1999 Annual Report

Guam Agricultural Experiment Station

College of Agriculture and Life Sciences
University of Guam
Mangilao, Guam

INTRODUCTION

Jeff D. T. Barcinas, Ph.D.
Dean/Director

The Agricultural Experiment Station (AES) is the research unit of the College of Agriculture and Life Sciences (CALS). The College is the Land Grant Institution within the University of Guam, having three functions. Research conducted by AES generates knowledge for the community. Informal education programs conducted by the Guam Cooperative Extension (GCE) provide the island residents with useful information and skills that are to the social and economic well being of the community. Formal academic instruction to the University's students is provided by the Resident Instruction (RI) program. These services to the University, the island and the region are ongoing with support from multiple sources within the federal and local governments, and private sectors.

Research in AES is focused on (1) finding solutions to pest problems affecting agricultural production, the islands homes and natural environments; (2) improving varietal selection and availability in vegetable crops, turf grass, fruit trees and ornamental plants; (3) conserving and protecting the islands water supply through increasing the efficiency of agricultural irrigation methods; (4) improving livestock production practices; and (5) protecting the local environment by investigating the propagation of endangered species, soil conservation, and the control of invasive plants and animals.

The AES received a total of $2,237,211 in fiscal year 1999 to support research and education projects. USDA/CSREES Hatch formula funds of $699,596 were provided by the federal government as part of the University of Guam's Land Grant funding. The Government of Guam provided $858,966 in local funds. These covered the basic operating costs of the Agricultural Experiment Station. New directed CSREES research grants totaling $678,649 were received in the following categories: Multi-state projects (Regional Research); McIntire-Stennis forestry programs; Tropical and Subtropical Agricultural Research grants (TSTAR); Western Regional Sustainable Agriculture (SARE); and National Agricultural Pesticide Impact Assessment Program (NAPIAP). Other research projects had been funded earlier by the USDA Natural Resource Conservation Service (NRCS), Agricultural Development in the American Pacific (ADAP), and the United States Air Force (USAF).

AES faculty work closely with Extension staff in the projects of Expanded Food and Nutrition Education Program (EFNEP); Children, Youth and Families At Risk; Food Safety; Small Scale Distance Education; Youth Mentorship Program; Water Quality; Integrated Pest Management; Sustainable Agriculture; Pesticide Applicator Training; Pesticide Impact Assessment; and through the ADAP Consortium.

The College offers two undergraduate and one graduate degree programs. In 1999, there were a total of 28 student majors in the BS in Agriculture program, 24 student majors in the BA in Consumer and Family Sciences program and 21 students in the MS in Environmental Science program. A total of 20 courses and 22 special projects were offered to over 500 students or about 12% of the total student enrollment at UOG. AES faculty members teach both undergraduate courses of Agriculture program and graduate courses in Environmental Science program.

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AGRICULTURAL ECONOMICS

John W. Brown, Ph.D.
Associate Professor/AES Associate Director
jbrown@uog.edu

Investigations of the agricultural marketing system of Guam

Hatch - April 1998 to March 2001

Guam imports more than 90% of the food that it consumes. Historically, Guam has relied on the majority of food supply from the West Coast of the mainland U.S. Transportation from the West Coast is expensive and time consuming. Local farmers have specialized in growing fresh products that either do not ship well, are expensive to ship or are not available on the West Coast. Fresh fruits and vegetables accounted for 81.3% of the value of local agricultural production in 1993. Aquaculture of fresh fish and shrimp and production of fresh eggs and fresh roasting pigs accounted for the vast majority of the remainder.

The purpose of this project is to develop a market channel analysis and to quantify the demand curves of the ten most important local agricultural products and their imported competition.

Most of the accomplishments have consisted of aiding in the development of agricultural statistics for Guam by assisting the Guam Department of Agriculture with the Agricultural Marketing Information Systems and Agricultural Statistics for the American Affiliated Pacific. The preliminary market channel analysis will be completed in 2000.

Combination of the market channel information, local production information and information from the Plant Protection and Quarantine Division of the Department of Agriculture on the quantities of imports will allow identification of best opportunities for increasing local production for fresh markets on Guam.

Agricultural Marketing Information Systems and Agricultural Statistics for the American Affiliated Pacific

ADAP - February 1994 to July 2000 - $172,838

The purpose of this project has been the establishment of a computerized market information and agricultural statistics system for the American Affiliated territories in the Pacific Ocean. This project has been a joint effort between the Guam Cooperative Extension and the Land Grant Colleges in the Commonwealth of the Northern Mariana Islands, the Federated States of Micronesia and American Samoa.

The system is based on field observation of farm planting to forecast near-term agricultural marketings and to estimate historical islandwide production.

The system has been established and is currently operating on Saipan, Rota and Tinian in the CNMI, on Pohnpei and Kosrae in the FSM and in American Samoa. The Guam Department of Agriculture has been provided with the software and training in the system, but has not yet fully implemented it.

The US Farm Services Agency has decided to support the use of the system with modifications in the CNMI, Guam and American Samoa for the record keeping necessary for its disaster relief programs. Five-year contracts have been signed with agencies in each of the territories to provide federal support of their efforts in this area.

Environmental Quality Improvement Program (EQIP) Farm Record Keeping Education

NRCS - April 1998 to March 2001 - $22,550

The Natural Resources Conservation Service (NRCS) has contracted with AES and Professor L. Robert Barber of the Guam Cooperative Extension Service for an educational program on farm record keeping for participants in their Environmental Quality Improvement Program (EQIP). The goal is to provide the farmers with record keeping skills necessary to ensure their reimbursement under the cost-sharing provisions of the EQIP contracts. In 1999, workshops were held in Guam, Saipan, Rota and American Samoa.

AGRICULTURAL ENGINEERING

Prem Singh, Ph.D.
Assistant Professor
psingh@uog.edu

Microirrigation: Management practices to sustain water quality and agricultural productivity

Regional Research - October 1994 to September 2004

The objective of this project is the development of a microirrigation system and management plans that will sustain crop production while minimizing both water application and water quality degradation.

Five microirrigation schedules were tested in the production of head cabbage, *Brassica oleracea* L. cv. Scorpio grown on shallow Guam cobbly clay soil during the dry season from March 11 to June 10, 1999. The factors evaluated included deep percolation, water use efficiency and yield. Two of the five schedules were to daily deliver 6mm and 12mm of irrigation water in a fixed schedule (1X and 2X seasonal average daily pan evaporation). The remaining three schedules used *in-situ* soil moisture sensors (switching tensiometers) set at 10, 30, and 50 centibars (cb) to automatically schedule irrigation events. Deep seepage from the 1m X 1m drainage lysimeters was checked daily. Each treatment had a set of 8 tensiometers installed at 5, 10, 15, and 20 cm depths for monitoring soil moisture tension in the root zone depth. Treatments were imposed four weeks after transplanting the seedlings in the field.

There was a significant difference in head cabbage yield. The highest mean yield of 13.27 Mg/ha was obtained with the 1X Ep treatment, and the driest treatment (50cb) yielded the lowest at 10.04 Mg/ha. The wettest treatment, 2X Ep, had the lowest water use efficiency at about 1.5 Mg/kL of water used. The 30cb treatment had the highest water use efficiency at 3.15 Mg/kL of water used. Deep seepage occurred after the first harvest (June 3, 1999) due to heavy rains. The fixed schedules produced about three times the deep seepage compared to the *in-situ* soil moisture based schedules.

