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RESEARCH NEEDS FOR NON-TRADITIONAL EXPORTS CROPS IN CENTRAL AMERICA.

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PROEXAG

NON-TRADITIONAL AGRICULTURAL EXPORT SUPPORT PROJECT

RESEARCH NEEDS FOR NON-TRADITIONAL
EXPORTS CROPS IN CENTRAL AMERICA

Assignment Number: ST/87-86
Contract Number: 596-0108-C-00-6060-00

SUBMITTED TO:

Regional Office For Central America And Panama (ROCAP)
U.S. Agency for International Development
Guatemala City, Guatemala

SUBMITTED BY:

Franklin W. Martin and Romeo Martinez Rodas

through

Chemonics International Consulting Division
2000 M Street, Northwest
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Washington, D.C. 20036

November 1987

PREFACE

Terms of reference:

Title of Assignment: Identify research and extension needs of a selected number of non-traditional agricultural products identified as having production and export potential in the Central American/Panama region.

Estimated Length of Assignment: 3 weeks - Frank Martin, 3 weeks - Romeo Martinez.

Estimated Timing of Assignment: October 26 - November 30, 1987.

Anticipated Travel: Travel throughout Central America.

Authorized work-days per week: Six days while in Central America.

Estimated Level of Effort: 42 workdays total for the two consultants.

Proposed Candidates: Frank Martin and Romeo Martinez.

Scope of Work: Purpose of study: to complement activities that are currently being carried out in promoting exports of non-traditional agricultural products in the Central American/Panama region.

1. Identify products with production and export marketing potential in close coordination with the agricultural exports associations in each of the Central America/Panama countries (Gremial in Guatemala, ASPENT in El Salvador, FEPROEXAAH in Honduras, CAAP in Costa Rica and CONDEPRO in Panama) and the national and regional research programs (FHIA in Honduras, CATIE in Costa Rica, etc.)

2. Study will identify:

- A. Specific commodity research currently being conducted.
- B. Institutions conducting the research.
- C. Sources of Financing.
- D. Gaps in current research programs.
- E. Estimates of the costs, personnel and time frame to conduct the research.

Make recommendations as to specific research activities and areas that lend themselves to a regional research approach which complement current programs.

Possible research subjects include variety improvement, agricultural chemical usage, pesticide contamination, post-harvest handling, virus control, crop physiology, new production technologies development, quarantine regulations, etc.

3. Study will also assess the current level of technology transfer capability in both the public and private sectors throughout the region, specifically, the study will evaluate current agricultural extension programs and

services in each of the Central America/Panama countries, including resources available for each of the countries, and make recommendations for support of those aspects of technology dissemination which are appropriate for regional approaches and for which economies of scale could be realized.

Expected results: A report containing technical information with recommendations.

Method of research

Visits and interviews, study of internal and published documents, discussion among the consultants, writing, criticism, and rewriting.

Acknowledgments

See Annex I. Summary of Institutions, organizations, and personnel visited. The authors acknowledge the invaluable and enthusiastic support received from all persons and express their admiration, respect, and gratitude.

EXECUTIVE SUMMARY

Research needs for Non-traditional Export Crops in Central America:

Research needs for non traditional export crops and extension capabilities were assessed in Guatemala, El Salvador, Honduras, and Costa Rica by Franklin W. Martin and Romeo Martinez Rodas in November, 1987 through a contract with Chemonics International Consulting Division. From interviews with national, USAID-funded, and independent private agencies with responsibilities for these crops, and from published documents the priorities and research status of current and potential non-traditional export crops of 4 categories (vegetables, rapidly growing fruits, tree fruits, and species and miscellaneous) were judged. Recommendations were made with respect to research needs in each country. On the basis of country analyses, a regional analysis was made, that include a summary of research status by crop and discipline. Recommendations were then developed.

Guatemala: With a varied topography, a strong horticultural tradition and a trained research force, Guatemala is in a good position to develop, produce, and export a wide variety of non-traditional crops. Research concentrates, however, on food crops and traditional exports of the country. Access to informatio already in existence is inadequate. Non traditional export crops to emphasize should be cool season vegetables (broccoli, brussel sprouts, cauliflower, sugar - snap and snow peas), as well as the newly emphasized "baby"

vegetables and more developed melon industry. Of second priority are asparagus, brambleberry, strawberry, and pickling cucumbers. As these crops begin their development, attempted technology transfer reveals numerous problems, especial with pests, diseases, and quality, that existing institutions cannot effectively manage only because of insufficient resources. Processing possibilities need confirmation through short-term research.

Honduras: The diversification program at FHIA promises to address the most crying needs of principal non-traditional export crops, although so far almost all emphasis has been on melon. Training courses, publications, and activities of technicians of FEPROEXAAH are expected to extend new technology efficiently. The potential contribution of EAP to research and of the Wilson Popenoe botanical garden are not fully utilized. Most of the necessary adaptive and short term research needed to potential crops has not even been visualized. A few tree crops are especially suitable for long term development in Honduras, but receive no research backing.

Costa Rica: CATIE regional program with cacao is very landable. Research with tropical spice and tree crops by CATIE and ASBANA is very promising for the long term development of new crops and merits support to increase the pace. Pest and diseases of these new crops are the chief limiting factors and need short term research. CATIE's Integrated Pest Management Project does not even touch most non-traditional export crops. The strategy of CAAP to begin developmental activities with three crops per year culminating in practical production guides after 2-3 years ought to result in groups of trained farmers.

It is not yet clear if the necessary adaptive research with annual crops can be managed by CAAP, and surely the need for short term research will increase.

El Salvador: CENTA has great expertise but little funding or flexibility for non-traditional export crops. The enthusiastic beginnings of FUSADES show great promise, but expertise is lacking for more than simple experimentation. Needs for adaptive research are appearing with every crop. El Salvador needs processing research and facilities badly to complement its proposed increased production of window market vegetables.

Region: The lack of efficient transfer of information within and among the four countries visited is a principal factor limiting the production of non-traditional export crops. When technology of these new crops is transferred from outside of the region, some adaptive (very short term) research is necessary, and this receives some fair attention throughout the region. However, unforeseen problems inevitable arise, particularly in the area of disease and pest control. This short term research, seldom receives the support it merits because national institutions are geared to the needs of local food crops and traditional exports. Several non-traditional crops, some indigenous and others from elsewhere, can be very important of long term research, now variable to non-existent is strengthened.

Therefore, it is recommended that no new research projects with non-traditional export crops be initiated until mechanisms of interchange of information are developed. A flexible research support fund should be used to address the

adaptive research needs of crops currently being marketed internationally. The diversification project at FHIA should be expanded to include short term research on new and non-traditional export crops, with a regional responsibility. A regional program of food processing should be developed to permit the use of crop exceedents and to widen the number of exportable crops and products. Principle tropical perennial crops with long term potential should be developed under long term stable funding. These crops are mentioned. On the more distant horizon is the need for basic research for long term development of annual crops that are shown by actual export to be of importance to the development of Central America.

SECTION I. GUATEMALA

A. Country Background Statement:

Guatemala is the most ecologically diverse country in the Region with important production areas suitable for growing a large number of export commodities. In the highlands of the Departamento of San Marcos; Huehuetenango; Quiché; Quetzaltenango; Totonicapán; Sololá; Chimaltenango; Sacatepéquez and Jalapa, cool season vegetable crops; deciduous fruits (apples, pears, cherries, plums, apricots); condiment and popular medicinal plants are grown. Cool-season vegetables such as lettuce; potatoes; broccoli; brussels sprouts, snap beans; snow and sugar snap peas as well as apples and strawberries are being exported through eighteen (18) exporting companies.

In the lower humid and dry tropical regions of the departments of San Marcos; Retalhuleu; Suchitepéquez; Escuintla; Santa Rosa; Alta Verapaz and Cobán, fruits such as mango; papaya; cashew nut; cardamom; okra; melons; and pickling cucumbers are produced and exported.

Traditionally crops such as coffee; bananas; cotton; rubber; and cardamom have contributed significantly as export crops to the Guatemalan Economy. Both the existence of irrigation systems in the dry and warm regions and of mini-irrigation in the highlands along with privately supported refrigeration and packing facilities, are contributing significantly to Guatemala's export capacity.

B. Institutions, Organizations and Personnel Visited:

Instituto de Ciencias y Tecnologías Agrícolas - ICTA
Danilo Gonzalez, Technical Director

This national research institute began activities in the early 1970's placing major emphasis on ON-FARM-RESEARCH as a strategy to produce site-specific technology within short-time frameworks. It has to date two major Programs of interest to this report: the Vegetable and Fruit Programs and two projects in Plant Genetic Resources and in Research at a Farm-Level in the Northern Transversal Belt of Guatemala.

The Fruit Program: initiated in 1982.

It is coordinated by Josué Vásquez who holds a Masters Degree. He has 4 Ingenieros Agrónomos in his team, none with a direct academic background in fruit culture. One person is now being trained abroad at an MSc. level in fruit culture and will joint ICTA in 1988.

Applied research activities in commodities such as apples, apricots, pears, plums and nectarines are conducted, in the department of Quetzaltenango primarily (this department produces over 50% of the deciduous productions of fruit in Guatemala). They also research activities are also conducted in San Marcos, Huehuetenango, Sololá and Jalapa.

Applied research areas in progress are: Pruning techniques (tree formation); weed control practices; plant protection techniques; soil fertility management through chemical fertilizer studies and animal manure utilization. They have

also developed rustic storage sheds and solar drying techniques for apples.

Important research areas not covered on that require strengthening include: a) variety introduction and evaluation; b) production of certified planting materials; c) weed management; d) intercropping systems that will adequately considered the size of production units and the ecological, the current production systems practiced and socio-cultural heritage. They lack resources to cover research in small-fruit such as strawberries; raspberries, etc.

The Vegetable Program:

Coordinated by Ing. Helmuth Leal, and supported by a team of 10 Ingenieros Agrónomos that are well trained but have no specify academic training in vegetable production or a related field. ICTA is training three persons abroad at an MSc. level; two of them will re-join in 1988 and the other in 1989. They conduct applied research in cool and warm-season vegetables.

Studies on cool season vegetables are conducted in the Departments of Huehuetenango, San Marcos, Quetzaltenango, Sololá, Sacatepéquez (Antigua) and in Jalapa. Crops being studied are: potatoes, broccoli, snow peas, snap beans, faba bean, cabbage, carrots and brussels sprouts.

Major emphasis is placed in agronomic areas of research such as variety testing and evaluation, and plant protection.

Applied research on warm-season vegetables is conducted in the departments of Zacapa, Jutiapa, the Valley of San Jerónimo

and Chiquimula at the "El Oasis" Experiment Station and in farmers fields. Crops include tomatoes (processing primarily), melons (honey dew and cantaloupes), okra, onions, and bell peppers. Areas of research being emphasized are: plant protection, agronomic management, and seed production (tomatoes and melons).

Important research areas not covered well include: vegetable breeding, seed production, and post-harvest handling (example: potato moth control in storage, and potato storage).

ICTA has a good infrastructure in support of the two above mentioned programs. In the Guatemalan highlands they have two experimental stations: a) Labor Ovalle and b) Chimaltenango; in the dry irrigated eastern valleys they have the OASIS Experiment Station.

In Labor Ovalle they have greenhouses; a new plant protection laboratory, relatively well equipped, and a collection of fruit cultivars that were introduced several years back (apples and apricots primarily).

In Chimaltenango they have greenhouses, and a pilot agroindustrial plant primarily devoted to potato subproducts. The plant has the capacity to dehydrate potatoes, produce potato chips and flour, for variety evaluations. Other products being dehydrated are garlic, onion, apples and plums.

The Plant Genetic Resources Project

It is conducted by a two-member team. (One Ing. Agron. and One MSc. specialized in Etnobotany). This is a

joint project with the Facultad de Agronomía of the National University. They have concentrated in the agronomic and nutritional quality evaluations (in cooperation with the Institute of Nutrition for Central America and Panama - INCAP) of crops such as pepitoria (*Cucurbita mixta*), hot peppers (8 species), amaranthus, squash and pumpkins (*Cucurbita ficifolia*; *C. mixta*; *C. moschata*, *C. pepo*). Aroids (*Xanthosoma*) and sweet potato.

They maintain an active germplasm bank (living collections), since they lack refrigerated and controlled humidity storage facilities.

The Northern-Transversal-Belt Project

Initiated in 1983, this gave rise to the Playa Grande Experiment Station located in the warm-humid tropical region of the Departments of El Quiché, Baja and Alta Verapaz. This project has a team of eight ingenieros agrónomos. An MSc. is being trained at the University of Puerto Rico in Tropical Agriculture. Applied research being conducted is in cardamom (primarily), cacao and annatto (achiote) peach palm (pejibaye), and macadamia nut. In cardamom research on planting densities and topology, fertilizer use and plant protection is emphasized. The Cacao National Collection and cacao hybrids from CATIE are being studied for their agronomic performance.

The Technical Director of ICTA, Ing. Agr. Danilo González indicated that this research institute would require the following kinds of support in an effort oriented towards non-traditional crops: a) human resource development; b) technology generation for raw-materials processing (Ex:

processing technology for hulling pepitoria seed); c) financial and technical assistance support in the area of production and post-harvest technologies.

Overall the institutional priorities are in descending order of importance: vegetables, the Northern-Transversal-Belt and the Fruit Program (which harbors the Plant Genetic Resources Project). It should be noted that in the new five-year Plan of ICTA, the "Northern Transverse Belt Project" will give rise to the NON-TRADITIONAL CROPS PROGRAM of ICTA.

USAID - Guatemala, Brian D. Rudert, Deputy Chief

The Small Farmer Diversification Project has an applied research area with the following components: a technical assistance team composed of two fruit specialists; two vegetable crop specialists; an irrigation specialist; two marketing specialists, a training specialist, and two animal science specialists. It is uniquely designed to work jointly with ICTA (Instituto de Ciencia y Tecnología Agrícola) and DIGESA (Dirección General de Servicios Agrícolas). A line of credit for the establishment of mini-irrigation schemes and production is channeled through BANDESA (Banco Nacional de Desarrollo). The availability of credit and irrigation schemes suitable for a region where the size of farms is very small has stimulated production of cool season vegetables and deciduous fruits primarily. Technical assistance is being provided for crops such as garlic, green onions, cabbage, potatoes, snap beans, broccoli, brussel sprouts, carrots and apples. The mini-irrigation schemes are allowing production in the dryer periods of the year and in a few cases like in broccoli and brussel sprouts, production is for markets to the United

States, through several of the established packing and exporting companies.

