ANNUAL REPORT FOR ACCOMPLISHMENTS AND RESULTS

Western Pacific Tropical Research Station
(Agricultural Experiment Station)

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Location

University of Guam
UOG Station
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Executive Summary

Guam, an unincorporated Territory of the United States, is located in the Western Pacific. 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. 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. Agriculture Experiment Station became a component of College of Natural and Applied Sciences (CNAS). In 2006 AES was renamed to Western Pacific Tropical Research Center. This new name will more accurately reflect the division's broad mission and research priorities. The Dean of CNAS is simultaneously the Director of the Western Pacific Tropical Research Center (former AES). The primary mission of WPTRC is to conduct applied and basic research in agriculture and to protect the natural environment. The Hatch funds and their respective Government of Guam matching funds are used to maintain operations of the University of Guam Agriculture Experiment Station. These funds principally support the salaries of permanent personnel of WPTRC.

National Goal 1.

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

Key theme: Plant germplasm

Vegetable horticulturist at Western Pacific Tropical Research Center (former AES) conducted research on plant genetic resources conservation and utilization. During 2006, the main activity of the project was to collect germplasm of hot peppers (*Capsicum annuum* and *C. frutescens*) for the field trials. Nearly 100 lines were obtained from commercial seed companies, Asian Vegetable Research Development Center, USDA-ARS, Plant Genetic Resources Conservation Unit, and local collection. These hot pepper accessions are being evaluated in the 2006 field trial for general screening of tropical climate adaptation in Guam, marketable yield and fruit pungency. Three large-fruited heat tolerant tomatoes (*Lycopersicon esculentum*) were studied for their total soluble sugar content and dry matter (%). Two cultivars, 'Solar Set' (mean=6.73%; sd=0.69, N=9) and 'Sun Chaser'(mean = 6.68%; sd=0.73, N=9) had higher %DM than 'Solar Fire' ((5.87%; sd=0.39, N=9). The % Brix was the lowest for 'Solar Set' (mean=4.12%; sd=0.76, N=9) followed by 'Sun Chaser' (mean=4.45%; sd=0.20, N=9) and 'Solar Fire' (mean=4.72%; sd=0.39, N=9). The antioxidant property of 'Solar Fire' was examined and it was found the fruit had the average of EC_{50} = 46.0 ml/g DPPH (sd=3.8, N=5).

A related project: Evaluation of hot pepper genotypes for growth and potential processed products in tropical islands was conducted in 2006. *Capsicum* spp. were collected from local farms, fields and national and international germplasm depositories. More than 70 accessions are being evaluated at Yigo Farm of WPTRC. This project will evaluate hot peppers for their adaptation to Guam's agro-environment. The long-term goal is to develop value-added product (hot pepper paste/sauce) to improve agro-business of Guam.

Source of funds: Regional Hatch and USDA, Tropical & Subtropical Agricultural Research Special Grant

Scope of Impact: Regional

Key theme: Plant germplasm

Scientists at Guam Western Pacific Tropical Research Center researched germplasm collection for improvement of local crop production. The project was initiated 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 WPTRC 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 2006 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. 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 2007.

Source of funding – Hatch multi-state research

Scope of impact – State specific

Key theme: Plant production efficiency

Scientists at Guam Western Pacific Tropical Research Center investigated response of vegetable crops to mycorrhizal inoculation in tropical limestone soils. Composting materials are being collected and aged at a compost bin for future experiment. Corn seeds were obtained from UH and would be used as an indicator plant study effects of organic amendments on distribution of indigenous mycorrhizae. This work would isolate indigenous arbuscular mycorrhizae from Guam for the first time
Glomus aggregatum inoculation improved plant growth and development of tropical vegetables. The study demonstrated the benefit of this VAM fungus on papaya and green onion seedlings grown in Guam cobbly clay soil in pot culture. The field experiment also demonstrated the possibility of improved performance of corn by inoculating G. aggregatum. Utilization of mycorrhiza in island agriculture may contribute in advancing the sustainable agricultural system.

Source of funds: USDA, Tropical & Subtropical Agricultural Research Special Grant

Scope of Impact: Regional

Key theme: Plant production efficiency

New project was conducted in 2006 by scientists from Agriculture Experiment Station along with University of Florida investigated *Corynespora cassiicola* and its impact on quarantine regulations. Isolates from all 20 hosts have been obtained from Guam. Isolates from 10 of the hosts have been obtained from Florida. Isolates from Coleus have been obtained from Guam, Hawaii, and Florida. They have been analyzed for differences that can be directly related to geographic location (biotypes). Data have been used to construct a Corynespora isolate diversity map for the Caribbean and Pacific Basins. Field agents at the various survey locations were

provided with a summary of results specific for their region. Each agent has received a list of hosts susceptible to *C. cassiicola*. The list indicated the hosts that occur in their location as well as the hosts found to harbor the pathogen during the survey. Susceptible crops that are currently free of the disease are currently being identified in each location. This will provide the basis for APHIS quarantine decisions. Additionally, an authoritative review of *C. cassiicola* based on our research results will be produced and disseminated to field agents at survey locations as well as state Departments of Agriculture, APHIS offices, and growers associations.

Source of funds: USDA, Tropical & Subtropical Agricultural Research Special Grant

Scope of Impact: National, Regional

Key theme: Plant production efficiency

Productivity of farmlands needs to be improved by selection of cultivars that are adapted to Guam's agro-climate, with resistant to pests, and have good post-harvest properties. The proposed study will evaluate local seed production of selected vegetable cultivars and will establish and practice the in-vitro production of selected plants. Local seed production of selected hybrids with available parental lines will be tested for agro ecological adaptability. Parental lines will be grown in pots at the nursery or at the field. The general characteristics of parental lines will be evaluated. Controlled crossings of parental lines and seed preparation will be performed by the procedure suggested by AVRDC (1990). The success rate of hybridization in Guam's condition will be evaluated by counting the number of attempt and the number of successful attempts for each cross. Bioassay will be performed to determine viability of seeds and uniformity of seedlings for major plant phenotypes. Vegetatively propagated plants will be tried in micro propagation methods. Procedures will be the standard in-vitro propagation methods established for various crops. Occurrence of somaclonal variation and the degree of success in culturing among different germplasm will be recorded. Successfully propagated plants will be acclimatized in a nursery and will be distributed to growers. In each step of plant tissue culture, any obstacles will be recorded to improve the propagation system. Anticipating problems include contamination of cultures. Seed s of chili pepper (Capsicum spp.) germlines were collected locally and deposited to the Horticultural Plant Germplasm Program of the University of Guam. Accessions were being investigated in a calcareous soil for their fruit characteristics and yields. Selected local lines with superior fruit quality, yield and good growth habit will be replanted for seed production for distribution to community. Seeds of local cultivars of okra (Abelmoschus esculentus) and white corn (Zea mays) are being distributed to local community when requested. All of selections currently being propagated are open-pollinated.
Selection, propagation and distribution of superior local lines will increase the production of crops in Guam. In addition locally available pathogen-free materials for planting ensure avoidance of pest introduction into Guam from off-island.

Source of funds: USDA, Tropical & Subtropical Agricultural Research Special Grant