Proper sheduling methods reduce deep seepage and consequently may reduce nutrient loading of the groundwater, particularly during heavy rainfall events. Rainfall amount, intensity, and time of occurrence relative to crop growth stage and fertigation will influence the differences in deep seepage of water and chemicals under the various irrigation schedules. The observations of deep seepage do indicate that *in-situ* soil moisture tension based schedules produce less seepage compared to the fixed schedules.

Irrigation Set-Up for Head Cabbage at the Inarajan Experiment Station

Drip Irrigation System and Head Cabbage Crop

ANIMAL SCIENCE

Farouq Abawi, Ph.D.
Associate Professor
fabawi@uog.edu

Developing egg production models for Guam and Micronesia

Hatch - September 1995 to September 1999

Despite increasing demand for fresh poultry and eggs, poultry production on Guam and the other Micronesia islands is still in its infancy. Although the major impediment to development is the high cost of imported feed, other factors such as lack of information on production performance and on costs, investments and returns under tropical conditions also hinder development of the industry. Standard industry data, models and assumptions developed for the large scale automated systems in the U.S. poultry industry are not entirely applicable to the region.

The main objective of this study was to compile and analyze data on production parameters and costs and returns of two common commercial layers under Guam's tropical conditions. Although it has been well established that it costs less to raise White Leghorn layers as compared to the Gold-link brown egg type layers in the mainland U.S., there is certainly a preference for brown table eggs in the region and little information about the relative costs on Guam. In addition, this study was designed to look into the economics of first and second post molt production in light of the high cost of replacement pullets on Guam.

Three hundred White Leghorn (WL) birds and 300 Rhode Island Red cross (RIR) birds were put on the experiment as day-old chicks. Birds were weighed at weekly intervals. Feed consumption, mortality and body weight gains were recorded. Overall, there appears to be little or no difference in body weight gain and feed consumption between the two breeds in the starter and pullet developer phase of production. However, during the layer phase, the RIR layers continue to gain 170 grams more weight and consume 4 grams more feed per day compared to the WL layers. Feed efficiency measured as kg of feed per dozen eggs for the two breeds was not significantly different during the 24-week production. The WL layers start laying slightly earlier, with higher production in the first 3 weeks, and maintain higher production after peak production compared to the RIR layers. Both breeds reached peak production at about the 8th week of production (28 weeks of age). Hen house total egg production for the period was 58% for WL and 51% for the RIR. Overall, there seems to be no significant difference in egg size between the two breeds during the period from 4 to 22 weeks of production.

From our work, it can be concluded that White Leghorn layers produce more eggs at a lower feed intake as compared to the Rhode Island Red cross under conditions on Guam. White Leghorn layers are definitely the right choice from a production cost viewpoint. However, it will take a lot of effort to convince the local population that there are no real differences in nutritional composition and taste. As long as the people prefer brown eggs and are willing to pay a premium price for them, producing brown eggs can be justified despite higher feed cost to produce them.

Evaluation of processing food refuse and by-products for growing and finishing swine

Western Regional SARE - September 1998 to August 2001 - $121,850

The purpose of this project is to explore ways of reducing feed costs and dependency upon imported feeds to stimulate animal production in Guam and Micronesia. Specific objectives are 1. to estimate the volume and feeding value of food refuse from different locally available sources, 2. toprocess representative samples of food refuse and determine the feeding value after processing, 3. to develop and evaluate different feed formulations for growing and finishing swine using food refuse and by-products and 4. To establish the costs and benefits of using processed food refuse in the region.

Recruitment for a technician is under way and full implementation is expected in 2000.

ENTOMOLOGY

Ross H. Miller, Ph.D.
Assistant Professor
rmiller@uog.edu

Toward integrated pest management of cucurbits on Guam

Hatch - March 1999 to February 2002

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. This is done by identifying whiteflies and associated natural enemies through surveys conducted throughout Guam.

Whitefly and whitefly parasitoid surveys are being conducted throughout the cropping areas of Guam. Collected whitefly colonies are being examined for hymenopteran parasitoids. Voucher specimens of whiteflies have been preserved and are currently being identified to species. Other insect pests commonly encountered on cucurbits on Guam are being monitored during the whitefly surveys. Whiteflies and associated natural enemies expected to be found include *Bemisia argentifolii* with *Encarsia nigricephala* and *Eretmocerus* spp., *Aleurocanthus dispersus* with *Encarsia haitiensis* and *Nephaspis amnicola, Aleurocanthus* with *Encarsia smithii* and *Amitus herperidum, Bemisia tabaci, Bemisia inconspica, Neemaskellia bergii, and Aleurothrixus floccosus*. To date only *Encarsia nigricephala* on *B. argentifolii* has been recovered from samples collected from Guam's growing areas. Releases of *Eretmocerus* species from the USDA are still pending.

Because of the small number of studies dealing with whiteflies on Guam, a systematic and comprehensive whitefly and whitefly parasitoid sampling scheme will enhance our knowledge of the whiteflies and natural enemy complex existing on Guam, and will provide a foundation database for future whitefly control efforts.

Biological control in pest management systems in plants

Regional Research - December 1992 to September 2002

The goals of this project are to: 1. survey indigenous natural enemies of aphids, 2. quarantine exotic natural enemies and conduct pre-release studies, 3. release, establish and redistribute natural enemies, 4. evaluate natural enemy efficacy and study ecological /physiological bases for interactions, 5. identify and assess factors potentially disruptive to biological control and 6. evaluate the environmental /economic impacts of biological control.

A comprehensive survey of aphids and associated natural enemies, emphasizing hymenopteran parasitoids, was continued through 1999 and expanded to include the islands of Saipan, Tinian and Rota of the Commonwealth of the Northern Marianas (CNMI). Aphids new to the Mariana Islands include *Brachycaudus helichrysi* on zucchini and *Aphis spiraecola* on eupatorium. Radio, television, and newspaper interviews on aphid biocontrol were presented on Guam and in the CNMI. Local television interviews with the principal investigator and cooperators were also broadcast in Europe on CNN. Critical editorials in the Guam local newspaper, the Pacific Daily News, allowed the principal investigator to write a perspective article on the project and biological control that was distributed in the western Pacific.

Dr. Keith Pike, an aphid expert from Washington State University and Dr. Petr Stary, Czech Academy of Science, the world's leading authority on aphidiid parasitoids, search for aphid parasitoids on Andersen Air Force Base. Their visit was part of various TSTAR aphid biocontrol activities, surveying aphid fauna on Guam prior to releasing host-specific aphid parasitoids as biological control agents.

Farmers throughout Guam have been contacted prior to surveying their fields for aphids. The need for aphid and parasitoid surveys has been explained to them along with the other objectives of the project. Farmers interested in aphid biocontrol and who use little or no insecticides have allowed hymenopteran parasitoid releases in their fields.

Developing "soft" insecticide pest management for young ifit trees on Guam

McIntire-Stennis - September 1997 to August 2002

The objective of this project is to identify environmentally safe insecticides and formulate appropriate application methodologies for use against the psyllid, *Insnesia glabrascuta* (Caldwell), on ifit trees, *Intsia bijuga* (Colebr.) O. Kuntze on Guam that are target-specific, possess low residual activity and pose minimal impact to the environment or human safety. A variety of insecticides, emphasizing insect growth regulators, systemic insecticides, and other novel compounds recently available on the commercial insecticide market, are being tested against *I. glabrascuta* on ifit trees using a single tree replication design in field plots. Application methodologies will be determined for use by government and commercial nurseries.

Field tests were conducted on *I. bijuga* at the Yigo Experiment Station using malathion spray, dimethoate (Cygon) spray and soil drench, and Avid spray. Avid outperformed malathion and both dimethoate treatments. Population suppression with Avid when applied at medium to high concentrations persisted longer than with the other two compounds.

