Caribbean Basin Administrative Group

TROPICAL & SUBTROPICAL AGRICULTURE

Research notes Summer

Pacific Basin Administrative Group

COMPUTER SYSTEMS FOR ENHANCING AGRICULTURAL DECISION MAKING IN THE CARIBBEAN

F.H. Beinroth & J.W. Jones

Breakthroughs in information science and technology - prompting visions of an "information superhighway" - are beginning to have profound impact in all walks of life. Among other ramifications, these advances have significantly increased our ability to generate, manipulate, utilize, and display environmental and agricultural data. The new tools and techniques now available include database management systems, simulation models, rule-based systems, remote sensing and image processing, and geographic information systems.

While many sectors and industries have been quick to exploit the new technologies, agriculture has been slow to do so. Nevertheless, agricultural systems research is now gaining momentum and crop modeling in particular has become a respectable scientific endeavor and is progressing rapidly. Crop models, however, are site-and-season specific whereas agriculture occurs in time and space. To address this predicament, CBAG funded a joint project at the Universities of Florida and Puerto Rico.

The principal product of this pioneer effort was AEGIS, the Agricultural and Environmental Geographic Information System. AEGIS is the prototype of a system that

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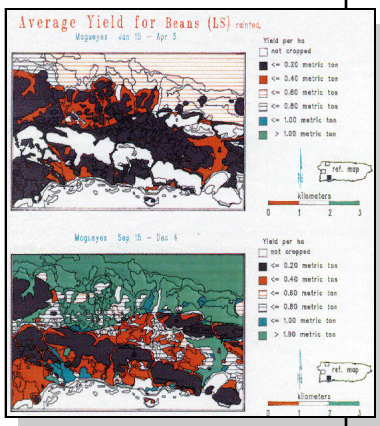

Atypical database printout.

BIOLOGICAL CONTROL OF EXOTIC WEEDS OF THE PACIFIC BASIN WITH PLANT PATHOGENS

Eduardo E. Trujillo

A tropical American shrub producing edible blue berries, *Clidemia hirta*, commonly known as "Koster's Curse", was introduced to Hawaii in 1941. Hawaii's fruit-eating birds favor the edible blue berries spreading the seeds resulting in the explosive spread of this plant to pest status in the forests of Hawaii. "Banana poka", *Passiflora tripartita* (Juss.) Poir var. *tripartita* Holm-Nie. Jorg. & Laws. [= *Passiflora mol - lissima* Neal], another weedy pest was first introduced into Hawaii in 1921 as an ornamental. This perennial woody vine with attractive pink, pendulous flowers, and oblong bright yellow fruit is native to the southern Colombia and northern Ecuador Andean region of South America. The fruit resembles a ripe banana, thus, its Hawaiian name banana poka. In Hawaii it has become established at mid to high elevations, 800-2200m, on the islands of Hawaii, Kauai, and Maui. Banana poka is the most aggressive introduced weed of high elevation in forest areas in Hawaii. In 1981 it was estimated to cover more than 500km2 of Kauai and Hawaii forests. Banana poka was classified as a noxious weed in 1979 by the Hawaii Department of Agriculture. The search for, evaluation and development of plant pathogens is leading to methods of controlling these pests. In the case of Koster's Curse a biological control program was initiated in 1953 by the Hawaii Department of Agriculture (DOA) because several control methods utilized in the past such as mechanical or chemical control were not able to stop its

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CONTROL OF PALM WEEVILS, RHYNCHOPHORUS SPP. AND RED RING WITH SEMIOCHEMICAL ATTRACTANTS

Robin M. Giblin-Davis

The coconut palm, *Cocos nucifera*, a multiple-use plant, is aesthetically pleasing as an ornamental in many areas as well as a source of food, oil, shade, fiber and a cash crop (water nuts) in the Caribbean, Mexico and Central and South America. It is considered one of twenty crops that stand between people and starvation in the Third World. CBAG research has been focused on several damaging palm and sugarcane weevils including those which not only damage but also vector a nematode, *Bursaphelenchus cocophilus* (a microscopic roundworm), causing a lethal disease of palms called red ring. The name, red ring, comes from the anthocyanin-rich red ring which forms inside the trunk of diseased palms and harbors millions of the nematodes. Palm weevils can spread the nematodes from diseased to healthy palms. Red ring kills palms in about 3 months. Estimated losses of 10 to 15% of young coconut and both young and established African oil palm have been reported. Red ring disease does not yet occur in the United States. The disease's proximity to Florida and Texas (less than 250 air miles away in Mexico) and the occurrence of the red ring vectors (*Rhynchophorus* and *Metamasius* weevils) in Florida and Texas represent a potential threat to ornamental palms in the United States.

