these soils. In this regard, we are evaluating the plant residue management such as no-till and reduced till planting as soil erosion control techniques on typical degraded soils in southern Guam. We also use sunnhemp in rotation to the corn crop to maintain surface cover between planting and also improve the quality of soils under study. The principal method of controlling soil erosion and its accompanying rapid water runoff is to maintain adequate vegetative cover at all times which is the main objective of this project.

b. Impact/accomplishment statement

An integrated approach is designed to evaluate the effect of conservation tillage, crop rotation with leguminous plant for organic matter build up, and residue management for soil re-habilitation and restoration of severely eroded soils of southern Guam. We anticipate that the results of these studies not only provide good a database for assessing the extent of soil erosion but will provide information on effectiveness of restoration techniques being applied to conserve soils and prevent water erosion in Guam and the other islands of Western Pacific with similar climatic conditions.

The educational impact of this project already have proven to be of a great value since some farmers started to consider rotating their corn crop with sunnhemp and use sunnhemp as

green manure and cover crop during the rainy seasons. The educational impact of this investigation will prove to be of great value not only to farmers but also the other members of the communities of the Pacific islanders whom are concerned about the degradation of soils and the impact of water erosion on natural resources of these islands.

c. Source of funding — Hatch
d. Scope of Impact — Multi-state integrated research and extension GU HI

Key Theme: Soil Improvement

Management of eroded soils for enhancement of productivity and environmental quality

a. Brief description of activity

Accelerated erosion as a consequence of poor soil quality threatens both the soil resource base and downstream environment in the island of Guam. These threats are manifested more seriously in the southern part of the island. The challenge facing soil and agricultural scientists therefore is to develop restoration strategies that improve the quality of these soils and address crop production needs within a framework of increasing environmental and financial constraints. Compost application as soil amendment can have a significant impact on increasing soil organic matter and enhancing the soil quality of these degraded soils and preventing erosion in southern Guam. The objectives of this project therefore are to evaluate the use of composted organic waste as soil amendments for the enhancement and maintenance of soil quality, and also to evaluate the use of composted organic waste on crop productivity.

Twelve field plots (25ft X 18ft) were set up at the Inarajan experiment station to evaluate the effect of compost application on soil quality and crop productivity. Composted organic wastes were produced and applied for increasing the organic matter content and to enhance the soil quality of these eroded soils. Corn was planted following the application of compost in June of 2002. As the result of a devastating typhoon (Chata`An) in July of that year all the newly established corn that were planted for this project were completely washed off the field and/or destroyed. The irrigation settings and plot markings were all scattered and disassembled. However, soon after the damage assessment processes were completed we proceeded with the project using composted organic waste as soil amendment to evaluate the effect of compost material on organic matter build up on these soils. Sweet corn was established on plots receiving compost and water was provided using drip irrigation systems. Four different application rates; 0 tons per acre, 30 tons per acre, 60 tons per acre and 120 tons per acre were used to evaluate the effect of application rate on soil quality and corn yield. Preliminary results from this experiment indicated that the organic matter content of the soils receiving composted organic waste were the highest as compared to the control treatments.

The project was continued and sweet corn was replaced by the field-corn in August of 2003 to evaluate the effect of different application rates on soil quality and field corn production. Results have indicated that organic matter content was the highest for the plots under 120 tons per acre of compost application. Corn yield however was shown to be the highest under 60 tons per acre of compost application.

b. Impact/accomplishment statement

In humid tropical, the warm, humid climate obviously causes a more rapid decomposition of crop biomass hence depleting the organic content of the soil. Additional biomass provided from

composted organic waste is often needed to maintain or increase soil organic matter levels. Conducting studies such as this is urgently needed to improve soil quality and maintain the sustainability of the agricultural lands in Guam as well as the islands of the pacific region. Our study results have shown that using compost can help build good soil structure, and qualities that enable soil to retain nutrient, moisture, and air for the support of healthy crop growth. Compost also helps control erosion that otherwise would wash topsoil into waterways. The educational impact of this project has proven to be of a great value to the farmers as well as other members of the communities of the pacific islanders whom are concerned about the degradation of soils and the natural resources of the island

c. Source of funding — Hatch
d. Scope of impact — State Specific

Key theme: Sustainable agriculture

Decreasing dependence on man-made fertilizers for crop production in tropical limestone soils

a. Brief description of activity

A farm trial was initiated to determine if sweet corn production could be improved through the replacement of man-made fertilizers with enriched chicken manure, and through the incorporation of a green manure crop. The objectives are to provide producers with a cost-effective means of improving the health of their farms' soil and to provide agricultural researchers with information regarding the benefits of adding organic matter to Guam's shallow, limestone soils.