Scope of Impact: National, Regional

Key theme: Plant production efficiency

Propagation and establishment of native trees and shrubs for landscaping and reforestation was studies in 2006. Most plants used for landscaping and reforestation on Guam are non-native. Development of native plant materials for the se purposes will help preserve the local environment and provide more suitable plant material for the local landscape industry. Langiti (Ochrosia mariannensis A. DC (Apocynaceae)) is a small to medium tree that grows on limestone. The leaves are an attractive glossy dark green in loose whorls. The flowers are small and white, but the 5 cm fruits are attractive and may be either yellow or bright red. This is a very attractive tree to incorporate into the landscaping palette. It is an edge species and not an understory species. It is anticipated that this tree will be successful as a specimen tree. The scaevola cultivars will be named and released to the public this year. The additional flower color patterns will expand that plant palette of native plants for Guam. Surveys of forested areas will be conducted to collect plant materials from native populations of trees and shrubs. The selected plant material will be propagated and established in a nursery for evaluation. The plant material will be located within the nursery in appropriate micro-climates that reflect their original habitat. For example, understory plants will be grown in shade. Plants that show poor seed germination results will be noted for further investigation. 2. Investigate practical methods for propagating. Plant materials that are selected will be used in further investigations to determine efficient ways of propagating and establishing particular species. Seed germination and cuttings will be the methods of propagation for this objective. Seeds will be germinated using various pre-treatments to speed germination and to increase the percentage of germination. Cuttings will be propagated under mist. The mist timing may be modified depending on the prevailing weather and the type of cutting. The actual method of propagation will vary with the species. Rooting hormones will be applied at different rates in an effort to accelerate the propagation of cuttings. Different age cuttings will be taken and compared for time to root and survival of cuttings. Several different media will be used to determine the most suitable propagating medium for each type of plant material. Once the seedlings and/or cuttings are established, the plant material will be transplanted to different nursery locations to determine the ranges of suitable habitats. Initially, the plants will be established in microclimates resembling their natural habitat as reported by various authors. 3. Monitor the growth and evaluate selected plant materials. Data will be collected on height, girth and branching habit. Other criteria for evaluating plants will vary with the intended use. The plant material will be evaluated for use based on adaptations to environmental conditions, some aesthetic quality or some functional use such as shading or as a living barrier. Conditions that are often problem areas for plants include beach areas (salt spray and sandy soil) and areas with shallow soil or steep slopes. Aesthetic qualities include fragrance, attractive habit, flower, or foliage. Functional uses include both historical uses such as for tools and construction, and functional landscape uses including living barriers and supplying shade. If the plant is deciduous, the time of leaf drop will also be noted. 4. Monitor establishment of plants in the field. After the plants are propagated, they need to be hardened to prepare them for transplanting to the field. This is a critical stage. Some plant materials which propagate readily are much more difficult to establish in the field. Wind damage has proved to be the greatest problem in establishing the plants in the field. Various approaches will be utilized to address this problem when transplanting the trees to open areas. Windbreaks and screens will be used to reduce the exposure to wind. These exposed trees will be compared to material grown as understory plants. Seedlings of Eleaocarpus joga were established in shallow Guam Cobbly Clay

soil. Variation in growth characteristics is obvious in the seedling population. The site is exposed to natural wind conditions. Mealybugs and thrips were observed on the trees which results in severe dieback of branches. Protection from bush cutter damage is critical to the survival of the trees. The trees develop a windswept canopy shaped by the prevailing winds. There was one hundred percent survival of planted trees. Seeds of Ochrosia mariannensis A. DC (Apocynaceae) were collected and arebeing germinated. These small trees will be planted in the field for testing as specimen trees. Five selections of Scaevola serica were made and are being propagated for release to the public. four of these selections have magenta bands or spots on the flower petals in contrast to the usual white flower. One selection has a floral fragrance. Langiti (Ochrosia mariannensis A. DC (Apocynaceae)) is a small to medium tree that grows on limestone. The leaves are an attractive glossy dark green in loose whorls. The flowers are small and white, but the 5 cm fruits are attractive and may be either yellow or bright red. This is a very attractive tree to incorporate into the landscaping palette. It is an edge species and not an understory species. It is anticipated that this tree will be successful as a specimen tree. The scaevola cultivars will be named and released to the public this year. The additional flower color patterns will expand that plant palette of native plants for Guam.

Source of funds: McIntire Stennis

Scope of Impact: National, Regional

Key theme: Plant production efficiency

Collection, evaluation and culture of ornamental plants in Guam were studied by horticulturist. Much of the plant material used in landscape construction is imported from Hawaii. A great deal of the plant material could be propagated in Guam instead of resorting to importation. There is limited information available on recommended plant materials for use in the tropical landscape. The majority of the available information is produced in temperate or sub-tropical regions. Great discrepancies have been observed in actual growth responses and timing of phenological events compared to reported data of greenhouse experiments. These inaccuracies lead to plantings failing or having growth characteristics not suited to the specifications for the site. Plant materials appropriate for various interior and exterior landscape uses will be collected and evaluated. Selected plant material will be evaluated for use in Guam. Key factors for consideration are tolerances to wind, nutritional deficiencies and pest problems. The data will be entered and stored in a database. Plant materials will be collected vegetatively or as seed. Sources of plant material include commercial nurseries, university collections, and field-collected local plants. Evaluation of mature selections will not be possible for several years due to the age of the collected plant material. Detailed propagation requirements will be determined for each taxon that appears to have a potential use in Guam. Criteria include, ease of propagation, low maintenance, wind and salt tolerance and esthetic value. A cutting protocol with a concentration range of root promoting growth regulators will be tested on selected plants. Studies will be conducted in an on-campus nursery, and shade house, or an experiment station field, as appropriate. The plantings will be monitored for key phonological events. Data will be analyzed using multivariate analysis techniques (Martinez-Falero and Gonzdlez-Alons, 1995).

The effects of treatments will be evaluated by measuring height, width, leaf area, canopy development, flowering behavior and visual esthetics. 3. Develop a database of ornamental plant materials for use in lowland tropics. Database ornamental plants will be annotated with cultural Fact sheets and booklets on ornamental plants will be included in the database in PDF format. Surveys will be conducted, as needed, to gather information on the phenological behavior of various plant materials. Photographs will be taken and digitized for inclusion in the database. The database will be compiled and transferred to CDs for distribution. Printed materials will be produced on selected plant materials and horticultural practices. Eleven cultivars of hybrid seed-propagated Catharanthus roseus (Vinca) were compared for use as a ground cover in the Guam landscape. The cultivars compared were: Jaio Dark Red, Stardust Mix, Tropicana Bright Eye, Pacifica White, Stardust Rose, Pacifica Polka Dot, Pacifica Punch, Pacifica Red, Mediterranean Apricot Broadeye, Mediterranean Deep Rose, and Stardust Orchid. Preliminary results indicated that several of the cultivars were tolerant to disease on the flowers. Few of the cultivars survived the duration of the rainy season. Most plants had declined within three months. Another trial will be planted next year.

Source of funds: Hatch

Scope of Impact: Regional

Key theme: Aquiculture

Scientist at Guam Western Pacific Tropical Research Center conducted a disease survey and marketing prospects for SPF shrimp production on Guam. Post-larval shrimp have been produced at the Guam Aquaculture Development and Training Center (GADTC) for many years. Post larvae (PLs) have been provided to Guam, Palau, the Commonwealth of the Northern Marianas in Micronesia, and numerous other parts of the world. However, much of the shrimp stock had to be destroyed during 1994-5 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; 1996a).

While the current GADTC *L. vannamei* stock has not shown signs of disease, it has not been closely examined; and currently there is no ongoing disease monitoring program. The lack of an on-going disease monitoring program on Guam also means that the general health status of the local industry is not known and the risks to the industry from seedstock imported from Taiwan or from other sources can not be determined.

Also, the GADTC uses a well with a pump submersed to provide seawater to their flow-through shrimp production system. As there have been shrimp in the facility continuously since 1986, there is a possibility that there are remaining external sources of the viral pathogens that could contaminate existing or new stocks. Under these conditions it cannot be certain that the GADTC is producing disease-free seedstock and SPF certification is not possible.

There is a need for additional SPF stocks on Guam. There are indications from the GADTC hatchery and the local industry that larval production has declined and that the growth rates of the seedstock produced are lower than they were with earlier stocks. These differences are thought to result from of a lack of genetic diversity or in-breeding depression in the current

stocks. To help alleviate this problem, additional stocks of SPF *L. vannamei* could be brought in if the facilities are certain to be pathogen free. In addition, a second species such as *P. monodon* could be brought in to further strengthen the economic viability of the facility. The black tiger prawn (*P. monodon*) is a highly desired species throughout the Asia-Pacific region, but successful hatchery production of this species may require research to achieve maturation in captivity and to insure the quality of post-larvae. If production of SPF *P. monodon* post-larvae from Guam can be realized, it is anticipated that the export markets for these will be lucrative.

The health of the GADTC shrimp stocks have been monitored since the start of the projects none of the viruses of concern have been found. There were White Spot Syndrome virus outbreaks on Guam and on Kauai in 2005. Since the shipment of shrimp P.L.s that was stocked immediately prior to the stocking found to be WSSV positive on Guam was from Hawaii, we suspected that the WSSV might have come from Hawaii. However, we compared the number of tandem repeats in the two virus samples and they proved to be different strains of the virus.