Conventional sprays, such as malathion or dimethoate, provide short term protection against psyllids on ifit trees. However, should insecticide protection be discontinued or disrupted, the resultant flush of tree growth in protected trees provides a favorable habitat for psyllids, and ultimately exacerbates the outbreak. Avid shows promise in seedling protection due to its longer residual protection, and because of its relative low impact on the environment.

Reducing pesticide use in the Mariana Islands through biological control of aphids

TSTAR - July 1998 to June 2001 - $124,669

The goals of this project are: 1. to reduce the amounts of insecticides used against aphids on Guam and in the CNMI by introducing micro-hymenopteran parasitoids that prey specifically on aphids in a comprehensive aphid biocontrol program on beans, melons, taro, and bananas, 2. to integrate aphid biological control with current chemical control tactics used against aphids and other insect pests by determining the effect of commonly used insecticides on aphid natural enemies, 3. to identify aphids and associated natural enemies on Guam and in the CNMI by continuing comprehensive aphid and natural enemy surveys currently ongoing throughout the island, and 4. to educate the agricultural communities of Guam and the CNMI to distinguish aphids and associated natural enemies on crops, and to recognize the value of biorational pest management strategies.

Aphidius colemani obtained from a commercial insectary were released on Guam against *Aphis gossypii* on taro in June and August of 1998, while a single release was made on Saipan against *A. gossypii*. *Aphidius colemani* and *Diaeretiella rapae* reared at Washington State University (WSU) were released against *A. gossypii, Toxoptera citricida, Aphis craccivora*, and *Pentalonia nigronervosa* in February 1999. Follow-up surveys have revealed aphid mummy formation at all three release sites, but establishment is not yet confirmed.

Dip tests have been performed on *A. gossypii, A. craccivora*, and *T. citricida* to assess their susceptibility to commonly used insecticides on Guam. These included malathion, dimethoate, and diazinon. Tests on hymenopteran parasitoids are pending.

A comprehensive survey of aphids and associated natural enemies, emphasizing hymenopteran parasitoids, was continued throughout 1999 and expanded to include the islands of Saipan, Tinian and Rota of the Commonwealth of the Northern Marianas (CNMI). Aphids and associated natural enemies were collected from major field crops and from non-crop plants.

Lipolexis scutellaris was the most common hymenopteran parasitoid found on Guam, and was collected from *A. craccivora* and *A. gossypii* on a range of crops, and from *T. citricidus* on citrus. *Lysiphlebis testaceipes* was also found infesting *A. gossypii, A. craccivora,* and *T. citricida* on Guam. A single female *Aphidius matricariae* was recovered from *A. gossypii*. To our knowledge, this is the first record of these parasitoids in the Mariana Islands. Identification of unknown *Aphelinus* species collected from *A. gossypii, P. nigronervosa* and *T. citricida* are ongoing, as are identifications of aphelinid collections from the CNMI. To date no aphidiid parasitoids have been observed in Saipan and Tinian. *Lysiphlebis testaceipes* has been recovered from Rota in the CNMI. Hyperparasites were collected from aphid mummy samples of *T. citricida* and *A. craccivora* on Guam. Syrphid flies and coccinellid beetles were the primary aphid predators observed in both Guam and the CNMI.

Surveys of aphids and their hymenopteran parasitoids reveal four aphid species, *A. gossypii, A. craccivora, P. nigronervosa,* and *T. citricida*, to be the major crop pests on Guam. Five other aphid species are common on crop and non-crop plants but appear to pose little economic threat. Two of these, *B. helichrysi* and *A. spiraecola* are newly described on Guam. *Aphis gossypii* and *T. citricidus* are the two most serious aphid pests in the CNMI. High populations of *P. nigronervosa* were found in Heliconia flowers on Guam and in the CNMI. Aphids on these flowers may migrate to adjacent fields of bananas and, if infected by virus, cause outbreaks of bunchy top.

The potential and methodologies used in this project have been conveyed to the public by reports in local and international news media. Additional local workshops for farmers and landowners are planned.

ENTOMOLOGY

R. Muniappan, Ph.D.
Professor Emeritus
rmuni@uog.edu

Biological control of siam weed with the gall fly in Guam and the Federated States of Micronesia

TSTAR - September 1997 to September 2000 - $155,000

Siam weed, *Chromolaena odorata*, is a scrambling weed that forms mono-specific thickets and grows to a height of 5 meters. It is highly competitive and crowds out other plants. Frequently, it is found in the patches of native scrub forest that are interspersed among the grasslands of southern Guam. In the dry season, it burns readily and allows grass fires access to areas that would not normally burn, thus leading to habitat loss.

The purpose of this project is to release the gall fly *Cecidochares connexa* on Guam and Palau. The procedure is as follows: 1. obtain an APHIS, USDA permit to bring the gall fly from Indonesia into the quarantine laboratory on Guam, 2. conduct host specificity studies in Guam, 3. obtain a permit from the Palau Department of Agriculture to ship the gall fly to Palau from Guam, 4. obtain an APHIS, USDA permit to field release the gall fly in Guam and 5. evaluate the efficacy of the gall fly in suppressing *C. odorata* in the field.

The shipment of 400 pupae of the gall fly was imported from Indonesia to Guam on March 30, 1998. From these, 198 adult flies emerged and a culture was established. Host specificity studies were conducted in the quarantine laboratory. Both "choice" tests (test plant and *C. odorata* exposed to *C. connexa*) and "no choice" tests (only the test plant exposed to *C. connexa*) were conducted with 12 plant species representing 8 families including weeds and crop plants. Each test was replicated 4 times. No galls developed in the test plants in both choice and no choice tests. These results were submitted to APHIS, USDA for permission to field release the gall fly.

On February 11, 1999, fifty adults of the gall fly were sent to Palau. It was host specificity tested in Palau, and then field released from August to October 1999. Field establishment of this fly has been observed.

Biological control of the fruit piercing moth, *Othreis fullonia*, in Palau and Guam

TSTAR - July 1998 to June 2001 - $159,400

The fruit piercing moth (*Othreis fullonia*) is native to the Indo-Malaysian region, but it is found from Africa to the Pacific. It is a serious pest of fruits and vegetables in the subtropical regions of Australia and the Pacific islands. Guava, citrus, mango, lichi, starfruit, banana, soursop, pomegranate, tomato, eggplant and bell pepper are some fruits and vegetables attacked by this pest. The only biocontrol agents known to occur in the American Pacific are egg parasitoids, which are not able to bring this pest into economic control.

The purpose of this project is to introduce a larval parasitoid into the American Pacific from India. The following objectives outline the procedure: 1. Obtain an APHIS, USDA permit to bring in the parasitoid, *Euplectrus maternus*, from India to Guam, 2. collect this parasitoid in India and ship it to the Quarantine Laboratory on Guam, 3. rear this parasitoid and obtain a USDA permit to field release, 4. establish the parasitoid in the field, and 5. ship the parasitoid to Palau for field establishment.

Euplectrus maternus, is a larval ectoparasitoid of the fruit piercing moth that lays eggs on the dorsal anterior abdominal segments of the first, second and third instar larvae of the *O. fullonia*. The egg stage lasts for 2 days, larval stage 3 days and the pupal stage for 5 days. The parasitoid lays 1 to 2 eggs on the 1st instar, 3 to 5 on the 2nd instar and 6 to 10 on the 3rd instar larvae.