Due to Guam's two major typhoons in 2002, the trial was delayed. Fields were planted to sunnhemp in the fall and disked under in January of 2003.

b. Impact/ accomplishment statement

Identifying an efficient method of using natural fertilizers could be more economical and does improve soil conditions.

c. Source of funding — SARE
d. Scope of impact — State specific

Key theme: Natural Resource Management

Phenology and toxicology of the Guam cycad

a. Brief description of activity

Cycas micronesica has the potential to become a dominant component in the urban landscape on Guam, since it is one of the native species that is highly prized. This is Guam's only botanical natural resource that is familiar to the international community, and strategies for conservation are not known. One factor that has held back expanded use of this cycad is the putative link between the presence of this plant and the very high incidence of amyotrophic lateral sclerosis-parkinson's dementia complex (ALS-PDC) on Guam. It is possible that some forms of neurodegenerative diseases in the United States involve dietary factors. So the implications of this research are far-reaching. Moreover,

any increase in our understanding of cycad biology will aid in the efforts in cycad conservation worldwide.

The decades of research on neurotoxins from this plant has never asked critical questions such as, “What are base-line toxin levels in various organs, what is the seasonal variation of toxin levels, do toxin concentrations support any of the hypotheses around natural defensive compounds?” This medical research will undoubtedly continue for many years to come. Baseline information from this proposed project will establish a protocol for collection of tissue will greatly improve accuracy and efficiency of this future research

b. Impact/ accomplishment statement

All of the objectives of this project are long-term, and we continue to make progress in understanding reproductive and vegetative phenology. We are also identifying the sex of every individual within established plots. These data will be used to determine demography and allometry characteristics of the natural populations. Our field sampling methods this past year have allowed identification of seed age as we continue to determine the possible causes for the heterogeneity of toxin concentration from sample to sample. The Shaw lab at the University of British Columbia has made great progress this year in determining the influence of sterol glucosides in cycad seeds on various histological and biochemical indices of neuronal dysfunction. The protocol to mimic most of the key behavioral, biochemical, and histological features of ALS-PDC via cycad seed ingestion has been established. This work was done in the absence of the known water-soluble toxins, which indicates the water-insoluble mixture of sterol glucosides that were recently identified is probably causal.

These results will aid in understanding resource partitioning and use in perennial species with conservative growth habits. Greater understanding of the dietary factors that influence ALS-PDC in the Guam population may translate to a greater understanding of neurodegenerative diseases.

c. Source of funding — USDA CSREES Special Project TSTAR
d. Scope of impact — State specific

National Goal 5: Enhanced economic opportunity and quality of life for Americans.

Executive Summary

Guam faced several challenges in the past several years that shook the emotional and financial stability of individuals. In the past year, the community of Guam began rebuilding efforts after suffering from double digit unemployment, record breaking bankruptcies, federal lawsuits against the government of Guam, and two back-to-back supertyphoons. Through the University of Guam Cooperative Extension Service, dozens of partnerships with community and local agencies were formed; disaster recovery efforts reached over 9,000 people; and a local Census report was produced, which helped forgive millions of dollars of Guam's debt paving the way for economic recovery.

Highlight (1):
Interagency collaboration promotes importance of University of Guam Cooperative Extension Technical Assistance Center

In 2003, the Government of Guam was unable to compile basic data information, which compromised thousands of dollars. The Guam Department of Labor's inability to initialize the training and hiring of enumerators created an impasse to the census project of the impact of the Compact of the Freely Associated States of Micronesia. The Cooperative Extension Service program, Economic and Community Systems, piloted the University of Guam Cooperative Extension Technical Center, which augmented the data compilation for the local government. Because of the Technical Center, a $14.2 million grant was secured for the island of Guam.

