A PROPOSAL FOR CREATING AN INTERNATIONAL INSTITUTE FOR AGRICULTURAL RESEARCH AND TRAINING TO SERVE THE LOWLAND TROPICAL REGIONS OF THE AMERICAS

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SUMMARY OF THE PROPOSAL

Increased productivity in agriculture is an important element in advancing the economic growth of largely agrarian, developing countries. In aggregate, world food production is barely keeping pace with population growth, even at the present levels of inadequate consumption, so there already is a deficit to supply. Increased food production is therefore an important need. Production alone, it is recognized, does not assure distribution and consumption by the world's needy. Production, however, must be the primary focus. The two principal ways to increase food production are by: 1) obtaining higher yields from land already in use, and 2) bringing new lands into use.

Lands presently contributing little to food production exist in the hot tropics of Latin America, Africa, and Asia. While modern scientific crop and livestock production knowledge of these tropical regions is scant, these areas are believed to have a substantial agricultural potential. In relatively close juxtaposition to the largely untapped lowland areas between the Tropics of Cancer and Capricorn live an estimated more than half of the world's people whose diets are usually deficient in both quantity and quality.

The hot tropics have been slow to develop because of many interrelated political, economic, social, climatic, and biological factors. Much of the knowledge which might permit rational utilization of the lowland tropics for food production remains to be developed. The hot tropical regions, except for export crop technology developed by colonial powers, have been largely bypassed by

modern agricultural science. Under increasing population pressure people are moving into lowland tropical areas that until now have been sparsely populated. The question therefore is this: Given the world's present and prospective food needs, can man through modern science develop the production, marketing, distribution knowledge, institutions, and techniques whereby more intensive agricultural use of lowland tropical areas becomes economically feasible?

To help answer the above question in Latin America, the creation of an International Institute for Research and Training in Tropical Agriculture is proposed. A possible location is Palmira, Colombia. The institute could be operated in a manner similar to the management of the International Rice Research Institute in the Philippines and the International Maize and Wheat Improvement Center in Chapingo, Mexico. A number of indigenous experiment stations have already been established in the tropical lowlands of Latin America. Thus a potential network of stations with which a strong, autonomous international institute could productively cooperate now exists.

To allocate funds for research and training in the hot tropics is to invest in an area of undefined potential. Short-run returns on scarce funds would probably be greater in the more favorable, temperate areas. The objective here, therefore, is not to make major diversions of funds from needed programs in the temperate zones of the hemisphere, but to make a strong start toward solving the problems peculiar to the tropics. If present rates of population growth continue,

both areas must develop their capacity and contribute to rising food requirements. If rising expectations of people in these areas are to be realized, productivity of the agricultural sector must rise.

The Latin American tropics comprise a variety of ecological zones, each of which will require specific adaptive research to capitalize upon its inherent productive capacity. The areas concerned may be roughly divided, based upon present knowledge, into land areas which are favorable, unfavorable, and unclassified as to potential. The first are known to have unexploited potential for greatly increased returns from relatively small inputs. These include the northern coastal plains of Colombia, the Caribbean and Pacific littorals of Mexico and Central America, the Pacific coast of Ecuador, and the eastern Andean slopes between 500 and 1,000 meters elevation extending from Venezuela through Colombia, Ecuador, Peru, and Bolivia.

The second category includes much of the hot humid jungles of the Amazon and Orinoco basins and the Colombian Pacific coast, where greater efforts and investment will be necessary to pave the way for agricultural advance. Little is known about the third category of lands. Their potential for both crop and animal production may be good. Included are the central plateau of Brazil and the flat plains or llanos of Venezuela and Colombia.

The areas described vary with respect to rainfall patterns, soils, topography, ease of access, communications, and stage of social and economic development. They have, however, two factors in common which are important for crop adaptation: temperature and photoperiod. Experience with rice, corn, and other crops has shown that these two

conditions make it relatively easy to move plant materials throughout the tropical zone and have them adapt reasonably well.

The proposed institute would follow in many respects the successful International Rice Research Institute model. It would emphasize an interdisciplinary approach by highly qualified career scientists employing advanced research facilities. It would help develop trained people at locations within the region in which the scientists expect to work. The institute would have as a major goal the training of scientists and the development of technology to serve in building strong national programs and institutions. Cooperative arrangements with other centers for research, training, and extension would be developed throughout a large region. International exchanges and communications among scientists from the several related fields and nations would be encouraged. Were such a center located in Colombia, it would add an important link to the chain of international institutes concentrating on tropical and semitropical agriculture, which now includes the International Rice Research Institute in the Philippines and the International Maize and Wheat Improvement Center in Mexico. An international institute of this type in Latin America is greatly needed to train Latin American scientists and to provide the mechanism to promote cooperative work in the Latin American area on common problems.

The Latin American institute would not be concerned with a single crop or enterprise. It would concentrate on the identification and solution of tropical crop and livestock production and distribution problems and on the training of people in a problem-solving research and educational environment.

It is recognized that the institute should focus its major efforts in crop improvement on only a few crops that are vitally important from the standpoint of nutrition rather than dilute its forces on a large number of crops. It is proposed that top priority be given to one or more of the potentially most important grain legume crops for direct human consumption such as soybeans, beans, cowpeas, and pigeon peas. These are rich sources of protein, the nutritive element that is so important for normal growth and health and the one that is the most deficient on a world-wide scale, especially in the tropical regions. A portion of the present protein deficit and greatly increased future needs for this vital component in man's diet must be supplied from animal sources. It is therefore proposed that forage legumes and grasses for livestock be given a high priority rating along with the grain legumes for direct human use.