E. maternus has been collected in India and brought to Guam. It is being reared in the laboratory, and periodic field releases are being made. Field monitoring for establishment is also carried out.

ORNAMENTAL HORTICULTURE

James McConnell, Ph.D.
Associate Professor
mcconnel@uog.edu

Collection, evaluation and maintenance of tropical landscape germplasm

Hatch - October 1998 to September 2003

The purpose of this project is to collect plant material and evaluate it for use in the tropical landscape and to develop recommendations for the maintenance of landscape plantings.

Seeds and cuttings of plant material are being collected and evaluated for ease of propagation. In general, many of the woody species have not readily rooted even when treated with IBA. Seed germination has, overall, been the more successful approach. Several local terrestrial orchid species have been propagated asceptically by seed and currently are being transplanted from flask to community pots. These orchids have great potential for mass planting in the landscape.

A Web site was created featuring a collection of plants found in Guam. The current format is HTML. Acrobat pdf files are being created. These documents will be available on the University of Guam Web site and on a CD-ROM that is being distributed through a SARE grant.

Evaluation and propagation of native trees and shrubs in Guam

McIntire-Stennis - January 1996 to September 2000

Native trees and shrubs of the Mariana Islands have been important island resources for centuries. The plants were relied upon for food, as construction materials, tools and for medicine. Unfortunately, the natural habitats are being destroyed as development occurs in Guam. In addition to historical uses, many of these plants have potential value as landscape plants and they are well adapted to local environmental conditions.

This project was initiated to survey local plants for urban forestry, windbreaks, living fences and as specimen plants for the landscape. Plants with potential will be propagated by various means to determine the most efficient method of propagation.

Propagation studies were conducted on *Guamia, Cerbera, Ochrosia.* Propagation by stem cuttings was poor for *Cerbera* and *Ochrosia* and was unsuccessful for *Guamia.* However, all three species were easily propagated from seed. Other studies evaluated ways of growing *Elaeocarpus joga, Bikkia tetrandra* and *Pemphis acidula. Elaeocarpus joga* were planted into the field. It was found that wind protection is necessary for establishment. The use of *Casurina* as a companion plant windbreak is being evaluated. Both *Bikkia tetrandra* and *Pemphis acidula* can be grown successfully in crushed limestone aggregate. *Bikkia* can be grown from seed placed on limestone rocks with the roots penetrating into the rock.

Production of Heliconias in Guam and Hawaii

TSTAR - July 1998 to June 2001 - $161,041

In Guam there are several nurseries producing small quantities of heliconias. Heliconias are also attractive additions to the landscape. To increase production and market share, suitable cultivars must be identified. There are restrictions in both Guam and Hawaii on the importation of heliconias. To make sufficient quantities available in this region, tissue culture propagation methods must be developed. The purposes of this joint project with Hawaii are to identify cultivars with market potential that will grow under local environmental conditions, to increase the available plant materials and to recommend cultural methods.

Tissue culture methods reported earlier for *H. psittacorum* are being adapted for propagation of selected cultivars . Poor regeneration and contamination of cultures has been major problems to establishing successful cultures.

The shelf life of flowers harvested from established heliconia cultivars were tested in an air conditioned room (25° C). The stems of cut flowers were soaked in water for ten minutes and the base of the stem was cut before the stem was placed in water and solution with preservatives. The flowers were evaluated every other day for signs of senescence. Average vase life for the heliconia cultivars was found to be 14 days. Ants have been a problem during the vase life experiments. Ant populations especially infest the treatments containing floral preservatives.

Portable Extension Office for Program Literature Exchange (PEOPLE)

SARE 1998-2000 - $60,000

The overall goal of the PEOPLE Project is to expand the sustainable agriculture information resources available to the agriculture professionals and their clients in the islands of the Pacific. The project has four objectives: 1. to identify, obtain and disseminate literature, in digital format, developed by extension programs in the Pacific and Caribbean regions and the U.S. mainland, that relate to tropical sustainable agricultural issues and practices, 2. to increase the institutional capabilities to publish and disseminate information that is uniquely relevant to the region, 3. to develop staff skills at each of nine sites regarding the use of equipment, software and information resources to enable effective site-specific implementation of "print on demand" program literature exchange and 4. to determine the extent to which guide sheets and other forms of instructional media distributed throughout the region has a positive impact on the development of tropical sustainable agriculture in the region.

The project has produced a CD containing the digital fact sheets. It is now being distributed along with color printers and CD burners to participants in the region. Training has been conducted in Saipan and American Samoa. A revised version of the database is under development which will include more fact sheets and an improved user interface.

FRUIT SCIENCE

Thomas Marler, Ph.D.
Associate Professor
tmarler@uog.edu

Nursery practices to maximize early growth of papaya transplants in the field

Hatch - June 1998 to May 2002

Goals of the research effort: To determine the influence of copper root training in nursery flats on initial growth and establishment of papaya transplants in the field.

The influence of copper compounds on the walls of nursery flat cells exhibited a strong influence on root growth in the nursery, but did not influence stem or leaf growth. Following transplanting to the field, initial canopy growth was not influenced by nursery treatment. Following 6 months in the field, stem circumference and height were not affected by nursery treatment. Fruits were harvested and weighed, and root systems were excavated to determine the morphology of the nuclear root system. These response variables were not influenced by nursery treatments.

The use of copper compounds to control root growth in nursery containers has been used widely in nursery production of many crops. While copper treatments did improve root growth of papaya plants in the nursery, they had no lasting influence on plant growth and development in the field. The results indicate that there is no need to include these practices in nursery production of papaya transplants.

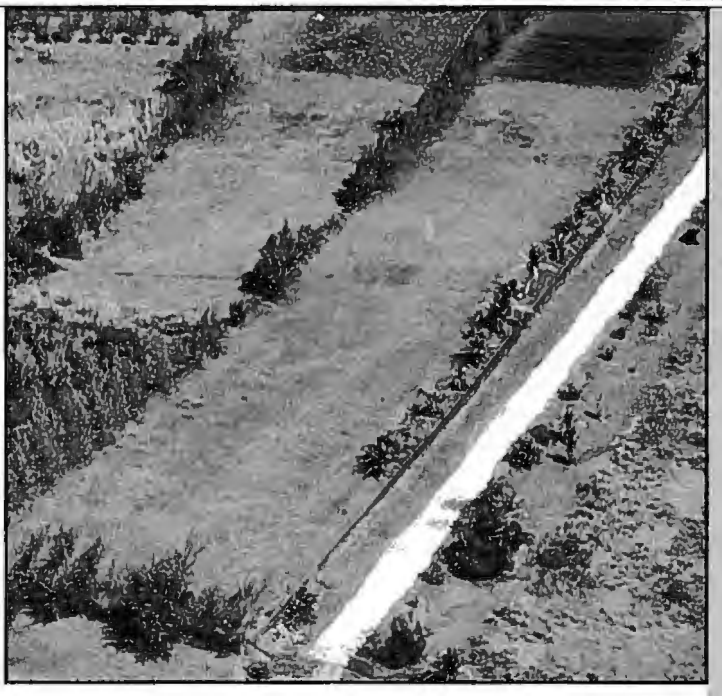
Regulation of photosynthetic processes

Regional Research - September 1997 to September 2002

Goals of the research effort: To identify the limitations on photosynthetic rates at the canopy level, and determine how developmental and physiological parameters may be deployed to optimize yields during times of environmental limitations.

