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Agricultural Experiment Station

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Location

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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). The Dean of CNAS is simultaneously the Director of the Agriculture Experiment Station (AES). The primary mission of AES 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 AES.

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

Key theme: **Plant germplasm**

Guam Agricultural Experiment Station conducted research on plant genetic resources conservation and utilization. Activities for this project included 1)collection of local and international plant germplasm and to propagate selected cultivars by seed production and in-vitro propagation for conservation of germlines and distribution, 2) evaluation of field performance of collected germplasm for tropical climate adaptation, pest resistance, and other desirable characters for consumers in Guam, and (3) improvement of a plant acquisition and management system for germplasm collection and plant propagation program by advancing technology of the Guam Agricultural Experiment Station Horticulture Laboratory. During 2003-2004 seven hot pepper (Capsicum annuum) accessions were evaluated in a calcareous soil in Guam for the total yield, marketable yield, the number of fruit, and the weight of fruit. Hot pepper accessions included three local cultivars, Guafi', 'Manu,' and 'Hachon.' Three commercial cultivars from Taiwan were also tested including 'Hot Beauty', 'Group Zest' and 'Long Chili.' One accession, 'Huaruar' was originated from Thailand. 'Hot Beauty' produced the highest total and marketable yields. 'Group Zest' was the earliest maturing cultivar and produced the largest size of fruit. 'Guafi', a local cultivar, was the latest maturing cultivar. Three local lines and 'Huaruar' were more pungent than three Taiwan cultivars. Fifteen sweet potato (Ipomoea batatas) accessions were compared for morphological characteristics using a cluster analysis. Accessions were originally obtained from Saipan, Rota, Guam and Taiwan (the Asian Vegetable Research and Development Center). Characters used in the analysis were yield of tuberous roots, growth habit (spreading or upright) and features of tuberous roots (color, shape, sugar content and moisture content). The phenetic analysis revealed that there were four major groups. Two sweet potato accessions of the University of Guam were deposited to USDA-ARS, PSI-FL Plant Germplasm Quarantine in Beltsville, MD on April 30, 2002. The two accessions, cv. 'Terlaje' originated from Guam, and cv. 'Kuri' of Saipan origin were distributed to the Tuskegee University in 2004 after being kept in the USDA quarantine system. Four accessions of Leucaena spp. were evaluated for growth and production of biomass as multi-purpose nitrogen fixing trees in calcareous soil. Four genotypes evaluated were KX2 (a hybrid of L. leucocephala x L. pallida), 'Hawaii K1000' (L. leucocephala x L. esculenta), K636 (L. leucocephala), and 'PulxDiv4N' (an interspecific hybrid of L. pulverulenta x L. diversifolia-4N. 'PulxDiv4N' out-yielded for biomass production. Further studies are needed to examine suitability of their uses as animal feeds and hedgerows in Guam's farming system.

Impact:

Conservation and evaluation of important tropical plant germlines will support development of sustainability agriculture in the region. The project generated information on field performance of collected germplasm for tropical climate adaptation, pest resistance, and other desirable characters for consumers.

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

Scope of Impact: Regional

Key theme: **Plant production efficiency**

Scientists at Guam Agricultural Experiment Station investigated response of vegetable crops to mycorrhizal inoculation in tropical limestone soils. The influences of Glomus aggregatum on growth of tropical vegetable crops grown in Guam cobbly clay soil were examined. The pot culture revealed the positive effect of the VAM fungus on seedling growth of papaya (Carica papaya) and green onion (Allium fistulosum). A field experiment was conducted to find out the influences of G. aggregatum and application of inorganic fertilizers on plant development of corn (Zea mays) in Guam cobbly clay soil. The experiment was conducted in a split-plot design with the level of fertilizers as a main plot and the inoculation with G. aggregatum as a subplot. At 40 DAP (days after planting) and at final harvest the shoot biomass was greater with mycorrhizal inoculation for all level of fertilization treatment. When the fertilization level was higher, the shoot biomass was greater. Currently the results of leaf tissue analysis are being summarized.

Impact:

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: TSTAR: USDA, Tropical & Subtropical Agricultural Research Special Grant
Scope of Impact: Regional

Key theme: **Aquiculture**

Scientist at Guam Agricultural Experiment Station conducted a disease survey and marketing prospects for SPF shrimp production on Guam. Post-larval shrimp have been produced at the Guam Aquiculture Development and Training Center (GADTC) for many years. Postlarvae (PLs) have been provided to Guam, Palau, the Commonwealth of the Northern Marianas in Micronesia, and numerous other parts of the world. Much of the shrimp stock had to be destroyed during mid 1990s because of an outbreak of infectious hypodermal and hematopoietic necrosis virus. 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. There is a need for additional SPF stocks on Guam. An 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 stock of shrimp at the GADTC were sub-divided into three pooled groups: broodstock, immature and post-larvae. Each group consisted of more than 1,000 individuals and a 1% incidence rate was chosen as the target for detection. From the OIE, Manual, we tested 145 animals from each group in order to be 95% confident of detecting a disease at this incidence level. Pleopods were taken from the broodstock and immature and combined into individual sample of 5 animals. Post-larvae were sampled whole and combined into groups of 5 individuals for PCR analysis. PCR analysis for the presence of WSSV, IHHNV, TSV and YHV were conducted at the Aquiculture Pathology Laboratory of the University of Arizona. All results were negative for shrimp samples taken from the GADTC facility. This process was repeated after approximately six and twelve months from the original sampling. Thus, preliminary results continue to be that the GADTC facility is free of these viral diseases. One Aquiculture farm on Guam reported having trouble with its shrimp health. Pleopod samples were collected from the last remaining affected pond and sent to the University of Arizona for real-time PCR analysis.

Impact:

Preliminary investigations 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. We have initiated communications with an Australian Prawn Company who had sourced their stocks from Fiji. Results are pending, but it looks as if there may multiple viruses present in their Monodon stocks at very low levels.

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

Scope of Impact: Regional

Key theme: **Small Farm Viability**

Scientists from Guam and Virgin Islands Agricultural Experiment Station 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. During the third year numerous fruit trees were planted in the orchard.. In the rotational operation for vegetable and goat production, stargrass and pangola grass were planted

in mother beds. Goats were purchased and fenced. Water catchment and compost bins were installed Windbreaks and hedges were planted end established.

Impact:

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

Source of funding — USDA CSREES Special Project TSTAR
Scope of impact — Multi-state integrated research

Key theme: **Adding value to new and old agricultural products**

Food Scientist at Guam Agricultural Experiment Station evaluated processing and storage of commercial noni products. Noni (Morinda citrifolia L) is a tropical plant that traditionally treats various diseases in the Pacific Islands. Noni extract is now taken by cancer patients to control cancer. Novel glycosides from noni juice exhibit free radical scavenging activity and demonstrate anti-cancer effects. Noni fruit are now commercially processed into juice or powders for disease prevention and therapies. However, it is unknown how processing and storage conditions affect the bioavailability of bioactive components and the shelf life of noni products. The objective of this research is to determine how the bioactive compounds of noni products degrade during processing and storage. The research project is just beginning. Instruments, chemicals, and supplies are being purchased, installed, and prepared for research. A full-time and a part-time research assistant were recruited and are doing experiments in making noni juices with fermentation and boiling methods and noni powders with hot air and freezing dry methods. We observed that freezing dried noni powders are white and hot air dehydrated noni powders are brown. Temperatures above 50 C can cause browning of noni powders during hot air dehydration.