Corn and rice are of primary importance in the tropical regions of Latin America. Fortunately the proposed institute will not need to make a primary thrust in its research and training programs to improve these two crops, since the basic work being done by the International Maize and Wheat Improvement Center in Mexico and the IRRI in the Philippines makes this unnecessary. In order fully to capitalize regionally on the valuable results emanating from the IMWIC and the IRRI, it would, however, be highly desirable for the institute in Latin America to serve as the headquarters for a small group of corn and rice specialists, probably only one or two for each crop, who would work in close connection with the IMWIC and the IRRI in extending these results and doing the necessary adaptive research throughout Latin America.

The crop improvement program activities previously mentioned are those recommended for the institute to concentrate on at the beginning. The development of proper cropping patterns or systems of rotation to overcome problems of soil management and fertility, diseases, insects, and weeds might make it highly desirable for the institute to give attention to a few other crops important to the tropics in the future. Needs, opportunities, and results should dictate the decisions in this connection. Crops, or categories of crops that are important, or potentially so, for the tropics are root crops such as cassava, yams, and sweet potatoes; vegetables; and tropical fruits such as plantains and citrus fruits.

The crop program would be conducted by an interdisciplinary team including geneticists - plant breeders, soil scientists, plant physiologists, plant protection and weed control specialists, agricultural economists, and engineers.

Livestock work would concentrate on ruminant animals, with emphasis on the study and prevention of diseases; nutrition; forage production, utilization, and range management; genetics and reproduction; and the economics of various systems of husbandry under tropical conditions. This, too, would be an interdisciplinary effort.

Library and documentation services will, of course, be necessary.

Much of the institute's work, particularly in adaptive research for the various ecological zones, would be carried on at cooperating indigenous institutions located throughout the Latin American tropics. Potentially these include two Mexican stations, one in the state of Veracruz and one in Chiapas; three stations in

the Caribbean, two in Puerto Rico and one in Trinidad; the National Agricultural Research Center at Maracay in Venezuela; the INIAP stations of Pichilingue and Santo Domingo in the Pacific littoral of Ecuador; two stations in Peru, one at Iquitos and the other at Tingo Maria; the Santa Cruz station of the University of San Simon in Cochabamba, Bolivia. In Brazil, the institute would expect to cooperate with the IPEAN station in Belem, the University of the Amazon in Manaus, the Rural University of the State of Minas Gerais especially at its Triangle station, and the University of Minas Gerais in Belo Horizonte. In Colombia, in addition to the institutions mentioned above, two ICA stations would collaborate in the work of the institute: La Libertad station in Villavicencio, and Turipana station in Cerete. The Inter-American Institute of Agricultural Sciences (IICA) at Turrialba, Costa Rica, is another potential collaborating organization. This is a tentative listing. Direct contacts with potential cooperators have not yet been made.

In addition to its own research program, the institute would cooperate with national institutions in the region on problems of mutual interest. It would conduct part of its experimental work in collaboration with these, and would maintain a bank of genetic materials for the major crops and perhaps breeding stock in animals which would be available to the cooperating stations. Ties with the other two major international institutes mentioned above, in the Philippines and Mexico, would assure the program an international scope, permit exchange of information and of scientists, and avoid duplication of work.

The training program would be an essential component of the work of the institute. In collaboration with other North American and Latin centers and through direct cooperation with the National University and the University of Valle, both formal academic and interne-type training would be provided. In-service training as well as opportunities for study at the predoctoral and postdoctoral levels are proposed.

The institute is expected to be an autonomous institution, directed by an international board of trustees, on which the Ford and Rockefeller Foundations would be represented. The technical staff would be international in character, with emphasis on highly-trained permanent personnel who would be, in the main, from Latin America.

Costs of the institute are estimated as follows: 1) At the outset, $1 million per year to cover staff salaries, perquisites, and transportation, with an increase to approximately $1,600,000 annually when the institute is fully operative; 2) $1 million annually for operating expenses during the initial stages, increasing to $1,600,000; 3) capital costs for buildings and equipment of between $4 and $5 million. If Colombia should be selected as the site for the institute, it is expected from informal statements by Colombian officials that the amount of land needed would be provided by the Colombian government.

It is proposed that the Rockefeller and Ford Foundations share equally the capital and operating costs. The institute would be organized and established in a manner that would enable it to attract and accept financial support from other sources, such as governments, private individuals and institutions, international agencies, etc., as time goes on.

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Considerations favoring locating the proposed institute in Palmira, Colombia, include: 1) Location within the ecological zone in which the work would be focused, with a climate which favors the maintenance of germplasm collections; 2) existence of distinct microclimates within short distances; 3) geographically central location at Palmira; 4) site adjacent to the National University Faculty of Agriculture at Palmira which adjoins an experiment station maintained by the Colombian Agricultural Institute (ICA). The University of Valle in Cali is also nearby; 5) attractive living conditions are available in Cali; 6) promised Colombian governmental support of the institute including the land for the institute buildings and experimental fields and plots; 7) apparent generally favorable attitude toward the proposed institute by the host country. All factors considered, no alternate location has been identified which has as many advantages as are believed to exist in the Colombia site.

A PROPOSAL FOR CREATING AN INTERNATIONAL INSTITUTE FOR AGRICULTURAL RESEARCH AND TRAINING TO SERVE THE LOWLAND TROPICAL REGIONS OF THE AMERICAS

Outside of Communist Asia and west Asia, most of the world's diet-deficit subregions are in the tropical belt between the Tropics of Cancer and Capricorn. Two-thirds of the world's peoples live in countries with nutritionally inadequate national average diets. The diet-deficit areas include all of Asia except Japan, all of Africa except the southern tip, almost all of Central America, the Caribbean and tropical South America except Brazil.[1] The less developed, diet-deficit countries have average per capita incomes only one-tenth that of diet-adequate countries. Food deficiencies reflect the low level of living standards in general.