CBAG support has assisted in research which has significantly impacted palm and sugarcane weevil (*Rhynochophorus* spp. and *Metamasius* spp.) management in Florida and the development of new mass trapping strategies for red ring management. On arriving at a host plant, male palm and sugarcane weevils produce chemicals (called aggregation pheromones) which attract other weevils (both males and females) of the same species to the location. Volatile chemicals produced by the host plant actually synergize the attractiveness of the aggregation pheromones. In this way, large numbers of weevils aggregate on the host plant for mating and overwhelm the natural defenses of the plant.

The aggregation pheromones and most of the host plant volatiles which synergize the pheromones have been identified. The aggregation pheromones can now be synthesized inexpensively which has led to new mass trapping techniques. New lethal traps containing sugarcane and aggregation pheromones are greater than ten times more effective in capturing weevils than traps without the pheromones. Experiments by collaborators have demonstrated that mass trapping of palm and sugarcane weevils in an African oil palm plantation in Costa Rica significantly reduced weevil populations and red ring disease in less than 1 year of trapping at 1 trap per hectare. The use of lethal traps containing sugarcane and pheromones is fast becoming a cost effective and environmentally safe method of weevil and red ring disease management. The same methodology can be used for inexpensive monitor stations which can be used by regulatory personnel to detect nematode contaminated foreign palm weevils. This should lessen the chances for the introduction of the red ring nematode into the U.S. palm weevil population. Preventing the introduction of nematodes is of great value to homeowners, landscapers and ornamental palm producers, as well as to Florida and the nation.■

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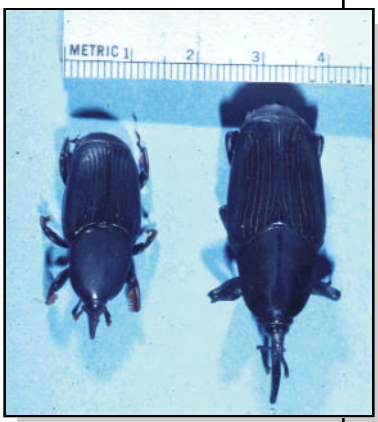
Red Ring diseased coconut palm in Costa Rica.

Cross section through Red Ring-diseased Trinidad coconut palm.



Rhynchophorus ***spp. Palm Weevils.***

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combines spatial soil, weather, and landuse databases; a crop simulation model; a simple expert system; a soil erosion model; a relational database management system; and a geographical information system. AEGIS also provides a linkage to the widely acclaimed Decision Support System for Agrotechnology Transfer (DSSAT) developed by the International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT) project. The prototype system can predict crop yields and soil loss, estimate resource requirements for alternative agricultural strategies, and assess the long-term consequences of agricultural practices.

An example of AEGIS output is illustrated on maps of bean yields for two growing seasons in an area of southern Puerto Rico. The maps show the effect of planting date on yields. The simulated yield levels and the yield differences between the dry and rainy seasons conform to the yields obtained in actual practice.

AEGIS has received wide exposure at national and international professional meetings as well as international publicity through AGROTECHNOLOGY TRANSFER, the newsletter of the IBSAT project that has a circulation of 4,000. The response triggered the development of a computer presentation on diskette that has been made available upon request. The positive reaction precipitated the subsequent development of a generic version by scientists at the University of Florida.

IFDC, the International Fertilizer Development Center, has adopted the generic version of AEGIS for their work in many developing countries abroad. In another application, AEGIS was used in a project sponsored by the South Florida Water Management District to assess nutrient import into Lake Okeechobee in southern Florida. The Universities of Florida and Georgia are working together to apply AEGIS to study the possible effect of climate change on crop production in a project supported by the Southeast Region Climate Center. And a case study based on AEGIS concepts and methodology is now in progress that evaluates landuse strategies that provide sustainable and economically viable alternatives to sugarcane production in southern Puerto Rico.

The impact of the CBAG project that produced AEGIS has thus been remarkable, but it has occurred at the scientific rather than the operational level. This is expected to change, however, once the prototype system has been validated through case studies and made more user-friendly. It must also be mentioned that the wide use of AEGIS will likely be hampered by inadequate and non-digital soil and climate databases. This fact underscores the need for natural resource inventories and their availability in digit.