The Penny Foundation Project: Funded at a level of US\$10.5 million, it has a strong credit line for land purchasing and financing of production with the purpose of diversifying production (vegetables, cacao and coffee are emphasized). There is no research component in this project; emphasis is placed in technical assistance to farmers in above mentioned crops.

Agribusiness Development Project, Peter Alfonso, Project Manager: This is basically a project designed to provide lines of credit to ten cooperatives and technical assistance that in order to an increase in their capacity to export, products such as snow peas, baby vegetables, cauliflower, broccoli, melons, onions and strawberries. These cooperatives have lacked a capacity to produce due to: a) lack of irrigation; b) credit (no lines of credit for irrigation); c) adequate soil analyses and fertilizer formulations. Examples of specific problems are: a) lack of onion varieties for export; b) in strawberries, the best marketing window is not reached since techniques such as the use of plastic tunnels are not in use. Project duration: three years (ends October 1988).

Non-Traditional Agricultural Export Support Project, José Mondedeo, Production Specialist:

A ROCAP funded project, implemented by Chemonics International was initiated in October 1986 and is a five year program. The technical assistance team is composed of a

post-harvest specialist, a production specialist, a marketing specialist, a training specialist, a computer specialist, and the chief of party and transportation specialist (Edward Hurlston).

It is a commodity oriented project with major activities in technical assistance and training. First priority commodities are: asparagus, melons, brambleberries and blueberries. Other commodities included are: strawberries, cut flowers, (roses, birds of paradise, red ginger), cucumbers, plantains and specialty bananas, processed fruit juice (papaya and guanabana), specialty vegetables and seafood (shrimp).

Areas that need attention either through applied research or technical assistance indicated by José Mondoñedo are: i) lack of continuous variety testing, for more specialized purposes such as dehydration, and for specific site adaptation ii) proper pesticide use; iii) virus control in melons.

Suggested areas that lend themselves to a regional approach are: a) fruit fly control; b) integrated pest management; c) quarantine infrastructure; d) processing research. Very specialized training in vegetables, fruits and ornamentals is required throughout the region.

Proyecto Regional de Manejo Integrado de Plagas, MIP-GUA, Mario Pareja (Country Coordinator), Edgar Alvarado (Research Specialist) - CATIE

In Guatemala, this project has concentrated in developing integrated pest management techniques in the dry region of Zacapa, Chiquimula and San Jerónimo, where irrigation

infrastructure is available. It is a joint project with ICTA and funded by ROCAP. Major emphasis is placed in tomatoes and peppers. Insect, disease, nematode, and weed problems are emphasized in tomatoes; variety evaluation with respect to *Fusarium* resistance; and in peppers, resistance to a wilting complex (*Fusarium*; *Rhizoctonia*, *Sclerotinia*). These problems affect crops that are important for local markets. Some applied research has been done in melons, (nematode and disease control) which is an export crop.

Mario Pareja and Edgar Alvarado indicated the following areas as neglected and that require attention: 1. vegetable breeding; 2. agronomic management; example: new topological arrangements: and the use of crop associations to reduce insect problems; 3. fertilizer use and soil fertility management, emphasis in organic matter management; 4. water management; 5. correct pesticide use; 6. pest diagnosis; 7. trained human resource; 8. marketing; 9. information networking for each important crop.

C. Discussion of In-country Findings.

Research and its Quality: Production for export markets in Guatemala has been a private effort where the participation of research and extension Institutions has been limited. Exceptions are: melon, cucumber, and cocktail onions, where ICTA has successfully participated in adjusting technology though applied research. Overall research quality is good, particularly that done with an on-farm-research approach. Variety testing and agronomic management have been emphasized but normally, applied research is behind the dynamic nature of producing for an export market. .

Crops, Fields and Research Gaps: Major research gaps in

vegetables and fruits are in: a) breeding and fine-tuned variety testing (particularly varieties in demand by export markets), b) pest control (including IPM tactics) and, effectiveness and residuality of pesticides; c) processing little emphasis on exploring dehydration and freezing of certain commodities, garlic, onions, apples, and strawberries)

TABLE I ANALYSIS BY CROPS AND DISCIPLINES OF POTENTIAL EXPORT CROPS FOR GUATEMALA

Regional Markets

Crop	Suggested Priority ^{1/}	Varieties ^{2/}	Production Technology ^{2/}	Pest Control ^{2/}	Post-Harvesting ^{2/}	Processing ^{2/}
<u>VEGETABLES:</u>						
Asparagus	5	2	2	1	2	FRO 1
Broccoli	5	3	3	2	4	N.A.
Brussel Sprouts	4	2	3	2	4	N.A.
Carrots (Baby)	3	3	3	4	4	N.A.
Chicory	5	3	2	2	4	N.A.
Celery	4	3	4	3	4	N.A.
Cucumbers	5	2	4	3	4	N.A.
Endive	5	2	4	4	1	2
Eggplants	4	3	4	3	4	FRO 3
Kale	3	2	3	*	4	3
Leek	5	2	4	4	4	DRY 1
Leeks (Snow, Sns)	5	2	4	2	4	FRO 4
Peppers	2	3	3	3	N.A.	CAN 4
Potatoes	2	5	5	3	4	DRY 3
Snap Beans	3	2	2	2	2	FRO 1
Specialty Vegetables	4	3	4	2	3	N.I.

FRUIT

Blackberries and Blueberries	5	1	1	1	1	1
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Crop	Suggested Priority ^{1/}	Varieties ^{2/}	Production Technology ^{2/}	Pest Control ^{2/}	Post-Harvesting ^{2/}	Processing
* Papaya	4	2	3	2	3	JUI
Plantain	5	1	3	3	4	DRY
Strawberries	4	3	2	3	3	FRO

TREE FRUITS

* Apples		3	3	3	3	JUI
Cacao	4	2	2	2	2	CHOC
* Cashew	4	1	2	2	3	DRY
* Macadamia	3	3	3	4	N.A.	DRY
* Mango	5	3	3	2	2	SYRUP
Pejibaye	5	2	1	1	1	CAN

SPICES/MISC

Achote	4	2	2	Oldium 1	N.A.	DRY/pes
* Cardamon		3	4	Virus 2	4	4
* Cut Flowers	4	2	4	3	3	N.A.
* Ginger	5	1	3	*	*	N.I.

* Crops being exported to U.S., CAVP, Caribbean regions

** Marketed in the C.A. region

1/ Suggested priority was rated 1, lowest, to 5, highest.

2/ Existing research rated as 1 (non existent), to 5 (very adequate).

3/ Abbreviations: N.A.=not applicable, N.I.=no information, FRO=frozen, DRY=dried, CAN=canned, JUI=juice, CHOC=chocolate

Extension Capabilities: DIGESA, the Institution in charge of extension, has a large number of personnel but they are poorly equipped to support the efforts of communicating updated technology to farmers involved in producing export crops. Normally extension personnel provide support to small-scale farmers. Extension support is also provided by technicians working with export companies, utilizing a standard recommendation approach for those crops that are contracted with individual farmers or cooperatives. Varieties, fertilizers and pesticides in use are recommended without having been thoroughly evaluated previously. *

D. Within Country Recommendations:

A regional need has been detected in the field of information gathering and networking. Vast amounts of information on production techniques, quality standards and postharvest handling and grading, are available and should be gathered, systematized and difussed in an effective manner, before attempting specific applied research efforts.

Crops requiring attention in applied and short-term research are: a) asparagus, baby vegetables, snow peas, sugar snaps, broccoli, brussel sprouts, cantaloupes, and honeydews, and strawberries (first priority), b) artichokes, garlic, brambleberries, okra (second priority). Applied research should be oriented towards diminishing or eliminating major constraints. Crops should be allowed to come-in and go-out of the research program as new needs arise in production.

Long term research in plantain, macadamia, mango, pejibaye, cacao, sapote, achiote, cardamon, and small fruits is needed to develop a competitive-edge in Guatemala and take advantage of market closeness.

Within Country Recommendations:

Guatemala is particularly well endowed to conduct applied research through an on-farm-research approach, especially as it applies to basic grains. The existence of a vegetable and fruit program staffed with well trained personnel (but lacking academic training at a post-graduate level) is indicative of the importance that is given to these crops. In general, good progress has been made in evaluating varieties and developing technology for small farmers that produce for local markets or for the Central American market. This is a market that is not up to the quality standards of the U.S. or European markets. Thus, technology generation and adaptation has not been fine-tuned for high-quality-demanding markets.

1. Up-date information on production through marketing should be compiled and usefully systematized and made available to the specialized guilds of vegetable and fruit producers. This could adequately represent a basis upon which to define specific applied research priorities.
2. The following crops should be given the highest priority for development of existing markets: broccoli, brussel sprouts, cauliflower, baby vegetables, sugar snap and snow peas, snap-beans, and in melons (honeydew).
3. Support should be provided to the following crops as potential export crops: asparagus, brambles, strawberries, and pickling cucumbers.
4. ICTA should be supported in the development of crops that require long periods for returns in research such as:

mango, macadamia, cardamon, pejibaye, sapote, and cashew. Development of the experiment stations of Playa Grande and Los Brillantes, along with specialized nurseries as sources of registered planting material is also essential.

5. Support for ICAITI and possibly INCAP in the field of development of processing and food science technologies would be very important in giving the establishment of a competitive edge for countries in the region.

6. The participation of private universities (particularly Universidad del Valle) and of the Facultad de Agronomía of National University in specific fields could also contribute to the effort of developing crops for export. These universities (particularly Universidad del Valle) are particularly well equipped for efforts in insect diagnosis and specialized laboratory services.

SECTION II: HONDURAS

A. Country Background statement:

With a strip along the coast with typical wet tropical climate, a poorly developed northwest corner of tropical lowland, an extensive drier interior at intermediate elevations, and a few highland areas, where cool temperatures occur year round, Honduras has great agricultural potential, limited chiefly by water supply. Honduras is a country that has been concerned with two kinds of agriculture, the production of basic grains for internal use as food, and the production of plantation crops for exportation (bananas, cacao, and palm oil). Bananas alone have been responsible for about 1/3 of the income from exportation. In recent years farmers and farmer groups have successfully begun shipping to US and other foreign markets. The chief products have been melons, tomatoes, and cucumbers, with smaller amounts of sugar snap beans, squash, okra, cardamom, and other vegetable crops. The prospects for production for foreign markets appear promising.

B. Institutions, organizations and persons visited, and their activities.

Secretaria de Recursos Naturales, Director of Research,
Leopoldo Alvarado.

This department is chronically underfunded. In spite of monetary support for basic salaries from USAID, funds are often late and personnel wait months for their salaries. There are problems in holding competent persons. Under these circumstances emphasis is placed on basic grains, and the

principal research activities are varietal introduction and testing, production methods, and pest control.

Although funds are not available for studies of fruits and vegetables there is great interest in working with these crops. Among the vegetables of interest are chinese cabbage, onion, broccoli, and tomato. This interest has not progressed to the point of specific plans.

The department also sponsors a project of technical assistance funded and staffed by Japan. Located at La Esperanza at 1800-2000 meters of elevation, the project concentrates on the production (in a traditionally potato growing region), of apples, mushrooms, asparagus, chinese cabbage, peas, sugar snap peas, strawberries, and carnations. Techniques are principally demonstrations and training. A diagnostic laboratory will be constructed in Esperanza. The initial 3 year project will probably be refunded for an additional 3 years or more. Some research is desirable to supplement this effort. Since this is the most important potato growing area of Honduras, a seed potato industry is very desirable to avoid costly imports.

Escuela Agrícola Panamericana in Zamorano, Director, Simon Malo.

This institution is unique as a hands-on training facility, resulting in the training of professionals for all of Latin America. Currently there are 560 students. Instruction includes practice in the field, where students learn by doing. The school maintains a store open to the public which sells vegetables and fruits, fresh and processed, milk and cheese, as

well as fresh and processed meats. With special projects and core funding from outside sources, the institution concentrates on a solid practical program. Instructors are expected to include a research program and some graduates obtain a four year degree (Ingeniero Agricola) with research experience and capability. Dr. Malo emphasized that a basic limitation to development in Honduras is lack of trained personnel. He feels that markets available to Honduras are enormous and only require people and organization. Some of the crops specifically mentioned as ready for export include mung bean and asparagus.

Alfredo Montes is the head of the horticultural department and as such, in charge of developing instructional material as well as research on specific crops. The outlines prepared on each crop are probably the best sources of information available in Central America, and should be acquired for the Chemonics library and as guides for producers. The kind of research undertaken is practical: introduction of varieties of potential crops to the area; comparative testing of varieties resulting in selection; trials of planting densities, fertilization, and pest control. Thus, both investigations and crop production bulletins are closely related to the ecological conditions of the region. As Dr. Montes pointed out, investigation at a practical level must be continuous as new varieties are produced and new problems arise. Among the crops in which recent investigation has revealed great potential are asparagus and mung beans. Those in which investigation is advanced are cantaloupes, honeydews, and cucumber. Dr. Montes expressed great interest in the export possibilities of strawberry, passion fruit, and Luffa (sponge gourd). One of the responsibilities of Dr. Montes is processing of fruits and

vegetables. Especially promising are mangoes and papayas in sugar syrup. Other fruits and vegetables discussed were green beans, lima beans, sugar snap peas, Asian-type cucumbers, tomatoes, cabbage, and lettuce. He is also producing a dried milled paprika.

Aspects of research that tend to be neglected with all these crops are seed production, fertilizer requirements (mineral uptake) as related to ecological situation, post-harvest aspects including handling, quality standards, containers and diseases. In addition, studies are needed of the by-products of a shipping industry, and the uses of second quality products that cannot be shipped.

Over the long run Dr. Montes would like to see research with fruits, including the pili nut, of which mature trees are available. Also of interest would be research with passion fruit and cashew. Funds and personnel are not sufficient for such long term studies. Furthermore, the primary purpose of the institution is training, and not research. Research activities should be closely linked to the training program.

USAID-Honduras, John Warren and Benjamin Villanueva.

