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des Plantes Alimentaires

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Agriculture Intensive dans les Iles de la Caraïbe : enjeux, contraintes et perspectives
Intensive Agriculture in the Caribbean Islands : stakes, constraints and prospects
Agricultura Intensiva en la Islas del Caribe : posturas, coacciones y perspectivas

CONTRIBUTIONS OF THE COLLEGE OF AGRICULTURAL SCIENCES OF THE UNIVERSITY OF PUERTO RICO-MAYAGUEZ CAMPUS TO THE TROPICAL AND SUBTROPICAL AGRICULTURAL RESEARCH PROGRAM.

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ABSTRACT

A research program in tropical/subtropical agriculture is being funded by Special Research Grants (under Public Law 89-106) from the U.S. Department of Agriculture (USDA), Cooperative State Research Service (CSRS). For the U.S. Caribbean Area the program is coordinated and operated by the Caribbean Basin Administrative Group (CBAG). CBAG membership consists of the Directors and/or representatives of each of the Agricultural Experiment Stations of the land-grant universities of Florida, Puerto Rico and the Virgin Islands, the Executive Director for the Southern Region of Agricultural Experiment Stations, and representatives for USDA-CSRS and for the Agricultural Research Service (ARS). Up to the present, 54 CBAG projects in areas of high-priority research have been conducted by staff members of the University of Puerto Rico-Mayaguez Campus, College of Agricultural Sciences. During a span of 14 years, more than \$5.4 millions have been invested in Puerto Rico to support research related to land use planning; tissue culture on plantains, bananas and pineapples; biological control of nematodes and insects; development of new value-added shelled bean products; irrigation requirements; virus diseases of tanners and passion fruit; and others. Results, findings and recommendations have been disseminated through publications in local

and international journals and oral presentations in annual technical meetings of scientific organizations in the Western Hemisphere, Europe and Asia. In addition, funds have been used to train graduate students and support their M.S. thesis research work based on high-priority research needs in tropical agriculture.

INTRODUCTION

In 1979 the Food and Agricultural Organization (FAO) of the United Nations issued a world based situation report that visualized a third world moving toward massive food shortages. The report emphasized that serious malnutrition and starvation occur in the tropical and subtropical zones of the world.

Studies on food and nutrition in tropical regions suggest key problem areas requiring comprehensive research of the type Agricultural Experiment Stations of The United States Land-Grant Universities are well suited to conduct. The "developing countries", mainly in the tropical/subtropical belts, have a wide range of socioeconomic, climatic and soil conditions, each with specific agricultural problems. Some of the agricultural problems demanding research are as follows: Nutrition and production technology of tropical/subtropical foods, and alternative food sources; energy resource alternatives; interactions of natural resources and agroecosystems; agrotechnology interchange; utilization of marginal agricultural resources; and alternatives for improved handling, preservation, distribution, marketing and storage of tropical/subtropical foods and commodities.

In order to provide solutions to these problems, a research program in tropical/subtropical agriculture has been funded by Special Research Grants (under Public Law 89-106) from the USDA-CSRS. For the United States Caribbean Area the program is coordinated and operated by the Caribbean Basin Administrative Group (CBAG), and is designed to strengthen the research capabilities and the agrosociences in tropical-subtropical areas, some of which are large importers of food (Caribbean Basin Administrative Group, 1991). Much of the research conducted in the temperate United States is not applicable to these areas due to marked differences in climate, soils, crops, insects, and diseases

as well as socioeconomic constraints. CBAG promotes tropical/subtropical agricultural research in a number of areas including root and tuber tropical crops, fruits, vegetable crops, ornamentals, plants, cropping systems, water management, forage-grass-livestock systems, animal diseases, insect pests, weeds, plant diseases, plant stress, postharvest technology, new crops, and marketing (Davis, 1992 & 1993).