We continued to study the influence of defoliation of papaya plants on subsequent recovery through analysis of non-structural carbohydrates in taproot, lateral structural root, and stem tissue. Papaya is a large, herbaceous plant with abundant non-woody storage tissue, and initial analysis indicated that the oldest plants demonstrated the greatest resistance to defoliation. Stem and taproot sucrose content declined within 2 weeks of defoliation and remained low while foliage was being replaced. Fructose and glucose content were more stable throughout the study. Net photosynthesis increased and remained elevated for about 80 days during the period of recovery.

Papaya is an important tropical crop, and is unique in that it is a giant perennial herb. Growth rates are rapid and plants are precocious. Thus, fruit production following planting is rapid



compared to most perennial crops. An understanding of the recovery dynamics following damage to foliage from tropical storms, insects, or disease is needed to make informed management decisions about whether to rogue and replant or to continue managing the damaged plants. When we have completed data collection and analysis, the results will aid in defining the role of carbohydrate reserves during recovery in relation to age of plant. Larger plants possess greater photosynthetic surface area and carbohydrate pool size, but also possess greater respiratory sink size.

Management systems for strawberry production in the Western Pacific

TSTAR - September 1997 to September 2000 - $99,937

Goals of the research effort: To develop strawberry production systems for the Western Pacific Islands.

Previous work in this project identified the northern soils of Guam as the most likely available agricultural soils for strawberry production. However, strawberry plant growth in these calcareous soils is inhibited by moderate to severe Fe chlorosis. The primary emphasis this year was to identify the reasons for Fe chlorosis, and differences among genotypes. We used an aeroponics system to produce the experimental units, then to supply nutrient solution devoid of Fe in order to induce Fe reductase activity in roots. We used five soybean lines with a known range in Fe chlorosis tolerance in the field as comparisons. Fe reductase activity was induced in less than five days on root tips of all strawberry cultivars. By day 21, Fe reductase activity of the cultivars did segregate, but the range (0.48 - 1.23 nmol Fe/mg/h) was minimal compared to the range among the soybeans (0.73 – 4.60 nmol Fe/mg/h). Furthermore, the Fe reductase activity of all strawberry cultivars was in the range of the least tolerant soybeans.

The results indicate that Fe reductase activity of the strawberry cultivars 'Camarosa', 'Chandler', 'Irvine', 'Oso Grande', 'Seascape', 'Selva', and 'Sweet Charlie' is about that of soybean lines known to be highly susceptible to Fe chlorosis. Frequent application of Fe chelate drenches will likely continue to be the only means of growing strawberries in calcareous soils. Since the range in reductase activity among these common California cultivars is minimal, future breeding efforts may require looking beyond current commercial cultivars for improved capacity for Fe reductase activity.

Most papaya plants are first grown in a nursery, then transplanted to the field or home garden as young seedlings. We are studying the influence of management in the nursery on performance after transplanting.

VEGETABLE AND ENVIRONMENTAL HORTICULTURE

Mari Marutani, Ph.D.
Associate Professor
marutani@uog.edu

Germplasm enhancement and improvement of supply of planting materials for vegetable improvement

Hatch - April 1997 to March 2002

The objectives of the project are: To evaluate new cultivars, hybrids and breeding lines of vegetables for adaptation to Guam; to evaluate 'local' vegetable cultivars as potential breeding materials; to evaluate the possibility of local seed production of some hybrids and open-pollinated cultivars to improve availability of planting materials for Guam; and to evaluate in-vitro propagation methods to improve availability of planting materials.

Fifteen sweet potato Ipomoea batatas accessions selected from previous trials are being evaluated during the 1999-2000 dry season (Dec-Apr.) in Guam cobbly clay soil (Lithic Usorthents). Plant characteristics in the evaluation have included growth habit, vigor, skin and flesh color of storage roots, and shape of storage roots. All accessions are showing micro-nutrient deficiency symptoms because of high pH of the soil. Sweet potato weevil Cylasformicarius has been a major pest. Two local cassava plants Manihot esculenta were collected and are maintained at Ija Experiment Station. New accessions of green vegetable soybean (Glycine max) were also obtained from the Asian Vegetable Research Development Center (AVRDC) for upcoming field evaluation during this dry season.

Collection of local cassava varieties will assist preservation of indigenous germplasm. These plants will be field-evaluated in future trials for their profitability. Selection and introduction of new sweet potato and green vegetable soybean accessions suitable to Guam will help expand the local production of these vegetable crops.

Establishment of *Musa* spp. as a living fire break on Guam grasslands

McIntire-Stennis - September 1998 to September 2002

Goals of the project are: To produce plantlets of dwarf Brazilian banana (*Musa* spp.) in *in-vitro* culture; to examine plant development and establishment of dwarf Brazilian banana in grasslands as a living firebreak; and to study pest and disease problems with this cultivar planted in the grasslands on Guam.

Forty-two offshoots of dwarf Brazilian banana *Musa* spp. were planted on July 9, 16, 23, and an additional three were planted on Aug. 6, 1999, at Ija Experimental Station in Akina clay soil

(very fine, kaolinitic, isohyperthermic Oxic Haplustalfs, pH=5.5). The planting sites were prepared by digging holes to a depth of 30 cm. Transplants were trimmed to have three leaves to reduce water loss and were planted in a single row with the distance between plants of 2.4 m. Three tablets (21g/tablet) of a complete fertilizer (20-10-15) were placed in soils prior to planting. Plants were irrigated by a drip irrigation system. The initial height of offshoots ranged from 60 cm to 150 cm. On Oct. 28, twelve plantlets derived from tissue culture were planted in the second row 1.2 m apart from the first row, and an additional 24 plantlets were planted on December 28.

Plant growth was monitored monthly after the initial planting date by measuring plant height, stem diameter at 15 cm above the ground, the number of new shoots and plant vigor. During September, no growth was observed, due possibly to insufficient water, insect damage, and disturbance by wild animals. Having the irrigation system repaired, plants recovered and grew well until human activity (wildlife poachers) damaged about 38% of the plants in December 1999. In March 2000, the height increase ranged from 24 cm to 53 cm for offshoots, and from 19 cm to 24 cm for the tissue-culture derived plants. More than 50 % of the offshoots had started to form mats, while no new shoots were yet produced from any tissue-culture derived plants.

The preliminary result of the project showed that dwarf Brazilian banana established well in acidic Akina clay soil on Guam. In spite of disturbance by human activity and wild animals and pressure by pests, plants recovered quickly with some producing mats. Further evaluation of plant survival and growth under various environmental stresses such as fire, flood and biotic pressures will determine the potential of dwarf Brazilian banana as a windbreak and firebreak plant in the farm system and grasslands on the island.

Market study and cultivar selection of processed root crops in Guam

TSTAR - September 1998 to September 2002 - $125,000

Objectives of the study are: To identify potential value-added products of sweet potato and taro for Guam; to evaluate field performance of sweet potato and taro germplasm suitable for selected processed produce; and to conduct a consumer preference survey on selected processed sweet potato and taro products in Guam.

Value-added products of sweet potato and taro were surveyed by reviewing information on the Internet and by conducting a survey of the products at local stores. The survey methods included telephone interviews and visits to various vendors. A manufacturer of taro chips in Hawaii was interviewed by telephone. The most popular form of processed sweet potato and taro sold on Guam was chips. Value-added products of root crops available elsewhere were summarized.

A concept test was conducted to determine preferred types of processed sweet potato, taro, cassava and yam products by consumers on Guam. Nearly 300 consumers participated in this survey. Survey data are being analyzed and the summary of data will be presented in a local extension newsletter.

More than 30 varieties of taro and 15 germlines of sweet potato were deposited and recorded as accessions in the Vegetable Horticulture Program of the University of Guam. These plants are being propagated for field evaluations.