The initial data sets show critical information that secures future funding for the next increment of Compact-Impact funds that will increase from $14 million to $30 million. Because of the interagency efforts, Guam was able to provide the technical support and assistance to provide a win-win for both local and federal partners. The local government met its mandate and a million-dollar grant was secured for the island. The credibility of a University environment provided an additional awareness and bolsters the University community partnership.

Highlight (2):
Regaining emotional stability the Project PRO way…Guam's Collaborative Model

In December 2002, Guam was destroyed by supertyphoon winds, which forced businesses to close, left families homeless, and destroyed schools. Islanders suffered months without basic services such as water, electricity and telephone service. Through collaboration with federal and local agencies, Project PRO was created. Project PRO has provided outreach and group counseling to over 9,000 people severely impacted by the federal declared storm. Funded by a $1.3 million grant awarded by the Federal Emergency Management Administration, this community outreach crisis counseling program targets specific population groups including public housing, faith-based groups, group shelters, school and work settings and centers. Since the program start, Project Pro Outreach counselors have collectively assisted thousands of people with varying degrees of crisis counseling, consultation education and support groups.

Highlight (3):
4-H life skills build confidence in youth

The University of Guam Cooperative Extension Service continues to successfully involve youth in its 4-H and Youth Development Programs. During the Fiscal 2003, a total of 3,251 youths participated in nine modules driven programs and completed 159 life skills workshops. Youth participation resulted from a combination of program sustainability, public awareness through media outreach, and by word of mouth. The youths that participated came from eight public schools, six elementary schools and two middle schools; Andersen Air Force Base, Child Development Center and Youth Center, and the 4-H Summer Program.

4-H clubs and training, i.e., sports clinics are self-sustaining and are directed by 4-H adult advisors and volunteers. Each program collaborates with all areas of the community, depending on the programs that are conducted.

1. 4-H F. B. Leon Guerrero Middle School - Annually beautifies 50 acres on campus, which includes development of a school nursery. The 4-H Club participates in all 4-H core programs. Mr. Lali Thundiyil was selected as adult leader in 2003.
2. 4-H adult leaders and a youth participant were nominated to attend the 74th 4-H Conference in Maryland.
3. Over 200 youths participated in 4-H summer core programs conducted by the University of Guam 4-H unit.
4. 4-H school based clubs submitted grant proposals to the 4-H National Council. Student club members wrote grants after receiving grant writing training from 4-H extension agents.

Key issues addressed in Fiscal 2003 were:

Consumer Management
Multicultural and Diversity Issues
Home Safety
Youth Development/4-H
Information Technologies

Key theme: Consumer Management

Enhancing economic opportunities and financial security in later life -- "Pacific Saves - Guam Saves"

a. Brief description of activity

The latest Extension *National Initiative Financial Security in Later Life* focuses on management of individual and family resources with emphasis on family finances in later life. Part of this initiative includes localizing the national campaign through a program concept entitled Pacific Saves. The intent is to promote a regional savings agenda effort with all the partners of the Land Grant system. The pilot version of this initiative, "Guam Saves", is the current format for workshop, seminars and training sessions for Extension clientele and stakeholders as well as students. The Guam Saves format was a perfect piece during the early period of this year 2003, wherein, the University of Guam initialized its Human Resource

Employee Resources Center. This program became an important part in the presentation held throughout campus.

b. Impact/ accomplishment statement

The Guam Saves format is the localized piece during the early period of this year 2003, wherein, the University of Guam initialized its Human Resource Employee Resources Center. This program became an important part in the presentation held throughout campus during a financial austerity period affecting University operations.

The Guam Saves venue continues to be the Flagship program for promoting the area of personal finances and the national agenda for the Financial Security in Later Life for Extension clientele and partners. Much of this effort continues to be realized in the number of requests for seminars and the format's flexibility in a variety of sessions (job fairs, training sessions). The most significant is the request to present this seminar to over 800 summer youth workers as part of their orientation program for career and job training. The session was entitled "Your First Paycheck".

c. Source of Funding — Smith-Lever
d. Scope of Impact — State Specific

Key theme: Multicultural and Diversity Issues

Interagency collaboration promotes importance of University of Guam Cooperative Extension Technical Assistance Center

a. Brief description

In 2003, the Government of Guam was unable to compile basic data information, which compromised thousands of dollars. The Guam Department of Labor's inability to initialize the training and hiring of enumerators created an impasse to the census project of the impact of the Compact of the Freely Associated States of Micronesia. The Cooperative Extension Service program, Economic and Community Systems, piloted the University of Guam Cooperative Extension Technical Center, which augments the data compilation for the local government. Because of the Technical Center, a $14.2 million grant was secured for the island of Guam.