Modest improvement in quantity of food per person and in food quality in diet-deficit countries is being scored in the decade of the 1960's. On a 1957-59 base equal to 100, the index of per capita food available in Latin America stood at 102 to 103 during the period 1960-1964; it rose to 105 in 1965. But much of the slow dietary improvement is due to increased imports. Prior to World War II, the less-developed countries of the world were net exporters of 11 million tons of grain. This year they will likely import 25 million tons.

To hold their own with burgeoning population growth, developing countries, including those in tropical Latin America, need to increase available food supplies three to five percent per year. To advance living standards and accelerate economic development, most of this increase should come from increased productivity of the

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1. The World Food Budget, 1970, FAER19, ERS, USDA.

agricultural sector of the countries themselves. Importation, even if the foodstuffs could be acquired, transported and paid for, is but a partial solution.

Economic development is a complex, inadequately understood process. We do know, however, that the less developed countries are predominantly agrarian; that the productivity of resources employed in agriculture is low compared to levels of developed countries; that properly designed and sustained research into the technical, economic and institutional aspects of agriculture can point the way to increased efficiency and higher output. Advances in agriculture are essential, integral components of the total economic development package.

To help resolve food-population balance problems, advances are needed on three fronts:

1) Production will need to increase in those areas capable of producing surpluses (the United States, Canada, Western Europe, Oceania, Argentina, Uruguay). The surplus productive capacity of these areas will be needed in the next decade or more to help meet minimal food requirements and overcome the threat of famines in Asia, Africa, and Latin America. Problems of increased output in these areas, with the possible exception of Argentina and Uruguay, are less technical than economic. (Deficit countries have limited purchasing power with which to buy from surplus producers.)

2) Production of food in food-deficit, economically underdeveloped countries throughout the world, especially in the tropical belt, should increase rapidly. Because technical production knowledge of the tropics is scant, the problem here has technical, economic and institutional components.

3) Reduction of population growth rates in most of the world, especially in those areas, mainly in the tropics, where there are already food deficits.

Technically, the output increases sought from surplus-producing countries should be forthcoming. As analysts have pointed out, however, "it is impossible to assume that maximum effort on the part of the surplus-producing nations will effectively resolve the growing world food deficit or that they can stand permanently between the hungry nations and the threat of famine. At best, this solution would be a temporary and unsatisfactory expedient, and in the long run would be self-defeating."[2]

The concern of this discussion is with increasing the capabilities of the underdeveloped countries in the tropics to improve the productivity of their agriculture. Increases in food output, where economically feasible, are sought. The overall objective is to help the total economies to grow more rapidly. The focus is on the hot or lowland tropics of Latin America.

The hot or lowland tropics as used here are arbitrarily defined as those regions of the tropics at elevations between sea level and 1,000 meters (approximately 3,000 feet). These areas, which range from dry to very wet, represent the greatest remaining potential for adding to present agricultural production. They are shown on the attached map, page 4.

The aggregate of hot tropics represents by far the greatest portion of land surface. Approximately 89 percent of all Latin America is lowland; yet only a small percentage of the population lives in this

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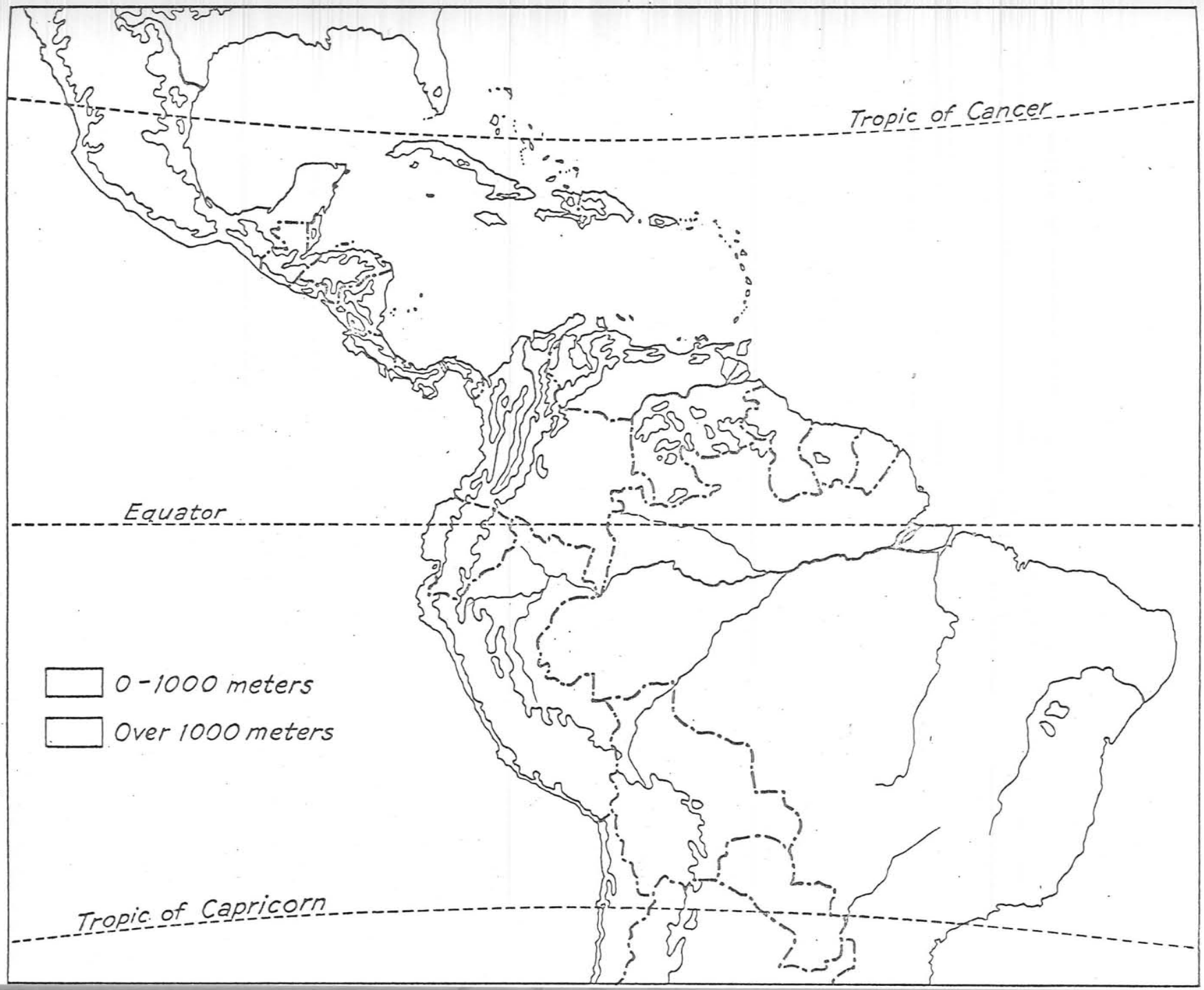
2. Report of the Ad Hoc Panel on the Proposal for the Creation of a Tropical Research Foundation - Harrar et al. Dec. 1965.