Eleven agricultural projects are supported in Honduras, only one of which has a strong research component. This project, administered by Blaire Cooper (not interviewed) is carried out by the Fundación Hondureña de Investigaciones Agrícolas (FHIA) in La Lima. In addition, through the project "Export Development and Services", 23 million lempiras have been used to support the development of exports through FEPROEXAAN. Some of the other projects sponsored by

USAID-Honduras include Natural Resources Management, Irrigation Development, Small Farms Crop Improvement, Small Farms Animal Improvement, Rural Technology, Small Farmer Organizations, and Land Titling.

Fundación Hondureña de Investigación Agrícola (FHIA)

Fernando Fernández, Director; Mario Contreras, Director of Research; Jairo Cano, Director of Communications, and Panfilo Tábor, New Crops.

The foundation is private, supported 90% by USAID funds (1.5 million lempiras/year) and oriented principally to the elimination through research of the constraints to production of export crops. Located in facilities donated by United Brands in La Lima, the foundation was initiated in 1984 and research began in 1985. FHIA employs more than 50 persons in research and maintains excellent laboratories for technical, state-of-the-art, services. Thus, it is better equipped and more capable of carrying out agricultural research than any other institution in Honduras.

Research in FHIA is divided into 6 commodity sections, bananas and plantain breeding (with an international focus), plantain production, cacao, citrus fruits, vegetables, and crop diversification (new crops).

With respect to non-traditional export crops, a study was made of work already accomplished in Honduras, and a total of 31 crops were identified. This was followed by a lengthy consideration of 251 potential crops. The procedures for evaluation of these crops are mentioned in Annex 2. Five crops

have been selected for further research at this time (mangoes, palmitos, black pepper, litchi, and soybean. Research with soybean has already been intensive, and research on the off-season production of mangoes has already showed promise.

Vegetable crop research has begun on a large scale in Comayagua and has been of immediate value. Results for 1986 include studies of cantaloupe, honeydew, and cucumber, while studies underway include comparison of varieties (cantaloupe, honeydew, cucumber, onions, snap beans, zucchini, chile peppers, okra, and tomato). These studies include observations of disease and insect resistance, and often such areas as plant density, disease control, season of planting, and fertilization. The annual reports of this foundation should be of value almost everywhere such vegetables are grown. Trials of commercial size are very useful in revealing problems in the finished technology. The experimentation is very closely related to problems revealed on export of the crops.

FEPROEXAAH, Manuel Borjas, Director of Productivity, San Pedro Sula.

This agency, heavily supported by USAID, aids farmers and farm groups in a wide variety of ways, including training. It is a principal initial contact with vegetables brokers from the USA. In addition, FEPROEXAAH helps groups in the purchases of necessary inputs. It does no research itself but may suggest studies to research agencies. Thus, it relates to FHIA, and Procacao as well as Proyecto Coagrova, which produces melons. By its position on the front line of exportation it is in a good position to know the most important problems at the level of exportation.

Crops that are now being exported are tomatoes, cucumbers, cantaloupes, honeydews, watermelon, pineapple, plantains, cardamon, cacao, and shrimp.

C. Discussion of in-country findings

Research and its quality: All research in Honduras is impeded by lack of a systematic research network within the country and within the region (see regional recommendations). The various entities engaged in research and development need to have immediate access to production guides, state-of-the-art technology and marketing information. Lack of such a network leads to inevitable duplication of efforts.

Honduras is fortunate to have a new, thriving, ambitious research institute, FHIA, that can be counted on to accomplish the adaptive and short term research necessary for its future development. The Escuela Agrícola Panamericana, though dedicated principally to training of future leaders in agriculture, maintains a research program and generates very useful production guides. Because of its much longer history EAP can be a useful source of technological information for FHIA and FEPROEXAAH. Recursos Naturales has too many responsibilities and too little funding to play a significant role in the development of non-traditional export crops. The background support of USAID/Honduras is very appropriate.

Crops, Fields, and Research Gaps

Potential Export Crops for Honduras are summarized in Table 2. Other crops could be added or some could be deleted. The priority assigned to the crops for development represents a

weighted judgement by the authors. The amount of research being given to these crops within the country has also been judged on the basis of the interviews made, in five traditional agricultural fields. This table suggests that considerable research has been done and considerable knowhow is available. However, as discussed in the regional evaluation (see later), the twin processes of research and development are never complete. Any new research envisaged should go hand in hand with the exporting process so that problems are attacked and resolved as they are found. Longer term research can and should be managed by FHIA, or if regional in import, by CATIE in Costa Rica.

Certain questions including quarantine, transport, markets, and marketing analysis were not evaluated by the authors. These questions fall largely into the area of development and not research. Market analysis are particularly fragile with respect to new produced crops or products.

TABLE 2 ANALYSIS BY CROPS AND DISCIPLINES OF POTENTIAL EXPORT CROPS FOR HONDURAS

CROP	Suggested Priority ^{1/}	Varieties ^{2/}	Production Technology ^{2/}	Pest Control ^{2/}	Post-Harvest ^{2/}	Processing ^{2/}
<u>VEGETABLES:</u>						
Carrot	3	4	4	3	2	N.I.
Cucumber	3	4	4	4	4	N.A.
Beans	4	5	4	4	4	N.I.
Edible bean	3	4	4	3	2	DRY 3
Pea	2	2	4	3	1	N.I.
Green bean	2	3	3	2	2	N.I.
Garlic Peas	3	3	2	2	2	N.I.
Potato	2	3	4	4	3	N.A.
<u>FRUIT</u>						
Avocado (Specialty)	3	2	2	1	1	N.A.
Passion fruit	3	3	4	3	2	JUI 1
Plantain	5	3	4	1	3	N.A.
Watermelon	2	4	4	3	3	N.A.

CROP	Suggested Priority ^{1/}	Varieties ^{2/}	Production Technology ^{2/}	Pest Control ^{2/}	Har ^{2/}	Processing
<u>TREE FRUITS</u>						
Mango	5	4	4	3	2	CAN 3
Pili nut	3	1	1	1	1	N.A.
Rambutan	3	2	2	1	1	N.I.
Sapote	4	3	3	2	1	FROZ 1
<u>SPICES/MISG</u>						
Black pepper	2	2	2	1	1	DRY
Cardamom	2	5	4	4	3	DRY
Cut Flowers	2	2-3	2	1	2	N.A.
Palmito	4	3	3	2	3	N.A.
Paprika	2	4	3	3	3	DRY

1/ Suggested priority was rated 1, lowest, to 5, highest.

2/ Existing research rated as 1 (non existent), to 5 (very adequate).

3/ Process name and priority suggested 1=lowest to 5=highest. N.A. = not applicable, N.I. = no information.

Can=canned, FRO=frozen, JUI=julce, DRY=dry.

Assessment of extension capability.

Conventional extension by governmental agencies does not appear to be the best methodology in Honduras at this time. The Secretariat of Natural Resources has its hands full with the development of basic grains, the food crops produced and used throughout the country. Because of its close relationship to farmers groups, FEPROEXAAH appears to be in an excellent position for educating farmers in exportation. This can be done through its courses given in its premises or field locations, through its newly begun bimonthly news bulletin, and through specific tasks assigned to its technicians. Thus, it appears that the extension role of the institutions visited, with respect to export crops, would be the following.

Secretariat of Natural Resources:

Personnel in the area of Comayagua and La Esperanza, if further trained, could become involved in increasing the coverage of FHIA as far as technical assistance to producers. Involvement in applied research could also be accomplished.

Escuela Agrícola Panamericana: Education at the post-high school level, source of basic production guides, research in locally adapted crops including development of production systems for new crops for export.

Fundación Hondureña de Investigaciones Agrícolas: Principal research support especially related to immediate needs, some extension through on-farm research and through publications.

FEPROEXAAH: Principal liaison and coordinator for export crops, training and extension with respect to appropriate informational needs, feed-back on problems impeding marketability.

USAID/Honduras: Support and monitoring of appropriate funded projects.

D. Within Country Recommendations:

1. That new research not be contemplated until better ways are found to exchange technical information and development news within Honduras and the region, so that a synergistic effect can be realized and duplication avoided.
2. That the following crops be given highest priority for development for existing markets: melons, cucumber, and tomato.
3. That the following crops be given support and pushed ahead as potential export crops: asparagus, mung bean seed, strawberries, and passion fruit (as juice).
4. That the following crops be considered potential export crops that can be suitably developed at FHIA because of its expertise and germplasm: specialty bananas and plantains or by EAP: mangoes (processed).
5. That the following crops not now high on the list of priorities be given priority for long term development due to the excellent germplasm available in Honduras, and the long term potential success of these crops: sapote, rambutan, and pilli nut.

That ways be found to bring the Wilson Popenoe Botanical
Garden at Lancetilla, into the research sphere.

That attention be given to the development of uses and
products of window market crops to reduce market excedents and
mitigate market risks.

Section III. Costa Rica

A. COUNTRY BACKGROUND:

Costa Rica is a country with a relatively small population (over 2 million persons) and a light population density, characterized by lowland, hot humid conditions on the Atlantic (northeast) coast, rather dry conditions on the Pacific coast, and a central mountainous range of varying altitude with numerous ancient volcanic structures and 10 volcanic peaks. The agricultural opportunities defined by the variable topography and climate are numerous and yet potentialities have not been fully exploited.

Among the agricultural enterprises of great importance are coffee, cattle, dairying, banana, and palm oil. Exports of importance, in approximate order, are coffee, sugar cane, banana, and meat products. These crops are produced in certain regions of the country. Thus bananas are produced on the Atlantic coast, coffee in the central mesa, sugar cane on the Atlantic slopes, cattle in Guanacaste. Certain sections of the country, especially the Pacific coast, the north and the south are underdeveloped agriculturally.

In spite of its agricultural potential, Costa Rica has developed very slowly. The principal obstacle appears to be lack of economic resources for development; especially credit.

Agricultural research is carried out in 3 experiment stations: Fabio Badrit in Alajuela; Jimenez Nuñez in Guanacaste; Los Diamantes (roots and tubers, spices, and

Pejibaye). There are no less than 7 private extension services as well as government-sponsored extension.

The history of exportation has been long enough so that exportation of african palm oil, pineapple, and some ornamental plants and seeds can now be considered traditional. Other export crops on a small scale are chayotes, citrus, strawberries, and palm hearts as well as many others exported in very small amounts.

B. Institutions, Organizations, and Personnel visited:

Ministerio de Agricultura, Jesús Hernández, Director, Francisco Alvarez, Subdirector for research, and Bernal Mendez, Subdirector for Extension.

The Ministry of Agriculture has many traditional responsibilities such as export regulation, quarantine, extension and pesticide registry, that are not concerned with research. Research funds are limited and are used chiefly to support basic grains and other traditional crops, including corn, rice, sorghum, beans, and sugar cane. Extension for these crops is managed chiefly through contacts with industry and with principal producers. Research includes basic elements such as varieties, distances, fertilizing, and pest control. The Ministry of Agriculture employs a few highly trained professionals for such research and a larger number of agronomists. About 20 persons are employed in research. These have responsibilities associated with the 8 regions of the Ministry.

With respect to horticulture the Director suggests that actual practice including export is far ahead of practical research. Personnel and support funds are especially short for fruits and vegetables. No attention is given to tree crops, which are considered to need too much time and furthermore are under study at the Fabio Baudrit station. Furthermore, although some attention has been given to studies with broccoli, cauliflower, chinese cabbage, sugar snap peas, and tomatoes, there is no continuity in this research.

The Ministry maintains 3 laboratories, in phytopathology, soils, and entomology, that are used for services.

There is no formal cooperation between the Ministry of Agriculture and the experiment stations of the University of Costa Rica, but there is good communication and informal cooperation based on good will.

USAID-Costa Rica, Ross Wherry,

Mr. Wherry pointed out that few agricultural projects sponsored by USAID included research components. An exception is the Non-Traditional Export Project, approximately 50% research. This project, still young, has a 4 year life time and a budget of 3.5 million dollars including in about 1.8 on technical assistance of which 1.6 million is for applied research through CAAP (see later). This budget is complemented with about \$900,000 of local funds, 500,000 of which is for research.

Agricultural projects include:

1. The coffee project, principally a support through credit, but a small budget for demonstration plots of coffee, macadamia, cacao, and cardamom.

2. Northern zone project. Principally road development.
3. CNP Grain Board.
4. Agricultural credit project.

Mr. Wherry is of the opinion that there is little if any need for new research in Costa Rica. He asked why should new research be paid for, if the job is already done. He feels that the very practical adaptive type research sponsored by CAAP is the most appropriate and cost effective. On the other hand, there is a great need for extension. But, if new money were available for research, it might be profitably used in plant breeding and studies of soil chemistry.

Consejo Agropecuario Agroindustrial Privado (CAAP)
Eduardo de la Espriella

This association of agricultural cooperatives was organized with USAID funds in order to help such groups export non-traditional crops. The association helps by providing technical guidance in the production and management of the crops but does not participate in the actual marketing. An initial task was to select traditional or non-traditional crops of great promise. Selections are made on the basis of available markets and possible profits; thus, this year strawberries, flowers, and ornamental foliage plants were emphasized. In the coming year asparagus, macadamia, and melon will be added. Possible crops for 1989 include passion fruits, black pepper, vanilla, and chayote. After 2-3 years of training and support, export groups are expected to continue alone.

With each crop a very competent authority on its production is first employed. Later, technicians from the Estación Experimental Fabio Baudrit are employed to work with technicians of the association. The technicians advise all farmers on appropriate practices. The technology initially adapted comes from the best sources available but, through trials in the fields of farmers, the technology is refined or adapted according to local needs. During this process bottlenecks to production are identified and resolved. Trained farmers are developed and cooperatives then can function.

Obstacles to the development of new crops, in order of their importance, include the absence of monetary resources so that credit can be given, and finding markets, especially stable markets. Lack of knowledge of the crops is an obstacle only at the beginning of the process; and it is not difficult to obtain the necessary technical knowledge.

CAAP has been working alone without contact or cooperation with similar organizations in other countries. In development of its program CAAP is optimistic. At this time it does not visualize the need for major research.

A major step for 1988 will be the establishment of an office in Miami which will afford feedback on how shipments arrive and thus help identify problems. The office will also identify new markets.