Plant and residue parameters for selected tropical crops

NRCS, RUSLE - June 1998 to September 2001 - $98,900

The main objective of the study is to collect plant growth and residue parameters of selected vegetable crops commonly grown on Guam and weeds which are often plowed under prior to plant cultivation. Data will be used in erosion prediction models (RUSLE) by NRCS personnel.

Tested plants have included petsai, *Brassica rapa L.* var. *chinensis* L (Brassicaceae), eggplant, *Solanum melongena* L (Solanaceae), cassava, *Manihot esculenta* Crantz (Euphorbiaceae) and common weeds found in farmlands. Data will be used in erosion prediction models (RUSLE) produced by USDA-Natural Resources Conservation Service to predict influence of plant residue in soil environments of tropical farms. Specific objectives for each plant examined in this study include: to record the history of land use and cropping system of the field; to record cropping system and cultural practices applied to the field; to collect plant growth data; and to collect plant residue decomposition data.

Evaluation and implementation of nitrogen fixing species in hedgerow inter-cropping in the Marianas

Western Regional SARE - August 1999 to August 2001 - $132,100

The goal of the project is to promote hedgerow intercropping as a management of a sustainable agriculture program on tropical islands in the Western Pacific.

Hedgerow inter-cropping is a recommended farming system in the agroforestry program for Pacific islands. Hedgerow inter-cropping enhances productivity of limited farm lands by providing for nutrient cycling from deeper soil layers, green manuring, and mulch benefit. Hedgerows also increase weed suppression, create barriers for disease and pest spread, control soil erosion, and supply biologically fixed nitrogen in the farming system. Additional benefits include the use of these trees and shrubs as animal feeds and lumber. During the initial stage of the project, seeds of *Cajanus cajan, Calliandra calothyrsus, Desmodium rensonii, Flamingia macrophylla, Gliricidia sepium, Leucaena leucocephala* and *Sesbania sesban* var. nubica were sown in potting mix, and seedlings were transplanted at three sites with different soil regimes to compare field adaptation and biomass production of plants. Currently plant development is being monitored.

Guam's FY 1999 CSREES NAPIAP program

NAPIAP - February 1999 to January 2000 - $5,800

The objective of the project is to determine an effect of irrigation systems on insecticide residue on a tropical leafy vegetable, using the Enzyme Linked Immunosorbent assay (ELISA).

The carbaryl residue on pakchoi *Brassica* rapa was examined by commercial ELISA (Enzyme Linked Immuno Sorbent Assay) kits. *B. rapa* cv. Gracious was grown under two different irrigation systems - overhead watering and watering at the base of the plant. The recommended concentration of carbaryl, Sevin 80S (13.2 g/L), was applied on plants with and without spreader, Latron B-1956. The experiment was arranged in a randomized complete block design with two treatment factors in split plots. The irrigation system was the main plot and use of spreader was the sub-plot. Prior to the pesticide application, all plants were protected from rain by setting up hoops and polyethylene cover. Four fully expanded leaves from each sub-plot were collected immediately after spraying to determine the initial amount of carbaryl. Samples were also collected after 2, 4, 6, and 8 days from the date of pesticide application.

More carbaryl residue was detected on plants that received irrigation water at the base of plant and the pesticide application with an additive of spreader. The fastest breakdown of the pesticide was observed from the plant tissues that received overhead watering and the pesticide without the spreader. Both the irrigation method and use of spreader influenced the amount of carbaryl residue on pakchoi plants.

Recovery of an endangered species in the Mariana Islands, *Serianthes nelsonii* Merr. (Fabaceae)

USAF - March 1998 to March 2000 - $18,065

Serianthes nelsonii Merrill is a large endemic leguminous tree grown in native limestone forest in the Mariana Islands. It has been designated an endangered species by the U.S. Fish and Wildlife Service. In 1992, the population of adult trees was 121 on the island of Rota. In 1999, only one mature tree existed on Guam. It is thought that the plant decline is caused by browsing by introduced animals, infestation of arthropods and other pests, and environmental disturbance by seasonal storms as well as human activities.

The project was initiated to meet goals of the Recovery Plan for *Serianthes nelsonii* prepared by U.S. Fish and Wildlife Service in February 1994. The primary objective was propagation of seedlings to re-establish a plant population on Guam. The secondary objective was to monitor the existing mature tree in native forest at Ritidian Point and other saplings growing at Northwest Field and near the Guam National Wildlife Refuge. Growth rate of new seedlings near the mother tree was also monitored to understand the plant development of S. nelsonii grown in limestone soils on Guam. During the survey, pest-infested seedlings were documented. Tissue culture of the plant was being attempted. Public awareness of this endangered species was promoted by discussion about the recovery of plant populations at meetings and in classrooms, and also by preparing a fact-sheet.

TURF SCIENCES

Greg Wiecko, Ph.D.
Associate Professor
gwiecko@uog.edu

Management and adaptation of selected warm season turfgrasses in the Western Pacific region

Hatch - January 1995 to September 2000

In 1999, activities of this project concentrated on growth regulator applications in weed control.
Optimal management practices that result in increased turf density also reduce infestation with weeds. In addition to natural management practices such as fertilization, mowing and watering, an increase in turfgrass density can be achieved by the use of trinexapac-ethyl growth regulator.

Two studies were conducted, one each during the dry and rainy seasons, with trinexapac-ethyl applied at 0.1, 0.2, and 0.4 kg/ha on a mature stand of weed free 'Tifgreen' bermudagrass under an intensive management regime. All treated plots and control plots were seeded with crabgrass (*Digitaria* spp.) two days after the trinexapac-ethyl application. There were significant differences between treatments within both dry and rainy seasons, and also substantial differences between seasons despite adequately applied supplemental irrigation. Application of trinexapac-ethyl at 0.1 kg/ha was the most beneficial. Application rates at 0.2 and 0.4 kg/ha caused moderate turf injury. However, within 3 to 4 weeks, the turf recovered and became denser than the control. In all instances, denser turf effectively prevented infestation with crabgrass.

Development of a herbicide program for crabgrass and goosegrass control in recreational turf in Guam

TSTAR - July 1996 to June 2000 - $120,000

The objectives of this project are: 1. to determine the efficacy of PRE and POST emergent herbicides on crabgrass and goosegrass control, the longevity of the control, and turfgrass tolerance of the herbicides, 2. to determine the efficacy of sequential PRE and POST herbicides for consistent control over one year period, and 3. to develop a weed control program that uses POST herbicides followed by reduced PRE and POST herbicide rates to maintain effective control.

Crabgrass, *Digitaria* spp. and goosegrass, *Eleusine indica* L.) are considered the most problematic weeds in recreational turf. Herbicide programs for crabgrass and goosegrass control were mostly developed for temperate climates where both weeds are known as summer annuals. Their control usually starts with pre-emergence (PRE) herbicides applied after matured weeds have been eliminated from turf by cold winter temperatures. Since, in the tropical climate, crabgrass and goosegrass seeds are constantly produced, multiple herbicide applications are required to maintain control. The 12-month growing season requires larger quantities of applied herbicides, and the total rate often exceeds the maximum allowed per year, especially for PRE herbicides.

In this project, it was found that sequential applications of reduced rates of pre-emergence and post-emergence herbicides applied at different dates effectively controlled crabgrass and goosegrass. Reduced rate of pre-emergence prodiamine, pendimethalin or oryzalin followed by a full rate of post-emergence MSMA controlled crabgrass as effectively as did the pre-emergence herbicides applied at normal rates. Goosegrass control was satisfactory when post-emergence MSMA was supplemented with metribuzin. Tank-mixes of pre-emergence and post-emergence herbicides applied in a single application controlled crabgrass better than goosegrass. Crabgrass control was satisfactory when reduced rates of either pendimethalin or dithiopyr were mixed with a full rate of MSMA.