As it is becoming evident that the notion of sustainable agriculture is no longer just an option but an imperative, the need for technologies and techniques that contribute to attaining this goal in a

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PEACH PALM - A NEW CROP FOR HAWAII

Richard M. Manshardt

Hawaiian agriculture is in a state of flux. The production of sugar and pineapple, both mainstays of local agriculture, is contracting rapidly due to competition from foreign producers, while diversified agriculture is expanding. Development in both sectors is limited by high costs of land, labor, inputs and transportation and a relatively small local market. Diversified agriculture is relatively more successful than sugar and pineapple production because it deals principally with high unit-value products. There is a need to identify, study and develop new crops that will fit into diversified agriculture production.

In 1990, a new candidate crop was identified for production in the diversified agriculture sector and PBAG support was obtained to evaluate it. The candidate was the peach palm, a native of the Amazonian region of South America. It was domesticated by the native peoples there as a starchy, staple fruit crop. The fruit of the peach palm was also fermented to make beer.
In Hawaii, however, the peach palm is being developed not as a staple or for beer, but rather the use of its heart and stem.

The heart of palm is a gourmet vegetable composed of the tender leaves just above the palm's growing point. At Honolulu supermarkets, canned hearts of palm, from Brazil, Costa Rica and other Latin American countries, retail for $7 per pound. One might ask, if they are available in the supermarket, why plant them in Hawaii? There are several answers. Canned hearts are inferior in quality to fresh hearts. Fresh hearts should command an even higher price on the market than canned ones. Diversified agriculture in Hawaii needs additional high unit-value crops.

In most of its range, the

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peach palm has long, sharp spines on the stem and leaves to protect it from mammalian predators. The first priority of research project was to introduce spineless types from Brazil, Costa Rica and Peru. Samples of spineless types were planted in three areas representative of Hawaii's major agricultural zones. Most of the types adapted well and some reached harvest size within 18 months after planting. Since time to harvest was similar to that in Latin America, the peach palm is considered well adapted to Hawaii. The yield, about 1,200 pounds per acre, is also similar to that in Latin America and can certainly be increased by selecting the best of the introduced types.

As harvest proceeded, samples were taken directly from the field to selected upscale restaurants on the Big Island of Hawaii and in Honolulu. All the chefs who received samples wanted to buy it in quantity immediately and they would be willing to pay a premium over the price of the canned product. Their customers have enjoyed the crispy texture and delicate flavor of the fresh heart of palm, skillfully preserved by the chefs in both salads and cooked dishes. The consumers' initial hesitation at eating hearts of palm turned to enthusiasm when they were told that the peach palm is multi-stemmed and, therefore, is not killed to harvest its heart. Latin American plantations have yielded hearts continually for 15 years without replanting. Enthusiasm among chefs and consumers has been transmitted to the farmers. They have imported seed from Peru and will plant the first commercial acreage in late 1994. The first objective of the PBAG project has been realized: Hawaii's diversified agriculture sector has a new crop. A preliminary study of the local market potential for fresh hearts of peach palm suggests that its production can expand to several hundreds of acres with sales of a million dollars per year within five years: a good and fast return for the money originally invested in research. The only possible limiting factor will be seed availability, as Hawaii's own seed production will not start for another 3-4 years.

As with any research project of this type, there have been surprises, both pleasant and not. The major pleasant surprise is that many Japanese and Thai chefs have liked the tender palm stem as much or more than the heart. (The stem occurs just below the palm's growing point and has a different texture, but the same flavor, as the heart.) At harvest, there is twice as much tender stem as heart. And the chefs are willing to pay a good price for this also. The Oriental chefs are using the palm stem to substitute for bamboo shoot and their customers are equally enthusiastic. One Japanese chef said, "If I could get fresh palm stem on a regular basis, I would never buy another bamboo shoot." This result essentially triples the farmer's yield and may double profits. The major unpleasant surprise is that some of the palms are slightly acrid. Acridity is the itching or mildly burning sensation in the mouth or upper throat caused by chemical irritants. Raw spinach and taro are acrid, for example. Fortunately, only a small fraction of the palms are acrid, less than 5% in the otherwise excellent Peruvian types. Also fortunately, most chefs have cooked the heart of palm, so the acridity is eliminated and doesn't reach the consumer. This negative quality character is now being given priority attention in followup research.