Tropic of Cancer
Equator
0 - 1000 meters
Over 1000 meters
Tropic of Capricorn

vast area. Only about 30 percent of the people of Venezuela, Colombia, Ecuador, Peru, and Bolivia live in the hot tropics; Brazil's interior has a population density of less than two persons per square mile. This situation is changing, however. Since the time of the conquest, people in tropical Latin America have naturally chosen to settle in the areas most attractive for living, where the climate was pleasant, health problems were minimized, communications were possible, and the essentials for life could be had. As a result, the population is largely concentrated in the higher elevations of the mountain chains running through Mexico, Central America, and the Andean region of western South America, and along the relatively narrow coastal strip of eastern Brazil. These desirable areas are now saturated; and as population pressures continue to build up, the people are forced to migrate to the less attractive regions if they are to be involved in agricultural pursuits. As might be expected, the migrants seek out and settle first the most favorable parts of these undeveloped areas. A brief review of some of the hot tropical areas under consideration illustrates their diversity:

Undeveloped Hot Tropics

1) Northern Coastal Plains of Colombia - The rather large coastal plain area in the north of Colombia has fertile soil, about 40 inches of rainfall annually with alternating wet and dry seasons, adapted to annual crops; its flat topography is susceptible to mechanization; it has communications, and is quite accessible geographically. Problems, such as poor drainage, remain to be resolved, but this is a hot tropical area which should prove relatively easy to develop.

2) Coastal Plains of Mexico and Central America - Parts of the coastal plains extending the length of both the Caribbean and Pacific sides of Mexico and Central America fall into the same general category as the northern coastal plain of Colombia from the standpoint of potential for food-crop and animal production and the relative ease of developing this potential.

3) Coast of Ecuador - The Pacific littoral of Ecuador is another quite favorable hot tropical area. It has basically good soils which could be converted into very productive ones if the proper management practices were known and applied. The average rainfall in this flat area ranges between 50 and 70 inches annually, falling in the months of December to May with an alternating dry season of about six months' duration.

4) Eastern Foothills of the Andes - the Oriente - This is another zone that deserves careful consideration. It is of potential importance in the immediate future. The term "zone" in this instance is used advisedly because the reference is to an aggregate of land in the eastern foothills of the Andean range extending from Venezuela through Ecuador and Peru to Bolivia, in these countries called simply the Oriente. This zone does not represent an area that can be neatly defined from the ecological or agricultural standpoint. It is a strip along the eastern slope of the Andes, beginning at an elevation of about 400 to 500 meters, where the Amazon headwaters start to rise more abruptly, and extending upward into the foothills to an elevation of approximately 1,000 meters.

The Oriente undoubtedly offers one of the best prospects in all of South America for opening new and potentially rich agricultural

lands during the next two to three decades. Colonization of this sparsely inhabited zone has begun on a significant scale in Peru and Bolivia and is getting under way in Colombia, Venezuela, and Ecuador.[3] In general, the soils are fertile and the natural drainage is good. It is quite tropical at the lower limit of its elevation range, and gradually becomes semi-tropical as the altitude approaches the upper limit of approximately 1,000 meters. The annual rainfall varies from averages of 70 to 90 inches to as high as 103 inches in Iquitos, Peru. The rainy season north of the equator, on the Venezuelan and Colombian slopes, is from April or May to November, and below the equator from October or November to April.

5) Tropical Jungles - In addition to these benign hot tropical areas just described, there are others that are much more difficult to settle and to make productive. Three areas in northern South America are in this category, and they have much in common. These are the vast Amazon basin that lies mainly in Brazil, and extends into the eastern portions of Peru, Ecuador, and Colombia; the Orinoco basin in eastern Venezuela; and the narrow Pacific littoral of Colombia. These are tropical jungle areas - very hot and humid. They comprise by far the largest aggregate of undeveloped land in the tropics of this hemisphere; the Amazon drainage system alone covers two-fifths of the South American continent. They also present some of the greatest obstacles to development. Up to the present time, they have so successfully resisted the encroachment of man that the population is approximately five million people in

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3. See Crist, Raymond E., "Andean America: Some Aspects of Human Migration and Settlement," the Graduate Center for Latin American Studies, Vanderbilt University, Occasional Paper No. 3, May 1964.

the more than 2.7 million square miles of the Amazon basin; most of the Orinoco basin and the Pacific coastal strip of Colombia are only slightly more densely populated, with averages of less than 10 persons per square mile.