Expo-Rico Internacional S.A.

Willy Loria

This agricultural enterprise has been in existence for several years. Foliage of tropical plants is sold principally

to Japan through contacts made on a personal basis years ago. This enterprise has not received help from government or international agencies, but maintains its marketing position through quality of its products and by virtue of its former contacts with buyers.

CATIE (Centro de Agricultura Tropical para Investigaciones y Enseñanza:

This institution has a broad regional responsibility and thus maintains the largest staff of investigators in agriculture in Central America and is capable of the most sophisticated work possible in the region. CATIE is undergoing an internal reorganization into three programs. Sustained Agricultural Production and Management, Improvement of Tropical Crops, and Integrated Natural Resource Management. CATIE is best located for the second of these programs because of its location in the hot, humid tropics. The type of research needed is indeed long term, for breeding and improvement need 10 years or more before significant accomplishments can be made (this is also true of the third program). The first program involves short term research in that it is supported by grants that may have a life time of 4-5 years. CATIE is not well-suited to adaptive research that involves rapid solution to immediate problems, nor is its location appropriate for many annual crops.

Victor Villalobos, Head, Program I, Improvement of Tropical Crops:

This project supports 12 PhDs, with plans for 21, and currently four technicians. Dr. Villalobos explained to us the

great push to make use of the germplasm CATIE has been collecting in Mesoamerica during the last decades. Within this germplasm a series of crops have been identified with export potential and thus for development at CATIE as follows:

Sapote: New elite germplasm is being collected. The trees on hand, and others in Puntarenas, have been evaluated and 13 potential varieties have been selected. A very successful grafting technique has been developed. Buds have been conserved in vitro for later grafting or for direct development as new trees.

Soursop: More germplasm is being collected. The existing germplasm has been evaluated and potential varieties have been selected and are being propagated by grafting. There is growing interest in this fruit. One important problem is a fly that infests the seeds.

Future possibilities: Passion fruit, of which there are beginnings of commercialization in the country. Macadamia, is being developed on the basis of four imported Hawaiian varieties. The Hawaiian Macaba Company is also participating in these efforts. While the plantations are advanced, many unforeseen problems are arising, especially in diseases and mineral nutrition. Still other crops of interest are pejibaye, an old favorite at CATIE, carambola, and arasá.

Achiote is under development as a source of its colorant, Bixin. The collection has been evaluated for total yield, and percent Bixin. Fifteen clones have been selected and are under evaluation. Some lines will produce eleven months after planting from seed. A major problem, susceptibility to Oidium

(mildew) still needs evaluation. The market situation looks good because of the need for non-hydrocarbon colorants, and samples sent to the market have been well received. There are 300 hectares planted to achiote in Costa Rica.

The germplasm collection includes 1500 collections of Capsicum (pepper or chile) Goals with this crop include preliminary evaluation and distribution to national programs. About 150 introductions are evaluated each year, but better criteria for selection are needed.

The roots and tubers project has included a large amount of research. Tisquisque (tannier) is practically disappearing due to the mal seco disease. Widely studied, there appears to be no easy solution to this spreading problem. Efforts are concentrated in yam (Dioscorea), and it has been impossible to fill the export market for this crop. There is some interest in dasheen and eddoe (Colocasia) but little in sweet potato for export. Market data are being analyzed at this time. The root crop collection is maintained in the field and in tissue culture.

Spice crops. CATIE has a good collection of these crops and is interested in their development, yet has done little. Black pepper has suffered from Phytophthora disease and resistant clones available elsewhere have not been obtained.

Plantains. Interest is chiefly on exploring the potential of somaclonal variation for use in non-traditional breeding schemes, in in vitro conservation of germplasm, preliminary testing for Black Sigutoka resistance, and the introduction of new types.

Carlos Burgos is involved chiefly with the annual crops as interim leader. These crops include principally the basic grains.

Jim French of the Integrated Pest Management project, explained the concerns of this regional effort. Insect disease, nematodes, virus, and weeds pests are under study in tomatoes, peppers, potatoes, cabbage, beans, corn, sorghum. These studies are carried out in 5 countries, as follows:

Panama: Tomato, pepper.

Costa Rica: Tomato, potato, cabbage.

Honduras: Potato, cabbage, corn.

El Salvador: Potato, cabbage, bean, corn, sorghum.

Guatemala: Tomato, pepper.

The decision for the specific problems under study were made on the basis of a joint analysis (national research institutions and CATIE) of crops and their problems in the aforementioned countries. This is a powerful project involving 11 principal investigators. This particular project is likely to contribute considerable basic information on the problems selected. No particular methods of extension are envisaged except scientific and extension publications. The project is not oriented towards export crops, nor does it have the flexibility to work with adaptive research on non-traditional crops.

The project is organizing a diagnostic laboratory that should make possible the identification of insect, disease, nematode, virus, and weed problems. Such a laboratory needs permanence, hardly achievable under the project limits.

Development of Tropical Crops: Cacao

Gustavo Enriquez and José Galindo

This major program of CATIE now covers chiefly the long term research and development of cacao. Cacao is somewhat intermediate to a traditional crop and a non-traditional export crop. The bulk of the production goes to the American market. Cacao production in Central America is threatened by increased world production, especially in Brazil and Ivory Coast. Nevertheless, Central American cacao holds an edge due to its superior quality (from a genetic standpoint) and quality could be better improved by using known fermentation methods. The market for cacao may be improving. The type of variety produced in CATIE is similar to a synthetic variety. It is a mixture of hybrids of selected parents. The seeds, all F_1 , are produced by hand pollination but theoretically could be produced in isolated crossing blocks. About 226 such crosses have been made and evaluated. This mixture, with a broad genetic base, protects against diseases.

There are many diseases of cacao in Central America (mainly, Black Pod, Ceratocystes, and Moviliasis). The most menacing of these is Menilia, a fungus disease that can destroy up to 98 percent of the pods. Because of this disease; plantations have been abandoned in many areas. Partial biological control technique has been developed that could be especially useful in the future. A broth culture of the antagonistic bacterium involved is simply sprayed with a back-pack apparatus. In commercial fields a package of control measures are recommended which include weekly inspection and removal of diseased fruits. Good attention to recommended practices reduces disease to tolerable levels.

At the present time there is great interest in distribution of improved materials and technical know-how throughout Central America, an effort supported by CATIE, FHIA, IICA, and ROCAP with 2 1/2 million dollars over three years. This is part of the Regional Agricultural Technology Network.

ASBANA (Asociación Bananera Nacional), José Antonio Guzmán
Director of Investigations

ASBANA was created in 1961 by the government banking system and private banana producers of Costa Rica, in order to help 16 banana exporting organizations with financial and production problems, and to orient the government on appropriate policies. ASBANA receives support funds from the original sources and from agricultural services it has developed. The organization has been highly successful and has now turned its attention to the area of new crops for exportation; but without losing its commitments to banana, it works in investigation and in development. Applied research findings and recommendations are well reported in its trade journal, *Diversificación Agrícola*. According to José Guzman, diversification is sought as a road to stability.

Screening of potential crops was begun in 1965, but over time most were eliminated from further consideration since funds were not sufficient. The five agricultural crops mentioned here, as well as shrimp constitute the chief diversification programs.

Coconuts have been developed as a fresh export crop, and with the hope of industrialization for copra, oil, coir fiber,

and charcoal. The research has included introduction and testing of a wide variety of coconuts. There is some export of coconuts at the present time, yet this is a slow crop to establish. It appears to have a good future even though a processing plant has not yet been developed.

The soursop has been studied from a variety standpoint. Whereas little variation has been found in fiber, sugar, and acidity, there are great differences in fruit size and total production. A clone has been selected that bears large numbers of small fruit suitable for export, it has not yet been commercialized. A frozen pulp product was developed with help of the University of Costa Rica. The soursop production system has been extensively studied. Good technology is necessary for adequate production. Trees can begin to produce in as little as 2 1/2 years. There are no organized plantations nor systematic exploitation, but the potential is there.

Pejibaye has been developed as a crop in cooperation with UCR and CATIE. It is now being exported for the heart, palmito, and about 1,500 hectares are planted, chiefly from seed. The production system developed is adequate with a recommended technological package. While superior clones have been propagated in tissue culture, there has been a problem in establishing them in the field. Some work on propagation and selection still appears to be desirable.

Black pepper, a major spice crop, has suffered from Phytophthora, a limiting root disease in all production zones. ASBANA claims to have a useful chemical control. Other studies have included plant density and staking systems. Effects of fertilizers will be studied.

The plantain has been studied for increased export. The limiting factors are Black Sigatoka disease and clonal instability. ASBANA is interested in a tissue culture lab for producing somoclonal variants in cooperation with CATIE. Experimentation includes Physiology and mineral nutrition. The program is limited by insufficient funds.

ASBANA maintains two experiment stations, in Guápiles, and La Lola, Limón. Laboratories in phytopathology and nematology, currently in San José, will be moved to Guápiles. At present ASBANA has two technicians (ingeniero agrónomo) in plant nutrition, one in entomology, one in phytopathology, and three in agronomy.

Universidad de Costa Rica: Laboratorio de Biología Celular y Molecular. Rodrigo Gámez and Carmen Rivera.

This center has been developed outside the formal structures of Faculties and Departments as an associations for purposes of research. The center maintains well kept and well used laboratories, and yet has funds available through BID for an even more modern and extensive laboratory. Much of the support has come because of a long and fruitfull project on viruses in edible plants. It is probable that this is the most advanced laboratory in virology in Central America, and practical techniques in biology, immunology, serology, electron microscopy, electrophoresis, etc., are in practice now. It plans to organize a diagnostic laboratory to identify and characterize viruses. The lab serves principally the needs of Costa Rica and yet has also accepted specific tasks from other countries. Dr. Gámez feels that in agriculture the risks of

viruses are chiefly with respect to the production of crops, and currently some severe virus problems are under study, including in bananas, potatoes, tomatoes, beans, papaya, strawberries, and sugar cane. In addition there are potential problems involved with increased agricultural exports in exporting undesirable viruses as well. Dr. Gámez is confident that existing techniques can confidently identify the presence of virus. These include testing for replicating RNA, for cytopatological inclusions in the cell, and by use of serology.

C. Discussion of In-country findings

Research and its quality:

Costa Rica is a highly institutionalized country heavily dedicated to agriculture and with a network of research facilities. Nevertheless, there are practical and financial problems in some aspects of the research network. CAAP is following a systematic effort to introduce three new crops each year following a set of priorities. Its methodology is very suitable for adjusting technology for immediate needs, but it is not in a position to follow up with short term research. The University and Ministry of Agriculture are highly interested in non-traditional export crops but limited by funding and traditional commitments. ASBANA, on the other hand, while limited by funds is not limited by ideas and appears to be doing a creditable job in developing new non-traditional export crops. This leaves CATIE, a large and powerful institute with broad responsibilities. It appears logical that much of the short term research needed for non traditional areas in Costa Rica as well as the long term development of some crops can and ought to be done within Costa

Rica but with potential for transference of technology elsewhere. The quality and consistency of work at CATIE has varied, however. The institution has appeared to be particularly susceptible to the requirements of donors, and this is particularly harmful to long term research. Thus, there is no security that research institutions can respond rapidly enough either to immediate adaptive needs or to short and long term priorities.

Crops, fields, and research gaps:

Potential export crops for Costa Rica are identified and research efforts estimated in Table 3. The priorities suggested are judgements based on the interviews made and comparison of viewpoints of various persons and institutions. The research progress is also an estimate, but suggests that considerable progress has been made throughout the country. Generally, pest control practices and post harvest treatments are less researched than varieties and production practice. Slow but definite progress can be expected in most of the crops suggested.

Costa Rica is in an excellent position to lead the isthmus in the production of several non-traditional export crops, including macadamia, black pepper, and palm heart. Research at CATIE, if pursued vigorously, could lead to the export on a significant scale of achote, soursop, and sapote. These are strengths that should be encouraged by research support.

The long term research in cacao at CATIE is a model of what can be done and what needs to be done in many important crops. Research problems do not respond well to water faucet type funding (turn-it-on, turn-it-off).

TABLE 3 ANALYSIS BY CROPS AND DISCIPLINES FOR COSTA RICA

CROP	Suggested Priority ^{1/}	Varieties ^{2/}	Production Technology ^{2/}	Post Control ^{2/}	Post-Harvesting ^{2/}	Processing
<u>VEGETABLES:</u>						
Asparagus	3	4	3	3	2	N.A.
Broccoli	4	4	3	2	3	N.I.
Cauliflower	3	3	2	2	2	N.A.
Beans	3	4	4	3	4	N.A.
Bayote	2	5	5	4	5	N.A.
Cams	4	3	4	4	3	N.A.
<u>WILD FRUITS</u>						
Passion fruits	4	4	4	3	1	JUL 5
Strawberries	3	4	4	2	2	N.I.
<u>TREE FRUITS</u>						
Cacao	5	5	5	4	5	5
Cocadamla	5	5	3	2	4	DRY
Cujibaye	3	3	3	3	2	CAN 3
Montain	4	4	3	2	4	N.A.
Papote	4	2	2	2	2	N.A.
Poursop	4	2	2	2	2	JUL 3

CROP	Suggested Priority ^{1/}	Varieties ^{2/}	Production Technology ^{2/}	Pest Control ^{2/}	Post- Harvesting ^{2/}	Processing
<u>SPICES/MISC</u>						
chilote	4	3	4	3	4	DRY 3
Black Pepper	3	4	4	2	4	DRY 4
But Flowers	5	5	4	4	3	N.A.
collago plants	4	5	5	4	3	N.A.
almite	4	4	4	4	4	N.I.

^{1/} Suggested priority was rated as 1 (lowest), to 5 (highest)

^{2/} Existent research rated as 1 (non-existent), to 5 (very adequate)

Process named and priority suggested as 1 (lowest), to 5 (highest).

N.I. = no information N.A. = not applicable

CAN=canned, FRO=frozen, JUJ=juice, DRY=dry

Assessment of extension capabilities:

Few persons in the entire country are trained in conventional agricultural extension. New technology is not easily obtained by a farmer unless he belongs to an organized group or cooperative. These groups consist mostly of farmers of intermediate sized farms. New technology is transferred formally through meetings of the cooperative, training courses sponsored by an agency, such as CAAP, and by an informal grass roots process.