The Economic and Community System continues to refine its community role by identifying the teaming and collaborative options with government and nongovernmental organizations. The ability of local government agencies to comply with federal mandates and carry out projects is threatened by the local government's poor financial condition. Through collaborative relationships between the University and local agencies, relief is provided to help agencies meet their mandates and carry out projects. This collaboration aligns well with the role of the University of Guam Cooperative Extension Service. The need for a University-based data center complements the University's strategic initiatives calling for centers of excellence that is based on a culture of evidence. The University's role of a State Data Center continues to expand its role in many ways. Efforts to promote both local and federal interagency data gathering initiatives that complement the University's unique capability and resources fills a much needed void. This is apparent for organizing and coordinating research and data needs that support grantsmanship efforts university wide.

In FY 2002, the concept of the Extension Center for Agricultural and Resource Data Institute (CARDI) was proposed to help define the Data needs for the College and Extension. This was a proposal that builds on the unique program areas and resources of the College of Agriculture and Extension and Agricultural Research. This concept was tested in FY 2003 through several initializing interagency projects: Compact Impact Census Staging and Training and Data Collection Efforts and the Secretariat of the Pacific Communities Data Training for planners and statisticians.

b. Impact/accomplishment

The initial data sets show critical information that secures future funding for the next increment of Compact-Impact funds that will increase from $14 million to $30 million. Because of the interagency efforts, Guam was able to provide the technical support and assistance to provide a win-win for both local and federal partners. The local government met its mandate and a million-dollar grant was secured for the island. The credibility of a University environment provided an additional awareness and bolsters the University community partnership.

c. Source of Funding — Smith-Lever and US Department of the Interior, OTIA
d. Scope of Impact — Multistate Extension GU NM ROP

Key theme: Home Safety

Regaining emotional stability the Project PRO way…Guam's Collaborative Model

a. Brief description

In December 2002, Guam was destroyed by supertyphoon winds, which forced businesses to close, left families homeless, and destroyed schools. Islanders suffered months without basic services such as water, electricity and telephone service. Some schools shut down for weeks, while other schools closed permanently, adding to already overcrowded classrooms. The storm and its aftermath left thousands emotionally distraught. Project PRO provides outreach and group counseling to individuals severely impacted by the federal declared storm. Funded by a $1.3 million grant awarded by the Federal Emergency Management Administration, this community outreach crisis counseling program targets specific population groups including public housing, faith-based groups, group shelters, school and work settings and centers. Since the program start, Project Pro Outreach counselors have collectively assisted thousands of people with varying degrees of crisis counseling, consultation education and support groups.

Project PRO is a localized program made up of local and federal government agencies, and nongovernmental organizations through a collaborative effort with the Department of Mental Health and Substance Abuse and the University of Guam Cooperative Extension Service and community partners. The University of Guam's Cooperative Extension fills a niche for providing the staging environment and delivery of support services for collaborators. Key themes covered in Goal 5 include: Children, Youth, and Families at Risk; Child Care and Dependent Care; Communications Skills; Family Resource Management; Home Safety; Jobs/Employment; and Consumer Management.

b. Impact/accomplishment

Project PRO provides outreach and group counseling to individuals severely impacted by the disaster. Crisis counselors recognize and provide counseling support and emotional support and information about common and understandable reactions to disasters. The counselor teams are from two nongovernmental organizations with specific target populations to provide outreach services. This project specifically provided direct counseling for First Responders called on to provide emergency and support services. Disaster crisis counseling includes consultation and education services, community intervention and public awareness and referral services.