Impact:

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

Key theme: **Aquiculture**

Agriculture Economist at Guam Agricultural Experiment Station conducted disease survey for specific pathogen free shrimp production on Guam. Because of Guam's geographic isolation, the absence of wild stocks of penaeid shrimp, and the government's strict importation laws, the University of Guam's GADTC is ideally suited to maintain SPF broodstock and to supply shrimp both to local farms and for export. The immediate impact of the proposed work is to allow Guam to begin production of SPF PLs for stocking local farms. This will reduce or eliminate the importation of post-larval shrimp as is currently practiced. In addition, early studies identified the Guam's potential as a producer of SPF shrimp for export (Iverson and Brown, 1993). At that time the recommendation was for Guam to produce black tiger prawn (P. monodon) for marketing in Asia as this was the main species of interest in that region. Also, in Asia, interest in the culture of white shrimp (L. vannamei) has been growing exponentially. Thus, the opportunity for Guam to sell SPF shrimp in Asian markets has blossomed. This project will set the stage for Guam to take advantage of this engaging opportunity. In the first on farm survey, the University of Arizona Shrimp Pathology Laboratory found White Spot Syndrome Virus (WSSV) on a Guam shrimp farm. While this result is preliminary, if verified, it would represent the first report of this pathogen in the United States in a number of years. What is troubling is that the source of the infection appears to have been a shrimp hatchery in Hawaii where the virus is as yet unreported. We are working with authorities in Hawaii to identify the source farm and to check it for the virus.

Impact:

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

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

Key theme: **Aquiculture**

Scientist at Guam Agricultural Experiment Station investigated conditions to produce pathogen free (SPF) marine shrimp on Guam. The focus of the proposed project is to revitalize the Aquiculture center on Guam by establishing stock of specific-pathogen free (SPF) marine shrimp. Though post-larval shrimp have been produced at the center for many years, much of the shrimp stock had to be destroyed because of an outbreak of infectious hypodermal and hematopoietic necrosis virus (IHHNV), one of several viral diseases that have seriously impacted shrimp production worldwide (Lightner 1983). While the stocks of white shrimp (Penaeus vannamei) that remain have not shown signs of disease, larval production has declined, growth rates are lower, and they are thought to suffer from a lack of genetic diversity or in-breeding depression. The first health survey of the GADTC shrimp has been completed. The results were that the hatchery was clean of all viruses of interest. A bio-sanitation workshop was held for the hatchery workers, extension personnel and farmers on-island.

Impact:

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

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

Key theme: **Plant Production Efficiency**

Plant scientist at Guam Agricultural Experiment Station investigated regulation of photosynthetic processes. Understanding its regulation is fundamental in designing strategies to develop improved crop systems that are environmentally sound. This project is designed to determine the limitations on photosynthesis of tropical species, and how development and physiological characteristics may be deployed to optimize yields during times of environmental limitations. Fluctuations in non-structural carbohydrates were studied in papaya plants following manipulation of source-sink balance by leaf removal. Starch pools were minimal and unchanged following defoliation. Lateral roots had higher concentration than taproots or stems, but maximum levels were only 5 mg/g. Glucose and fructose concentration was similar for taproot and stem tissue, but was lower in lateral root tissue. Alternatively, sucrose concentration was similar for lateral root, taproot, and stem tissue. Other saccharides were minimal or undetectable in papaya tissues. The increased need for carbohydrates for reconstructing source leaves following foliage injury was not apparently met by mobilization of soluble carbohydrates from stem or root tissue.

Impact:

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

Source of funding — Multi-Regional Hatch
Scope of impact — Integrated research and extension

Key theme: **Plant health/ plant production efficiency**

Plant Scientist at Guam Agricultural Experiment Station 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.

Impact:

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

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

Key theme: **Plant Health**

Plant Pathologist at Guam Agricultural Experiment Station researched diseases of traditional Pacific Island crop plants. The most significant diseases of Coconut, banana and taro on Guam are Coconut Tinangaja, Banana Bunchy Top, Black Leaf Streak and Panama Wilt, and Taro Leaf Blight (TLB), respectively. The aim of this project is to facilitate ways to develop control measures for these important diseases. A banana cultivar similar to local cultivar Manila was imported in tissue culture and is being propagated for testing. We hope that it will show resistance to Panama Wilt, unlike Manila, which is very susceptible. Taro germplasm (77 cultivars) were propagated in tissue culture and given to the entomologist for insect resistance testing. Some of this work is already complete and comprises a M.S. thesis for a graduate student. It is hoped that this information will be useful for the entire region and help in keeping taro cultivar names straight. When comparing cultivars from one island to the next, taros with different names may actually be the same, and vice-versa.

Impact:

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

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

Key theme: **Adding Value to Old Agricultural Products**

Scientists at Guam Agricultural Experiment Station investigated possibilities of increasing market of traditional root crops of Guam. The study was designed to conduct field evaluation of sweet potato (Ipomoea batatas), and a market study of sweet potato, taro (Colocasia esculenta and Xanthosoma sp.), cassava (Manihot esculenta). This study also included sweet potato

preference test and taste test of selected sweet potato accessions. The concept test showed that people of Guam consumed sweet potato, taro, cassava and yam in both traditional dishes and as new processed foods. Taro and cassava tamales were still popular forms among Chamorro, and a variety of processed root crops were available at local market. Chips and breads of sweet potato and taro have a great potential to be processed foods made in Guam for local consumption as well as for export. From the survey, it was found that sweet potato with purple skin and flesh color was preferred type. Purple sweet potato chips were also preferred over yellow chips.

Impact:

The research suggests that the development of processed products made from traditional root crops would be a possible agri-business on Guam and other tropical islands of this region. Results indicated that chips and breads made from taro and sweet potato could be sold to local venders and at gift shops on Guam.

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

Key theme: **Plant Health**

Plant pathologist at Guam Agricultural Experiment Station investigated resistance for papaya ring spot in the West Pacific. Papaya Ring spot virus 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 and shows promise. Work is behind schedule due to our fields getting decimated by storms in previous years. One year after we had 2 storms in one season, PRV incidence declined dramatically, but again it has reached high levels throughout the island at this time. During the past year, 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 were included in the evaluation, and both have shown increased resistance to our local strain of PRV compared to all other entries. One in particular, Rainbow, has held up very well during the 2004 growing season. 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 will be planting the seed obtained from those crosses to continue this work and to start making selections. PRV-infected papaya leaves from Guam were collected and sent to HI under the required local and federal permits. Nucleic acids from the virus were isolated, purified, and eventually the coat-protein gene was sequenced. This step has already been completed and will now allow two things, one is to compare it to PRV strains currently found in HI, and the other is the transformation of a papaya cultivar with specific resistance to the PRV strain found on Guam. The coat-protein gene sequence of the virus 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. This material will eventually be shipped back to Guam for evaluation.

Impact:

The work is not yet completed, but some impact is already visible. One of the HI transgenic accessions introduced in the course of this study has shown some resistance to the local strain of PRV. 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. But any progress is welcome. Perhaps in the future we will be able to replace this one with another resistant cultivar that possesses all the desired traits.