Work continued on the T-STAR funded project to introduce the production of SPF L. vannamei to Guam. The Guam Aquaculture Development and Training Center continued to test free of viruses. Four new breeding lines of L. vannamei were obtained and introduced into the hatchery. The market specifications for Pacific White Shrimp brood stock were obtained during two visits to Thailand and one to Taiwan. A new tenure-track faculty researcher was hire to assist with the shrimp breeding and biosecurity issues involved in development of an SPF brood stock industry. A memorandum of understanding was negotiated and signed a company for the marketing of the shrimp brood stock in Asia. Work on the production of hard corals from larvae for the aquarium trade and reef restocking/rehabilitation continued. Significantly better metamorphosis and survival of the larvae and settled corals was obtained in the second year of work. The difference in survival of the newly settled corals was due to improved control of the overgrowth of macroalgae. A preliminary screening of four species of edible seaweeds was conducted, and one species, Caulerpa racemosa, was selected for further work. A prototype polyculture system of seaweeds and hard corals was developed. The system used the sea grapes (Caulerpa racemosa) as scrubber to remove plant nutrients from the water flow ahead of the cultured hard corals. This should limit the growth of undesired species of macroalgae and provide and second product that is marketable in the short-term. Finally, a team was assembled and grant was written and funded by the Center for Tropical and Subtropical Aquaculture to develop an Aquaculture Development Plan for Guam. Data indicated that it is unlikely that truly clean P. monodon stock of shrimp exists on Guam. Most stocks turned out to be contaminated with IHHNV. Results suggest there may multiple viruses present in their Monodon stocks at very low levels.

Source of funds: USDA, Tropical & Subtropical Agricultural Research Special Grant

Scope of Impact: Regional

Key theme: Small Farm Viability

Scientists from Guam and Virgin Islands Western Pacific Tropical Research Center constructed and tested a model sustainable farm for the U.S. Caribbean and Pacific Islands. The project was conducted to illustrate successful sustainable agriculture under Guam's limited resource constraints. Specific objectives were set to produce profitable local fruit and vegetable crops, to produce ornamental plants used in local art and lei making, and to raise goats to illustrate rotational grazing techniques. The demonstration farm became a site of education in tropical island agriculture. There were no additional federal funds in 2006 but project continued. The activities on UOG Triton Farm were presented at the 103rd Annual Conference of the American Society for Horticultural Science (ASHS) in July 2006. Termination report was submitted to the Virgin Island University and USDA in October 2005. For the past year, college students, DYA, 4H and public school students visited the UOG Triton Farm. The farm included animal production, aquaculture, hydroculture, and orchard, ornamental and vegetable production.

Farming practices in the model farm are presented to students and visitors and promoted throughout the island community. The model farm is an educational ground for students and a community to learn how to improve crop/animal/fish production, to recycle resources, and to protect the environment.

Source of funding: local funds (since 2005)

Scope of Impact: Regional, national.

Key theme: Plant health/ plant production efficiency

Plant Scientist at Guam Western Pacific Tropical Research Center investigated photosynthetic recovery rates of Ifit. This project was 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. 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. This project increases understanding of how native ecosystem responds to periodic tropical storm systems.

Source of funding — Multi-state Hatch

Scope of impact — State specific

Key theme: Plant Health

WPTRC Scientist has been addressing issues related to phenology and toxicology of the Guam cycad. Objectives addressed during past year were: to determine the influence of resource availability on the production of secondary metabolites in the Guam cycad, to determine the concentrations of secondary metabolites in seeds from the Guam cycad as a function of phenology, to determine concentrations of secondary metabolites in pollen from the Guam cycad. This project is the first to look at cycad secondary metabolites in relation to plant and habitat characteristics. We have focused on a suite of sterile glycosides known to elicit neurodegeration in mammalian models, and their sterol precursors. Spatial variation within a habitat is greatest among tissue types within seeds, intermediate among plants, and intermediate among locations within plants. Concentration was greatest in the stony sclerotesta tissue, least in the starchy gametophyte tissue, and intermediate in the sarcotesta tissue. However, gametophyte tissue comprises the majority of a seed's dry weight, so on an absolute basis most of these metabolites are in the gametophyte. This is the tissue that has historically been used for flour preparation and human consumption. The heterogeneity of these chemicals within seed tissue is also heterogeneous among habitats, with Guam's littoral habitats exhibiting the highest concentration. We do not understand the function of these molecules, but they are in greatest concentration in young tissue and decline with age of organs. The decades of research that has been invested into studying Guam's ALS-PDC diseases has been plagued by poor research methods. All of the past publications on neurotoxins from Guam's cycad plants have failed to use appropriate botanical standards in experimental design. Our results will be useful for identifying ambiguities from former studies, which will help steer future research efforts as we continue to try to understand the neurodegenerative diseases that have been prevalent on Guam.

All field work and biochemistry analyses have been completed. Our first two secondary chemistry articles touched on some of the issues relevant to this objective and set the foundation for the remainder of publications. The first major manuscript has been generated from this work. The next manuscript reported the direct influence of covariates from the plant and habitat descriptors on seed chemistry. All field work and biochemistry analyses have been completed. The first article from this objective has been published in the *Functional Plant Biology*.

We have determined sterile glycoside and sterol levels in pollen samples from four habitats. The results validate for the first time that pollen from the Guam cycad is loaded with these neurotoxic glycolipids. More importantly, these data are the first conclusive data revealing a distinct difference between the plants from southern Guam (Inarajan) and the plants from the other three habitats in northern Guam.

The metabolites are stigmasterol □-D-glucoside (SG), stigmasterol (SS), and □sitosterol (BSS). What remains to be done is to quantify some of the plant and habitat variables that influence the loading of these metabolites into pollen to see if we can identify the reasons behind the higher concentrations in the pollen from southern Guam.

Our only work remaining for all three objectives is to continue publishing.

Source of funding — Multi-Regional Hatch

Scope of impact — Scope of Impact: Regional, national.

Key theme: Plant Health

Management of the causal agent of arecanut bud rot on Guam was studied by plant pathologist. This project was conducted to address an outbreak that started to kill arecanut trees (Areca catechu) in the village of Maleso in Southern Guam towards the end of 2003. The symptoms of affected trees often included a bud rot. Thousands of trees have died as a result of this malady. The diagnosis of Phytophthora bud rot on arecanut can be a bit tricky. Typical symptoms of the disease are mimicked closely by a condition provoked by sugarcane weevil damage. The surest way to distinguish between the two, for a lay person, is to split open the tree trunk and see if there are weevil tunnels in the affected area. Otherwise, a lateral flow kit for the detection of all species of Phytophthora is commercially available. We evaluated the performance of this diagnostic kit for the detection of P. palmivora on A. catechu. After finding evidence of trunk damage following drilling and injection of Fosphite into the trunks of betel nut trees, a decision was made to look for other ways of applying the fungicide in order to avoid damaging trees in the process. The fungicide Fosphite was recommended against bud rot disease, which is caused by *Phytophthora palmivora*. A test was devised to study the effect of applying Fosphite solution via adventitious roots of betel nut trees. A group of betel nut trees was sampled pre- and post-application. Levels of P were determined from leaf samples collected from each frond. There were 24 trees in the study; half of these were treated and half were controls. After the appropriate statistical analysis (NCSS, Kaysville, UT), differences were found in the level of P in the leaf tissue according to treatment. Control trees, given only water, had higher levels of P in their leaf tissue compared to trees given Fosphite through their adventitious roots (table 1). The underlying hypothesis was that applying Fosphite via adventitious roots of betel nut trees would result in a systemic distribution of the fungicide throughout the tree. We expected all leaf tissues of treated trees to show higher levels of P compared to untreated controls. Surprisingly, P levels were lower in treated trees, yet there was no difference between fronds, suggesting an even effect throughout treated trees. I have no explanation for the reduced P levels observed after treatment. However, results were consistent enough to yield statistically significant differences. The next step will be to repeat the above experiment for validation of results. Additionally, we will treat betel nut seedlings with Fosphite and later inoculate them with *P. palmivora* and compare them to untreated controls to study the effect of Fosphite on infection by the pathogen. We are also studying ways of applying Fosfite, a fungicide that is recommended against Phytophthora on trees, in a way such that it will have as little environmental side effects as possible. During the year 2006, we were able to do tests in plants with Phytophthora palimvora, isolated from arecanut trees and inoculated onto healthy seedlings, to evaluate the lateral flow diagnostic kit for the genus Phytophthora. The results were quite encouraging when using infected plant tissue from still active lesions. In the course of the year we injected many arecanut trees with Fosphite. Studying the effect of injection of this fungicide on A. catechu, we found internal discoloration in the area of the injection. Representatives from the fungicide manufacturer have suggested other application methods, which we are now in the process of evaluating. Another host range test was done, which included fruits of Annona squamosa, A. muricata, Artocarpus altilis, Carica papaya, Cocos nucifera, Mangifera indica, Musa acuminata, and Psidium guajava. Of the 8 species tested, only A. squamosa and A. muricata failed to become infected and support sporulation of P. palmivora isolated from A. catechu. This suggests that the 6 other species are

possible hosts for the bud rot pathogen, which could survive and propagate by infecting these species besides A. catechu. We have stopped recommending the injection of Fosphite into trunks of arecanut trees for protection against bud rot, and are instead evaluating other application methods. We now have evidence that P. palmivora has a broader host range than is reported in the literature, and that includes A. catechu, A. altilis, C. papaya, C. nucifera, M. indica, M. acuminata, and P. guajava.