Based on well documented research and years of experience from temperate climate, it was expected that different PRE herbicides would perform differently with regard to their efficacy (percent of weed control) and longevity (time of degradation in the soil). Collected data have proven that, in the tropics, application timing, time interval between POST and PRE, and the magnitude of initial infestation played a more powerful role than the type of herbicide. In a tropical climate, constantly moist soil surface and adequate light striking the surface seemed to be triggering factors for seed germination rather than the sudden rise of soil temperature that typically triggers seed germination in temperate climates.

It was found that wet season weed control programs in bermudagrass should start with an application of POST herbicide. MSMA for crabgrass and MSMA + metribuzin for goosegrass were proven the most effective. Applied POST effectively controlled existing weeds and caused some temporary injury to bermudagrass. As a result, turf became "wide open" for the light to penetrate and reach the soil surface. When the soil surface was constantly moist, weed seeds that were previously dormant because of inadequate light began to germinate on a massive scale.

These favorable weed germination conditions lasted 2-3 weeks, until bermudagrass recovered from injury, resumed an intensive growth, shaded the soil, and became competitive to weeds. If within the first 2-3 weeks PRE herbicide was present in the soil at adequate concentration, it could effectively control germinating seedlings. Based on the data collected for the following 5 months, it was evident that the vast majority of seeds germinated at that time (early herbicide application) and resulted in fewer weeds later.

In the dry season, POST herbicides acted very similarly as in the rainy season. Open turf allowed for light penetration but seed germination was highly reduced. Dry wind and infrequent rainfall or an irrigation event resulted in a soil surface that was moist only occasionally. Even when soil moisture was adequate and available for the roots, a thin layer of organic matter on the surface made it too dry to allow for massive seed germination. As a result, germinating time was substantially longer, and not all viable seeds could germinate. Even when PRE herbicides were present in soil at adequate concentration, they could control less of the germinating weeds. Efficacy of PRE herbicides could be also reduced because their active ingredients are water soluble, and in dry conditions their soil translocation was slower. Consequently, when a weed control program started with POST in the dry season, it had to be followed by multiple application (every 6-8 weeks) of PRE herbicides at full application rate. When a program started in the rainy season, one full rate of POST followed by one full rate of PRE assured excellent control for many months.

Severe drought (El Nino) in 1998 and the resignation of the research assistant who was responsible for maintenance of the research plots and data collection, resulted in the delay of scheduled experiments. In 1999 experiments on turf research plots were resumed, and all field experiments were completed.

Effects of ocean water on weed control in recreational turf in the Pacific Islands

TSTAR - September 1999 to September 2001 - $83,000

The research conducted was designed to minimize pesticide usage and lessen environmental impact by applying readily available ocean water to control weeds in turfgrasses. Sensitivity to ocean water of several tropical weeds including crabgrass *Digitaria* spp., mimosa *Mimosa pudica* L.,DC., purple nutsedge *Cyperus rotundus* L., yellow nutsedge *Cyperus esculentus* L. and one-leaf clover *Alysicarpus vaginalis* L DC was evaluated. Concurrently, the salinity tolerance of hybrid bermudagrass *Cynodon dactylon* x *C. transvaalensis* Burtt-Davy), seashore paspalumgrass *Paspalum vaginatum* Swartz., zoysiagrass *Zoysia japonica*, and St. Augustinegrass *Stenotaphrum secundatum* was evaluated. Three different salinity levels (19 dS m-1 , 37 dS m-1 , and 55 dS m-1) and 2 salt-stress durations (3 and 6 days) were tested. The first of two studies was conducted outside, under a rain-shelter (polyethylene film), on the main University of Guam campus. Preliminary results indicate that mimosa showed severe yellowing within one day and complete necrosis after 3 days of watering at 55 dSm-1 and 37 dSm-1. Crabgrass was less sensitive. However signs of pronounced necrosis were noticeable after 5 days. One leaf clover and both types of nutsedge were the least sensitive. No treatments severely injured seashore paspalumgrass or bermudagrass; in all instances, they recovered from the injuries. The primary results indicate that ocean water can be used as an alternative to herbicides in turfgrass management. The effect of ocean water on weed control will be studied under field conditions in the year 2000.

PLANT PATHOLOGY

George C. Wall, Ph.D.
Professor
gwall@uog.edu

Uniform taro variety trials - Guam component

ADAP - May 1997 to - August 1999 - $50,000

This project was a part of a uniform taro variety trial on the islands of Hawaii, Guam and American Samoa. A set of regional taro cultivars were carefully selected and included: 1. those that were found to have resistance to taro leaf blight in previous screenhouse tests on Guam, 2. those that were found resistant in a previous field trial on the island of Hawaii, plus 3. a susceptible control and 4. a local cultivar.

Unfortunately, the resistant materials from a field trial in Hawaii, mostly originating from Palau, were not made available to Guam. Two of these Palauan cultivars were obtained indirectly from the island of Kauai (P-10 and P-20). However they were received when our in-vitro propagation of the other cultivars was already halfway completed.

The pre-selected cultivars were propagated by tissue culture at the University of Guam and distributed to the other sites. We report here on the Uniform Taro Trial planted at Radio Barrigada Experiment Station, Guam.

Because of imposed timetables tied to the funding for this work, and because of delays in funding, tissue culture propagation was started a few months late. This led to the field plots not being planted in accordance with the traditional growing season, and consequently the harvest also had to occur off-season (last week of June 99) after the rains had already begun. Since infection by taro leaf blight did not appear by way of natural inoculum, it was provided artificially by introducing infected, potted taro plants in between the rows.

The experiment plot consisted of 11 cultivars, with 3 replications. Out of the 11 cultivars, 3 were not harvested (P-10, P20, and Gilin). These were planted later than the rest and were not ready for harvest. The following data pertain to the remaining 8 cultivars, namely: Ol, Pwetepwet, Sushi, Oglang, Kugfel, Pasdora, Visaya, and Niue.

Data collected included plant height, number of leaves per plant, leaf area, percent taro leaf blight, number of corms, corm weight, number of rotted corms, and marketable yield. Statistical differences were found only with respect to incidence of taro leaf blight. This is most likely because the epidemic did not take off until near harvest when the rainy season started. Thus, the disease occurred late in the experiment and had no detectable effect on yield.

In summary, our results prove conclusively that we have taro cultivars in our region with resistance to Guam's taro leaf blight strains. Empirical observations of these cultivars in farmers' plots on their islands of origin indicate that they are resistant to local strains. Results from other sites in the variety trials will tell us if the resistance is generally applicable..

In our previous work, it was observed that certain cultivars had fewer aphid counts than others. Aphid population development was monitored in the taro plots. We believe certain taro cultivars actually retard aphid reproduction somehow. The mean number of offspring per female varied according to the taro cultivar on which they were feeding

The trial continues in the field, in spite of ADAP funding terminating. A second year of data is essential, and further trials should more thoroughly test the yield parameters of these cultivars. We hope future testing will give us an opportunity to study the relationship between taro leaf blight and yield.

Coconut tinangaja: Its geographic distribution, dissemination and resistance

TSTAR - July 1996 to August 2000 -$106,000

A survey of the Mariana Islands was undertaken in 1998. The islands of Pagan, Alamagan, Anatahan, and Saipan were visited. Samples collected there were analyzed by molecular hybridization assay (MHA), using two separate oligonucleotide probes specific for CTiVd, the Tinangaja viroid. A few samples from the island of Anatahan gave a positive reaction, indicating the presence of sequences identical or very similar to CTiVd.