Funding source - TSTAR

Key theme: **Plant Health**

Plant pathologist at Guam Agricultural Experiment Station research breeding methods to develop Fusarium wilt-resistant bananas (Musa sp.). The banana is an important staple food in the Western Pacific. Panama wilt is a limiting factor in its production. This is particularly true today in Kosrae, where production is worth $100,000 annually. The disease is also important on Guam, where banana production reaches annual values of $121,000. Cultivar Saba the most popular in FSM has been established in tissue culture, and propagated. Banana cell cultures have already been also initiated and tested. Protocols are still being developed. On Guam, several cultivars has been propagated in vitro for tested against Panama Wilt disease in the field.

Impact:

Concern about Panama wilt of bananas, both on Guam and FSM is profound. It seems right to try to address this problem by seeking to develop resistant plants from popular cultivars.

Source of funding — USDA CSREES Special Project TSTAR
Scope of impact — Multi-state

Key theme: **Plant Production**

Agriculture engineer at Guam Agricultural Experiment Station 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. Field experiments have shown that switching tensiometers when properly maintained and set to the proper soil matric potential for a particular crop perform better than timers in both crop yield and water-use efficiency in micro-irrigation systems. Irrigation management series publications were distributed at a workshop conducted at the end of a watermelon experiment.

Impact:

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

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

Key theme: **Invasive Species**

Entomologist at Guam Agricultural Experiment Station researched invasive insects of Micronesia.
Invasive arthropod pests pose a continuous and serious threat to agricultural, urban and natural ecosystems on Guam and in Micronesia at large. The majority of insect and mite pests on Guam are alien species accidentally introduced from Asia, from adjacent islands, or from the US mainland. These arthropod pests infest crops, vector plant and animal diseases, lead to quarantine of plant produce, destroy houses and wood structures, and threaten the island's biodiversity. Similarly, introduced arthropod pests comprise the majority of serious crop pests in the other islands of Micronesia. With increased air and ship travel between the islands of Micronesia, and with increasing demand for products from Asia, the US mainland and from other continents and island ecosystems comes an increasing threat for the introduction and establishment of additional pests. Although previous workers have sought to catalogue the insects of Guam and other Micronesia islands, there have been no comprehensive insect surveys in Micronesia for many years. Biological control has been employed to mitigate alien invasive arthropods on Guam and in Micronesia. Part of the reason for the relatively limited biocontrol activities in the region is the lack of knowledge on which natural enemies would be best suited for release in the humid tropical islands of Micronesia. A systematic evaluation of the invasive pests present in Micronesia, coupled with a survey of possible biocontrol agents with an estimations of the risk/benefit associated with the particular host – natural enemy will allow better use the limited funds available for pest mitigation by targeting systems with the highest possibility for success. A project Website (http://frontpage2000.family-net.org/amoore/Micronesian%20Invasives%20Web/) has been established to facilitate coordination with collaborators and dissemination of information generated by the project.

Impact:

Personnel have been trained on the importance of invasive species, and how to recognize them during their inspections. Workers and other interested parties are able to access information regarding invasive species in the region by accessing the web site.

Source of funding — USDA CSREES Special Project TSTAR
Scope of impact — Multi-state

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

Key theme: **Human nutrition**

Food scientists at Guam Agricultural Experiment Station investigated potential for usage of food colorants. The safety of synthetic food colorants is a concern. Anthocyanins are natural pigments alternative to synthetic colorants. However, only acylated anthocyanins are stable to pH, heat and light. A Japanese purple sweet potato cultivar (Ipomoea batatas L.) cultivar "Ayamurasaki" is composed of 93% aclylated anthocyanins, and has been used as a food colorant. Anthocyanins from purple sweet potatoes also exhibit healthy benefits such as antimutagenicity and hepatitis therapy. Several purple sweet potato cultivars, originated from the Western Pacific Islands, are different from purple sweet potato cultivars in Japan. It is unknown of the stability and physiological function of anthocyanins from the Western Pacific purple sweet potato cultivars. The objective of this project is to determine potential application of anthocyanin from the Western Pacific purple sweet potato cultivars as food colorants and nutraceutical ingredients. Fresh or steamed purple sweet potatoes (cultivar "Terlaje") were dehydrated with freeze dry, hot air, and vacuum oven.

Impact:

Dehydration and steaming of purple sweet potatoes affect anthocyanin content in powders. The purple sweet potato powders from the Western Pacific can be potentially applied in foods. This research project promotes to utilize Western Pacific regional resource to provide national benefits for food industries and consumers. The project potentially impacts on tropical agricultural science and practice, including production, processing and exportation of purple sweet potatoes and products in the Western Pacific Islands. The project also enhances competitiveness of the project director to develop research capacity to achieve to improve crop marketing through value-added product schemes. An abstract "Anthocaynin content and color characteristics of the Western Pacific sweet potato (Ipomoea batatas) powders" was submitted to the 2005th IFT Annual Meeting for presentation in New Orleans, LA, July 16-20.

Source of funding This project was funded by CSREES-USDA National Research Initiative (NRI) Grant
Scope of impact: Regional

Key theme: **Human health**

Food Scientists at Guam Agricultural Experiment Station tested bioavailability of biological components in Noni (Morinda Critrolia) products as affected by processing and storage.
Noni (Morinda citrifolia L) is a tropical plant that traditionally treats various diseases in the pacific islands. Noni extract is now taken by cancer patients to control cancer. Novel glycosides from noni juice exhibit free radical scavenging activity and demonstrate anti-cancer effects. Noni fruits are now commercially processed into juice or powders for disease prevention and therapies. However, it is unknown how processing and storage conditions affect the bioavailability of bioactive components and the shelf life noni products. The objective of this

research is to determine how the bioactive compounds of noni products degrade during the processing and the storage. 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 fresh noni juice was prepared by centrifuging noni puree. The fermented noni juice was dripped from noni fruits in sealed pitchers. Noni powders were prepared by dehydration of noni puree with hot air. Noni juice and powders were stored at room temperature, refrigerator, and freezer. The fresh noni juice exhibited the TAC at 130-150 mg equivalent ascorbic acid (EVAA)/100 ml juice and noni powders exhibited the TAC at 700-900 mg EVAA/100g powder. After 3 months storage, the TAC of noni juice decreased to 13% at 30 C, 45% at 4 C, and 93% at -22 C, and the TAC of noni powders decreased to 60% at 30 C, 82% at 4 C, and 80% at -22 C. After 1 week, the inside fermented noni juice lost 70% of the TAC and the outside fermented juice lost 80% of the TAC. After 3 months, the inside and outside fermented noni juice retained only 11% and 7% of the original TAC, respectively. Hot air dehydration of noni puree lost 20% of the TAC at 50 C and 30% of the TAC at 60 C. Temperature negatively affects the bioavailability of bioactive components of noni products during processing and storage. Storage of noni juice in freezer retains much more bioactive components than in refrigerator and at room temperature.

Impact:

Research outcomes benefit noni product processors in the Pacific islands. Noni product processors have a guideline to process high quality noni products with good bioactive components. A paper “Total antioxidant capacity of noni (Morinda Citrifolia) products as affected by processing and storage” was accepted for presentation at the 5th International Conference and Exhibition on Nutraceutical and Functional Foods in San Francisco, California Nov 7-10, 2004. An abstract “Bioavailability of biological components of Noni (Morinda Citrifolia) juice and powders as affected by processing and storage” was submitted to the 2005th IFT Annual Meeting for presentation in New Orleans, LA, July 16-20.