Source of funding: USDA, Tropical & Subtropical Agricultural Research Special Grant

Scope of impact: Multi-state, regional

Key theme: Plant Health

Development of PRV resistance was studied by plant pathologist. Papaya Ringspot Virus (PRV) continues to be the most damaging and limiting disease for papaya production on Guam. No resistance to PRV can be found in the species Carica papaya. Transgenic resistance has been developed for Hawaii and shows promise. Work is behind schedule due to our fields getting decimated by storms in previous years, and also due to the transfer of our collaborator, Dr. D. Gonsalves, from Cornell University to the ARS center in Hilo. In previous years, we planted 2 experimental fields at the Inarajan Station and evaluated papaya cultivars on their reaction to PRV. The first one had to be inoculated; the second relied on natural incidence. Two transgenic accessions from HI, Sunup and Rainbow, were included in the evaluation, and both have shown increased resistance to our local strain of PRV compared to all other entries (Saipan, Dagua, Trujillo, Malaysia). Cultivar Rainbow held up very well during the 2004, 2005 and 2006 growing seasons. In Yigo experiment station, a papaya collection was grown with the object of performing new crosses between cultivars to improve the most important marketing traits of existing cultivars. This year we have been evaluating the progeny of these crosses in the F2 generation at the Yigo Experiment Station. So far we have found materials that display traits of both parents regarding flesh color, fruit shape and size, tree size, and disease reaction.

In previous years, PRV-infected papaya leaves from Guam were collected and sent to HI under the required local and federal permits. Nucleic acids from our strain of the virus were isolated, purified, and eventually the coat-protein gene was sequenced. This sequence will be inserted into the natural genome of a Hawaiian solo-type papaya cultivar; the same used in previous similar transformations in HI, except that the insertion will have the Guam PRV isolate sequence, and not that of HI. A local Guamanian variety will also be transformed. The “construct”, that is, the intended DNA sequence to be inserted for this transformation, is ready further study. The work is not yet completed, and impact is already visible. One of the HI transgenic accessions introduced in the course of this study has shown an adequate level of resistance to the local PRV strain. After cross-protection was abandoned for lack of a mild strain, which we used to obtain from Cornell University until they quit producing inoculum, we haven’t had a practical alternative to use against PRV on Guam, until now. The cultivar, however, does not produce the desired fruit shape, size, or color that the local market demands; furthermore, the tree is too tall for our strong winds. If need be, this cultivar may be recommended to our growers; with no other choice, the market will accept Hawaiian type papayas. At least the level of resistance to the main

production constraint, PRV, is adequate in cv Rainbow. Meanwhile, we will keep waiting for our own transgenic cultivars, which are under transformation in Hawaii, and which should perform better under our conditions and against our own strain of PRV.

Funding source: USDA, Tropical & Subtropical Agricultural Research Special Grant

Scope of Impact: Regional.

Key theme: Plant Production

Agriculture engineer at Guam Western Pacific Tropical Research Center researched various methods to improve crop production and water use efficiency. This project strived to improve crop production and water-use efficiency by using micro-irrigation management practice. The major objective of the proposed activity is to begin to obtain and compile in a database the local data a) on soil physical and hydraulic properties, and plant optimal root zone relevant to drip system design, b) on irrigation scheduling and fertigation of selected vegetable crops, c) microclimate created by the use of polyethylene mulch and floating row covers. Soils data on physical and hydraulic properties relevant to the design of a drip irrigation system will be obtained following established laboratory and field procedures subject to the equipment and resources availability. Soil moisture characteristics curves will obtained on undisturbed core samples using pressure plate apparatus in the laboratory. Soil wetting patterns relative to emitter flow rate and spacing will be determined in the field using various drip lines and flow durations. The data will be analyzed and processed for mathematical representation where possible or needed. Optimal wetted soil volume will be determined for various crops from current and planned field research projects. Irrigation and fertigation scheduling information for selected crops will be obtained from current and planned field research. Research experiments on irrigation scheduling using automated in-situ soil moisture sensors will be used to obtain information optimal plant water consumption on a daily basis as the crop grows in a season. Weather data will be used from Agricultural Weather Stations at the Western Pacific Tropical Research Center on Guam for developing crop coefficients for use by the growers in manually operated or semi-automatic drip systems. Mulch and floating row covers created microclimate will monitored in the current and planned field experiments. Such data will be archived in a database. As the experimental plant observations and microclimate data indicate that there is a significant risk of seedling or crop damage during certain periods of the year, further research will be initiated to determine suitable row covers, mulch, or both for extending the crop growth seasons. Soil wetting patterns observed for two drip lines -4" and 9" emitter spacing and flow rates rated at 1 and 0.65 gpm/100ft on Guam Cobbly Clay soil at Yigo Western Pacific Tropical Research Center, Guam. This soil is very shallow only 6" to 10" deep underlain by coral substrate and vertical flow is faster than lateral flow. Observations were made for 15 and 30 minute runs. Water reached the coral substrate in less than 30 minutes for both drip lines. Hourly weather data was collected from two agricultural weather stations located at Experiment Stations at Yigo and Inarajan. Crop coefficients for watermelon crop were developed from data obtained in previous experiments. Leachate was collected throughout the year from the experimental field to ascertain after experiment nutrient leaching to the groundwater as well as to observe the number of times the soil will be flushed of the soluble nutrients during a year. Weather with an

average rainfall of about 100" a year plays an important role in impacting the environment by leaching out the soluble nutrients from the prevalent shallow soils into the groundwater several times a year. This situation necessitates developing highly efficient water and nutrient management practices. Growers will be able to use crop coefficients developed for cash crops like watermelon in manually operated or semi-automatic drip systems and achieve better production while minimizing environmental impact.

Source of funding — Hatch

Scope of impact — State specific

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

Key theme: Adding Value to Old Agricultural Products

Potential application of anthocyanins from purple sweet potato cultivars originated from the Western Pacific Islands was studied by food scientist. Anthocyanins in purple-flesh sweet potato (PFSP) cultivar 'Terlaje' grown in the Western Pacific island of Guam were investigated from September 15, 2003 to September 14, 2007. The flesh of the PFSP cultivar 'Terlaje' possessed about equivalent pn 3-caf.sop-5-glc 80 mg/100 g fresh weight. The spectrum of the anthocynin extract from PFSP demonstrated anthocyanins were dominantly acylated with caffeic acid. Steaming PFSP tubers for 30 minutes stabilized anthocyanins content and freeze and air dehydration of steamed PFSP at 60°C for 24 hours retained the anthocyanin content in PFSP powder. The PFSP powder exhibited antioxidant capacity at 7600-9300 ORAC unit and total phenols at 400-500 mg gallic acid/100 g dry weight. The PFSP powder exhibited purplish color with a hue angle at -18-24° and Chroma at 16-27. The noodles made with PFSP powder at 40% exhibited pleasant purple color and equivalent sensory quality to commercial noodles and were accepted by consumers. Heat treatment of PFSP anthocyanins extract at pH 1 and 3 for 3 hours resulted in a substantial loss of anthocyanin content. During 30 day storage of anthocyanin extract from PFSP powder, the anthocyanin content retained 100% at pH 1, 80% at pH 3, 65% at pH 5, 35% at pH 7, 7% at pH 9. In fluorescent light treatment for 64 days, anthocyanin extract from PFSP powder lost about 60% of anthocyanin content at pH 1, while anthocyanin extract covered with aluminum foil did not exhibit a change of anthocyanin content. Compared the stability of anthocyanin extract from PFSP with anthocyanin extracts from red cabbage and grape skin, PFSP anthocyanins were more stable than that of grape skin but less stable than that of red cabbage. The research results of this purple-flesh sweet potato project were presented in the IFT annual meeting in 2005 and 2006, in the 2006 Western Pacific Tropical Research Center conference, and in the regional conference at the University of Guam. One research manuscript was completed and in the process of review. Two more research manuscripts will be written and submitted to refereed journals.