With respect to non-traditional export crops, the degree of interest is high, and yet a relatively small fraction of farmers are producing these crops. Thus, extension is a fairly easy process.

CATIE has only limited extension facilities. The Ministry of Agriculture employs a few persons in extension and these are dedicated almost entirely to basic grains. The experiment station Fabio Baudric is not very capable with non-traditional export crops. Thus CAAP is the agency most likely to train farmers. CAAPs policy of starting new work on three high priority crops each year, and dropping efforts after 2-3 years, leaving a simple production bulletin and trained farmers is a good strategy for Costa Rica. ASBANA works principally with an associated group of farmers who are likely to test and adopt readily its findings.

D. Within country recommendations:

That new research should not be contemplated until better

ways are found to exchange technical information and development news within Costa Rica and the region so that a synergistic effect can be realized and duplication avoided. An example of duplicative effort is the interest of CATIE and ASBANA in developing somoclonal variants of plantain in tissue culture, when FHIA in Honduras is interested in exactly the same task (and, has the best germplasm resources). It does not make sense economically, nor from the standpoint of regional development, to develop competing programs, unless research is clearly complementary.

2. That sufficient short and long term support be given for six non-traditional tropical export crops of high potential: black pepper, achiote, pejobaye (as fruit and as palmito), sapote, soursop, and macadamia, so that these crops can become important crops for Central America.

Section IV El Salvador

A. Country Background:

A small country with a relatively dry climate, El Salvador has been one of the poorest of the Central American Countries. Nevertheless, there are several features that might suggest possibilities for future development. The coastline is indented in some areas by prominent estuaries. There are several large lakes. Much of the land is relatively flat, yet there are prominent volcanic peaks and some mid level plateaus. In spite of high population densities, much land is still available for development. Poverty is widespread, and thus farm labor is abundant and of high quality.

El Salvador's economy has been characterized by relying on export crops such as coffee, cotton, and beef cattle, and these agricultural industries have been controlled by a few powerful families. The country also has many small farmers that have produced the traditional basic grain food crops. The agrarian reform has placed large numbers of untrained small farmers in a position to contribute to their country economy. USAID predominantly, and other international agencies, now as well have done much to develop the infrastructure for agriculture and its institutionalization. There is still much more to be done and very large investments in aid are underway.

B. Organizations, Institutions, and Personnel Visited.

CENTA, Centro Nacional de Tecnología Agrícola:

Oscar Coto Amaya, Head, Department of Horticulture, José Enrique Mansilla, Division of Investigation, René Pérez Rivera, Plant Genetic Resources Program.

CENTA is a very large research organization dedicated to basic crops in El Salvador. It has had as many as 5,000 employees, but due to a transfer of extension personnel to another agency and a policy of austerity it now embraces only 1,000. Only about 23-30% of the salaries of these employees are paid by the government. All the rest, including operations, is paid by about 25 funding agencies.

The Department of Horticulture is divided into 4 areas with number of research leaders (ingenieros agrónomos) as follows:

Vegetables, 5 technicians (cabbage, cauliflower, broccoli,
cucumber, tomato, green beans)

Fruits, 5 technicians (mango, avocado, pineapple, papaya,
temperate fruits)

Genetic resources, 6 technicians (preservation and research
of native crops,
collection)

Water management, 1 technician (demonstrations of production
with irrigation)

The most important crop responsibilities of these sections are noted above.

Most of the funds of CENTA are used for research with either the traditional export crops (sugarcane, cotton, cattle)

or basic food grains (corn, rice, sorghum, and beans). There is also a strong commitment to oil crops. Technical personnel include about 11 "Ingenieros Agrónomos" and 25 chemists. The organization maintains 11 service laboratories such as soils, control of quality, nematology, seed quality, etc. There is a strong program on production of seeds.

Some of the more interesting (in terms of potential exports) small scale program priorities include colorants (achiote and marigold), unexploited fruits (sapotes, cashew) and spices (tumeric). Temperate zone fruits are under investigation at Las Pilas Experiment Station, at 1000 meters of elevation.

There is a growing cooperation between CENTA and FUSADES in that the latter is not equipped for other than adaptive research. A few technicians and consultants work directly with FUSADES needs. Especially important are larger scale tests including statistical analysis, and trails of irrigation technology.

CENTA has its hand full with technological research for the country itself and thus has practically no resources for new export crops. Nevertheless, the total resources are large, and the crop possibilities very diverse.

USAID/El Salvador

Frank Skowronski, Agribusiness Coordinator

Some basic questions concerning El Salvador's agricultural development were discussed. Mr. Skowronski sees the

year-round tropical climate as a definite asset for the country, especially where drought can be overcome with irrigation. He believes that the production of fish, shrimp, crab, etc., is a great opportunity for the coast, in the estuaries and the lakes. Shrimp are currently produced in 200 hectares of land, and the area is expanding rapidly. He asks what will happen when "everyone" is producing for window markets. He is very much interested in processing of foods to avoid window market effects. Efforts are underway to attract major processors such as Del Monte. Some name brand processors are already in the country (Quality Foods, Griffin, and Brands) and there are several smaller processors producing for local markets. Processing could be the solution to market surpluses and rejects. He estimates that non-traditional export crops may be reaching 20 million in value, and that much growth is still possible.

As a strategy for development Mr. Skowronski thinks of the U.S. Pacific coast as the most likely market, clear to Alaska. He would like to see efforts concentrated on a few crops that prove to do very well in El Salvador.

The needs for research for the future were discussed in terms of the institutions available. The very practical and immediate problems should best be left in the hands of FUSADES, (Fundación Salvadoreña para el Desarrollo Económico y Social). ASPENT, however, can fill a useful role in feedback as it becomes acquainted with such problems. CENTA (Centro Nacional de Tecnología Agrícola), the government supported research organization, has a long history of contributions to the agriculture of El Salvador, and yet suffers constraints in budget and policy. ENA, Escuela Nacional de Agricultura, might

be able to participate in short term research through its programs with students. The possibility of research at the Universidad Nacional and the Universidad Tecnológica exists. The former has a farm; the latter is planning a bachelors degree on irrigation technology.

Antonio Gonzales, Agribusiness Agricultural Manager, and Rodolfo Cristales, urged USAID support of research in diversification. All efforts are channeled through FUSADES. Such aid comes through three projects in support of diversifying agriculture. In addition aid is provided (\$10 million) for a Water Management Project where CENTA, FUSADES, ENA, and CENCAP will participate in developing export crops through financing production and irrigation equipment primarily.

FUSADES, Mario Molina, Manager

Pablo Alvarado: Fundación Chilena

FUSADES begun in 1985, and was organized as a private sector entity to promote the development of non-traditional crops. It is financed almost entirely by USAID. It has a variety of interests, non-traditional crops, processing of crops, promoting small enterprises, irrigation programs, and development of infrastructure. The Fundación Chile was contracted to study the prospects of producing non-traditional crops for export and for import substitution. A published report is now available. Crops selected for export are honeydew and cantaloupe, watermelon, cucumber, zucchini, and snap beans. Crops for import substitution are potatoes, onion, cabbage, tomatoes, and carrots.

As a second step, three areas were selected for trial plots, San Diego, Chalchuapa, and Valle de Zapotitlán. These represent areas where irrigation infrastructure is or will be available. About 10 varieties of each crop were evaluated in small plots planted monthly or bimonthly, and from this study selections of appropriate varieties have been made. The third step has been to organize larger trials of the selected crops, followed by commercial sized trials. Some other crops have now been added to the list, including brussel sprouts, broccoli, cabbage, cauliflower, green pepper, okra, and black-eye peas.

The possibility of production in El Salvador is closely related to the availability of irrigation. FUSADES has employed two technicians from Israel to set up and demonstrate efficient and low cost irrigation systems.

As pointed out by Mr. Molina, numerous production problems have been encountered, first, working with melon producers, and now in the practical trials. FUSADES is not developing technology but is copying technology developed elsewhere. That technology must be adjusted to the ecological conditions of El Salvador, and this frequently requires some study or research. However, the problem of development is so large that the tendency of FUSADES is to move ahead with new crops as quickly as successful exportation is achieved. FUSADES wants to develop fairly simple publications on the production and preparation for export for each crop, and to get these directly to farmers. There is a consensus that short term (3-5 years) and long term research is not appropriate at this time. There is, however, a need for adaptive research, trials made yearly devised to resolve specific technological problems. Because the important problems are constantly changing, FUSADES would

welcome a type of research support that made funds available on a very short term basis for immediate field experimentation.

ASPENT,

Pedro Urquilla, Director.

ASPENT is practically a one-man operation, but appears to be efficient due to the dynamic qualities of its director. Its main functions are to give guidance to producers, and its roles are still under development. In addition Mr. Urquilla has numerous suggestions for FUSADES based on his own experience as a farmer.

C. Discussion of In-Country Findings

Research and its quality:

Research in El Salvador is evidently hampered by lack of financial resources due to prevailing socio-economic conditions. In CENTA, the research institution in El Salvador, operational costs (30% of its total budget) are financed through projects; particularly by the local AID Mission. Also, personnel costs (250 persons) are covered by this Mission. Qualified trained personnel are also insufficient for the mandate of CENTA. A critical mass, both in terms of economic resources and personnel is needed in order to facilitate efforts geared towards conducting applied research in support of export crops.

Applied research efforts in El Salvador have been traditionally of acceptable quality, and well oriented.

Crops, Fields and Research Gaps

Current and potential export crops, fields and an assessment of research is present in Table 4. As indicated elsewhere the figures represent weighted judgements by the authors and thus, are valuable only on a within-country basis with respect to relative importance of the scored headings.

TABLE 4 ANALYSIS BY CROPS AND DISCIPLINES OF POTENTIAL EXPORT CROPS FOR EL SALVADOR

Crop	Suggested Priority ^{1/}	Varieties ^{2/}	Production Technology ^{2/}	Pest Control ^{2/}	Post-Harvesting ^{2/}	Processing
<u>VEGETABLES:</u>						
Baby Corn	4	2	3	3	N.I.	3
Black-eye Peas	4	2	3	2	N.I.	3
Broccoli	4	2	3	2	Tech 4	N.A.
Brussel Sprouts	3	2	3	2	Avad 4	N.A.
Cauliflower	3	2	3	2	4	N.A.
Cauliflower	5	3	4	3	4	N.A.
Cucama	2	2	4	4	N.I.	N.I.
Celion	5	3	4	3	4	N.I.
Okra	3	3	4	3	4	N.I.
Celions	2	2	3	3	2	CAN 2
Peppers (Cherry)	4	2	3	3	2	N.I.
Snap Beans	4	2	3	INS 2	2	FRO 3
Tomatoes	2	3	4	3	3	PASTE 4
Watermelon	4	3	4	3	3	N.A.
<u>FRUIT:</u>						
Mango	4	3	4	2	2	JUL 2
Passion fruit	3	1	3	0	N.I.	JUL 1
Pineapple	5	2	3	2	2	1
Guava	4	2	3	2	2	1

Crop	Suggested Priority ^{1/}	Varieties ^{2/}	Production Technology ^{2/}	Pest Control ^{2/}	Post-Harvesting ^{2/}	Processing
<u>TREE FRUITS</u>						
Avocado	4	4	4	2	3	2
Calmito	3	1	3	2	N.I.	1
Cashew	4	1	3	2	N.A.	1
Citrus	3	2	3	2	2	2
Honey	3	1	2	1	1	1
Mango	4	2	3	2	1	1
Sapote	4	2	3	2	1	1
Tamarind	2	2	3	2	N.A.	1
<u>SPICES/MISC</u>						
Achote	3	2	3	2	N.A.	1
Curcuma	3	2	4	•	N.A.	1
Marigold Petals	4	3	4	3	N.I.	DRY
Sesame	3	3	4	3	N.A.	2
Shrimp	5	N.A.	3	1		FRO 4
Vanilla	2	1	3	2	2	1

^{1/} Suggested priority was rated 1, lowest, to 5, highest.

^{2/} Existing research rated as 1 (non existent), to 5 (very adequate).

^{3/} Process named and priority suggested 1=lowest to 5=highest. N.A. = not applicable, N.I. = no information.

Can=canned, FRO=frozen, JU=juice, DRY=dry.

Within country recommendations:

1. New research in support of export crops should be prioritized only after having compiled and systematized existing information; particularly because research gaps will initially require fine-tuning of already existing knowledge to specific site.
2. Export crops for development of existing markets should be: baby corn, black-eye peas, melons, watermelon, and cucumbers.
3. Potential export crops that should receive support for applied research are: papaya, soursop, passion fruit, broccoli, snap-beans.
4. Support for long term research for CENTA should be provided for the development of crops such as: avocado, sapote, mango, mamey, and caimito.

Regional Analysis

Introduction and definition of terms:

For all of the non traditional export crops there are precedents that demonstrate that these crops can be grown in and exported from Central America. With the present level of interest in these crops one can expect considerable growth in exports catalyzed by the relatively small scale beginnings. It is now very appropriate to consider the kinds and amounts of research needed as well as localities for the research, in order to stimulate the beginnings already made. There are other important considerations as well.

On initiating the production of any crop it is very desirable to use as fully as possible the known technology. By obtaining production recommendations from other areas much will be learned of immediate value. Nevertheless, technology can rarely be transferred without local trials. Local production trials will always reveal minor or major problems that may require simple adjustments, but may also require more extensive study or research. It is difficult to predict in advance the problems that might occur.

Nevertheless there is a logical order in which problems of a new crop can be studied as follows:

- a. Varietal trials comparing the most likely varieties for the crop and uses envisaged. These will reveal problems of adaptation, quality, pest and disease, and production costs, and permit the preliminary selection of one or more varieties.

- b. Spacing trials with one or more varieties using reasonable fertilizer levels, to define these basic aspects of the production system.
- c. Using the selected varieties and spacings, finer trials of fertilizer requirements.
- d. Tests of pest and disease management.
- e. Post harvest trials. These may involve handling practices, containers, shipping temperatures, etc.

The practical problems associated with production and export of crops are not problems that are solved once and forever. There is a continual need for practical research to meet newly arising problems. Furthermore, problems tend to be local in nature and adequate solutions in one country or region may not be solutions in another.