The peach palm research is also working to change the way farming is frequently done in Hawaii and elsewhere. Many farmers believe that a bare soil surface is the sign of good management. In high rainfall areas, like the Big Island of Hawaii, this is an invitation to erosion and reduces the sustainability

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SPECIAL THANKS

Dr. Daniel R. Tompkins, who administered the Tropical/Subtropical Agricultural Research program since its inception, announced his retirement from USDA/CSRS effective October 31, 1994. We applaud Dan's dedication, professionalism and service throughout his career, particularly for his strong support and guidance to CBAG/PBAG in building a successful agricultural research program for the Caribbean and Pacific regions. It is certainly appropriate and we are honored to dedicate this inaugural issue of Research Notes to Dr. Tompkins. Best Wishes from all of us for a happy, healthy and invigorating retirement. Thanks, Dan!

NEW ONAMENTAL POT CROPS FOR THE ISLANDS

Chris Ramcharan

Ornamentals, like Hibiscus, Bird Pepper and Christmas Snowflake and the newer Mussaenda from the Philippines and Africa and the Lipstick plant from Central and Tropical America can be found growing throughout the Caribbean. According to Chris Ramcharan of the University of the Virgin Islands Agriculture Experiment station on St. Croix these plants and other common and not-so-common garden species can now be tailored for pot crop production for the Virgin Islands and the Caribbean by using pruning techniques and plant growth regulators. Increasing the number of available potted plants is important for home and yard beautification, the capability of changing landscape patterns by moving plants to different locations and augmenting the number and type of such potted plants local nurseries can offer to the consumer. Most tropical ornamentals grow actively throughout the year which makes it difficult to contain them in pots. Continuous pruning for adapting such plants to pots continually destroys the stem tips where blooms are formed as in Hibiscus and Christmas Snowflake or the colorful and edible peppers in the Bird Pepper group. Aunique group of Plant Growth Regulators (PGRs) has now overcome this problem. These PGRs physiologically slow growth by the inhibition of natural growth promoters. Applied in controlled amounts to many potted plants the PGRs inhibit growth while maintaining or promoting flower production resulting in a much smaller but more floriferous plant adapted to a pot situation. Hibiscus cultivars when treated with the growth retardant Cyocell have remained floriferous for over a year in 15cm pots. The leaves of treated plants were greener and less susceptible to insects than untreated plants. The potted and treated plants were successfully maintained under house and yard conditions.

Christmas Snowflake is a popular local Poinsettia with magnificent white blooms resembling snowflakes creating a temperate-type scenery at Yuletide from Jamaica through the Caribbean islands to Trinidad. Potted Christmas snowflake plants can now be precisely scheduled for flowering a week before Christmas through the application of Cycocel or Bonzi. They can be forced for Easter flowering by careful photoperiodic manipulation. This plant has the potential of becoming the new Christmas or Easter Poinsettia of the Caribbean replacing the costly imports of traditional Poinsettias and saving critical foreign exchange reserves. Bird Pepper is a local and popular Chili pepper that is always a part of the home garden in the Caribbean. With the application of growth retardants, Bird Pepper flowers and fruits profusely yielding up to 500 fruits per 40-50 cm high plant in a 15cm pot. This technique transforms a common garden plant into a highly prized dual purpose crop - an ornamental for its attractive appearance and a culinary and medicinal product for its pepper fruits widely use in the West Indies and world-wide. Mussaenda, a member of the coffee family, is a spectacular flowering shrub grown for its flower bracts ranging from deep Ashanti Red of Africa to the Snow White of the Philippines and pink of the hybrid Dona Luz cultivar. Untreated plants bloom in l to 2 years requiring pruning for further growth and flowering. Mussaenda does not tolerate high pH soils limiting its culture in calcareous islands like St. Croix and making it a good candidate for potting. Starting from a soft wood cutting, Mussaenda can be forced to flower in a 15cm pot within 5 months through the application of 2500ppm Alar sprays. After 2 months of flowering it can be repotted and similarly forced again to flower within the next 6 months. It can be made to produce its attractive blooms twice within the same year. Since Mussaenda is nonphotoperiodic, it can be an excellent flowering pot crop any time of the

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Christmas Snowflake, a popular Poinsettia in the Caribbean.

Ashanti Red Mussaenda, a member of the coffee family.