Because of this project, the collaborative model for emotional recovery disaster relief continues to be refined at the University level. The collaborative piece unites community partners and subgrantees (Guma Mami Inc. and Catholic Social Services) providing the teaming arrangement for an effective outreach capacity. The crisis counseling part ensures the targeted, underserved populations (elderly, children, those with limited resources, individuals with disabilities, minority groups) are reached.

The University's staging team provided the technical work and support for fieldwork teams. Without the support role of the partners in Project PRO, much of the community presence and outreach would have been limited to existing government resources and funding. So far, two key trainings and other related stress management and resource management training sessions continue during this grant period. A stronger collaboration between local and federal agencies continues to be reinforced, as relationships and program are better understood. These communications among the essential agencies keep the project dialogue open and areas needing attention are addressed immediately. This effective teamwork resulted in the development of a Project PRO Website and a Project PRO database of all the fieldwork data collection efforts.

c. Source of Funding — Smith-Lever and FEMA
d. Scope of Impact — State Specific

Key theme: Youth Development/4-H

4-H life skills build confidence in youth

a. Brief description

The 4-H & Youth Development Program enables one to learn and then teach another the life skills that will help build self-confidence and improve quality of life. Youth development is a process of mental, physical and social growth, during which young people prepare to live a productive and satisfying life within the customs and regulations of their society. The program is an informal educational program that is conducted by the U.S. Department of Agriculture, state land-grant universities, state and local extension staff and volunteer leaders. The program works with local and federal government agencies. It empowers children, youth and adults to participate in education activities designed to help them improve life skills and learn basic concepts in human development.

This program provides a systematic approach to plan activities that will enhance the quality of life through "learn by doing" for children, youth, and families at-risk – particularly in mentorship training skills

An essential goal of the program is to conduct mentorship life skills presentations/ workshops to youths grades K-12. The Experiential Learning Model and the Targeting Life

Skills Model are both incorporated into the various modules that are used during presentation delivery. These modules are based on learning activities that can be applied to real life situations.

The framework involves a team of mentors shadowed by an Extension Specialist and faculty. The Master Mentor(s) oversees the other mentors and serves as the leader in the team delivery program. Mentors were assigned into teams to ensure the sessions are carried out as scheduled. The teams were assigned to represent core units (modules and life skills) accordingly. All teams were required to undergo cross training in the different Extension Programs, which was the basis of the different curriculums (modules) and workshop series. Training sessions were held periodically and all mentors were expected to attend.

b.Impact/accomplishment

A total of 3,251 youths participated in nine modules driven programs and completed 159 life skills workshops. Youth participation resulted from a combination of program sustainability (many workshops were requested by professionals who were already aware of the program), public awareness through media outreach, and by word of mouth. The youths that participated came from eight public schools, six elementary schools and two middle schools; Andersen Air Force Base, Child Development Center and Youth Center, and the 4-H Summer Program.

Of the total number of participants, 3,031 or 93% of youth participants responded to the evaluation tool and the results show that 58% of youth reported greater understanding of the life skills which was a 29% increase before the life skill was taught. The 29% increase in participation is due to youths that have participated in the program in the previous years. The most recent 2003 final Youth Risk Behavior Survey by DOE and Centers for Disease Control, Division of Adolescent and School Health showed about 14% of Guam's high school students participated in 4-H life skill programming.

c. Source of Funding — Smith-Lever and self-sustaining clubs and programs
d. Scope of Impact — State Specific

Key theme: Youth Development/4-H

4-H Youth Development Programs enhance youth life-skills on the island of Guam

a. Brief description

Guam's youth face monumental social, psychological, and economic strain. The problems are startling levels of poverty, illiteracy, high school dropout rates, poor health and nutrition, child neglect and abuse, teenage pregnancy, chemical substance abuse, depression, and suicide. 4-H life skills curricula have targeted at-risk youth in order to effectively address these issues. 4-H school-based clubs have been in existence for the last seven years. All 4-H club programs and projects are involved horticulture, grant writing, mentorship training, photography, sports, and environmental field trips.

4-H clubs and training, i.e., sports clinics are self-sustaining and are directed by 4-H adult advisors and volunteers. Each program collaborates with all areas of the community, depending on the programs that are conducted.