Source of funding: Tropical/Subtropical Agriculture Research (T-STAR) grant.
Scope of impact: Regional

Key theme: **Human nutrition**

Food Scientists at Guam Agricultural Experiment Station 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.

Impact:

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.

Source of funding — USDA Hatch Project Grant
Scope of impact — Multi-state integrated research

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

Key theme: **Integrated Pest Management**

Entomologist at Guam Agricultural Experiment Station investigated impact of Aphis gossypii on crops and ornamental plants in the tropical Pacific Basin. While confined primarily to glasshouses in cooler climates, in the tropics and subtropics A. gossypii is a major pest of cotton and cucurbits, where its high reproductive rate allows it to rapidly build up high populations and kill otherwise healthy plants by direct feeding or through the transmission of over 50 virus species. Despite the abundance of past work on A. gossypii, its taxonomic status is still poorly understood The lack of certainty in identifying A. gossypii renders interpretation of biological information, including host plant-herbivore-natural enemy relationships, questionable. Lack of understanding about the specific identity of A. gossypii populations lessens the chance for successful natural enemy introductions against them in classical biological control programs. Similar taxonomic confusion may also exist among the aphid's aphidiid parasitoid complex, further reducing the chances of successfully establishing an introduced parasitoid on a specific target host while avoiding unanticipated and undesirable nontarget activity. Aphis gossypii was collected from a range of crop and non-crop plant hosts and at various times during the year on Guam. A. gossypii was also collected from a range of crop and non-crop plant hosts in the Commonwealth of the Northern Marianas islands of Saipan, Tinian and Rota, and from the Republic of Palau islands of Koror and Babeldaup. In addition, A. gossypii collections were obtained from five of the Hawaiian Islands, Japan, Canada, the USA, Syria, and the Republic of the Marshall Islands. Plant hosts were determined and ant/aphis associations describe Aphid collected were morphometrically analyzed from slide mounted specimens using principal components analysis. These analyses suggested that aphid variation was most closely related to

geographic provenance, followed by host plant. Results from microsatellite flanking region analysis (MFRA) performed on aphids from these same collections, but which had been preserved in 95% ethanol, suggested that the majority of genetic variation observed among aphid samples was most closely related to the host plant they had been collected from.
Field observations made on Guam suggest that the physical appearance of aphids in subsequent generations may be altered by altering the host plant upon which the aphids develop. Aphid collections from various sites continue, as does refinement of both morphometric techniques, DNA sequencing and data analysis.

Impact:

Conducted research improved knowlage about Aphis gossypii biology as well as helped in plant protection.

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

Key theme: **Soil Erosion**

Soil Scientist at Guam Agricultural Experiment Station 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. These threats are manifested more seriously in the southern part of the island The challenge facing soil and agricultural scientists therefore is to develop conservation strategies that restore the soil and improve their quality for crop production and environmental quality. Similar challenges are facing the island of Hawaii and therefore this research project is also being conducted at the University of Hawaii by our collaborators as part of this grant. In this investigation the extent of soil erosion and its effect on soil physical and chemical properties is being evaluate By using rainfall simulators the parameters of erosion and sediment losses will be measured and determined for further assessment of the environmental impact of erosion and the effectiveness of the applied conservation techniques on these soils. In this regard, we are evaluating the plant residue management such as no-till and reduced till planting as soil erosion control techniques on typical degraded soils in southern Guam. We also use sunnhemp in rotation to the corn crop to maintain surface cover between planting and also improve the quality of soils under study. The principal method of controlling soil erosion and its accompanying rapid water runoff is to maintain adequate vegetative cover at all times which is the main objective of this project. An integrated approach is designed to evaluate the effect of conservation tillage, crop rotation with leguminous plant for organic matter build up, and residue management for soil re-habilitation and restoration of severely eroded soils of southern Guam. We anticipate that the results of these studies not only provide good database for assessing the extent of soil erosion but the data will provide information on effectiveness of restoration techniques being applied to conserve soils and prevent water erosion in Guam and the other islands of Western Pacific with similar climatic conditions.

Impact:

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

Source of funding - Special Grant
Scope of impact – Local, regional

Key theme: **Rangeland/Pasture Management**

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

Impact:

Soil quality degraded to an alarming stage in most regions of Guam, was improved with compost especially in southern Guam where most rangelands are located. Use of compost helped to build good soil texture, structure and qualities that enable soil to retain nutrients, moisture and air for the support of healthy crop growth. Compost is also used to protect the surface of the eroded soils and as organic amendments for enhancement of rangeland productivity, sustainability and maintenance of soil productivity. This benefits farmers and ranchers, landowners as well as the general public who use ranches and other public lands as recreation areas.

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

Key theme: **Biological control**

Entomologist at Guam Agricultural Experiment Station investigated biological control of ivy gourd (Coccinia grandis). Ivy gourd is a perennial vine native to Africa that thrives in warm, humid tropical regions. In its native habitat, it presents little or no threat to cultivated crop land or native vegetation because it is kept in check by competing plants and effective natural enemies. However, in recent years, it has become a serious pest in the Hawaiian and Mariana Islands, by out competing native plants, suppressing roadside vegetation, forest plantations, and ornamental and fruit farms. It was accidentally introduced to the Marianas in the 1980's and is a serious problem in Saipan and Guam. This weed is a problem for the following reasons: (1) Interferes with cultivation of plantation crops. Ivy gourd vines smother cultivated ornamental plants and fruit crops including mango, guava, banana, breadfruit, citrus and coconut, (2) Invasive: Ivy gourd infests vacant lots, roadsides pastures, forests, natural resources and power poles. (3) Results in negative effects on the ecosystem. Ivy gourd climbs on natural vegetation in forests and natural reserves and disinfects them. (4) Serves as a host for pests of melons. Several pests of cucurbitaceous crop multiply on ivy gourd. Suppression of ivy gourd is a prerequisite for starting a program to eradicate melon fly in the Marianas. It has been estimated that over 15,000 acres in Saipan, 500 acres in Guam and 5 acres in Rota are now infested and infestations continue to spread. There is a need for a host-specific, self-perpetuating, biological control agent for this invasive species. Successful control of this weed has occurred in the Hawaiian Islands by releasing Acythopeus cocciniae (Coleoptera: Curculionidae), Melittia oedipus (Lepidoptera: Sessidae) and Acythopeus burkhartorum (Coleoptera: Curculionidae). The leaf mining weevil, Acythopeus cocciniae of East African origin imported from Hawaii was host specificity tested against the endemic melon plant, Zehnaria guamenis. An Environmental Impact statement was prepared and published in the Federal Register. A leaf mining weevil, Acythopeus cocciniae and a gall forming weevil, Acythopeus burkhartorum have been released in Guam and Saipan after conducting host specificity studies. A third natural enemy, Melittia oedipus is being reared in the quarantine for host specificity studies.