DEFOLIATION RESPONSES AND QUALITY-RELATED DETERMINANTS OF *PENNISETUM* FORAGES

L. E. Sollenberger & J. E. Moore

Planted and native grasslands provide nearly all of the nutrients consumed by cattle in subtropical and tropical areas. Grasslands in these regions support approximately 55% of the world's cattle, yet only 33% of the total meat supply and 16% of the world's dairy products are produced there. Perhaps the most important factor that limits animal productivity in tropical regions is the poor nutritional quality of most tropical grassland plants.

Research supported by the Caribbean Basin Administrative Group and conducted at the University of Florida has as its objective the development of more nutritious forage plants for use in warm climates. Because of the large animal population in subtropical and tropical areas, even small increases in nutritional value of forages have potential to make a major contribution.

Studies were conducted in 1989 to 1993 with grasses in the genus *Pennisetum*. Some of the grasses in this genus are called elephantgrasses and have leaves that are high in nutritive value for livestock. Unfortunately most elephantgrass plants are very tall and stemmy and have relatively little leaf. Development of dwarf types of *Pennisetum* has resulted in less stemmy grasses of higher nutritional value.

Specific objectives of the research were to quantify the nutritional value, productivity, and long-term survival of dwarf elephantgrass types and of the more recently developed hybrids between elephantgrass and pearl millet (also in the *Pennisetum* genus).

Additionally, studies were designed to evaluate the structural components of elephantgrass and Bahiagrass plants, the latter being a grass of low nutritional value.

Results of the studies demonstrated that dwarf elephantgrass is productive when defoliated for use as a livestock feed and that it is highly nutritious. Its nutritional benefits were linked to a high leaf percentage (over 64% of the plant by weight, even when harvested as infrequently as every 12 weeks) and leaf tissue that was easily and extensively digested by livestock. Superior digestion and utilization of dwarf elephantgrass than Bahiagrass occurred because elephantgrass has fewer vascular tissues and structural support cells (very undigestible cell types) than Bahiagrass and more readily digestible cell types. In addition, Bahiagrass cells are arranged in such a way that the leaf surface resists a great deal of pressure during chewing and does not rupture easily. Thus the bacteria in the cow's stomach (rumen) cannot gain access rapidly to the interior of the leaf and digest it. Elephantgrass leaves, on the other hand, break apart readily during chewing and a greater proportion of the cells in the leaf are accessible for digestion.

As a result of this research, planted acreage of dwarf elephantgrass has increased in many regions of the tropics.

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of the farm. Experimental trials are all laid out along the contours of the field and there are strips of legume groundcovers between each row of palms. The palms and the legumes form a continuous cover that protects the soil from the impact of the rain, reducing erosion to a very low level. The contour arrangement reduces erosion further. The legumes provide an additional benefit: they compete with weeds and have reduced the need for herbicides by nearly l00%. They may even add nitrogen to the soil. Although the research is not targeted toward farming , the field practices used show that peach palms could be organically grown in Hawaii and still provide very high returns to the farmer.

The success of this PBAG project has attracted the attention of Hawaii's farmers, extension service and local government. It provides a model for development of other new crops for Hawaii. Because of Hawaii's high costs and distance from continental markets, agriculture in the mid-Pacific may never be cost competitive with other producing regions. Innovation, exploitation of novel products and marketing opportunities are therefore extremely important.

The search for new crops must continue for the foreseeable future.■

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PLANT PATHOGENS *from page 1*