1. 4-H F. B. Leon Guerrero Middle School - Annually beautifies 50 acres on campus, which includes development of a school nursery. The 4-H Club participates in all 4-H core programs. Mr. Lali Thundiyil was selected as adult leader in 2003.

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4. 4-H school based clubs submitted grant proposals to the 4-H National Council. Student club members wrote grants after receiving grant writing training from 4-H extension agents.

b. Impact/accomplishment

4-H clubs and activities have a tremendous long-term impact on the student participants and the adult partners. Students learn life skills and ethical values. Students become aware of their ethnic background and traditions, and understand the vast ethnic diversity of youth in our community.

c. Source of Funding — Smith-Lever and self-sustaining clubs and programs
d. Scope of Impact — State Specific

Key theme: Information Technologies

Developing distance education promotes agriculture education

a. Brief description

In part, because of a lack of knowledge in the population and a lack of qualified teachers to instruct in the use of more efficient and appropriate agricultural production and marketing methods, the region's local food production base of subsistence agriculture is unable to meet the market demand of its population. Thus, there is an over-dependency and imbalance of trade for higher priced, processed food imports. This dependency drains off cash availability for its re-circulation in local markets. This program seeks to stimulate and enable colleges and universities to provide quality education for producing a strong food & agriculture scientific and professional workforce.

This project was piloted with the launch of the first online Web-based course, "Introduction to Agriculture," during the summer. At that time, 13 regional adult learners who are teachers came to Guam for orientation and training in the use of the online technology. Through the grant partnerships with other institutions of higher learning, new online courses including general education courses are being developed. By fall semester, Palau Community College was able to offer Freshman English and Algebra to its students using this technology.

b. Impact/accomplishment

Agriculture teachers have increased their qualifications & proficiency of instruction for teaching agriculture content and curricula to the K-12 population of students in Micronesia; coordination and support for distance education has increased making access to higher education and the agriculture sciences more accessible for transferring the knowledge of food production, thus reducing dependency on imported food products in the region and producing more efficient farmers. Faculty who have developed the distance education courses have gained new skills and training for use in the teaching and learning process.

c. Source of Funding – Smith-Lever and Higher Education grants
d. Scope of Impact – State Specific

B. Stakeholder Input Process

Actions taken to seek stakeholder input

For the most part, our professionals know the primary stakeholders in their particular disciplines, and interact with them regularly in the course of their normal university duties. Input from these interactions allows extension agents and researchers to tailor their programs to the unique needs of Guam's diverse community.

The University of Guam Cooperative Extension Service Fiscal 2003 Plans of Work and subsequent annual impact reports were evaluated by a community advisory panel. Each extension agent was required to solicit the services of two members in the community to guide Extension Plans of Work and evaluate impact reports. The panel met with UOG Cooperative Extension Service administrators, extension agents, staff, and paraprofessionals and evaluated, by a nominal process, the three Cooperative Extension Service programs and the annual impact report submitted by each extension agent.

Besides the formal evaluation process by stakeholders, stakeholder input is solicited at other times during the year to critique the research and outreach activities of the faculty, and to offer suggestions on changes needed to make the program more relevant to the various University of Guam stakeholders on the island. We found that because many of the agri-businesses on Guam are transitory, and because the recent economic downturn and natural disasters have caused dramatic changes in the business and agricultural landscape, that membership on several of these committees was sometimes altered. However, we feel this may be advantageous in the long run, as it forces extension agents and research scientists to be more aware of who is doing what in the community at large, and will likely reduce the inbreeding of relationships which is common on a small island and which was highlighted in the 2003 report as a potential problem with this system of obtaining stakeholder input.

Results of consideration of received stakeholder input

We feel our informal and formal contact system with stakeholders works quite well. Perhaps one of the best examples of how stakeholder input is translated into action by the rapid manner in which UOG was able to react to the sudden appearance of a debilitating disease of betel nut on Guam. Due to the close contact extension and research scientists maintain with local growers, and because of the breadth of experience on other islands in the region, UOG-AES pathologists and CES extension agents were able to identify, characterize and provide a rational method of management for this disease by issuing a small pocket flyer within a few weeks of the first report of the disease. Scientists were then able to apply for funding for more in depth research on the nature and optimal management technique of the disease for Guam and other concerned growers on adjacent islands where betel nut is a major cash crop.