Impact:

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

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

Key theme: **Biological control**

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

the New Guinea sugarcane weevil Rhabdoscelus obscurus has been developed. Population density of the weevils in different parts of the island was assessed and it was found that there was a high concentration of the weevils in the villages Tamuning and Dededo corresponding with the commercial nursery business. Lures of aggregation pheromones of the Australian and Hawaiian populations of New Guinea sugarcane weevil, with other semiochemicals were used to clarify the identity of the weevil population in Guam. In a field experiment at eight different locations (Dededo, Tumon, Yigo, Hagåtña, Mangilao, Yona, Agat and Malesso), plastic bucket traps baited with the lure of the Australian R. obscurus population in combination with a food volatile compound (ethyl acetate) and cut sugarcane captured significantly more weevils (total of 348) than traps baited with pheromone lure of the Hawaiian R. obscurus population in combination with food volatile and cut sugarcane which caught a total of 128 weevils. Traps baited with lure containing only the food volatile and cut sugarcane or only cut sugarcane captured significantly fewer weevils (total of 36 and 30, respectively) than those baited with pheromone compounds. Data from trap catches indicate that the Guam population of R. obscurus responded significantly more to the pheromone lure of the Australian population than to pheromone lure of the Hawaiian population, indicating that the Guam R. obscurus population is related more closely to the Australian population. Trap catches at the Tumon and Dededo locations were greater than those in Yigo, Yona, Mangilao, Hagåtña, Agat, and Malesso. Rainfall had a low correlation with trap catches at all locations except at Yigo where it positively correlated to the Australian population lure treatment.

Impact:

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

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

Key theme: **Forest Resource Management**

Plant Scientists at Guam Agricultural Experiment Station researched selected cultivars of the native tree Eleaocarpus joga to be vegetatively propagated for use in the landscape and for reforestation. Due to increased clearing of forested areas and typhoon damage, the population of Elaeocarpus joga Merr. has reduced in numbers. E. joga is an attractive tree which is indigenous to the region. Yoga has great potential for use as a specimen landscape plant and for reforestation. Variation in leaf shape, color and texture as well as variation in canopy characteristics makes it necessary to vegetaively propagate selections. Previously trees were only successfully propagated from seed. Hardwood, semihardwood and softwood cuttings were treated with acid and salt forms of IBA and/or NAA at several concentrations. The cuttings were treated with one of the following: acid form at 05 mL IBA/L + 0.25 mL NAA/L, 1 mL IBA/L + 0.5 mL NAA, 2mL IBA/L + 1 mL NAA/L; salt form at 1, 3, or 8 g IBA/kg. Rooting was

compared after 8 weeks. The best rooting (occurred with the salt form of IBA at 3 g/kg. The acid form containing both IBA and NAA produced poorer results.

Impact:

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

Source of funding — McIntire-Stennis
Scope of impact — State specific

Key theme: **Plant germplasm**

Scientists at Guam Agricultural Experiment Station Plant 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 AES Horticulture Laboratory. Activities for this year included (1) to collect local and international plant germplasm and propagate selected cultivars by seed production and in-vitro propagation for conservation of germlines and distribution, (2) to evaluate field performance of collected germplasm for tropical climate adaptation, pest resistance, and other desirable characters for consumers in Guam, and (3) to improve a plant acquisition and management system for germplasm collection and plant propagation program by advancing technology. A crop evaluated in 2004 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 toUSDA-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 2005, and will be distributed to the Tuskegee University.

Impact:

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

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

Key theme: **Nutrient Management**

Horticulturist at Guam Agricultural Experiment Station investigated mycorrhizal fungus potential to enhance crop production on Guam. Guam cobbly clay soil is commonly cultivated for agricultural crop production. Important plant nutrients such as nitrogen, phosphorus, and

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

Impact:

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

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

Key theme: **Biodiversity**

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

Impact:

A key for 100 major weeds on Guam is near completion. These weeds are now being photographed, herbarium samples prepared and growth habitat information collected. Over half of the weeds have been examined for the presence of C. cassiicola. A list of worldwide hosts of the pathogen is also being compiled. The impact of the study is limited to the knowledge gained by the researcher working on the project. Their skills in weed identification and fungal pathogen identification have increases. Once the guide is completed, the impact will be extended to students and growers that will be using the resource material.

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

Key theme: **Agricultural Waste Management**

Animal Scientist at Guam Agricultural Experiment Station researched utilization of Animal Waste. Laying hen houses produce nutrient rich waste that if not properly managed can result in water pollution and overgrowth of tropical coral reefs by algal blooms.

Impact:

Results of this project enable to reduce the phosphorus level in poultry wastes in tropical environments.

Source of funding — Hatch
Scope of impact — State Specific

Key theme: **Integrated pest management**

Scientists at Guam Agricultural Experiment Station researched integrated pest management of important Guam crops. Cucurbits are among the most important cash crops grown on Guam and in the Commonwealth of the Northern Mariana Islands (CNMI). Of the cucurbits, cucumbers and watermelons predominate and are produced in sufficient quantities to fill most of the local demand. A number of serious insect pests infest cucurbit crops on Guam and the Mariana Island archipelago. A truly integrated cucurbit pest management system must address the effect that controlling each pest might have on populations of other pests. Among the serious pests of cucurbits in the Mariana Islands are several species of whiteflies. The silverleaf whitefly, Bemisia argentifolii, was first observed on Guam in 1993 and rapidly became a serious pest of cucumber, watermelon and vegetables. It was also found infesting various farmland weeds. The sweet potato whitefly, Bemisia tabaci, had been observed nearly 20 years earlier in farmers' fields but rarely attained pest status, probably due to population suppression by natural enemies. B. tabaci populations appeared to increase to economic pest status when insecticides were used against cucurbit pests, and decreased when sprays were not used (Schreiner et al. 1998). Cucurbits are preferred sites for oviposition by B. argentifolii (Blua et al. 1995, Chu et al. 1995).

Among the Cucurbataceae, pumpkin, Cucurbita maxima Cuch cv. Ebisu was the most severely affected by B. argentifolii, while watermelon, Citrullus lanatus (Thunb.) Batsum et Nakai cv. Kodama, Karimori, cantaloupe, Cucumis melo L. var utilissimus Duthie et Fuller cv. Karimori and bittermelon, Momordica charantia L. displayed only a slight spotty chlorosis. Damage among cantaloupe cultivars was variable (Hokama et al. 1993). The major objective of the proposed research is to lay a foundation for developing and implementing IPM strategies, emphasizing non-chemical pest management techniques, for cucurbits on Guam. Comprehensive aphid and ant surveys on Guam have been conducted on Guam, the CNMI and Palau. Surveys on other islands continue as opportunity arises to visit them, and in collaboration with PPQ and agriculturalists. Surveys of whiteflies and their associated natural enemies on Guam are conducted quarterly. No Encarsia parasites have been located in any sampling area for the past three years, contrasting with past surveys conducted on Guam where Encarsia sp. was abundant.