spread. This program involved the introduction of a shoot-feeding thrip from Fiji and a Pyralid moth from the American Tropics. However, the spread of Koster's Curse continued at a rapid pace. By 1984 the plant had covered more than 40,000 hectares in Oahu with small centers of infestation in Kauai, Maui, and Hawaii. In September of 1985 an anthracknose disease of Koster's Curse was discovered at the Gariche river in Panama during an exploratory trip to search for fungal pathogens of this plant in its center of origin. Diseased leaves were sent to Frederick, Maryland for study under a U.S.D.A. Agriculture Plant Health Inspection Service (APHIS) permit. The pathogen was isolated and identified as *Colletotrichum gloeospori - oides*. Pathogenicity was demonstrated at Frederick and limited host range studies confirmed specificity of this fungus to *Clidemia hirta*, Koster's Curse. The pathogen was named *Colletotrichum gloeospori - oides f. sp. clidemiae* (CGC). In January of 1986 CGC was introduced to Hawaii, by permission of DOA, for extensive host range determinations in containment. Host range studies of CGC done at USDA, ARS, Foreign Disease Weed Science Research Unit, Fort Detrick, Bldg. 1302, Frederick, Maryland, and U.H. Manoa, Honolulu included 48 plant species and representatives of 28 families of plants. This pathogen was found to have a very restricted host range and to be specific to Koster's Curse in Hawaii. In September of 1986 the Hawaii Board of Agriculture granted approval for the release of this biocontrol fungus from quarantine for limited field tests in Oahu. From 1987 the fungus was manually sprayed on weedy sites in all infested Hawaiian islands. Every summer, students participating in the College of Tropical Agriculture and Human Resources, National Science Foundation Jr. scholars were exposed to this research, and were encouraged to participate in the manual distribution of the fungal pathogen in Hawaiian forests. The fungus is also produced on request by our lab for use by other interested parties throughout the year. Fermentation technology has been applied to the production of the biocontrol fungus of Koster's Curse with success. Spore production in liquid culture is possible in potato dextrose broth with high oxygenation. Surveys made in 1993 of forest sites inoculated with the biocontrol fungus in the last six years have shown excellent control of the plant. In Oahu, particularly in sites exposed to high annual precipitation, more than 90% of the *Clidemia* plants have been killed. For "banana poka", a powdery mildew, *Phyllactinia sp.*, was studied at Providencia, Narino, Colombia in 1987-1989 and approved for introduction and release by the Hawaii Board of Agriculture in 1989. However, failure to maintain the viability of this pathogen during transportation, has precluded its successful establishment in Hawaii. An unreported leaf spot caused by *Septoria* sp. was collected from Hawaii's banana poka seedlings planted at Ipiales, Colombia. A series of host range studies conducted with three strains of this fungus at the new Foreign Plant Disease Quarantine facility of the Hawaii Department of Agriculture indicated a narrow host range and aggressive pathogenicity to banana poka. Almost all members of the *Passifloraceae* present in Hawaii are not attacked by this pathogen. Permission has been requested to use this pathogen as a bioherbicide for banana poka in Hawaiian forests. The aggressiveness of this pathogen can be enhanced by formulating the inoculum in 0.5% gelatin, 2.0% sucrose solution. Many other pathogens have been recorded in tropical America on plants considered to be serious weed pests in Hawaii. Currently, support for biological control of weeds is limited to the most serious pests.■

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contemporary fashion is more and more recognized. *AGENDA 21*, as formulated in the Rio Declaration of the U.N. Conference on Environment and Development, of which the United States is a cosignatory, stipulates the "development and greater application of...the analytical and predictive tools now available such as computer modeling." In the context of this wider perspective, the project has also contributed to a broader agenda in the national interest.■

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year. Mussaenda is almost pest-free and could become a good substitute for Poinsettias which are both highly seasonal and very susceptible to pests. Another little-known plant grown for the food coloring value of its seeds is the Achiote or lipstick plant. In its natural tree-state, the uniqueness and beauty of its apple blossom-like blooms and its attractive yellow or red fruit pods are easily obscured. When grown in a 2-3 gallon pot with careful pruning and growth retardant treatments the lipstick plant can be induced to exhibit its magnificent blooms and fruits within 2 years. The dramatic impact of the lipstick plant resulted in the selection of a color photo of a flower head for the cover of the 1994 Mother's Day issue of Caribbean Impressions TV Guide of the Virgin Islands. These are just a few of the examples of the local flora species being developed as new pot crops at the University of the Virgin Islands Agriculture Experiment Station. Additional new ones will increase the number in the nurseryman's range of crops, add beauty and variety to the local scenery and provide valuable substitutions for importations.■

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Pennisetum *from page 6*

Reports from Central America, Venezuela, Pakistan, and China indicate excellent contributions of the plant to livestock production systems.

Plant improvement programs have used the results of this work in two ways. First, because of its superior agronomic and nutritional traits, dwarf elephantgrass has been used as a parent in ongoing plant breeding efforts. Specifically, seed-producing hybrids between dwarf elephantgrass and pearl millet have been developed that have promise for use in the southeast U.S.A. and the tropics. Secondly, this research has identified plant characteristics associated with superior nutritional value, thus providing tools to- plant breeders for-assessing and improving nutritional attributes of new germplasm. In summary, results from these studies have led to successful introduction of technology to farming systems and have provided impetus for further development and refinement of grasses that may benefit animal agriculture in the 21st century.■

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