Typical rainforest climates prevail. Temperatures in the Amazon basin near the equator are close to 80°F with little seasonal variation; an estimated average of 70 to 80 inches of rain falls annually, becoming heavier near the eastern slopes of the Andes. Flooding is frequent; in the rainy season, whose peak is reached in March-April, the river rises as much as 40 feet, and its tributaries flood most of the area. South of the equator, a short dry season occurs in August-September.

Along the Colombian littoral, the average yearly rainfall is 100 inches, and in places reaches record heights of over 350 inches. Inhospitable in themselves, these conditions foster others even more hostile: plant diseases, pests, and weeds which prosper better than food crops; poor soils; lack of drainage; absence of land transportation; and diseases which attack both man and animals.

6) The Campo Cerrado - There are two other major hot tropical areas whose potential agricultural resources and development possibilities for the immediate future are an enigma at the present time. These are the expansive campo cerrado area of north central Brazil and the llanos of eastern Colombia and southern Venezuela.

The central plateau of Brazil, covering an area of 750,000 square kilometers, (about 290,000 square miles) has a rural population of 2,128,028. Lying in the southern half of the tropical zone,

with elevations ranging from 300 to 1,200 meters, it is characterized by moderate temperatures (an average of 70° to 73°F, dropping to 43° in winter and rising to 79° in summer). Rainfall averages 50 to 60 inches annually for most of the area, concentrated in the summer months of October to April, with an alternate dry season lasting four to six months. Low soil fertility accounts for the prevalence of campo or savannah vegetation; the area has some good soil, however, and much soil that could be made productive with modern techniques. Roads exist and more are being built; rail and air transport are also available to a lesser degree. Large areas of nearly level or gently rolling land are suitable for mechanized farming, and broad areas of rolling and hilly topography could support grazing.[4]

7) The Llanos - This area comprises over 130,000 square miles of low-lying flat plains extending from the Orinoco River basin inland to the Amazon basin, occupying one-third of the total area of Venezuela and almost one-third of Colombia. It is sparsely settled - 10 to 25 persons per square mile near the Andean slopes and less than 10 in the lands skirting the Amazon basin. The climate is hot and dry from December to April, with parching winds; the rains start in May and continue to November, interrupted by a drought in June and July. During the rainy season flooding occurs, with rivers rising 12 to 15 feet.

4. Survey of the Agricultural Potential of the Central Plateau of Brazil, American International Association for Economic and Social Development (AIA), Rio de Janeiro, March 1963.

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From these brief descriptions of the principal areas in the lowland tropics of Latin America, it is readily apparent that there are wide variations in amounts of rainfall and precipitation patterns, soil qualities, topography, vegetation, and other ecological factors in the hot tropics of the western hemisphere. They all have two very important ecological factors in common, however. These are high and rather uniform temperatures and uniform photoperiod. The low latitude regions throughout the world also possess an important attribute which is economically important when combined with other production factors: this is the amount of solar energy at earth's surface, which in the low latitudes is at its maximum for the photosynthetic process.

Within the tropical belt, temperatures are largely a function of elevation. Near the equator itself, the annual mean temperature at sea level will vary slightly between 78° and 82°F and at 1,000 meters it is usually rather constant, ranging between 65° and 70°. As the Tropics of Cancer and Capricorn are approached, these ranges of temperature tend to lower a bit; but within the elevation range of sea level to 1,000 meters, they still maintain a strong direct relationship to altitude. Also, within the tropical belt, the variations in length of day (number of hours of daylight, technically referred to as photoperiod) are moderate.

Temperature and photoperiod are two of the most fundamentally important factors in determining the adaptation of plant species and varieties, as well as the range of adaptation of their disease and

insect enemies. The relative uniformity of temperature and photoperiod in the lowland tropics permits great flexibility in moving plant materials throughout the latitudinal range of the tropical zone and having them adapted reasonably well. This is the basic explanation for the fact that the outstanding race of maize, Tuxpeno, originally from the Caribbean coastal plain of Mexico, can be grown successfully in the hot tropics of Central America, Venezuela, Colombia, Ecuador, Peru, and Brazil, and in many countries of Africa and Asia. The soils are quite different in these countries, and the rainfall patterns are also extremely varied, yet Tuxpeno has proved to be quite well adapted in the lowland tropics in all three continents. Similarly, the tropical maize germplasm of Colombia and the Caribbean region is well adapted in many parts of India and Africa. In fact, the first nine corn hybrids released in India were made up, on the whole, of approximately 50 percent of inbred lines imported from the corn improvement program in Colombia. The improved varieties and lines of wheat produced in Mexico and Colombia do well in Pakistan, India, Kenya, and other tropical countries around the globe.

Superior rice varieties bred at the International Rice Research Institute in the Philippines are sent to tropical and subtropical countries with widely varying growing conditions; for example, in 1965 research was conducted at over 40 different locations in Southeast Asia, and over 5,000 samples of seed were sent to other experiment stations throughout the world. Water and soil management, disease and pest control, and other improved techniques developed by the institute are being introduced by rice scientists in the different areas.

These are just a few selected examples from among many that could be cited to illustrate the relative ease of transferring the research results derived in one location of the tropics to many other areas throughout the tropical belt, provided proper precautions are taken to assure their applicability to different regional conditions through adaptive research.

Role of Agricultural Research and Training in Developing the Hot Tropics

Several books and papers have been published[5] dealing with the lowland tropics in general, and especially with the western hemisphere. Some trace the slow pace of development and advance possible explanations for low levels of agricultural utilization and performance. Complex inter-relationships among historical, political, economic, social, climatic, and biological factors contribute to the conditions that prevail today.

Scientific knowledge that is needed to permit rational and economic use of the lowland tropics for crop and livestock production is clearly inadequate. Except for specialized work on traditional export crops, the hot tropical regions in Latin America, and also in Africa and Asia, have been largely bypassed by modern agricultural science and technology.