One month old coconut seedlings were bombarded with nucleic acid extracts from Tinangaja-diseased palms. Four months later they tested weakly positive in MHA. The seedlings are still under observation. Pollen from diseased trees was collected and purified, then analyzed also by MHA, and found weakly positive for CTiVd. Coconut red scale insects were collected from diseased nuts, and found to contain CTiVd as well.

Samples collected island-wide over Guam, and analyzed by agarose gel electrophoresis or MHA or both, revealed the occurrence of tinangaja on all types of coconut cultivars. At this time, there is no evidence to indicate that any particular cultivar is resistant to this disease.

Seed transmission experiments are still under way. Two hundred nuts from healthy trees were planted in Ija Experiment Station. Nuts from diseased trees have also been planted at the same location, but their numbers still do not add to 200, because diseased trees only produce nuts for a short time. It is hoped that the question of seed transmission of the disease will be elucidated by this study, which is still ongoing.

Study of coconut tinangaja and possible modes of transmission

TSTAR - September 1999 to September 2002 - $116,644

Coconut is one of the predominant tree species on Guam. Indeed, the coconut tree is a visible symbol of a tropical tourist destination. Tinangaja, a viroid infection, represents a serious threat to the coconut trees of the Mariana Islands. The objectives of this study are: 1. to determine if tinangaja is transmitted by pollen, seed or insects, 2. to study ways of managing infected trees to minimize the likelihood of spread, and 3. to develop control techniques aimed at reducing the spread of tinangaja and preventing the reduction of the coconut population of Guam.

In the first few months of the project, an assay of the coconut plots at the Ija experimental farm was completed for the presence of Coconut Tinangaja Viroid (CtiVd), the causal agent for the disease. Leaf samples were collected from the "healthy plot" and the "sick plot" at Ija where we have 200 coconut seedlings that originated from trees that were identified as either infected or healthy, and planted in 1997. Incidence of the disease is being monitored. The experiment continues.

Micro-propagation of local banana cultivars

USDA Special needs - August 1998 to August 2000 - $15,000

Typhoon Paka devastated most of the banana fields on Guam, and other storms have done the same in the past. Local banana producers have to rehabilitate their fields using propagative material from existing mats each time their fields are ruined. The use of propagative materials from existing fields can introduce a number of diseases such as banana bunchy top, Panama wilt, and nematodes into the field from the onset.

This project is designed to develop a rapid and reliable in vitro system for the propagation of clean banana stock, and then transfer the system to a public or private enterprise.

A collection of local favorite banana cultivars, including Manila and Macao, has been made, and tissue culture experiments are under way. The initial experiments have been successful, and the work on the rapid propagation of these cultivars is promising.

Future work will focus on introduction and propagation of cultivars from the South Pacific Community's tissue culture facility in Fiji that are resistant to banana leaf streak, on field trials of the tissue cultured cultivars, and on holding workshops to introduce the tissue culture technology and cultivars to the public.

SOIL SCIENCE

Vacant since March 1999 -
Greg Wiecko, Ph.D. is the acting soils program manager.

Developing plant nutrient recommendations for soils on Guam

Hatch - August 1995 to March 1999

The soils of Guam support a wide range of agricultural and recreational activities, including farming, ornamental nursery operations, golf courses and home gardens. Despite widespread use of fertilizers, nutrient deficiencies often occur in economically important horticultural crops. These nutrient deficiencies are often the result of poor nutrient management under the tropical climatic conditions that occur on Guam. In addition, there are public concerns about the possibility of plant nutrient mismanagement leading to the contamination of the northern Guam aquifer.

This project has led to the development of a computerized nutrient recommendation program named the Nutrient Recommendation and Reporting System (NRRS Vers. 1.0). NRRS consists of a database program linked to a Web page. The Web page includes a search engine for cross-platform access to soil and plant sample testing results and links to an automated nutrient recommendation engine. Nutrient recommendations used by the NRRS are based on soil P and liming buffer coefficients for Guam as determined in the laboratory for this project.

Chemistry and bio-availability of waste constituents in soils

Regional Research - October 1994 to September 1999

Poultry manure and office paper are two problematic organic waste materials that have the potential to be combined to form a soil amendment that improves both the nutrient content and structure of the local soils. The objective of this project is to determine the chemistry of nutrients in these organic wastes and the bioavailability and mobility of the nutrients under a soil-applied compost disposal regime.

Two field experiments planted in sweet corn were conducted to cover both the wet and dry seasons. Nitrate leaching was monitored using suction lysimeters and periodic soil analysis.

The nitrate-nitrogen leaching patterns observed during the wet and dry seasons of the field experiments indicate that the critical time for nitrate-nitrogen leaching is immediately after planting and fertilizer application. Crop uptake appeared to be sufficient during the latter stages of growth to minimize losses even at the highest rate of N fertilizer application. The data indicate that paper application does reduce nitrate-nitrogen leaching losses even under heavy rainfall, but with no apparent advantages to crop growth.

We suggest that the use of this material may be more appropriate as a soil amendment in the case of high rates of N fertilization, in the transition period after the conversion of forest land to agricultural use, or when crop failure occurs.

Protection of water quality using tropical rock/plant filters and nutrient recycling irrigation systems

NRCS, EQIP - January 1998 to September 2000 - $31,605

The animal wastes produced by confined swine culture can be a significant source of environmental contamination. The wastes can contaminate surface and subsurface water supplies with both excess plant nutrients and pathogenic agents.

The Agricultural Experiment Station has entered into a joint development project with the Natural Resources Conservation Service using funds provided by the Guam Environmental Protection Agency to protect the local water supplies from these pollutants. The objectives of this project are: 1. to increase public awareness of animal waste pollution issues, 2. to engineer a technically sound and culturally appropriate rock/plant filter system for pollution prevention and 3. to install and monitor three demonstration projects using rock/plant filters and one irrigation-based nutrient recycling system.

Engineering designs and contracts are completed. Construction is scheduled for early 2000.

APPENDIX 1:

BUDGET

New funds received in fiscal year 1999

Station operation and base research funding:

Hatch formula funds	$699,596
Government of Guam	$858,966
Sub-Total	**$1,558,562**

Directed research grants:

Multi-state projects	$121,496
McIntire-Stennis forestry	$37,160
Tropical and Subtropical Agricultural Research	$260,243
Western Regional Sustainable Agriculture	$253,950
NAPIAP	$5,800
Sub-total	**$678,649**
Total funding for FY-1999:	**$2,237,211**

APPENDIX 2

PUBLICATIONS

Research/Extension Contribution of AES Faculty (1993-1999)

Publications in Books and Peer Reviewed Journals:

Abawi, F.G. and O.H. Diambra (1997). Enzyme and amino acid supplementation of leucaena leaf meal-based diet for broiler chicks. *Micronesica*, 30:429-434.

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Clemente, H.S. and T.E. Marler (1996). Drought stress influences gas-exchange responses of papaya leaves to rapid light transition. *J. Amer. Soc. Hort. Sci,*. 121:292-295.

Couillard, A. and G. Wiecko (1998). A saline solution: seawater as a selective herbicide. *Golf Course Mgmt.* 66:54-57.

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Design and layout by A.J. Rosario
Typing assistance by M. Johnston
Printing by Star Press General Printers

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Experiment Stations

1 - Barrigada

2 - Yigo

3 - Inarajan

4 - Ija