There are two centers of research: the Caribbean Basin represented by CBAG and the Pacific Basin represented by PBAG (the Pacific Basin Administrative Group). The Caribbean Basin focuses on the Agricultural Experiment Stations of the University of Florida, the University of Puerto Rico, and the University of the Virgin Islands. Also cooperating is the Tropical Agriculture Research Station (TARS) of the Agricultural Research Service (ARS), USDA, at Mayaguez, Puerto Rico. Information from research projects is exchanged between the Caribbean and Pacific Basin programs (Agricultural Experiment Stations of Hawaii, Guam and American Samoa). Linkages are strongly encouraged among scientists of the three participating Caribbean Basin universities to utilize specialized expertise and equipment. CBAG membership consists of the Directors and/or representatives of the Agricultural Experiment Stations of Florida, Puerto Rico, and the Virgin Islands; the Executive Director for the Southern Region of Agricultural Experiment Stations, and USDA-CSRS. CBAG selects its chairperson from the representatives of the participating Agricultural Experiment Stations and has a program manager for administrative matters.

PROGRAM PROCEDURE AND GUIDELINES

CBAG establishes policy at the Basin or regional level. It calls for research grant proposals, has them peer-reviewed, evaluates them, and recommends to USDA-CSRS research proposals for awarding Special Research Grants. CBAG also conducts yearly performance evaluations of on-going research, and sponsors workshops on timely research topics.

The general guidelines governing the operations of the Tropical/Subtropical Agricultural Research are as follows:

1. The nature of the research activities can be fundamentally oriented as well as applied. Research shall deal with problems which may bring solutions to critical tropical areas in the tropics as well as to develop opportunities for agricultural production and marketing in the tropics and subtropics of the United States.

2. Crops research shall include, but not be limited to, forage and pasture crops, legumes, root and tuber crops, ornamentals/nursery crops, and fruits and vegetables adapted to The United States tropical and subtropical conditions.

3. Animal research will give emphasis to small ruminants and other animals suitable for the United States tropical and subtropical areas, and special opportunities for large animals and aquatic animals/fish will be considered.

Table 1 depicts a list of 17 high priority research areas that prevailed from 1979 to 1991 (Arroyo, 1984). Based on problems and opportunities for tropical and subtropical agriculture in the Caribbean Basin, the list of high priority research areas was reviewed and addressed to develop knowledge and technology for new or alternative cropping systems having sound market potential and compatible with a growing eco-tourism industry in the Caribbean Basin (Table 2).

CONTRIBUTIONS : PROJECTS, THESIS, PUBLICATIONS AND PRESENTATIONS

Research projects

Scientists from the Departments of Crop Protection, Agronomy and Soils, Horticulture, Agricultural Economics and Rural Sociology, Animal Industries, and Agricultural Engineering, and the Rum Pilot Plant and Food Technology Laboratory of the College of Agricultural Sciences of the University of Puerto Rico at the Mayaguez Campus have submitted a total of 180 research proposals during a 13-years span. The peer panel review of the College of Agricultural Sciences

recommended 64 proposals of a total of 107 for funding during the 1985-1993 period; whereas the CBAG Committee approved 32 for funding by USDA-CSRS. Up to the present a total of 54 projects have been funded to conduct laboratory, greenhouse and field work (Table 3). Most of the research has been addressed to twenty-five crops, including selected vegetables, tropical fruits, grains and legumes, coffee, plantains and bananas, herbs, and others. In addition, three of the projects have emphasized research work on fresh water tilapia fish, and on beef and dairy cattle. Special Grant Funds from USDA-CSRS amounting to \$5.4 millions, have been invested in research dealing with ethiology, chemical and biological control of pests and diseases; fertilization and nutrition, tissue culture; improvement and development of resistance to specific pest; irrigation requirements; improved management systems for selected crops, and computer systems for enhancing agricultural decision making, and others.

Results and achievements

Estimates of several genetic parameters of fruit set, fruit size and yield were found while attempting to improve tomatoes under the high temperatures and humidity prevailing in the south coast of Puerto Rico. In another project addressed toward integrated nematode management, a crop rotation with velvet bean (*Mucuna deeringiana*) significantly reduced nematode population and increased yields of tomato.