Impact:

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

Source of funding — Hatch
Scope of impact — State specific

Key theme: **Biological control**

Plant Scientists at Guam Agricultural Experiment Station looked into biological control in pest management systems in plants. The purpose of this project is ultimately to reduce the amounts of insecticides used against aphids on Guam and in Micronesia by introducing parasitoids that prey specifically on aphids. In a classical biocontrol program for beans, melons, and taro, the project integrates aphid biological control with crop management tactics used against other insect pests on the target. The project further identifies aphids and associated natural enemies in Micronesia by continuing comprehensive aphid and natural enemy surveys currently ongoing throughout the island. The project educates Guam's agricultural community on distinguishing aphids and associated natural enemies on crops, and recognizes the necessity of biorational pest management strategies. Surveys of aphids, their host plants, and associated natural enemies continue in the Federated States of Micronesia, the Commonwealth of the Northern Marianas, Guam, and the Republic of the Marshall Islands. The primary focus of the surveys is the melon aphid, Aphis gossypii though all aphids from all host plants are considered. Colonies of L. testaceipes collected on Guam were reared in the University of Guam insectary on the UOG campus. These parasities were then released on A. gossypii and T. citricida at agricultural sites where they had not previously been observed on farms in northern and southern Guam. Follow-surveys were conducted on the islands of Babeldaub and Koror in the Republic of Palau where about 1000 L. testaceipes were released in 2001 on A. gossypii and A. craccivora. Studies on ant-aphid-parasitoid associations have begun in 2001 continue in Guam, the CNMI and in Palau. A collaborative network of ant/aphid/aphidiid taxonomists has been established to work on aphid-associated question of the Western Pacific Basin.

Impact:

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

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

Key theme: **Sustainable agriculture**

Plant pathologist and entomologist at Guam Agricultural Experiment Station researched insect- and disease-resistant taro. Taro, Colocasia esculenta (L.), is a culturally important and profitable crop grown on Guam and throughout the tropical Pacific that is beset by insect pests and diseases that restrict its production in the Pacific, and impede expansion of its use elsewhere in the US. The purpose of the research is to: Identify sources of resistance in regional taro cultivars to the aphid A. gossypii and taro leaf blight, Phytophthora colocasiae (TLB). In conjunction with this activity an insect/disease resistant taro germplasm collection will be assembled on Guam for use in on-island field trials and for eventual distribution to interested parties throughout the Pacific region. Adapt and refine conventional aphid field screening techniques for use in screening for host resistance in taro cultivars for the serious homopteran pest, the taro planthopper, Tarophagus proserpina. Create germplasm nurseries for future use in developing molecular markers for aphid resistance, and for evaluation of potential commercial cultivars. Aphid and TLB resistant taro lines identified in this project will be made available to breeders and growers to hasten the development of commercially suitable taro varieties for US and Pacific region growers. Primary aphid and disease screenings and work on T. proserpina will be performed on Guam, while a taro nursery with differential aphid resistance will be created through collaboration with University of Hawaii-Maui. Fifty-nine varieties of taro, Colocasia esculenta (L.), obtained from the Western Pacific and Hawaii have been screened for aphid resistance on Guam by evaluating the extent of naturally occurring infestation by Aphis gossypii Glover, by assessing survivorship and reproduction of A. gossypii caged on the leaves, and by assessing preference using leaf disks in laboratory choice trials. Significant differences were observed among taro varieties in the number of aphids naturally infesting plants in the field. Similarly, significant differences in reproductive rate and longevity were observed between taro varieties. Aphids also showed preferences for certain varieties of taro, as shown by controlled laboratory choice tests. Data have been analyzed and prepared for use by plant breeders seeking to improve the genetic resistance to aphids of commercial taro varieties.

Impact:

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

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

Key theme: **Biocontrol**

Entomologist at Guam Agricultural Experiment Station investigated genetics of Aphis gossypii. Aphis gossypii Glover is an extremely cosmopolitan and polyphagous pest of crops and ornamental plants in the tropical Pacific Basin and worldwide. While confined primarily to glasshouses in cooler climates, in the tropics and subtropics A. gossypii is a major pest of cotton and cucurbits, where its high reproductive rate allows it to rapidly build up high populations and kill otherwise healthy plants by direct feeding or through the transmission of over 50 virus species. Despite the abundance of past work on A. gossypii, its taxonomic status is still poorly understood. The lack of certainty in identifying A. gossypii renders interpretation of biological information, including host plant-herbivore-natural enemy relationships, questionable. Lack of understanding about the specific identity of A. gossypii populations lessens the chance for successful natural enemy introductions against them in classical biological control programs. Similar taxonomic confusion may also exist among the aphid's aphidiid parasitoid complex, further reducing the chances of successfully establishing an introduced parasitoid on a specific target host while avoiding unanticipated and undesirable nontarget activity. Aphis gossypii was collected from a range of crop and non-crop plant hosts and at various times during the year on Guam. A. gossypii was also collected from a range of crop and non-crop plant hosts in the Commonwealth of the Northern Mariana Islands of Saipan, Tinian and Rota, and from the Republic of Palau Islands of Koror and Babeldaup. In addition A. gossypii collections were obtained from five of the Hawaiian Islands, Japan, Canada, the USA, Syria, and the Republic of the Marshall Islands. Plant hosts were determined and ant/aphis associations described. Aphid collected were morphometrically analyzed from slide mounted specimens using principal components analysis. These analyses suggested that aphid variation was most closely related to geographic provenance, followed by host plant. Results from microsatellite flanking region analysis (MFRA) performed on aphids from these same collections, but which had been preserved in 95% ethanol, suggested that the majority of genetic variation observed among aphid samples was most closely related to the host plant they had been collected from. Field observations made on Guam suggest that the physical appearance of aphids in subsequent generations may be altered by altering the host plant upon which the aphids develop. Aphid collections from various sites continue, as does refinement of both morphometric techniques, DNA sequencing and data analysis.

Impact:

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

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

Key theme: **Biocontrol**

Entomologists at Guam Agricultural Experiment Station Effects of indigenous and exotic ants on Guam's native trees. A number of forest trees and ferns indigenous to Guam and the Marianas Islands are considered threatened or endangered. Suspect in the decline in recruitment has been the rise in the number and species of alien, invasive ants that have been introduced over the years into Guam, and that now have established extensive populations throughout its forests. While most ants are opportunistic foragers, some ant species feed on plant exudates or leaf and stem material, on arthropods infesting trees, and on seeds. A number of ant species have become widespread, often associated with human activity. While most of these ants are most commonly encountered in urban environments, many are also found in disturbed areas and on oceanic islands where they area able to exploit vacant ecological niches. Invasive ants frequently have drastic disruptive effect on the native ant populations and upon the general ecology of the habitat they invade. Invasive ants may exclude competing native species from food resources and may raid their nests. Indigenous aboveground foraging ants are often the most severely affected, and established ant-plant interactions may be disrupted. Ants were collected from a variety of habitats on Guam, with emphasis on the limestone forests of northern Guam and ants that were associated with aphids. Similarly, ants were collected from the islands of Koror and Babeldaup in the Republic of Palau, and ant-aphid-host plant relationships ascertained. Microslide mounts of selected ant species and aphids were made prior to their identification by Dr. Laurel Hansen, Spokane Community College and by Ms. Olivia Idechiil, University of Guam. Aphid identifications were made by University of Guam personnel, and verified by Dr. Keith Pike of Washington State University.