Anthocyanins in purple sweet potato are stable in neutral pH during steaming and dehydration. Steaming and dehydration can be used to process purple sweet potato powder as food ingredient with good pleasant purple color. Although purple sweet potato possessed high content acylated anthocyanins, the anthocaynin of purple sweet potato was not stable to light. Application of anthocyanin extracts of purple sweet potato in acidic foods requires no exposure to light during storage. This research information will be useful for food industries to consider applying purple sweet potato powder or anthocyanin extract from purple sweet potato in food products.

Funding source: USDA, Tropical & Subtropical Agricultural Research Special Grant

Scope of Impact: Regional.

Key theme: Adding Value to Old Agricultural Products

Bioavailability of biological components in Noni (Morinda Critrolia) products as affected by processing and storage were studied by food scientist. The effect of heat and light on the radical scavenging activity, total phenols and ascorbic acid of noni juice and were studied. The free radical scavenging activity was assayed by scavenging the free radical 1,1-diphenyl-2-pcrylhydrazyl (DPPH·). The total phenolic content was measured by the Folin-Ciocalteu reagent. The ascorbic acid content was analyzed using HPLC method. The fresh noni juice was prepared by centrifuging noni puree. Noni powders were prepared by dehydration of noni puree with hot air at 50°C. Noni juice and powders were treated with fluorescence light and stored at the ambient temperature for three month. Noni juice was treated in water bath at 85°C for 24 hours. Light treatment resulted in a greater decrease of radical scavenging activity and total phenols in both noni juice and powder. However, after storage for 90 days, the difference of radical scavenging activity and total phenols between light treated and non-light treated noni juice was small. The reduction of radical scavenging activity and total phenols in light treated noni powder was much greater than the non-light treated noni powder after storage for 90 days. The ascorbic acid content in noni juice decreased faster in light treated noni juice than non-light treated noni juice. However, after storage for 4 weeks, both light and non-light treated noni juice lost almost all ascorbic acid. Heat treatment at 85°C resulted in a decrease of radical scavenging activity and ascorbic acid in noni juice greater than total phenol. The results suggested noni powder possesses much longer shelf life than noni juice. For consumers to have health benefits from noni juice, storage of noni juice at the ambient temperature is not recommended.
The research results are presented in conferences. The obtained knowledge provides instructions to manufacturers and consumers to improve functional quality of noni products in processing and storage.

Funding source: USDA, Tropical & Subtropical Agricultural Research Special Grant

Scope of Impact: Regional.

Key theme: Food safety

Food safety education and training for consumers and food establishments in the U.S. Territory of Guam was studied in 2006. Guam is a U.S. territory with a population of 150,000 people. Each year at least 150 cases and 50 outbreaks of food borne diseases are reported. The lack of food safety knowledge and poor food handling practices are the two major reasons. The purpose of the project is to develop a stronger food safety proposal, to promote food safety education on Guam, and to effectively prevent and reduce food borne diseases in Guam communities. "Kelaguen", an ethnic food on Guam, is one of a leading vehicles resulting in food borne illness. Kelaguen made from raw or partially cooked meat with lemon juice or powder and often served at ambient temperature at parties and fiesta for many hours. Estimated food borne illness associated with 'kelaguen exceeds 1,000 cases per year. Kelaguen is a food acidified with lemon. However, we observed bacteria and pathogen *Salmonella* survived in the kelaguen preparation. The level of lemon used in kelaguen was not effective to kill bacteria and pathogen *Salmonella*. Increasing the amount of lemon in 'kelaguen' can inhibit pathogen growth and allow 'kelaguen' to be served at ambient temperature without temperature control for safety. The minimum amount of lemon for the kelaguen was presented in the 1st Annual Guam Food Safety Education Conference and recommended to consumers in communities. Extension brochure "Keep kelaguen Safe without Being Kept below 40°F" was developed. The research results increase consumer's awareness of improper handling practices in kelaguen preparation and serving. The message of use recommended amount of lemon in kelaguen preparation will reduce the risk of food borne illness associated with kelaguen that is served at the ambient temperature without temperature control such as at parties or fiestas. Instead of using raw meats, recommendation of using cooked meats to prepare kelaguen is expected to reduce the risk of food borne illness associated with kelaguen and protect high risk populations.

Source of funding: CSREES-USDA National Research Initiative (NRI) Grant

Scope of impact: Regional

Key theme: Human nutrition

Food Scientists at Guam Western Pacific Tropical Research Center investigated ways for improvement of thermal and alternative processes for foods. There are several foods and herbal beverages from tropical source that are gaining in popularity in temperate climates. These represent potential markets for products from the insular areas of the US. The purpose of this project is to study the effect of processing on the nutraceutical components of these products to improve their usefulness and marketability. The fresh noni juice prepared by centrifuging noni puree was treated at 65, 75, and 85 C. The bioavailability of biological components of noni products was evaluated by the total antioxidant capacity (TAC) assayed by scavenging the free radical 1,1-diphenyl-2-pcrylhydrazyl (DPPH). The total phenolic content was measured by the Folin-Ciocalteu method at 765 nm, using gallic acid as standard. The ascorbic acid was analyzed at 582 nm using 4-Chloro-7-nittrobenzofurazane (NBD-Cl). The fresh noni juice exhibited the

TAC at 130-150 mg equivalent ascorbic acid (EVAA)/100 ml juice, 210 mg galic acid/100 ml juice, and 145 mg ascorbic acid/100 ml juice. After heat treatment at 65 C, 75 C, and 85 C for 10 hours, the noni juice remained 82%, 72%, and 30% of TAC, respectively. Total phenol content of noni juice decreased 37% at 65 and 75 C and 40% at 85 C after heat treatment for 24 hours. After heat treatment for 10 hours, the noni juice lost 33% of ascorbic acid at 65 C and 75 C and lost 65% of ascorbic acid at 85 C. However, heat treatment of noni juice at 65 C, 75 C, and 85 C for 4 hours did not result in significant changes of the TAC, total phenols, and ascorbic acid in the juice, indicating mild heat treatment does not significantly change the bioavailability of bioactive components in noni juice. The research contributes to understanding of how nutraceuticals change during processing in functional food products. Research outcomes will benefit food manufacturers to processing functional foods.

Funding source: USDA, Tropical & Subtropical Agricultural Research Special Grant

Scope of Impact: National

National Goal 4:

Greater harmony between agriculture and the environment.

Key theme: Integrated Pest Management.

In 2006 Entomologist continued to examine the morphological, genetic and ecological differences in *Aphis gossypii* in new aphid collections from the Federated States of Micronesia islands of Pohnpei, Chuuk and from Guam and the Commonwealth of the Northern Mariana Islands (CNMI). He had completed data acquisition on the morphological and genetic differences in *Aphis gossypii* and analysis of data is ongoing. Results continue to suggest that genetic variation in *A. gossypii* varies by host plant and then by geographic provenance of the sample, while morphometric variation is most closely correlated to geographic provenance. *A. gossypii* reared on various hosts, and then switched to new hosts, have been mounted on microslides for morphometric analysis. Morphometric and DNA data generated for the banana aphid, *Pentalonia nigronervosa*, and suggested that this aphid may consist of two separate species, with the species commonly found on banana being the principle vector of banana bunch top virus (BBTV). We better understand the make-up of aphid-parasitoid-ant complexes on crops and ornamental plants in many of the islands of Micronesia and Hawaii. Pest managers can identify the major aphid pests they encounter at ports of entry and on crops and ornamentals on the various islands using keys developed in this activity. The association between many tramp ant species and specific aphid species has been described. If the species composition of what we now call banana aphid is correct, and if only the species found on banana is capable of vectoring bunchy top virus, we will be able to revise PPQ protocols for bunchy top virus in Micronesia, as well as revise recommendations for planning non-banana hosts of *Pentalonia* sp. in proximity to banana plantations.

Funding source: USDA, Tropical & Subtropical Agricultural Research Special Grant

Scope of Impact: Regional.