Therefore, there is a continual need for research at a very practical level. One method of developing the research program is to work with practical problems as they occur. Most of this research will be adaptive research where methods developed elsewhere are tried and adapted in a particular region. This kind of research might be considered as development, and is referred to herein as adaptive research (AR). Research that requires 3-5 years of study, more sophisticated equipment, and more highly trained personnel it referred to herein as short term research (STR).

More basic research including development of new varieties by plant breeding, and development of new pest control methods, may be beyond the scope of development projects. Because basic research involves institutional development it may be appropriate for a developed project to address its STR needs through technical consultants and existing institutions. Nevertheless the long-term development of agriculture will need

the attention of permanent research institutions with long term projects (long term research, LTR) and dependable funding. Project type funding may be detrimental to the development of LTR.

Among the very high number of crops produced in Central America are those that can be produced in the temperate zone, including the USA, where opportunities exist to fill markets during certain seasons. Producers can enter this market readily and can make large amounts of money, or lose everything in a very short time due to volatile markets and frequent disastrous prices.

There is high risk associated with this type of production, and this high risk is not appropriate for the size and financial status of many Central American farmers. The lure of the buck occasionally obtained may tend to blind growers to the risks. Too frequently this has occurred in Central America. Appropriate research to increase product quality, and up to date information networks reduce but cannot eliminate the risk. Processing of food into long lasting forms reduces the possibility of loss, helps use market excedents and rejects, and permits marketing over longer periods. Central America probably needs stability in marketing more than top profits.

Another group of crops are these tropical crops for which markets already exist in the United States or elsewhere, but in which Central America has not participated sufficiently. The key to success with these crops is to use the competitive edge that some countries have in order to enter the market and to

sustain a position in the market. Some of these commodities (black pepper, macadamia, passion fruit juice) need only STR, and development of infrastructure (DI). Tree fruits and nuts, however, always need LTR.

A third set of crops include those that have not been marketed in the United States or have been marketed only on a small or irregular basis, but which are believed to have potential markets of varying size (achiote, sapote, pejibaye, pili nut, rambutan, soursop). These crops are not likely to enter the market unless sustained efforts are made to develop them (LTR). While this research is costly on a short term basis, it probably has more potential pay off over the long term, in increased earnings and regional stability. Perhaps the happy future exists with those crops.

Country advantages:

Guatemala: This country has a varied topography with large areas at altitudes which permit the production of temperate fruits and vegetables. It has a horticultural tradition and a well trained work force. Areas of lowland tropics are also very suitable for tropical fruits.

El Salvador: It is difficult to pick out the comparative advantages of this small country. Located on the dry side of Central America, agriculture must either be seasonal or sustained by irrigation. There are few areas in the highlands, and these should be used for the country's own food needs. El Salvador lacks a truly humid tropical region. The high

population density, however, means there is a large work force and a tradition of hard work. The agricultural export future of the country may include the development of export vegetables under irrigation, and the development of processing to employ labor, extend the season, and decrease risk.

Honduras: This country has a strong tradition of production of tropical crops in its northern belt, the germplasm of not only bananas but also of plantains, rambutan, pili nut, and sapote (chiefly unselected). The newly founded FHIA is likely to give Honduras an edge in research, and the underused facility at Lancetilla can be brought into service. Valleys of the mountainous interior are suitable for a wide variety of fruit and vegetable crops for export as well as for the basic food crops of the country. Research potentials of EAP should not be overlooked.

Costa Rica: With a rich and varied agricultural tradition and a wide range of altitudes and varied climates, Costa Rica could develop in almost any direction desired. Interest and germplasm might suggest the development of spices (black pepper now, perhaps vanilla later), specialties such as achiote, pejibaye as fruit and palm heart, plantains, macadamia, soursop and sapote. There are precedents and opportunities for each of these crops in the country.

A summary of research underway in the region

Introduction: Strong interest in the development of non-traditional export crops exists in all countries of Central America. This interest, which is not new, has been increased

by strong project efforts, and has resulted in a wide variety of activities, including:

Developmental activities (institutions, infrastructure, relationships, and networks)

Adaptive research, to adapt known technology to new areas.

Short-term research, to fill gaps as quickly as possible with practical technology.

Long-term research, to develop new crops and new technology and to solve difficult technical problems.

Of course, not all efforts are equally adequate in coverage or in quality. Therefore, gaps in research exist (to be discussed later).

Summary of research and related activities by time-frame category. Adaptive and short-term research. The major part of the research underway with non-traditional export crops is adaptive research. This type of research is appropriately concentrated at the country level, is and must be extremely flexible from year to year, is responsive to immediate needs, and varies in adequacy from place-to-place and time-to-time. There must be constant foment in this type of research. Furthermore, it is extremely difficult to predict needs for this kind of research, and the best type of support is a flexible support program.

Within countries, probably the best support of adaptive research is that of FHIA in Honduras where there is strong recognition of the nature of the research need, and a high level of technical competence. Success in this area depends on the ability of FEPROEXAAH to efficiently recognize and communicate research needs and the ability of FHIA to respond efficiently. A question exists either FHIA is interested in and can do the adaptive research required for a wide variety of crops or for crops of principal interest in countries other than Honduras. The system of CAAP in Costa Rica of working with the needs of a few crops for 2 or 3 years appears to assure the development of a body of capable farmers, yet there is some doubt that this can substitute for a continuous program in each crop.

On a regional basis probably only melons are receiving the amount of research necessary. Nevertheless, there is a significant amount of appropriate research scattered throughout all four C.A. countries visited. Badly needed as a prerequisite for any new research is to pull together the existing research into coherent, logical research reviews. This must be done on a crop by crop basis.

An overall priority of adaptive and short term research needs by crop is the following, by order: melons (including watermelon), asparagus, broccoli (including cauliflower and brussel sprouts), baby vegetables, Chinese cabbage, peas, cucumbers, tomatoes, and peppers.

Some of the necessary research is underway of the above vegetables, the Integrated Pest Management Project at CATIE

includes only tomatoes and peppers. In Guatemala, varieties are under study of broccoli, cauliflower, Brussel sprouts, baby vegetables, pepper, cucumber, and melón. In Honduras FHIA so far has emphasized chiefly melons. The varietal trial of potential export crops by FUSADES in El Salvador, with recommended crops and some others of intermediate potential are useful and is revealing some problems that need short-term research. While CENTA is a cooperator with FUSADES, it is not at all certain that CENTA will have the funds to make significant contributions. Thus, with respect to vegetable crops for the export market the purely adaptive research is marginal in coverage, and short term research is not adequate. Probably the only crops receiving adequate attention are melons (with the exception of virus control).

Long term research. None of the non-traditional export crops is receiving significant long term research support in C.A., with the possible exception of the germplasm collection phase. Some of the most promising of these crops and existing research are as follows:

<u>Crop</u>	<u>CATIE</u>	<u>FHIA</u>	<u>ASBANA</u>	<u>MAG</u>	<u>CENTA</u>	<u>DIGESA</u> <u>o ICTA</u>
Achote	Varieties					
	Production	--	---	--	--	---
Black pepper	Collection	--	---	--	--	---
Banana (specialty)	Collection,					
	Characterization	Collection	Collection	--	--	---
Brambleberries	-----	--	---	--	--	---
Cashew	-----	--	---	--	Collection	Collectio
Mango	-----	Out of	---	Varieties,	Collection	Collectio
		season production		Production		
Palmito	Collection	Interest	Collection	Collection	--	---
Piantains	Tissue culture	Collection	Production	--	--	---
		Full program				
Passion Fruit	Collection	--	---	--	--	---
Pili nut	-----	(Lancetilla,	---	--	--	---
		collection)				
Rambutan	Few trees,	(Lancetilla,	---	--	--	---
	Collection	collection)				
Sapote	Varieties	--	---	--	Collection	Collectio
Soursop	Varieties, Production	--	Collection	Collection	Collection,	Collectio
					Production	
Macadamia	Collection,	--	---	--	--	Collectio
	Production					

Note: Cacao is not included here in spite of its importance because it is a traditional export crop, and research is fairly well supported.

The native fruits tend to be taken for granted and few steps have been made to improve them. The introduced fruits and spices are often held in collections, but there is little effort made to develop production methods. A few of the above fruits, therefore, are known chiefly by experts. The only comprehensive research with these crops are the studies at FHIA, CATIE, and ASBANA.

A summary of Communication and Research Gaps

1. Diverse organizations associated with research and development of non traditional crops are not fully aware of what the other is doing nor are they fully cognizant of the literature available on their crops.
2. While there are indications that present institutions and organizations are interested in adaptive research, Government agricultural departments have little time or resources for such work.
3. The responsibilities of present regional institutions do not include more than limited research on non-traditional crops. The regional export federations are aware of research needs but in general are limited in what they can do about them.
4. FHIA appears to be developing a very useful project, and yet is not deeply involved in research on non traditional crops except for melons.

5. What appears to be a key problem in the 50 million dollar melon export business, virus infection, does not yet appear to be under study anywhere in C.A.

6. There is practically no research in processing of horticultural products in C.A. yet that kind of research and development is very necessary to complement production and reduce risks and losses.

7. The perennial crops which could give stability to C.A. exports are neglected by most institutions, although this neglect varies from crop to crop. Plantain, however, is not neglected and is probably receiving the research attention necessary.

Status of each Non Traditional Export Crop

Vegetables:

Asparagus: A perennial important vegetable of the temperate zone, now being adapted to C.A., used fresh, frozen, or canned. Very perishable. Technology developed elsewhere may serve here with principally adaptive and short term research. Markets with definite windows including high risks and high benefits. Of potential principally in highland areas of great potential principally in Guatemala and Costa Rica, yet of interest in Honduras and Panama as well. This crop requires 1-3 years before harvest can be begun, and then produces for 25 or more years. Some research attention is given at EAP but the crop merits short term research support if it is to become an important export.

Baby vegetables: This term has been used to cover the immature tender forms of a number of vegetables, including zucchini; other squashes, carrots, and others. These are non-traditional either locally or for exportation, but appear to have great potential in the U.S. market. Therefore, it is recommended that they be included in any short term research project envisaged.

Black-eyed peas: Also called cowpea. Of very minor potential as a non-traditional export.

Broccoli: A major vegetable introduced to Central America, adapted to cool regions or cool seasons, used fresh or frozen. Technology well-developed elsewhere would probably need serious changes here. Definitely a window market opportunity, suitable for highlands of Central American. Grown as an annual crop, usually from transplants. Expertise widely scattered. This crop receives little research attention (some varietal screening only) but merits short term research as a major export vegetable.

Brussel Sprouts: A minor vegetable crop with some export potential. Not recommended for short term research now. The diamond backed moth limits this and the following crop.

Cabbage: An important vegetable in Central America, but not for export.

Chinese Cabbage: An introduced vegetable still little known in Central America or USA, yet with great potential. Technology developed in Taiwan merits trial in Central America. Markets would need development for this crop. It is

a crop that merits short term research attention with the belief that this can become a major export vegetable, but over time.

Cucumber: An important salad vegetable, introduced, widely grown, and used as a fresh uncooked vegetable or for pickles. Technology is well developed elsewhere and successfully applied in Central America. The market is of the window type, very subject to fluctuations. It can be grown almost anywhere in Central America but is especially suited to winter production in irrigated fields. Cucumber is now receiving a little research attention, principally in terms of variety testing, at several locations. This crop can be a major export crop and deserves short term research to improve production technology.

Lettuce: A major vegetable crop, yet not recommended here for research as an export.

Melons: Several different introduced crops are included under this category for convenience (cantaloupe, honeydew, persian, and watermelons). All of these crops can be produced satisfactorily for export during winter months in Central America, and they are under study in all C.A. countries, with probably the best work at FHIA and ICTA. The technological problems are diverse, but require principally adaptive research. Because of their great potential as major export crops it is recommended that they receive short term research attention.

Lima beans: A minor vegetable crop of some export potential, not recommended for research now.

Mung beans: This crop of Asian origin is being developed for seed at EAP and could become an export crop. Its principal use is as a sprouted seed vegetable. Some type of developmental support is probably necessary to make this crop a reality.

Okra: An introduced minor vegetable crop of some export potential, no research is recommended at this time. Some research has been completed in Guatemala.

Onion: A very important vegetable for local consumption, onion is only a minor crop for potential export. The same can be said of the special type, the cocktail onion. No research is recommended at this time.

Peas: Introduced crops in Central America, the several forms of peas, snow peas, edible podded, and sugar snap peas, have a definite potential as crops for the US market. Produced in highlands and cool seasons. Technology developed elsewhere needs some adaptation to C.A. conditions. These crops are assigned here an intermediate priority, and no extended research is recommended at this time, with the possible exception of Ascochyta, a fungus disease.

Peppers: This term covers a wide range of crops of several distinct species that range from mild-flavored vegetables to intensively hot condiments. Paprika, a mild condiment is a dry milled type. Of great regional importance, widely adapted, some forms have export potential, especially the green, bell-pepper. There are many problems of insects, virus, and diseases, some of which will be limiting factors. Some research with these crops will be included in the regional integrated pest management project at CATIE, and no new research is recommended at this time.

Snap beans: Also called string beans and occasionally green beans, this vegetable is not of great importance in CA, but is of definite potential for exportation. Nevertheless, considering it as of intermediate priority, no new research is recommended at this time.

Tomato: A crop indigenous to the region, of great local importance, and with a tremendous market, tomato is widely adapted almost everywhere. With definite market potentials, nevertheless, there is tremendous competition in the market and rapid fluctuation in prices making this a very risky crop. Technology is available in abundance yet experience has showed that this technology is always location specific. Nevertheless, it appears highly desirable to develop export capacity in C.A., and short term research is recommended. It must be noted that much of this research is covered by the regional integrated pest management project.

Watermelons: See melons.

Yams: The most important yam of Central America is Dioscorea alata, introduced, although small quantities of yampi (Dioscorea trifida) are also found. This crop is being exported from Costa Rica and to a smaller extent, from Panama. The markets are eager and the future looks good. The crop has a number of production problems, but is receiving sufficient research attention in CATIE.

Zucchini: See Baby Vegetables.

Rapidly Growing Fruits

Brambleberries (raspberries and blackberries): Minor fruit with possibilities of growth. indigenous to Central America, but improved varieties are available elsewhere for introduction. Well adapted in highlands, used for fresh fruit, frozen, jams, wines. Technology developed elsewhere can be applied in Central America. Markets exist and probably can be expanded. Suitable for highland only. Crop can be established in 2-3 years. Very little research or expertise in C.A. Needs short term research.