Two recurrent selection methods were successful in developing red beans adapted to the tropics. Recurrent selection with advanced generation testing was more effective in developing indeterminate red bean lines with seed yields 30% greater than determinate check beans. In addition, significant progress have been achieved in studies related to develop technology for canning and preservation of white and red green-shelled beans at the Food Technology Laboratory of the Agricultural Experiment Station.

Recurrent selection was also used to accumulate into one population those alleles that contribute to polygenic mildew resistance in the Caribbean pumpkin or calabaza. Sources of resistance for both powdery mildew and downy mildew that are being incorporated into pumpkins with other desirable traits have been identified. Two

populations of pumpkins were included in international trials to test advanced Cucurbita material. The population PRB-150 (also known as Soler) is in the process of being released by the U.P.R.-Agricultural Experiment Station, and seed production practices have been developed for either commercial or experimental purposes.

Estimations of water consumption by selected crops, including vegetables, legumes and tropical fruits, on the southern and northern coasts of Puerto Rico were developed in a project dealing with evapotranspiration rates for different regions, irrigation requirements for selected crops, and comparison of effects of irrigation methods and plastic mulching on crop response of tomatoes and peppers.

Tissue culture technique was selected for breeding and testing of sugarcane subclones resistant to rust, production of virus-free and resistant subclones of taniens and yams; in vitro production of propagation material for pineapples varieties such as Bullhead, Smooth Cayenne and Red Spanish, and development of plantains and bananas resistant to yellow Sigatoka. Production of spineless plantlets of Red Spanish pineapple via tissue culture and its subsequent propagation was achieved. Field data indicated no differences in fruit yield and quality (fiber content, Brix, and acidity) between spine and spineless pineapple plants.

Use of chicken manure as fertilizer for vegetables, fruits and pasture production was evaluated. Manure applications of 7.26 and 14.0 kg, split in 3 or 4 applications prior to the sixth month after planting, can satisfy the nitrogen requirement of plantains and bananas, respectively. Optimum yields of papaya (Sunrise Cv.) can be attained with the application of 15 tons/ha of manure prior to planting. The application of 20 tons/ha, incorporated to the soil, prior to planting, can satisfy the nutrient requirements of star grass for seven months.

Studies were conducted to determine the tolerance limits to soil acidity factors of selected crops, and alternatives to correct soil acidity through response of test crops to application of lime, manure, gypsum and magnesium sulfate in several acid soils. Amendments of manure and gypsum can have significant effects on soil acidity on the tropics, but an option of using lime in conjunction with other amendments, particularly gypsum, appears to be the best one. Pumpkin was the most sensitive to soil acidity and the most responsive to lime. It was also found that magnesium availability may be significantly

reduced by excessive lime rates.

Survey for passion fruit mosaic virus (PMV) indicated that this virus is well distributed in the Dominican Republic and so far mainly restricted to the western coast of Puerto Rico. The virus is not seed-transmitted but easily non-persistently transmitted by three aphid species. Both the Dominican Republic and Puerto Rican isolates are closely related as indicated by immunodiffusion assays. Passiflora foetida may be one of the reservoirs of the mosaic virus affecting Passiflora edulis in Puerto Rico.

A study of mango flowering to reduce erratic bearing behaviour was conducted. Applications of potassium nitrate, three months prior to normal flowering in the Keitt cultivar to slow-growing shoots during the first flush after harvest, resulted in a significantly higher number of panicles in comparison with an application to faster-growing shoots. The growth inhibitors Cycocel and Daminozide, when applied one week before a single application of potassium nitrate, increased significantly the number of panicles, and reduced the coefficient of variation from 74% to 28.2%. Gibberellic acid, inhibited panicle formation when applied before potassium nitrate foliar sprays.

The performance of two alternative beef production systems for cattle grazing Stargrass pastures under different stocking rates and fertilization levels was evaluated. Based on a straight line equation describing the relationship between weight gain per animal and stocking rate, a maximum meat production was obtained at the stocking rate of 5.2 animals/ha, and a low fertilization of 896 kg of fertilizer/ha/year.