Key theme: Integrated Pest Management.

Entomologist worked on management of the New Guinea sugarcane weevil. *Rhabdoscelus obscurus* in Guam. The New Guinea sugarcane weevil (NSW) was first collected from New Ireland in the Pacific in 1835. Since then it has spread throughout the Pacific. In order to import, mass rearing and field release of the larval parasitoid *Lixophaga sphenophori* (Villeneuve) (Diptera: Tachinidae), there is an urgent need to develop a mass rearing method for the parasitoid host *R. obscurus* in which parasitoids can be reared. Successful oviposition was achieved by exposing 30 pairs of ♂ and ♀ to healthy canes in a laboratory. Immature stages were fed on exposed cane tops which were in containers with moist sand for 28-30 days. The duration of egg, larval, pre-pupal and pupae were found to have a mean of 5.6, 68.5, 4.3 and 16.6 days, respectively. The length and width of the egg was measured to be 2.2 and 0.8 mm, respectively. Only three parasitoids of *Lixophaga sphenophori* were collected from the first exploratory trip made to Oahu (Hawaii) from March 20-25th, 2002. However, 105 pupae of this parasitoid were collected from the second exploratory trip to Maui and Hilo (Hawaii) from May 28th to June 3rd, 2004. The parasitoid imported from Hawaii could not be multiplied at the quarantine facility. As a result, only 53 adults were field released in the Western Pacific Tropical Research Center at Yigo. The field establishment of the parasitoid is yet to be confirmed. Lures of aggregation pheromones of the Australian and Hawaiian populations of the New Guinea sugarcane weevil, *Rhabdoscelus obscurus* (Boisduval), 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 cuttings of sugarcane significantly captured more weevils (total of 348) than traps baited with pheromone lure of the Hawaiian *R. obscurus* population in combination with food volatile and sugarcane cuttings which caught a total of 128 weevils. Traps baited with lure containing only the food volatile and sugarcane cutting or sugarcane cutting alone 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, indicative that the Guam *R. obscurus* population is more closely related to the Australian population. Trap catches at the Tumon and Dededo locations were greater than those in Yigo, Yoña, Mangilao, Hagåtña, Agat, and Malesso. Rainfall had a low correlation with trap catches at all locations except Yigo where it positively correlated to the Australian population lure treatment. Semi chemical based trapping in weevil management has potential either in mass trapping or as part of an IPM program. A future line of work is also proposed for the control of weevil borers based on these initial results. *Rhabdoscelus obscurus* (Boisduval), in conjunction with other semiochemicals, was used to develop an efficient trapping method for the weevil population in Guam. In a field experiment at Yigo, plastic bucket traps baited with the lure of the Australian *R. obscurus* population in combination with ethyl acetate and a cutting of sugarcane significantly captured more weevils than traps baited with pheromone + ethyl acetate,

pheromone + sugar cane or individual lure components alone. Traps baited with various semi chemical based lures and treated with insecticide captured significantly greater numbers of weevils than traps not treated with insecticide. Traps baited with sugarcane cuttings caught significantly more weevils than traps without sugarcane. Semi chemical based trapping in weevil management has potential either in mass trapping or as part of an IPM program. Based on the present findings, a future line of work for the control of this weevil is proposed.

Source of funds: TSTAR: USDA, Tropical & Subtropical Agricultural Research Special Grant

Scope of Impact: Regional, national.

Key theme: Integrated Pest Management.

On the subject of genetic, morphometric, and ecological variation in *Aphis gossypii* we continued to examine the morphological, genetic and ecological differences in *Aphis gossypii* in new aphid collections from the Federated States of Micronesia islands of Pohnpei, Chuuk and from Guam and the Commonwealth of the Northern Mariana Islands (CNMI). Additional aphid collections were made on the Hawaiian islands of Oahu, Molokai and Hawaii. These data were combined with those from previous collections in Micronesia and North America to expand our comprehensive aphid catalogue, with emphasis on *A. gossypii*. The presence of aphidiid parasitoids, where present, was noted and the aphidiid identified. Morphometric analysis and DNA sequencing also continued for aphids collected previously. Ants collected in association with aphids, and that may have a role in altering the effectiveness of aphidiid biological control agents, were also identified. Ongoing DNA analysis seeks to confirm previous results suggesting that genetic variation in *A. gossypii* was found to vary by host plant and then by geographic provenance of the sample, while morphometric variation was most closely correlated to geographic provenance. *A. gossypii* reared on various hosts, and then switched to a new host, were collected following the third generation and are presently being mounted for morphometric analysis. We better understand the make-up of aphid-parasitoid-ant complexes on crops and ornamental plants in many of the islands of Micronesia and Hawaii. Pest managers can identify the major aphid pests they encounter at ports of entry and on crops and ornamentals on the various islands using keys developed in this activity. The association between many tramp ant species and specific aphid species has been described.

Source of funds: TSTAR: USDA, Tropical & Subtropical Agricultural Research Special Grant

Scope of Impact: Regional, national.

Key theme: Invasive Species

Biological control of Ivy Gourd, *Coccinia grandis* in Guam and Saipan was studied by WPTRC entomologist. *Acythopeus cocciniae* was brought in from the Hawaii Department of Agriculture to the Quarantine Facility at the University of Guam. It was host specificity tested on the endemic melon plant *Zehnaria guamensis*, and an Environmental Impact Statement (EIS) was prepared and placed on the APHIS web site. It was advertised in the local newspapers in Guam

and Saipan. Finally a FONSI was prepared and APHIS issued the permits to field release on Guam and Saipan in 2003. *A. cocciniae* has been successfully established both in Guam and Saipan. Over a year ago, *A. cocciniae* was field released at the Rota Resort Golf Course. A year after its release, it has been well established in most parts of Rota. *Acythopeus burkhartorum* was also brought in from the Hawaiian Department of Agriculture to Guam and host specificity tested on *Z. guamensis*. EIS and FONSI were prepared and the field releases made in Guam in 2004 and Saipan in February 2005. This natural enemy is slowly being established in both islands.
The first attempt in 2001 to culture *M. oedipus* in Guam quarantine laboratory failed as the moths would not mate under the fluorescent lighting. However, later on we found that the moths mated under sodium vapor lamps. The second and third attempts in 2003 failed because of two super typhoons that hit Guam in July and December 2003. This caused loss of power and water for weeks to our quarantine facility. In June 2004 we collected *M. oedipus* in Kona, Hawaii and a culture is being maintained in the laboratory. To reinforce the culture and to take up the host specificity studies we planned to visit Kona and collect *M. oedipus* from February 21 to 24, 2005. Host specificity tests on *Zehnaria guamensis* were conducted in April 2005 and the results were submitted to APHIS, USDA for obtaining permission for field release. However after the evaluation, APHIS has asked us to carry out further tests on larval development on both the hosts. At this moment we are completing these tests and results will be submitted to APHIS for further evaluation.

Funding source: USDA, Tropical & Subtropical Agricultural Research Special Grant

Scope of Impact: Multi-state

Key theme: Invasive Species

Biological control of pink hibiscus mealy bug in the Mariana Islands was studied. The overall goal of this project is to suppress the population of the pink hibiscus mealy bug (PHM) in Saipan, Tinian, Rota and Guam. Surveys in 2004 up until the present date indicated that the parasitoid, *Anagyrus kamali* was introduced fortuitously to Saipan, Tinian, Rota and Guam. In addition, we also found a parasitoid, *Allotropha* sp. occurring on PHM on these islands. Hence, we did not have to introduce the parasitoids from Puerto Rico. The existing population level of these parasitoids will be enough to control the pink hibiscus mealy bug population in all the islands. We have been conducting population dynamics of the PHM and its natural enemies (parasitoids and predators) in these islands. However, the population level has been low. Since two species of parasitoids have fortuitously established, we decided to evaluate their impact on PHM before planning on introducing the other parasitoid, *Gyranusoidea indica*. We have found that it is not necessary to introduce this additional parasitoid in any of the islands. Monthly surveys were carried out on Guam to study the population dynamics of PHM and its natural enemies at eight sites. Quarterly surveys on Saipan (8 sites), Tinian (7 sites) and Rota (6 sites) are being conducted to evaluate the population dynamics of PHM and its natural enemies. We will be correlating PHM populations with the weather data and the population of the natural enemies.