Banana (specialty types): Minor crop, introduced but widely distributed, used as fresh fruit or cooked. Technology for principal banana crops can be adapted. Markets can be developed. Suitable for all countries of Central American, but especially for humid Pacific and Atlantic coasts. Can be grown as a crop in two years. Local expertise available. These varieties have received very little research attention and may need some short term research.

Passion Fruit: Minor crop in the tropics, the species desired is not native, introduced from elsewhere, widely adapted, used principally for juice. The market exists and probably can be expanded. Technology has been developed elsewhere (Hawaii, Puerto Rico) and probably can be readily adapted. Passion fruit is suitable for any part of Central America. The crop can be produced in less than a year and vines produce for 2-3 years. There is considerable expertise available in Hawaii, Florida, and Puerto Rico. Only adaptive research and development is needed.

Papaya: Important tropical fruit, possibly indigenous. Widely adapted but subject to virus and fruit fly problems in some regions. Used as fresh fruit, frozen, or nectar. Technology developed elsewhere can be transferred here. Needs local trials and adaptation, and some adaptive and short term research likely. The crop is produced in 11-12 months and production is continuous for 3-5 years. There is little research or expertise in C.A., but expertise available in Florida and Hawaii.

Pineapple: Major tropical fruit, indigenous, widely adapted, used for fresh and canned fruit and juice. Technology developed and widespread, may need some adaptation. Markets are large but highly competitive. Can be produced in all countries of C.A., and produces as a crop in 1-1.5 years. Probably needs only adaptive research. Expertise widely available.

Plantains: Important tropical fruit, introduced but widespread, adapted to the hot, humid tropics, used chiefly green as cooked vegetable. Market small but growing, larger outside the US. Suitable especially for Atlantic and Pacific humid costs but subject to Sigatoga Negra disease. Tissue culture is desired to produce variants. Interest in this crop is high. The crop can be produced in as little as 1 year and produces for about 5 years. Research underway at FHIA and CATIE merits long term support.

Strawberries: An introduced crop of importance, adapted to cool climate, used as a fresh fruit, frozen, or processed as jams and jellies. Technology developed elsewhere needs adaptation, and short term research will probably be necessary. The market is good, but with definite windows.

This highly perishable crop suffers problems of quality. Can be produced in less than 1 year and plantings last several years. Expertise is scattered, chiefly in the USA. This crop is risky for export purposes, needs adaptive and short term research.

Tree Fruits

Cashew: Potential important crop. Tropical, introduced to Central America, adapted to dry regions, often wild, especially in Panama, used for its fruits (jellies, wines) and its seeds (cashew nuts). Technology has not been developed in C.A. but can be transferred readily. Markets for the nuts are good, for the wine and jelly markets must be developed. Suitable as a crop for the Pacific side of all Central America countries, especially Panama. Long term crop. Expertise outside of C.A. and Caribbean. No current research. Research desirable in Panama.

Cocoa: Major crop of the tropics, probably indigenous to C.A., adapted to hot, humid tropics, used for its seeds, fermented as a source of chocolate and other subproducts. Technology has been developed and the crop is traditional in C.A., improved materials available through CATIE. Markets are strong and continuous but long term might be affected by world over production. Suitable as a crop in lowland hot, humid regions, especially the Atlantic Coast. Long term. Breeding and production as well as expertise in CATIE. Continuous research and development effort desirable.

Citrus: Potential major crop, subtropical, all types were introduced to C.A., adapted to somewhat dry and somewhat cool

conditions, but widely grown. Used as fresh fruit or juice, often concentrated. Technology has been well developed and most is transferable. Local adaptation of technology is desirable. Markets are large and continuous but influenced by US and world production. Can be produced as a crop in all of C.A. But, conditions are not optimum for competitiveness in international markets. Long term Research and expertise developing in FHIA, further research not recommended now.

Coconut: Major crop of the tropics. Tropical, possible introduced before Columbus, widely adapted, especially in coastal strands. Subject to an important limiting disease, virus yellows, used as fresh fruit, dried as oil source (copra). Technology is developed and mostly transferable. Market is fairly large for copra but prices are marginal, market for fruits is small. Suitable for all coastal areas of C.A. Long term crop. Major expertise outside of C.A., perhaps Jamaica. Research underway in ASBANA.

Macadamia: Potential important crop, tropical, from Australia but developed in Hawaii, adapted to wet tropics, used for its edible nut. Technology developed in Hawaii is not perfectly suited to C.A. Numerous problems require short term research. Market situation excellent and can probably increase. Prospects for C.A. look good, especially on Atlantic side slopes and uplands. Long term crop. Expertise growing in Costa Rica. Needs immediate short term research support.

Mango: Major crop of the tropics, introduced and widespread, widely adapted, but especially suitable for Pacific (dry side) of C.A. Used as fresh fruit and processed frozen,

canned, as nectar. Market is expected to be large. Fresh marketing limited by fruit-fly problems, and frozen and nectar markets poorly developed so far. Suitable for all C.A. countries. Long term crop. Expertise local, EAP, and in Florida. Research programs in Fabio Baudrit and Los Brillantes, needs short term, especially processing research, interest exists in FHIA in promoting out-of-season production.

Pejibaye: Potential important crop, indigenous and well adapted, used for its vegetable-like fruit and for its palm heart. Technology exists principally in C.A. Market situation expected to be good for processed palm heart, less for the fruits, suitable for upland areas, especially on Atlantic side slopes. Long term crop. All expertise local, especially in CATIE and in Los Diamantes. Needs long term research to develop its potential.

Pili nut: Potential important crop, introduced from tropical Pacific-Asia area. Adapted to hot humid tropics, used as a fresh and processed high quality nut. Markets are not developed due to lack of production but potentials are very high. Suitable for Atlantic coast. No expertise in C.A. except one horticulturist in FHIA. Germplasm available in Lancetilla and EAP. No current research. Needs long term support to make this crop a reality.

Rambutan: Potential important crop, introduced from Southeast Asia, adapted to hot, humid tropics, used as a fresh, frozen, or canned fruit. Markets are not developed due to lack of fruit, but expected to be large. Suitable for Atlantic slopes. Grown as a minor crop in Costa Rica. Germplasm available in Lancetilla and a small amount at CATIE. No expertise in C.A. No current research. Requires long term research to make this crop a reality.

Sapote: Potential important crop, native to C.A. and adapted to somewhat dry regions of tropics, used principally for its fresh fruit, excellent frozen as well. Technology developed in Florida needs adaptation here. Markets are beginning to grow in the USA with excellent prices and expected future. Long term crop. Clones selected at CATIE, production techniques developed. Expertise developing locally, especially CATIE. Short term research increase immediately needed, and long term support justified.

Soursop (Guanabana): Potential important crop, native to C.A. and well adapted, used as fresh fruit or processed frozen or as concentrate. Markets underdeveloped due to lack of product but expected to be good. Suitable for all C.A. countries. Long term crop. Varieties have been selected at CATIE and ASBANA, production system more or less developed. Local expertise growing in C.A., and long term research support is desirable.

Spices and miscellaneous crops

Achiote: A minor crop, tropical origin, possibly native, widely adapted, especially in the humid tropics, used for its fatty carotenoid cover of the seed, to flavor and color foods. The technology is not complex, well developed, and mostly applicable. The market is growing because of a need for non-hydrocarbon colorants. The crop can be grown to maturity in one year and lives for several. It is suitable for many areas of C.A. Research is underway at CATIE but may need some push to bring it to commercialization.

Black Pepper: Introduced major spice of high value, adapted to hot, humid tropics, used as white and black pepper. Technology is available and it appears that control of a major limiting disease, Phytophthora, has been achieved at ASBANA. The market is constant but not very flexible, must not be saturated. The crop needs 1-2 years to begin production and production continues 5-10 years. Suitable only for limited areas of high rainfall, principally on Atlantic slopes. If, indeed, the disease can be controlled, this crop needs mostly development efforts.

Cardamon: Important spice crop already grown and exported in the region, suffers from overproduction and low world prices at this time, and no new research or development efforts are recommended (except probably for cardamon mosaic resistance through hibrid production).

Cut Flowers: Includes many separate crops of varying adaptation and promise. This is a major field, highly lucrative, yet with a definite saturation point. The entire subject merits separate and complete evaluation, and research would be desirable. It is suggested here that this research and development be left to the private sector.

Foliage Plants: See comments for cut flowers.

Ginger: An important spice crop introduced from the orient, adapted to regions with a long rainy season. Used as a fresh vegetable, dried and milled, or extracted, and for ginger ale. Technology well developed and successfully applied on a small scale in Guatemala. Suitable for limited areas on Atlantic slopes. No research in progress, and none recommended now.

Luffa or Sponge gourd: A very minor crop even though well adapted. No research can be recommended now.

Palmito: A generic name covering palm hearts of many species, but especially pejobaye. See under Tree Crops.

Paprika: See under peppers.

Vanilla: An important spice crop of the tropics, native to Mexico and possible some regions of C.A., adapted to hot, humid tropics. Technology developed elsewhere at a primitive agricultural level needs better trials in C.A., two limiting factors present, a disease, Fusarium, and need for hand pollination. Adapted only to very rainy zones, may be uneconomical to produce. While research is needed, it cannot be recommended at this time.

Seeds, flowers: See remarks under "cut flowers".

Seeds, vegetable: This category involves a wide range of crops. The technologies are appropriate mostly for the Pacific (dry sides) of all C.A. countries. This is a specialty that merits separate study and development, with the belief that opportunities exist for export from C.A.

Status of Important Disciplines for Export Crops:

1. Basic Research: in applied biological fields is lacking in the region with exceptions in Taxonomy of native plants (in Guatemala, Costa Rica and Panama) and in virus identification and characterization at the Laboratory of Molecular and Cellular Biology of the Universidad de Costa Rica. Assessment of nutritional quality of plant foods as well as improvement of such attributes is being performed at INCAP (Instituto de Nutrición para Centro América y Panamá) in Guatemala and at CITA (Centro de Investigación de Tecnología de Alimentos) in Costa Rica.

Important contributions are also being made by ICAITI (Instituto Centroamericano de Investigación y Tecnología Industrial) in Guatemala, and CIPRONA (Centro de Investigación para Productos Nativos y Autóctonos) in Costa Rica.

2. Plant Breeding: efforts in this field has traditionally been placed in basic grains (maize, sorghum, dry beans, wheat) due to their socio-economic importance and to the continuous support of International Research Centers. There are a few examples of breeding vegetable crops: a) in Guatemala: Mass selection in Mayan Sweet Melons and b) in Panamá: fresh market tomatoes and pepper breeding. Fruit breeding efforts in the Region are done by FHIA (bananas and plantains); by CATIE (cacao and in evaluation of the potential of somaclonal variants in plantain).

Assessment of nutritional quality of some potential

export crops is underway in : a) CATIE (achiote, cacao, pejobaye fruits, peppers and native cucurbits); b) in CIPORNA (achiote, peppers); c) in INCAP (amaranthus); d) in ICAITI (cashew); e) in the Los Diamantes Experiment Station of ASBANA (pejobaye fruits). Assessments of nutritional characterizations and other quality characteristics in sapote, guanaba; passion fruit, carambola, and palm hearts of pejobaye, are lacking in the region.

It is evident that the development of quality standards for these crops is imperative if export markets are to be developed. Additionally, this kind of information is essential for simple or more sophisticated methods of breeding or selecting superior crop types for export. The development of quality selection criteria for use in plant breeding schemes of the above mentioned crops should receive the highest priority in order to develop a truly competitive edge in these potential export commodities, in crops for which countries in the region are particularly well adapted for their production. It should not be forgotten that viable production alternatives for the humid tropics of the region are in need in order to partially counteract deforestation and make rational use of the low land humid tropics that represent around 50% of the land in the region.

Local production of seed and planting materials is a field related to breeding that is also highly neglected and should be given due consideration. One should not assume that planting materials of sapote, guanabana, macadamia, etc., are available in adequate amounts for planting in 50 or 100 hectare plantations (or even lesser amounts). Due to the

long-term nature of fruit tree production, special breeding schemes are required that will ensure a wide-genetic base for disease and insect resistances. These special schemes are not developed but a good example can be found in cacao at CATIE. Immunity to diseases and other pests has no place in tropical ecosystems, due to their highly dynamic biological nature. In addition, variety testing for specific purposes such as dehydration should be performed in the near future.

With respect to seed and vegetable production, every effort should be made to establish formal linkages with the Asian Vegetable Research Center (AUROC) in Taiwan, in order to network their expertise in Tropical Vegetable Production.

3. Pest Control:

Important efforts have been traditionally made in the field of plant pathology (particularly fungus diseases) and entomology in the Region. Areas such as nematology, virology weed control, and bacteriology have been highly neglected overall. Development of pest control measures has been emphasized with respect to basic grains; to a much lesser extent in vegetable crops and almost nonexistent in fruit trees, with recent notable exceptions in cacao (pod rot, monilia and ceratocystes); bananas and plantains (black sigatoka and nematode control); coffee (coffee rust and coffee seed borer); various fruits (med fly control through male-sterility and pesticide applications).

Integrated Pest Management strategies and tactics, particularly for export crops are a very highly felt need in the region. Considering the fact that if irrigation is available, crop production in dry climates in this Region can be accomplished in a continuous way and that tropical agroecosystems are more complex, the development of

integrated pest management schemes should be high in a priority research list for the region. The presence of well known and still probably undiscovered beneficial organisms should be seriously taken into consideration, particularly if sustainable and an ecologically sound agriculture is to be sought in the future. The introduction of biological agents as well as the rearing of important native and useful organisms should be supported in the long run. Relevant examples in this area are black sigatoka and moniliasis control by antagonistic bacteria in plantains and cacao respectively, at CATIE.

IPM projects are only underway in Zamorano (basic grains), at CATIE (vegetables such as: tomato, peppers, cabbage and potatoes and, maize, beans and sorghum), and in El Salvador (cotton primarily).

Poor pesticide management in the region is wide-spread due to various reasons and it is particularly prevalent in high value crops. It is noteworthy that evaluation of pesticides as to effectiveness and residuality is, in general, not the responsibility of specific institutions in the region. Rapid development of pest resistance to certain agrochemicals may be prevalent (Example: diamondback moth-Plutella spp., in crucifers).