C. Program Review Process

Significant changes in the program review processes

There have been no significant changes in Guam's program review processes since our 5-year plan of work.

D. Evaluation of the Success of Multi and Joint Activities

The University of Guam participates in four multi-state research projects in FY 2002. These were W-1185 - biological control in pest management systems of plants, W- 128 – micro-irrigation management practices to sustain water quality and agricultural productivity, NC-1142 - regulation of photosynthetic processes, and S-009 - Plant Germplasm. In addition, the University of Guam dropped participation in NC 174 – Management of Eroded Soils, and added participation in two others, namely S-1000 - Animal Manure and Waste Utilization, Treatment and Nuisance Avoidance for a Sustainable Agriculture and NC 136 - Improvement of Thermal and Alternative Processes for Foods. We are contemplating participation in S 1004 - Development and Evaluation of TMDL Planning and Assessment Tools and Processes. We also participated in four multi-state coordinating committees. They were WCC- 011 - turfgrass research, WCC-067 - western coordinating committee for sustainable agriculture, WCC-205 - integrated water quality research and extension program for the western United States and WCC-206 - Pacific Basin tropical agriculture.

The AREERA guidance asks that the following four questions be answered in evaluation of the University of Guam's participation in Multi and Joint Activities.

Did the planned programs address critical issues of strategic importance?

Most did, but we are still reviewing our participation in NC-1142, regulation of photosynthetic processes due to concerns that it lacks focus on our strategic needs. The others are addressing the long-term needs of our clientele on Guam and in the region.

Did the planned programs address the needs of under-served populations?

Yes, our planned programs focus on tropical agriculture, and our farmers and general population on Guam are generally under-served and underprivileged clienteles. The population on Guam represents several ethnic minorities of which the majority are Asian/Pacific Islanders.

Did the planned programs describe the expected outcomes and impacts?

Multi-state programs addressed expected outcomes and impacts, initially through the development of proposals and later in progress reports. In the local Plans of Work and AREERA reports, however, individual scientists and extension agents on Guam still vary considerably in their success in meeting this goal.

Did the planned programs result in improved program effectiveness and/or efficiency?

Our membership in multi-state projects and committees allows our researchers and extension professionals to interact with counterparts from within the region and around the country. Because of Guam's location and distance from the US mainland, we have no more

than one or two faculty in each discipline. Annual and ongoing interactions are critical to maintaining our programs' performance standards and ensuring that our activities are relevant and effective.

Appendix A. Allocation of Local, Hatch and Smith-Lever 3c and 3d Funds within the Agriculture Experiment Station and Cooperative Extension Service

	Prof FTE	ParaProf FTE	Staff FTE	Admin FTE	Federal Funds	State Funds	Total Funds
Goal 1							
research	4.50	1.00	8.00	1.50	465,666	482,910	948,576
extension	4.58	0.00	1.00	1.00	273,022	221,286	494,308
Goal 2							
research	0.25	0.00	0.00	0.10	13,887	16,660	30,547
extension	0.30	0.00	0.25	0.10	23,152	18,765	41,917
Goal 3							
research	0.00	0.00	0.00	0.00	0	0	0
extension	2.42	0.00	0.50	0.80	211,681	124,501	336,182
Goal 4							
research	2.62	1.00	5.50	1.50	370,976	331,459	702,435
extension	1.28	0.00	0.75	1.00	167,770	91,541	259,311
Goal 5							
research	0.00	0.00	0.00	0.00	0.0	0.0	0
extension	6.10	0.00	1.00	2.00	372,303	308,755	681,058
Programatic Subtotal	22.05	2.00	17.00	8.00	1,898,457	1,595,877	3,494,334
University and Community service	1.12		2.00	0.50		233,861	233,861
Fall teaching	1.40		0.50	0.50		162,525	162,525
Spring teaching	0.93		0.50	0.50		132,674	132,674
Research	7.37	2.00	13.50	3.10	850,529	831,029	1,681,558
Extension	14.68	0	3.5	4.9	1,047,928	764,848	1,812,776
Teaching and service	3.45	0	1	1.5	0	576,377	576,377
Total	25.50	2.00	18.00	9.50	1,898,457	2,172,254	4,070,711