Certain crops important for industrial purposes and world trade such as rubber, sugar cane, bananas, cacao, tea, cotton, and spices, have received considerable attention, and have been the subjects of good research work, especially in some of the former European colonies. The Dutch had their network of very fine experiment stations

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5. See Appendix, page 61, for a partial listing.

on the island of Java in Indonesia, the Belgians their huge center in Gandajika in the Belgian Congo, and the British their rather small but well-run tropical center in Trinidad, along with centers in Africa and India. Most of these research stations had no real concern with the problems of increasing basic food production in the regions where they were located. With the decline of colonialism, the work of these centers diminished or ceased altogether.

The creation of the International Rice Research Institute in 1961 represents the first step taken in recent years to develop an international agricultural research and training institute concerned with increasing man's basic food supply. The philosophy underlying the institute and the techniques employed by the Ford and Rockefeller Foundations in its development have already demonstrated their worth. In its five-year life IRRI has contributed to the architecture of superior rice varieties, has evolved superior production practices, and has implemented widespread application of findings through training and information programs. In presenting the reasons favoring the establishment of an International Institute of Tropical Agriculture located in Africa, Dr. F. F. Hill of the Ford Foundation[6] made the following comments:

"Although the International Rice Research Institute established by the Ford and Rockefeller Foundations is still quite young, experience to date indicates that an organization of this kind can perform the following important functions:

(1) By bringing together a highly-qualified staff on indefinite tenure, well-balanced as between the relevant disciplines, and

6. Proposal for an International Institute of Tropical Agriculture located in Africa, Overseas Development, Discussion Paper.

by providing them with the facilities required for high-quality research and experimentation, it is possible to increase materially the speed with which higher-yielding varieties of crops and improved management practices adapted to varying conditions within a major region are developed.

(2) An important contribution can be made toward training professional personnel within the region in which they expect to serve -- the high-level manpower required to staff agricultural colleges, experiment stations, and administrative posts in ministries of agriculture and extension services.

(3) An institution such as the Rice Research Institute can serve as catalyst and pace-setter -- an instrument for helping to improve the efficiency and effectiveness of other research, training, and extension organizations throughout a large region. It can demonstrate to visiting administrators and scientists in a way that is not otherwise possible the kind of balanced, sustained attack that is necessary if the foundations are to be laid for steady and reasonably rapid progress in increasing agricultural production.

"A series of well-staffed regional institutes with adequate facilities, located at strategic points in the major underdeveloped regions of the world, could materially speed the process of agricultural development in these regions. Like the Rice Research Institute,

they could put teams of highly-trained, experienced specialists to work on major problems requiring basic or applied research; they could help train the high-level professional manpower needed in the region; and through regional conferences and seminars, provision of good library facilities and exchange of plant materials, they could make it possible for scientists at other institutions in the region greatly to increase their effectiveness. They would, in effect, provide the kind of function that was performed by a half dozen major land-grant institutions in the United States during the latter part of the last century and the first part of this one. Every state had an agricultural college and a system of experiment stations. But a half dozen leading institutions set the pace.

"It is not suggested that private foundations could or should undertake to establish all of the high-level regional research and educational centers that are needed. In an earlier OD discussion paper, the development currently under way in Mexico looking toward the establishment of a strong education-research-extension center at Chapingo was described. If this center develops as anticipated, it can serve as a regional resource for Latin America although more than one such center is needed to serve this large region."

Adding an Important Link to the Chain

The International Rice Research Institute is continuing to develop well. The International Maize and Wheat Improvement Center in Mexico is being restructured to help it do a more effective job in assisting nations to improve their production of these two vitally important food crops.

For reasons outlined above, it is proposed that an international agricultural institute for research and training be created in South America to serve the lowland tropical regions of this hemisphere.

Basic Objectives of an International Agricultural Research and Training Institute Located in South America

The basic goals of the proposed institute would be similar to those of the other two links in the chain. These are clearly stated in the excerpt of Dr. Hill's comments quoted on pages 13-15. Such an institute would represent the addition of a new component of international cooperation. It would complement indigenous national programs of research and training in the hot tropics. Its creation would be based on the premise, and the understanding on the part of the collaborating nations and international organizations which may be involved, that giving more attention now to the hot zone would not be achieved by lessening the present emphasis on the higher-elevation, temperate-climate areas in the Latin American tropics, or for that matter, on the other temperate regions of the hemisphere. Increasing the productivity of the lands in these temperate areas where most of the people now live is tremendously important, and undoubtedly deserves top priority in the allocation of national and international funds and efforts. Further, sustained growth of indigenous institutions is essential. Creation of the institute, therefore, is intended to complement, not to divert resources from indigenous research and training establishments. The institute is seen as one means of positively focusing additional attention and investment on tropical agriculture.

Scope of the Institute's Research and Training Activities

The institute would concern itself with research problems in any area of the lowland tropics where the rainfall amount and distribution is adequate for the economic production of basic food crops and of forages and feeds to support animal industries. This may be as little as 20 inches of annual precipitation, if it is distributed in such a way as to provide sufficient moisture for good plant growth over a period of normal crop season under the high-temperature conditions of the tropics - four to five months is ordinarily enough.

In other words, the institute would not limit itself to working only in the humid or very wet tropics (60 inches or more of rainfall annually). However, at least at the beginning, it would not concern itself with areas that are so arid (about 15 inches of rainfall or less) that they must depend basically on irrigation for successful crop production.

Clearly, this gives the institute a broad latitude of ecological conditions within which to work. It would focus its efforts and resources within this wide range of conditions to make significant progress on well-defined, important problems. As the institute grows, such focusing would be left largely to the judgment of the director, the staff, and the board of trustees, with the general criteria always in mind that resources and efforts should be so directed as to have the broadest possible impact for increasing basic food production in the shortest possible time.