4. Crop Physiology:

There is considerable experience in soil testing in the region, but information is dispersed and not structured in useful ways. Experience in fertilizing vegetables and fruits (particularly the ones mentioned in this document) is limited; phenological absorption studies of major nutrients

is almost non-existent. Fertilizer placement experiments and problems of phosphorus fixation and nitrogen volatilization have not been addressed in a significant way in the region. Little attention is being given to crop rotations; green covers; alley cropping systems and organic matter maintenance.

Novel and/or commercially valuable propagation techniques is another applied field that will be required in the future, particularly as support for plant breeding schemes and commercial production of registered materials.

Cycle manipulation of crops and management of irrigation water as it applies to the different water application methods is also in need in the region.

5. Post harvest: Produce Handling, Grading, Quality Control and Losses

Practices in this field are tailored after US standards, mainly. Adequate information is available abroad and should be carefully gathered and diffused. Nonetheless, local expertise at a country level should be developed, particularly in the practical aspects of classifying and packing potential export crops. The local guilds of producers and experts should have personnel trained in this area.

The diagnosis of postharvest pests and particularly physiological disorders have been important causes for produce failing to reach export markets (Example: boron and calcium deficiencies in crucifers and celery; soft roots caused by Erwinia, etc.). Diagnostic capacity, although low, should increase with the regional diagnostic network being promoted by CATIE-IICA, in the Region.

Specific quarantines are in effect in the region, particularly for mango, other native and exotic tropical fruits and deciduous fruits. Even though this could be circumvented by exporting frozen or processed products, chemical and other treatments are in need and should be adequately evaluated and put to use.

Specialized equipment for treating with chlorinated water, hydro-cooling, vacuum cooling, waxing are not common in the region.

RECOMMENDATION

1. No new research projects with non-traditional export crops should be initiated until mechanisms of interchange of information are developed. Both within and among countries there is a lack of knowledge of problems, activities, and successes of other organizations. This results in wasteful and duplicative efforts, sometimes expensive. Even where communication is open frequently there is broad knowledge but lack of important details. Furthermore, there sometimes exist competitive or jealous attitudes that tend to hide details. Even USAID supported organizations are not free of these problems. The net result includes an inhibition of the developmental process.

A cumbersome information network involving major regional or national institutions is not recommended. Such institutions become involved in their own program building activities. A question and answer service cannot be recommended for the details of daily correspondence

overburden the system. A service directly to individuals would quickly lead to unworkably long mailing list.

To resolve this need, a one-man operation is suggested. This person would need as his qualifications a broad knowledge of the region and its organizations, institutions, and key persons, the personal charm and abilities to communicate and work freely with many persons at many levels, a broad knowledge of crops, the ability to absorb information, judge it and integrate it, and the ability to communicate clearly by word and by writing. This person would need the services of an office, secretary, word processor, and printer. He would need support to travel.

The task of the information specialist would be to gather detailed information on each crop, varieties, production techniques, pests and diseases, treatments, yields, post harvest aspects, containers, shipping, markets, and their seasons, one crop at a time, and to distribute this information in periodic (frequent) newsletters to all organizations, institutions, and key personnel of the region. While each newsletter would feature one crop, a portion of the newsletter would report any urgent or up-to-date information on other crops. These newsletters would be freely available on request. The person in charge would encourage unsolicited news through correspondence, but would also develop the news through phone calls, travel, and first hand inspection.

A suggested budget for this operation would be \$150,000 annually. This would be little for the benefits expected. The funds could be part of a present or future project

providing that the key elements of the recommendation are maintained.

2. A flexible research support fund should be used to address the adaptive research needs of crops currently being marketed internationally. As externally developed technology is used to initiate or enrichen the production of crops for exports, it will always be found deficient. Furthermore, production, post-harvesting, and shipping problems will always exist, and thus there will always be a need for adaptive research. The precise needs cannot be predicted in advance and thus are not subject to detailed planning. Funds are needed that can be used for very short experiments designed to resolve limiting factors as they are detected. This type of research would be very pragmatic, snort term, would result in brief, explicit reports to the funding organization to be distributed immediately through the information exchange network. This type of research would sidestep the complications of institutions including institution building, hiring of personnel, costly overheads, lengthy review process and the restrictions on technical publications. It would be subject to requests and justification for funds, research plans and timetables, peer evaluations, and short periodic reviews; a legitimate research organization or research leader could request such funds. Funds would be released at the beginning of research, during the research, and final payment on receipt of the report. A budget of \$250,000 a year is recommended, and this would stimulate appropriate and timely information. These funds could be a part of a present or future project.

3. The diversification project at FHIA should be expanded to include short term research on new and non-traditional export crops, with a regional responsibility. Short term research as visualized here as research over a 3-5 year timespan. This type of research is needed to attack the numerous problems of non-traditional export crops that cannot be resolved by very short term or adaptive research, that need the facilities of laboratories, and that require highly trained technical competence. These facilities are available at several locations, as follows:

Guatemala: ICTA, DIGESA: facilities are needed for national program needs.

El Salvador: CENTA, but such facilities are needed for national programs.

Honduras: FHIA, the institution tends to have a national outlook, but is still young and flexible enough to be changed.

Costa Rica: CATIE, but the numerous commitments of CATIE impede the development of a new, short term research.

Research under this project should be practical, responsive to real, definable needs, and manageable within the time-span visualized. Virus research with melons is an example of a current research need. It should be planned on a yearly basis, but plans should be flexible and modified yearly. It should involve permanent professionals, but the research might be subcontracted to other organizations (such as EAP) as necessary, and these might be in countries other than Honduras. The research would be subject to normal review procedures.

The suggestion is made that FHIA be selected for this research because of its dynamic attitudes, professional position, newness, and ability to manage the challenge. The existing diversification project would need to be broadened in scope, and new professionals would be needed.

Funds recommended are \$800,000/year. This amount would drastically change the nature of FHIA and move it towards a regional outlook. The funds should come from a new project.

4. A regional program of food processing should be developed to permit the use of crop seconds and excedents and to widen the number of exportable crops and products. Production of crops for export inevitable generates large quantities of rejects or seconds, and often, because of markets, of unsaleable prime materials. These materials could be processed into long-lasting products that could be sold on national, regional, and international markets. In addition, some potential export crops cannot be shipped because of extremely short lives or because of quarantine problems. These could be processed into exportable forms. Processing into frozen, dry, canned, and other forms can develop new markets and add stability to the production system.

The type of research envisaged by this recommendation is practical, short term (3-5 years) research highly related to present and readily available non-traditional crops. It would make maximum use of technology already developed within and outside of the region, and concentrate on attractive, inexpensive products. The research would be centered in an institution with a regional outlook on food processing, interest, and capabilities. Nevertheless,

research would be subcontracted as well, to smaller institutions capable of handling a distinct portion of the research. Some of the possible institutions are given below.

<u>COUNTRY</u>	<u>INSTITUTION</u>	<u>NOTE</u>
Guatemala	ICAITI	Regional responsibility, laboratories
	INCAP Universidad del Valle	" " Laboratories, demonstrated capability
El Salvador	CENTA	Laboratories and capability
Honduras	FHIA	Laboratories
	EAP	Modest facilities, interest, demonstrated capability
Costa Rica	TRONA	Laboratories, capability
	CITA	Laboratories, capability
	ASBANA	Great interest, facilities

The recommendation includes the development of linkages with major processors in the USA and with distribution networks, and foresees the need for cooperation and development through the national federations. The research would be planned on a project basis but subject to review and revision according to progress made.

This research would be done through a newly developed project and \$1,000,000 a year is recommended.

5. Principal tropical perennial crops with long term potential should be developed under long term stable funding. The history of development of principal export crops of the tropics is that long term research was needed to develop potentialities. These are precisely the crops that can bring stability of production and of income to Central America. Some tropical fruits have potential markets similar to that of banana. Other of these crops have smaller but long term stable markets. These particular crops have never received significant research support. While the list of crops is long, this recommendation covers the following crops only:

Achiote--as a non-synthetic coloring

Black peppers--as a principal spice

Sapote--as a new fruit, probably frozen or processed, for the American market

Macadamia--as the number one tropical nut

Soursup (Guanabana)--as a gourmet item with ready market

Pejibaye--as a gourmet salad item

Plantain--as a versatile, widely accepted farinaceous food.

Pili nut--as a nut crop of promise completely undeveloped in this hemisphere.

Rambutan--as a fruit crop of promise very little known in this hemisphere.

These crops vary in country of adaptation, in research done and research needs, in degree of ready access for marketability and in size of present market. However, these crops are widely known and appreciated.

The research needed with these crops is developmental in part, and in part basic, but in each case long-term. Because the germplasm, the precedents and the capabilities are widely and unevenly distributed, probably these crops should be developed under a project dedicated specifically to them, and at this time not subject to the pressure of immediate export needs.

Some institutions in the Region are particularly well endowed with highly qualified personnel and infrastructure and should be seriously considered in the development of the above mentioned crops. These are:

<u>Country</u>	<u>Institution</u>	<u>Note</u>
Guatemala	ICATI	Has generated valuable information in postharvest physiology and processing of avocado, papaya, mango, pineapple, cashew. Bioengineering applications in coffee pulp; cashew pulp and others have been developed.
	INCAP	Nutritional assessments of many native crops have been performed. Examples are: improvement of nutritional quality of dry beans; chickpeas; opaque maize, amaranth. Expertise is available in applied applications in food science. Very good facilities for pesticide residue monitoring.

Universidad
del Valle

A new private university with extremely good laboratories that is developing research programs jointly with private guilds of producers. Could very well participate in development of breeding programs; diagnosis of pests; chemical characterizations and tissue culture.

Honduras

FHIA

Particularly well endowed for providing services in foliar and soil analyses, diagnosing diseases and pests; testing of pesticides and for analyzing residues of pesticides. A postharvest physiology facility and a tissue, culture laboratory is available.

Costa Rica

CATIE

Specialized facilities for short and long term cold storage of germplasm; living collections of recalcitrant species; two tissue culture laboratories; growth chambers for in vitro conservation of germplasm and a heat-treatment chamber for virus inactivation are available. Fungus, bacterial, insect, nematode, and weed diagnostic facilities are available. Also, a small facility for rearing beneficial insects is in operation.

CITA

Very good infrastructure and personnel are available for food science research. Has the capacity for making important contributions in this field.

CIPRONA

Oriented towards conducting research in native crops. Should be capable of assessing nutritional characteristics of new crops. Has developed experience in pejobaye, achiote and peppers.

Funding of \$1,500,000 is recommended.

6. A program of basic research is needed for the long term development of annual crops that are shown by actual export to be of importance to the development of Central America

It is appropriate that the research underway and in the next few years with these crops should be adaptive and short term, using the technology developed outside of the region or, when present, within the region. As development proceeds, it will become increasingly desirable to conduct applied and basic research on these crops to provide inputs for a continuous, practical, pragmatic research program and to resolve complex and recalcitrant problems. It is not appropriate that this kind of research be initiated at this time, but it is time to begin thinking of the kinds of research to be done and the countries and institutions where such research will be desirable. It is somewhat early to specify crops except in general terms. Therefore, the kinds of research are best specified at this time in terms of discipline. The following, then, is a suggested outline of research needs for an unspecified tomorrow:

1. Breeding: Desirable for all export crops yet premature except for highly successful current exports (melons).
2. Integrated pest management: The current project by that name hardly touches on non-traditional export crops.
3. Crop physiology: Development of the understanding necessary for production systems including mineral fertilization, water management, spacing and cycle control.

4. Post harvest technology: Needed to reduce losses, maintain quality, and meet market requirements.
5. Processing technology: For keeping ahead in new product development, for assuring food safety and for nutritional considerations.

ANNEX I

A summary of Institutions, Organizations,
and Personnel Visited

Guatemala:

Instituto de Ciencias y Tecnologías Agrícola (ICTA)
Danilo González, Technical Director

USAID/Guatemala

Brian D. Rudert, Deputy Chief
Peter Alfonso, Agribusiness Development Project

PROEXAG (ROCAP)

José Mondoñedo, Production Specialist

Integrated Pest Management Project (ROCAP)

Mario Pareja, Country Coordinator
Edgar Alvarado, Research Specialist

Honduras:

Natural Resources

Leopoldo Alvarado, Director of Research

Escuela Agrícola Panamericana

Simón Malo, Director
Alfredo Montes, Head, Department of Horticulture

USAID/Honduras

John Warren

Benjamín Villanueva

Fundación Hondureña de Investigación Agrícola (FHIA)

Fernando Fernández, Director

Mario Contreras, Director of Research

Jarro Cano, Director of Communications

Panfilo Tabora, New Crops

PEPROEXAAH

Manuel Borjas, Director of Productivity

Costa Rica:

Ministry of Agriculture

Jesús Fernández, Director

Francisco Alvarez, Subdirector for Research

Bernal Méndez, Subdirector for Extension

USAID/Costa Rica

Ross Wherry

CAAP

Eduardo de la Espriella

Expo-Rico Internacional, S. A.

Willy Loria

CATIE

Victor Villalobos, Head, Tropical Crops Improvement
Carlos Burgos, Annual Crops
Jim French, Integrated Pest Management
Gustavo Enriquez, Cacao Project
José Galindo, Plant Pathologist

ASBANA

José Antonio Guzmán, Director of Investigations

UCR, Cellular Biology and Molecular Genetics Laboratory

Rodrigo Gámez
Carmen Rivera

El Salvador:

CENTA

Oscar Coto Amaya, Head, Department of Horticulture
José Enrique Marsilla, Investigation Division
René Pérez Rivera, Plant Genetic Resources

" AID/El Salvador

Frank Skowronski, Agribusiness Coordinator
Antonio González, Agribusiness Agricultural Manager
Rodolfo Cristales

FUSADES

Mario Molina, Manager
Pablo Alvarado, Chile Foundation

ASPENT

Pedro Urquilla, Director

ANNEX II

Documents and Reports Assessed
(to be placed in Alphabetical Order)

- ASBANA, Revista de la Asociación Bananera Nacional Año 11, No. 27.
- ASBANA, Diversificación Agrícola, 84-85, 86
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