Funding source: USDA, Tropical & Subtropical Agricultural Research Special Grant

Scope of Impact: Multi-state

Key theme: Invasive Species

A biological control of cycad aulacaspis scale, *Aulacaspis yasumatsu*i (Hemiptera: Diaspididae) in Guam was studied in 2006. A parasitoid *Coccobius fulvus* has been imported several times from Florida to Western Pacific Biocontrol Quarantine Laboratory at the University of Guam since August 2005 and it is being cultured in caged scale infested sago palm plants. To date we have received 3165 adults (1015 were used for lab culture while 2150 were field released). In January 2006, it was first field released in Marbo Cave, Dededo and Talofofo. At the Marbo Cave location, one exit hole was observed. This indicates that there is a possibility that this parasitoid will be established. However, we need more number of parasitoids for the field release. Once established, follow-up studies on the spatial and temporal spread of the parasitoid and its efficacy in suppressing the sago palm scale population will be conducted. Currently we are concentrating on laboratory rearing of the parasitoids so that a large number of them can be field released. Part of the problem in field establishment seems to be the predation of the parasitized scales by the introduced ladybeetle, *Rhyzobius lophanthae* Blaisdell (Coleoptera: Coccinellidae). Additional shipments of this parasitoid from Florida are also expected in the near future. Scale infested cycad leaves are collected every month to monitor the establishment of the parasitoid and the population dynamics of the scale in relation to the weather factors.

Source of funding — USDA CSREES Special Project

Scope of impact — Multi-state

Key theme: Invasive Species/Integrated Pest Management.

WPTRC entomologist conducted a survey of invasive ants that affect the survival and efficiency of homopteran parasitoids on the islands of Guam, Saipan, Rota in the Mariana Islands. This activity was also part of a USDA-APHIS-CAPS project on surveillance of Wasmannia auropunctata and Solenopsis invicta on Guam and other Mariana Islands. Checklists of invasive ants are being prepared for each island, along with identification keys for use by local farmers and scientific personel. Data from ongoing aphid surveys on cucurbits and other plant hosts is being analyzed. Analysis of morphometric and DNA (microsatellite flanking region analysis and bar-coding data from the COx1 locus) data continued in conjunction with the TSTAR-sponsored project "Genetic, morphological and ecological variation in Aphis gossypii." Results continue to suggest that A. gossypii on Guam consists of a single species with genetically distinct races occurring on various hosts. Morphometric and DNA data generated for the banana aphid, Pentalonia nigronervosa, and suggested that this aphid may consist of two separate species, with the species commonly found on banana being the principle vector of banana bunch top virus (BBTV). If banana aphid consists of two distinct species, only one of which is capable of vectoring banana bunchy top virus, growers will no longer have to worry about planting ornamentals, such as comb ginger, around property where bananas are grown. We will also be able to understand the dynamics of spread of bunchy top virus, of the lack of spread, to other

islands in Micronesia, and be able to amend quarantine protocols to more accurately reflect the potential for introduction of the disease on imported plants. Data from A. gossypii studies suggests that biocontrol agents targeting A. gossypii, and perhaps other aphid species as well, need to be more finely matched to ensure successful establishment of the natural enemy.

Source of funding - Special Grants

Scope of impact – Regional

Key theme: Invasive Species/Integrated Pest Management.

Survey of Alien, Invasive Insects in Micronesia continued in 2006. We continued the comprehensive survey for invasive insects in the islands of Micronesia, concentrating this year on Guam, CNMI, Pohnpei and Chuuk. Collecting trips were made to Pohnpei and Chuuk in April where a workshop sponsored jointly by this project and the Secretariat of the Pacific Community (SPC) was held for agriculturalists and agriculture administrators. A second collecting trip was made to Pohnpei in August. Collected insects have in many cases been successfully identified, while unidentified insects have been referred to experts for assistance. Dr. Richard Zack, curator of the James Entomological Collection at Washington State University, traveled to Guam during the spring to further assist in collecting Marianas fauna, and to assist us in organizing our Guam Territorial Insect Collection and establishing an electronic database that provides a reference foundation for subsequent collections. Because most of the invasive insects we have encountered are Homoptera, we developed laboratory facilities for clearing and mounting them on microslides, an essential first stem in the identification of many aphids, scales and mealybugs. Participation in USDA-APHIS and Western Pest Diagnostic Network workshops have enabled us to identify many of the homotperans encountered during the survey and become acquainted with experts who will assist with difficult identifications. Miller and Moore actively participated in the Guam Invasive Species Advisory Committee (GISAC). Moore designed a wiki (a website that can be edited online) for GISAC to facilitate compilation and access to information on Micronesia's invasive species. The wiki is located at http://GISAC.Guam.net. Within a few months of operation, the wiki was adopted by the Western Micronesian Invasive Species Council as a regional resource. Several new invasive insects were detected within the past year on Guam. These were: Oleander hawk moth, *Daphnis nerii*, (Lepidoptera: Sphingidae); the cycad blue butterfly, *Chilades pandava*, (Lepidoptera: Lycaenidae); the velvet shore bug, unidentified species, (Hemiptera: Hebridae); the Erythrina gall wasp, *Quadrastichus erythrinae*, (Hymenoptera: Eulophidae). A major emphasis in this years work was on the biological control of cycad Aulacaspis scale (ACS), *Aulacaspis yasumatsui*, on Guam. ACS was detected on Guam during the last quarter of 2003 on ornamental cycads. During 2004, it rapidly infested Guam's wild, endemic cycads throughout most of the island. Uncontrolled infestations of this scale insect kill cycads within one year. In an attempt to protect some of Guam's cycads, a predaceous lady beetle, *Rhyzobius lophanthae*, was imported from Maui in November 2003. Beetles were mass reared and released at Ritidian Point. Adult beetles became numerous at the release site within three months. Sticky traps are being used to monitor beetles, scale crawlers, and scale males at the release site. Following successful establishment of *R. lophanthae* at Ritidian, laboratory beetles and field collected

beetles were distributed on infested cycads throughout the island. To date, 8124 beetles have been released at 163 sites. Although it is too soon to claim success, *R. lophanthae* is well established on Guam and most samples of CAS currently show heavy predation by this beetle.

Four new invasive insect species were detected on Guam during the past years, and mitigation procedures initiated where warranted. The GISAC wiki was established to facilitate the rapid exchange of information on invasive species between islands within Micronesia as well as outside of the region. Due in part to information generated by this project, and to participation by project scientists, Guam developed a draft emergency response plan which contains a protocol for managing biotic invasions. The agricultural community and general public are better informed on the impact of invasive species through attendance at several workshops held during the last year.

Source of funds: TSTAR: USDA, Tropical & Subtropical Agricultural Research Special Grant

Scope of Impact: Regional, national.

Key theme: Integrated Pest Management.

Entomologist at Guam Western Pacific Tropical Research Center investigated impact of Aphis gossypii on crops and ornamental plants in the tropical Pacific Basin. The major objective of the proposed research is to begin to explain why whitefly parasitoids have declined on Guam over the past few years, begin to assess the effect of prokayriotic endosymbionts on aphid species composition and abundance on Guam, and to identify and initiate IPM against selected vegetable and cucurbit pests on Guam. Surveys of the key aphid and whitefly pests and their associated natural enemies will be coupled with data on abiotic factors associated with the cropping environment to fill in knowledge gaps in Guam s humid tropical environment. Data from past and ongoing whitefly and whitefly parasitoid surveys conducted throughout the cropping areas of Guam will be combined with data on soils, weather, and cropping strategies to determine why whitefly parasitoid populations on Guam have declined. The potential for reintroducing whitefly parasitoids will be assessed and if deemed appropriate, measures for importing parasitoids will be taken. Aphids will be sampled from Guam and other islands in Micronesia as funds allow. Growth rates and endosymbiont activity under different climatic regimes will be examined under controlled laboratory conditions, in the field, and in collaboration with workers at institutions in temperate climates. Information on growth rates under Guam conditions will be obtained for the aphidiid parasitoids Lysiphlebus testaceipes and Lipolexis oregmae that have successfully established on Guam. Other insect pests are commonly encountered on cucurbits and vegetables on Guam. These insects will be monitored during aphid and whitefly sampling. As data indicate that populations of these pests are approaching economically attaining economically serious levels, or in response to public demand, further research will be initiated to determine suitable pest management strategies.

Funding source: USDA, Tropical & Subtropical Agricultural Research Special Grant

Scope of Impact: Regional.