The institute should have two main avenues of research activities, directed toward increasing the efficiency of production of

1) food crops, and 2) livestock. Work in these two general fields should be launched simultaneously. As the undeveloped hot tropics begin to be opened up for settlement, many areas will prove to be best suited, and indeed in certain instances only suited, for animal production. Food crop production may be too costly because of moisture, soil, climate, drainage, location, or market problems. Ruminants, especially the bovine species, can convert coarse forages into high quality human food rich in protein. These highly-prized, high-value animal products have expanding international markets; they may be a source of much-needed foreign exchange so essential to the development of the nations involved. Animal products can also make important nutritional contributions to the diets of local people if priced within their reach. Hence the need for a balanced crop and livestock program.

Suggested Priorities and Staff* for Crop Research

It is proposed that the institute concentrate its major efforts in crop improvement on a few carefully selected crops rather than diffuse its efforts by working on a wide variety of crops. The crops selected should have potentially very broad utility in the lowland tropics of the world and should be especially important from the standpoint of human nutrition.

With these concepts as major guidelines, it is suggested that the areas of program activities briefly described below be seriously considered for high-priority attention. It is recognized that additional careful analysis and planning are needed to develop precise program and staffing patterns. Operationally, it would be wise to name an institute director as soon as the institute's creation

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* See Table, page 39.

is assured. It would be his responsibility, with the assistance of his management board, to evolve detailed research and staffing plans.

Grain Legumes (soybeans, beans, cowpeas, pigeon peas) - It is proposed that top priority be given to the potentially most important grain legume crops for direct human consumption such as those mentioned above. These are rich sources of protein, the nutritive element that is so important for normal growth and health and the one that is most deficient on a world-wide scale, especially throughout the tropical regions. Well-adapted grain legume crops need to be identified to fit into the cropping systems of the tropics. Two senior and one junior staff members would be needed at the beginning to initiate the program. As research develops in this general field of grain legumes, two additional staff members, one senior and one junior, will probably be needed.

Forage Legumes and Grasses - A portion of the present protein deficit and greatly increased future needs for this vital component in man's diet will have to be supplied from animal sources. It is therefore proposed that forage legumes and grasses for livestock be given a high-priority rating along with the grain legumes for direct human use. Work to improve the forage legumes and grasses would dovetail very closely with another major thrust of the institute, the program to increase livestock production with concentration on bovine species, which will be described later on. There would be very close cooperation and coordination between these two program efforts, especially in the areas of forage evaluation and utilization and range management.

The staff requirements for this research would include two forage specialists at the outset with two range-management specialists to be added as the program develops.

Corn and Rice - Corn and rice are of primary importance in the tropical regions of Latin America. Fortunately the proposed institute will not need to make a primary thrust in its research and training programs to improve these two crops, since the basic work being done by the International Maize and Wheat Improvement Center in Mexico and the IRRI in the Philippines makes this unnecessary. In order fully to capitalize regionally on the valuable results emanating from the IMWIC and the IRRI, it would, however, be highly desirable for the institute in Latin America to serve as the headquarters for a small group of corn and rice specialists, probably only one or two for each crop, who would work in close connection with the IMWIC and the IRRI in extending these results, and doing the necessary adaptive research throughout Latin America.

Corn - The base of the Northern Andean Maize Improvement Program is already established in Colombia. Even closer coordination of efforts between this regional base and the overall International Maize and Wheat Improvement Center is now possible with the recent reorganization of the center in Mexico. Dr. D. D. Harpstead, present head of the corn improvement work in the Andean region, is a candidate for leadership of the corn work in the proposed new institute. Two junior staff members would be needed. These should be Latin Americans trained to at least the M.S. degree level.

Rice - As in the case of corn, the institute would serve as a regional base for a rice specialist who would work as a member of the team effort of the International Rice Research Institute, concentrating on rice problems of tropical Latin America. One senior staff member would be required, plus one, possibly two, junior staff members as the program develops.

The crop program would be conducted by an interdisciplinary team including geneticists-plant breeders, soil scientists, plant physiologists, plant protection and weed control specialists and agricultural economists. The scientists from all of these disciplines would focus their joint efforts on the identification and solution of problems that restrain the increase in yields of those crops with which the institute will be concerned. They would be expected to march in lock step to achieve these goals, and would work together in the same geographical and agricultural regions agreed on as having top priorities for attention.

Soils - A solid, well-rounded research program on the important problems of the soils of the hot tropics is basic to all other efforts to increase food crop and animal production. These areas can become major contributors to the increased food resources of the world only if a fuller understanding is attained of the soils therein and of the physical, chemical, and biological interactions of the soil environment, and if practical systems of management of such soils for sustained productivity are developed. The bush fallow system practiced in certain areas has served a useful purpose but cannot provide the level of productivity needed for increasing population intensities. This and other management systems must be studied thoroughly to develop basic principles that can be translated into practices which will give sustained high levels of productivity. A uniquely competent and imaginative group of soil scientists will be required for this program, which must serve as a major focus of the work of the institute. It is proposed that the soils research program be launched initially with two senior specialists - one in soil fertility and management and one in soil physics, water movement, and drainage. It is possible that Dr. J. M. Spain, a soil scientist on The Rockefeller Foundation

staff in Colombia, might be available for the position in soil fertility and management. It is anticipated that workshops organized periodically at the institute, bringing together selected groups of experienced soil scientists for limited periods of intensive consultation, will form an important feature of program development for this group.

Plant Physiology - There is a general lack of sound knowledge of most of the basic physiological processes that govern the adaptation and healthy growth of a population of crop plants under field conditions, even in the temperate zones of the world where science and technology are far advanced. The scarcity of such knowledge under tropical conditions is many times greater. A much better understanding of plant-soil-water-light-temperature relations under hot tropical conditions is required. Plant physiologists at the institute would work closely with the soil and crop management specialists, and also with the plant breeders and geneticists. This phase of the program would require one senior specialist at the start, and probably an additional senior or junior scientist as the program develops.