Graduate training and master thesis

The Special Research Grants in Tropical/Subtropical Agriculture Program provides the opportunity for graduate student to be trained in the "research process" under an experienced research scientist. In Puerto Rico, the College of Agricultural Sciences has encouraged the Principal Investigator to select graduate students interested in obtaining a Master degree. The investment of over \$150,000 in graduate training has resulted in significant results, findings and useful recommendations from over 30 master thesis of graduate students at the Faculty of Agriculture of the College of Agricultural Sciences.

Some of them have pursued studies conducive to a Ph. D. in the United States. Others have been employed by private companies dedicated to winter nursery farms, (mainly in the south coast of Puerto Rico), agribusiness and governmental sector, whereas some of them have returned to their country of origin such as Saint Lucia, Grenada, Colombia, El Salvador, Guatemala and Panamá to work with either the government or the private sector.

PUBLICATIONS AND PRESENTATIONS

Principal investigators and collaborators have published about 202 technical papers to disseminate major results and findings on work related to 25 agricultural crops, tilapia, and dairy and beef cattle. The majority have been published in the Journal of Agriculture of the University of Puerto Rico although some have appeared in the Journal of Economic Entomology, HortScience, Florida Entomologist, Journal of American Society of HortScience, Cucurbit Genetics Cooperative Report, Plant Disease, and others. More than 144 technical presentations have been delivered at local and international meetings of professional organizations and societies. Papers have been presented at the annual technical meetings of the Caribbean Food Crops Society, Puerto Rican Society of Agricultural Sciences, American Phytopathological Society-Caribbean Division, American Society of Agronomy, American Society for Horticultural Sciences and others. Further dissemination of results and findings have been attained through participation in international symposia on mango, virology, crop science,

Table 1. List of high priority research areas, as developed by CBAG for 1979-1991

- Tropical root crops for food and other purposes.
- Tropical fruits including germplasm evaluation.
- Tropical vegetable crops.
- Tropical/subtropical ornamental horticultural plants and plant products.
- Tropical cropping systems.

- Water management in tropical agricultural systems.
- Forage-Grass-Livestock systems in the tropics.
- Animal diseases in the tropical environment.
- Arthropod pests unique to the Caribbean area, or potential threats to the Caribbean and U.S. continental areas.
- Weed pests unique to the Caribbean area, or potential problems to the Caribbean and U.S. continental areas.
- Plant diseases unique to the tropics, including basic studies of disease organisms (descriptive, etiology, genetics, management, etc.)
- Plant stress in the tropical environment. (Physiological, ecological, environmental).
- Postharvest technology for the tropics : storage, transportation, commodity treatments for export/import quarantines, quality preservation during marketing.
- Special commodities of specific interest to small farmers in the Caribbean. Alternate agricultural enterprises.
- Movement of biotic agents through tropical zones.
- Marketing and market development for tropical commodities.
- Increasing effectiveness of research utilization through technology transfer in the tropics.

Table 2. New list of high research priorities related to specific commodities or multiple cropping systems.

- Resource management, conservation and utilization (water, soil, forests, bays and estuaries).
 - Development and application of environmentally sound sustainable practices for tropical and subtropical agriculture in the Caribbean Basin.
 - Effective and environmentally sound methods for the management of livestock and crop pests (diseases, insects, weeds) on both an individual basis and with integrated systems.
- Improvements in or development of germplasm (plant and animal) to enhance the productivity, pest resistance, nutrition and marketability of existing and new crops in the Caribbean

Basin and to minimize the effects of environmental stress on plant and animal systems.

- Post-harvest technology related to processing, storage, transportation, import/export regulatory requirements, marketability, preservation of quality and development of new market niches for products of production.

- Market definition, development and applications for current and new commodities in the Caribbean Basin.

- Application of systems technology for management and decisions aides that optimize economic return, minimize economic and biologic risk and provide for prudent and sustainable use of resources for agro-environmental systems in the Caribbean Basin.

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