Key theme: Soil Erosion

Soil Scientist at Guam Western Pacific Tropical Research Center investigated methods of 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. Soil erosion as a consequence of poor soil quality threatens both the soil resource base and the 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 soil erosion control techniques and 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. In addition, the environmental impact of land application of compost as soil amendment is being evaluated in this project. 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. Field 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 90 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. Results have indicated that organic matter content was the highest for the plots under 90 tons per acre of compost application. Corn yield however was shown to be the highest under 60 tons per acre of compost application. In addition, suction cup lysimeters are being installed to evaluate the effect of compost application on water quality within the root zone under the study plots. 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. Compost is more than a fertilizer, more than a soil conditioner. 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. Some of the results of this project were presented in a conference and a descriptive article of the results is published in the conference proceedings. Also, up to date data produced from this project is being reviewed for journal publication. In addition, Radio and TV interviews were conducted to inform the farmers and the public about the benefit of composting and its use for soil quality improvement and crop productivity.

Source of funding – CSREES Special Grant

Scope of impact – Local, regional

Key theme: Rangeland/Pasture Management

An ecosystem approach to restoring and conserving soil quality in degraded lands of the Pacific islands was investigated by soil scientist. The overall objective of this project is to evaluate the effectiveness of conservation practices as well as compost application on the control of soil erosion. In this investigation the effectiveness of surface residue management for controlling runoff hence, erosion on these soils is being evaluated. In a companion study the effect of land application of composted organic waste is being evaluated and reported as part of overall ecosystem approach for restoring and maintaining soil quality in degraded lands of southern Guam. Two sets of twelve field plots (28 X 33ft^2) were set up at the University of Guam Ija and Inarajan Experiment Stations in Southern Guam for this project. In order to evaluate the effectiveness of conservation techniques on these soils degraded by erosion the following regimes was practiced: No-Tillage (NT) Reduced Tillage (RT) Conventional Tillage with Sun hemp Rotation (CT/SH) Conventional Tillage without sun hemp (CT) (control) Compost application as soil quality enhancement strategy. These regimes represent a wide range of practices that are being evaluated as conservation and restoration techniques. The conventional regime consists of tilling before and after planting and will serve as control treatment. These regimes will consist of conventional tillage without sun hemp meaning no sun hemp is planted prior to corn, and conventional tillage with sun hemp in which sun hemp is planted as rotating crop to corn. The conventional tillage without sun hemp is the yardstick for erosion measurements and is considered as control treatment for comparison with all the other treatments. The No-tillage treatment or zero tillage will represent the most effective treatment in term of erosion control technique. In reduced tillage, the soil surface is left un-disturbed after each harvest and tilled only before planting. Following the initial characterization, the soil quality indicators and changes as a result of restoration is being carried out following each crop growth cycle. Rainfall simulator is being used to evaluate the effect of conservation techniques on water infiltration and sediment loss for each individual plots. In a companion study conducted in Inarajan research station, after the application of composted organic waste, crop yield was measured for yield evaluation. Soil samples were taken and analyzed to evaluate the effect of compost application on soil quality. Rainfall simulator was also used to measure the infiltration as one of the components of soil quality indices and to assess the effect of compost as an erosion control technique. 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 the badlands in Southern Guam. In our companion study we are using composted organic waste not only as organic amendments for enhancement and maintenance of soil quality and productivity but also for reducing the erodability of these degraded soils. Considering that, this is a long term project and the effect of various conservation tillage treatment specially with No-Till management will become evident

only after at least 5 years of continuous no-till management we are anticipating however, that the results of these two companion studies not only provide good database for assessing the extent of soil erosion but the data will provide information on effectiveness of the restoration techniques being applied for soil conservation on these and other similar soil condition in the Western Pacific islands. The educational impact of these projects already have proven to be of a great value since some farmers started to consider rotating their corn crop with sun hemp and use sun hemp as green manure and cover crop during the rainy season. Also some farmers have started using compost as soil amendments and are pleased with the results. The educational impact of this investigation will prove to be of great value not only to farmers but also to ranchers and the other members of the communities of the pacific islanders whom are concerned about the degradation of soils and the natural resources of these islands.

Source of funding – Regional Hatch and NRCS Special Grant

Scope of impact – Multi-state

Key theme: Forest Resource Management

Ecophysiology of Guam's endemic and indigenous forest species was studied in 2006. More than 3 decades ago Stone (1970) reported that on Guam 'the physiology of local plants is virtually unknown.' The purpose is to study and form mediation recommendations relevant to abiotic factors that negatively affect Guam's forest health. Main objectives of this project were: to improve our understanding of the responses of important endemic and indigenous species to natural stressors, and to improve our ability to manage these species in the urban forest or in conservation reserves. We continued to study the ecology of common species in Guam's forests as well as focused on Guam's native cycad this past year. A major assault on Guam's cycad population has come from two alien arthropods. Our record of the typical cycad pests that pre-existed these recent introductions has become invaluable in determining the impact of the new pests on plant growth and development. We finished two studies of stem growth and development of this cycad species, to learn that the pachycaulis structure does not behave as do stems of other gymnosperm species. Guam's forests are under acute threats due to historical conversion of forested lands to non-forest use and the fragmentation of remaining forests. The chronic threat of new arthropod pest species and new invasive plant species add to the assault on forest health. Our studies of native species may improve our ability to conserve these important forest resources. Our studies of invasive plant species may allow us to implement better control measures. Two Pandanus species are found throughout Guam’s forest habitats. These are also regularly planted in the urban landscape. The influence of drought stress on leaf physiology was studied . Carboxylation efficiency and quantum yield declined shortly after the most recent rainfall event. Water use efficiency was also dynamic, since the speed with which stomata re-opened after passage of cumulus cloud cover to full sun conditions was lower for drought-stressed plants. Osmotic adjustment did not occur for either species. The various responses conformed to drought tolerance by dehydration postponement as the mechanisms for these two species.

Source of funds: USDA, Tropical & Subtropical Agricultural Research Special Grant

Scope of Impact: Regional

Key theme: Soil Improvement

Soil Scientist at Guam Western Pacific Tropical Research Center researched management of eroded soils for enhancement of productivity and environmental quality. 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. 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 2005 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. 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

Source of funding — Hatch

Scope of impact — State Specific

Key theme: Natural Resource Management

Pomologist at Guam Western Pacific Tropical Research Center investigated phenology and toxicology of the Guam cycad. 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. 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 glycosides 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 glycosides that were recently identified are 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.

Source of funds: USDA, Tropical & Subtropical Agricultural Research Special Grant

Scope of Impact: Regional

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 the faculty to tailor their programs to the unique needs of Guam's diverse community. Agriculture Experiment Station faculty within the College of Natural and Applied Sciences maintain regular contacts with Guam EPA, Northern and Southern Water District, and NRCS. Most of WPTRC scientists know the farmer's needs and make their programs relevant to the various University of Guam stakeholders' needs. We feel our informal and formal contact system with our stakeholders works quite well. 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-CNAS scientists are able to identify, characterize and provide a rational method of management for insects, diseases and other problems.

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 continued participation in four multi-state research projects in FY 2005. 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, S-009 - plant Germplasm. 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 also participated in three multi-state coordinating committees. They were WCC- 011 - turfgrass research, WCC-067 - western coordinating committee for sustainable agriculture, WCC-205 – and integrated water quality research and extension program for the western United States

Our planned programs focus on tropical agriculture, and our farmers and general population on Guam are generally under-served by the U.S. agricultural research and extension system as well

as under-served based on economic, social and ethnic criteria. All populations on Guam are ethnic minorities. Most of our farmers are Asian/Pacific Islanders. We are striving to address their unique needs by adapting the framework provided under the US agricultural research and extension system.

We feel that the multi-state programs generally do a good job of describing their expected outcomes and impacts in their initial proposals to the regional directors associations and in their progress reports as a whole. In their local Plans of Work and AREERA reports, however, individual scientists vary considerably in their success in meeting this goal. Some have a good understanding of what are outcomes and impacts, and do a good job of reporting, and some perform poorly. We will continue to work with our faculty to improve their understanding and performance in this area.

Our membership in multi-state projects and committees allows our researchers to interact with counterparts from within the region and around the country. Because Guam is isolated, and 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. On an individual basis, we are working with the PI of one of our projects to improve the outcome and impact of the project. If we do not see improvement in the local management and results of this project we will terminate out participation in it during the coming year.