Impact:

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

Source of funding — McIntyre-Stennis
Scope of impact — Multi-state integrated research and extension GU NM ROP

Key theme: **Invasive species**

Entomologists at Guam Agricultural Experiment Station researched the economics of invasive species. Alien, invasive plant and animal species pose one of the most serious threats to the fragile ecosystems of the insular environments of Micronesia. Combined with the impact of human-related urbanization and other development, invasive species pose a threat to endemic and indigenous species alike. Perhaps the foremost example of the potential for invasive species to wreak havoc on island ecosystems is the case of the brown tree snake, Boiga irregularis, which

was introduced from Asian islands onto Guam in the late 1940's when WWII military equipment was being transited through Guam en route to the US mainland. Within 40 years the snake had spread throughout the islands, and ultimately caused the extirpation of 11 bird species, which had formerly been common. Cascading ecological effects of these extirpations continue today as some insect populations undergo periodic outbreak cycles since there are no longer predatory insectivorous birds to regulate their populations. Elevated population densities of spiders on Guam may also be related to the lack of bird predation. Other related effects to the Guam community include numerous power outages by snakes climbing across power lines, attacks on infants, depredations of chickens, etc. While the effect of the brown tree snake was not anticipated, there is a need to provide policy makers a mechanism whereby they can assess the cost of managing future invasive species introductions once they are detected as opposed to delaying mitigation efforts until they attain pest status. The development of such an economic model is the object of this activity, conducted jointly with the University of Hawaii, the University of Florida and the University of Puerto Rico. Several species that are invasive and alien to Guam have been discussed for inclusion in case studies designed to provide baseline information for the economic model that is the ultimate objective of this project. We have narrowed the possible case studies to: 1) the brown tree snake - because of it well documented impact on the birds of Guam, its potential to infest and devastate other island ecosystems in the Pacific, and because of the less well know cascading effect its introduction to Guam has had on insect and other reptile populations; 2) the papaya mealybug - the successful introduction of three hymenopteran biocontrol agents successfully controlled this recent introduction to Guam from the Americas that had devastated Guam's papaya production capabilities and was of great concern in the tourist and home gardening industries because of its wide host range on a number of high profile ornamental plants; 3) the giant African snail - which was brought under control by a flatworm accidentally introduced to Guam, and which has been introduced to a number of Pacific islands threatened by the snail. This association continues to be controversial because of the threat the flatwork poses to indigenous snails on many islands; and 4) melon fly - a tephritid fruit fly that has been the object of an extensive and nearly successful sterile insect release program. Tephritid fruit flies are serious pests throughout the Pacific, including Hawaii and Micronesia. Case study subjects and protocols will be finalized at a workgroup meeting between PBAG and CBAG participants during the first year of the project.

Impact:

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

Source of funding —USDA CSREES Special Project TSTAR
Scope of impact — Multi state research GU HI FL PR

Key theme: **Biocontrol**

Entomologists at Guam Agricultural Experiment Station researched biological control of papaya mealy bug, Paracoccus marginatus in Guam and Palau. The papaya mealybug (PM), Paracoccus marginatus, a pest in the Central America and the Caribbean was noted to have established on Guam and was causing serious damage to papaya, plumeria, hibiscus and other plants. The

recent establishment of PM in Guam was a serious concern for the Pacific Islands including Hawaii, Commonwealth of the Northern Marianas and Federated States of Micronesia. The serious damage caused by PM to papaya, plumeria, hibiscus and other plants in Guam and Palau warranted immediate attention as in the case of the countries in the Caribbean and Florida. Since the establishment of PM in Guam and Palau, farmers and home gardeners have been using some chemical and cultural control methods to control PM without much success. The parasitoids Anagyrus loecki, Pseudleptomastix mexicana and Acerophagous papayae totaling 46,200 were imported from Puerto Rico and field released . Similarly, these parasitoids totaling 9,100 were released at various locations in the island of Palau. Releases and assessment sampling was conducted on a monthly schedule. Notes were taken on other predators observed at each study site.

Impact:

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

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

Key theme: **Biocontrol**

Entomologists at Guam Agricultural Experiment Station investigated biological control of Chromolaena in the Federated States of Micronesia. Chromolaena is a scrambling weed that grows to a height of 5 m and forms monospecific thickets. It is highly allelopathic and invasive, posing a threat to indigenous vegetation. It is a short day length plant, flowering in December-January in the Northern Hemisphere and from April to June in the Southern Hemisphere. Seed production is prolific and the seeds are dispersed by wind. The shoots dry up during the dry season and become a fire hazard as the pithy dry stems burn readily. However, the stubbles remain alive and sprout immediately after the onset of the rainy season. Chromolaena is a problem weed in plantations of coffee, tea, teak, rambutan, mango, rubber, oil palm and coconut, pastures, disturbed forests, natural reserves, vacant lands and roadsides. Although P. pseudoinsulata was reported to be established in Kosrae (1992), it was not found in the recent surveys. The project therefore decided to release P. pseudoinsulata in Kosrae. In Yap the situation is similar as in Kosrae, P. pseudoinsulata was released in 1988 and was reported to be established. During surveys in early 2000 P. pseudoinsulata was not found in Yap. The lab assistant went to Yap with 200 P. pseudoinsulata larva and 70 pupae were shipped to Yap to start a rearing colony. Several people from the College and Agriculture in Yap were trained in rearing techniques. Unfortunately the rearing of P. pseudoinsulata activities failed. Excess caterpillars reared in the laboratory were field released in Pohnpei. For 2005 rearing of P. pseudoinsulata will continue, first priority for release will be given to Chuuk but also Kosrae and Yap will be included in the release program. Trials needs to be repeated because some of the C. odorata plants did not have galls.

Impact:

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

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

Key theme: **Biocontrol**

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

Impact:

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

Source of funding — Special grants
Scope of impact — State specific

Key theme: **Water Quality**

Agricultural engineer at Guam Agricultural Experiment Station investigated efficiency of drip irrigation alternatives in watermelon crops. Field experiments were conducted to evaluate drip system design parameters – drip spacing, and number of drip lines per row for watermelon crop. These are important parameters for very shallow soils (15 to 30 cm deep) of northern Guam situated over the sole-source fresh water lens which supplies potable water. One, two, three, and four drip lines per row with a 200 cm spacing were tested for yield and leachate. Based on in-situ soil moisture irrigation scheduling at 20 centibar, no differences in yield were observed and there was no leachate under any of the treatments. However, data indicated that the frequency of irrigation was inversely related to the number of drip lines per row.

Dissemination of information was done via a farmer's workshop at the field site just before final harvest. About 70 farmers, gardeners, teachers and entrepreneurs attended the workshop. An article in a local newspaper to reach a wider audience covered the workshop activities. There were 25 requests for information made at the time of the workshop. One high school student received summer apprenticeship training during the summer of 2004, while the field experiments were in progress. In addition a legislative group, University of Guam students and High School students visited the experimental field and learned about the irrigation system, irrigation controllers, tensiometers, watermelon crop, and weather station.

Impact:

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

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

Key theme: **Weather and climate**

Agricultural engineer at Guam Agricultural Experiment Station evaluated Guam agricultural weather stations. Weather stations provide important climatic information to the agricultural community. The Guam Agricultural Climatic Data System (GACDS) has been created to assist scientists, students, golf course managers, farmers and gardeners. Climatic data from two weather stations (northern and southern Guam) are collected on a daily basis. Rain, temperature, relative humidity, wind speed, wind direction, total solar radiation, photosynthetic radiation, pan evaporation, and estimated turf grass evapotranspiration are measured via sensors and a datalogger. Modems allow data to be collected at a central location. GACDS is to be initiated in four phases:
Phase 1: Install GACDS on an in-house shareware network.
Phase 2: Disseminate GACDS information through yearly technical bulletins
Phase 3: Create a GACDS web site for use by the local community
Phase 4: Add an additional estimated evapotranspiration measurement from a system similar to CIMIS. The first two phases have been implemented. Phase three has been started, and will require seminars and workshops to instruct the community about accessing and using the information. Phase four is still being researched.

Impact:

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

Source of funding — Hatch
Scope of impact — State specific

Key theme: **Agricultural Waste Management**

Turf Scientist at Guam Agricultural Experiment Station investigated the fate of wastewater effluent used for irrigation on turfgrass lndscapes. Municipal wastewater or effluent is the partially treated wastewater from community or industry sewage. During treatment suspended solids are removed, however the effluent may still contain a host of potentially harmful substances including organic and inorganic compounds such as nitrates and phosphates, heavy metals, organic disinfection by-products viruses, bacteria and protozoan pathogens. Mobile nutrients such as nitrates may readily leach through the soil profile, contaminating underground aquifers.

Golf courses and other turfgrass landscapes are increasingly viewed as environmentally desirable disposal sites for wastewater effluent. Turfgrass areas on Guam and Hawaii are ideally suited for effluent irrigation as turfgrass grow year-round, providing a continuous supply of nutrients for plants. There is limited information available on Guam and Hawaii concerning the variability in effluent composition, and the effects of irrigating turfgrass landscapes with effluent water in regards to environmental factors related to water and soil quality and public safety. There is also little information concerning the biological and chemical composition of effluent water discharged from sewer treatment plants. On Guam, water discharged from a typical municipal sewage treatment plant was analyzed for inorganic ion concentrations, salinity, E. coli, and other basic chemical characteristics such as nitrates, phosphates, Na, K, Mg, Mn, B, Ca, and Fe. Water samples were taken twice a week over a period of 8 weeks during the rainy season. Results of the conducted analysis were compared to the results from samples taken during the dry season in 2004. To determine contaminant absorption and fate, non-absorbed contaminants in water discharged to deep (150 cm) parts of the soil profile were monitored with pressure/vacuum lysimeters and pen lysimeters. A field study was conducted during the rainy season on common bermudagrass turf established over lysimeter units. Secondary treated municipal wastewater was applied twice a week at three different rates. Leachate was collected twice a week over the period of 8 weeks and analyzed for Escherichia coli, fecal coliforms, nitrates, phosphates, potassium, sodium, and magnesium. An identical study was conducted in the peak of the dry season in 2004. Initial results indicate that collected leachate contained significantly lower nitrate concentrations at all rates of wastewater application. At the highest application rate, turf removed 52% of applied nitrates. At the lowest application rate, nitrate removal averaged 85%. Turf removed most of the water-soluble phosphorus at any application rate. Removal of potassium, magnesium, and sodium was modest and inconsistent. Turf removed more than 60% of Escherichia coli and less than 25% of fecal coliforms from wastewater regardless of the application rate.

Impact:

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

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

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

Key theme: **Agricultural Waste Management**

Turf scientist at Guam Agricultural Experiment Station investigared implications of application of effluent water on recreational turf. The total potable water demand on Guam is approaching current estimates for a long-term sustainable yield. Currently, a smaller portion of aquifer potable water is being used for drinking purposes, and a larger part is being used for irrigation which usually does not require potability. The current practice of using municipal water for irrigation and the simultaneous practice of dumping wastewater (effluent) to the ocean is both environmentally unacceptable and wasteful. Recycled wastewater is a potentially valuable resource that could free-up potable water supplies for future human consumption. Research began with a survey assessing the chemical composition of wastewater effluent discharged from sewage treatment plants that could be used for irrigation of turf and landscapes. After identifying the basic composition of effluents originating from different sources, a study to assess the long-term effects on major soil characteristics and turfgrass quality was conducted. Long-term effects (2 years) of wastewater effluents on soil parameters such as salinity, structure, permeability, saturated conductivity and turfgrass quality was evaluated. In the field study four lysimeter units 1m2 by 60 cm deep have been installed in the ground and filled to the top with topsoil. In addition, pressure/vacuum lysimeters were installed at two depths 6" and 12". The area was sodded with hybrid bermudagrass. Four treatments were applied including irrigation with potable water, irrigation with effluent, irrigation with potable water plus a standard level of nitrogen fertilization, and irrigation with effluent water plus a standard level of nitrogen fertilization. Compared to tap water, turf quality, especially turf color, increased as a result of irrigation with wastewater. Conventionally fertilized plots had a similar quality to plots irrigated with effluent water and plots irrigated with effluent water but supplemented by fertilizer. Effluent water had a positive impact on turf rooting. The total amount of roots increased more than 20% in both treatments utilizing effluent water when compared to standard fertilization. The clipping yield was affected by nitrogen fertilization and the application of effluent water. The yield of clippings increased 23 percent as a result of effluent water application. Twelve months of continuous application of effluent water had little effect on soil permeability and soil flocculation. No accumulation of sodium in the soil was found. During the rainy season around 25 percent of applied N was recovered in leachate under treatments with supplemental fertilization, however, nitrate (NO3) concentrations never exceed 10 ppm (current EPA limit). During the dry season less then 10 percent of applied N was recovered in the leachate with at most NO3 concentration below 3 ppm. The concentration of phosphates in the recovered leachate was inconsistent across treatments and substantially varied at different sampling dates. The conducted soil analysis indicated a buildup of phosphates in the upper 10 cm of soil probably as a result of phosphate precipitation in highly alkaline soil. The levels of other nutrients were not influenced by effluent water application.

Impact:

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

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

Key theme: **Soil erosion**

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

Impact:

An integrated approach is designed to evaluate the effect of conservation tillage, crop rotation with leguminous plant for organic matter build up, and residue management for soil re-habilitation and restoration of severely eroded soils of southern Guam. We anticipate that the results of these studies not only provide good a database for assessing the extent of soil erosion but will provide information on effectiveness of restoration techniques being applied to conserve soils and prevent water erosion in Guam and the other islands of Western Pacific with similar climatic conditions.
The educational impact of this project already have proven to be of a great value since some farmers started to consider rotating their corn crop with sunnhemp and use sunnhemp as green manure and cover crop during the rainy seasons. The educational impact of this investigation will prove to be of great value not only to farmers but also the other members of the communities

of the Pacific islanders whom are concerned about the degradation of soils and the impact of water erosion on natural resources of these islands.

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

Key theme: **Soil Improvement**

Soil Scientist at Guam Agricultural Experiment Station 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 2004 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.

Impact:

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 Agricultural Experiment Station 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

Impact:

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

B. Stakeholder Input Process

Actions taken to seek stakeholder input

For the most part, our professionals know the primary stakeholders in their particular disciplines, and interact with them regularly in the course of their normal university duties. Input from these interactions allows 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 Environmental Protection Agency, Northern and Southern Water Districts, and Natural Resources Conservation Service. Most of AES 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 2004. These were W-1185 - biological control in pest management systems of plants, W- 128 - microirrigation 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 four multi-state coordinating committees. They were WCC- 011 - turfgrass research, WCC-067 - western coordinating committee for sustainable agriculture, WCC-205 - integrated water quality research and extension program for the western United States and WCC-206 - Pacific Basin tropical agriculture.

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.