Plant Protection: Diseases and Insects - In the hot tropics, plant growth is rapid because of the high temperatures, high incidence of solar radiation, and usually quite adequate moisture. But the plants' enemies - diseases, pests, and weeds - also prosper under such conditions. Research programs to control the economically important diseases and insects in the main crops which are selected for the institute to concentrate on will be required. Dr. David Thurston, plant pathologist with The Rockefeller Foundation program

in Colombia, might be available for transfer to the institute by the time it is operational. A senior specialist in entomology would also be needed, and as these programs develop, four junior staff members may be added, two in pathology and two in entomology.

Weed Control - Crop agriculture will be possible in the hot tropics only as we learn how to control weed competition economically. Some of the new chemical herbicides are quite effective and will be very useful in helping to control weeds in the lowland tropics. One senior specialist and two junior specialists will be needed to work on this aspect of the problem. These specialists will need to work in close collaboration with the crops specialists, the agricultural engineers, the physiologists, and the agricultural economists in order to mount the kind of attack that is called for to solve the weed problem. Herbicides will have to be combined with proper rotations and with sound practices of land preparation and tillage by mechanical means to devise effective methods of control that will be economically feasible and advantageous.

Animal Improvement Program: Livestock Production Needs in the Tropics

The diet of people who live in the tropics is very often deficient in the quality, as well as quantity, of the protein component. By incorporating even small amounts of animal products, dietary imbalances of amino acids can be corrected, leading to substantial improvement in the total worth of the diet. In addition, large parts of the tropical areas offer enormous potential to add to the world supply of food resources because these will remain in grass and forage

production for a long time to come. The animal improvement program should concentrate on ruminant animal production. It is believed that it is entirely feasible and highly desirable to increase meat production in many of the tropical regions previously described, and that the institute should have an important role in helping to bring this about. In this way, the institute could make one of its most valuable and far-reaching contributions, since more meat, and other animal products as well, are required in the solution of the number one problem of human nutrition, protein deficiency.

Animal production plays an important role in the agricultural economy of most Latin American countries. It is a principal source of income from export sales in Argentina, Brazil, Uruguay, and Mexico. On the other hand, some Latin American nations such as Chile, Venezuela, Peru, and Bolivia rely upon imports to meet their deficit, even though their potential for livestock production has not been realized. The use of milk, eggs, and meat in the family diet is largely determined by economic considerations; consequently, given the importance of the nutritive value of animal products, the need is urgent to lower production costs through the application of improved technology.

Livestock production in the tropics has suffered from a lack of sound information which can be deliberately applied toward resolution of the problems. For example, losses caused by diseases are routinely accepted by livestockmen as a cost of doing business over which they have little or no control. Direct losses from death due to diseases such as anaplasmosis, rabies, enteric infections, and anthrax, are excessively high. However, the occurrence of many

diseases which result in unthriftiness, poor growth, abortion, etc., although less apparent to the casual observer, cause incalculable losses in potential productivity. In addition, the erratic nutrient intake of cattle, sheep, pigs, goats, and chickens lessens their resistance to disease organisms.

Death losses, often reaching 20-40 percent of herd population, are common. Low fertility, abortion, and death of newborn result in extraordinarily poor reproductive rates. In some cattle-producing areas, calving percentages are as low as 30 percent, whereas they should be well above 70 percent of cows of breeding age.

In some tropical areas substantial quantities of milk are obtained as a by-product of the beef operation. The extent to which beef cattle can be made more productive in milk yields should be explored. Milk production is affected by feeding, disease, management, genetic factors, and climate. To date, no one has satisfactorily solved the problem of increasing the milk-producing potential of cattle in the tropical areas of the world. There are data which indicate that higher milk yields can be realized in the tropics, but more intensive study of the factors involved is needed. Whereas criollo cattle in the tropics will produce barely enough milk to feed a calf, production records from a few experimental cattle indicate that with proper care improved cattle will produce 5,000 lbs. and more of milk a year.

Considering the fact that these animals are raised under extremely adverse conditions - precarious health of the mother,

exposure to innumerable disease hazards, semistarvation - it is little wonder that those which survive require five to six years, and often more, to reach a size acceptable for market. We know that even the indigenous cattle will respond to better feeding and improved health measures to such an extent that they can be marketed in less than half the period normally observed. Whether the necessary practices, as now understood, are economical under tropical conditions remains to be determined.

Large areas of many countries are devoted to pasture and range lands for cattle, sheep, and goats, for several reasons: These regions may be inaccessible, or unsuitable for agricultural purposes; too great an investment may be required to adapt them to cultivation; they may be public lands as yet awaiting distribution and settlement. Undoubtedly some of these areas will ultimately be utilized for the production of food crops to be consumed directly by man; others can be improved for forage and pasture use, while still other portions will remain partially or totally unproductive.

Suggested Priorities and Staff:* Concentration on Bovine Species with Major Emphasis on Beef Cattle

In considering research priorities and staff requirements, the animal program of the institute should concentrate on ruminant animal production, for two important reasons: firstly, ruminant animals possess the unique ability to utilize the fibrous substances of which forage and fodder plants are composed. The bacterial fermentation processes which take place in the digestive tract of polygastric animals have the additional advantage of making it unnecessary to

* See Table, page 39.

provide the delicate balance of amino acids normally required by monogastric animals. Because of their unique physiology, these polygastric animals are able to utilize enormous nutritive resources which man cannot consume directly. This is not true of poultry and swine, whose rations include ingredients that may be consumed directly by man, and are needed as sources of energy and proteins.

Secondly, our knowledge and know-how concerning poultry and swine production can be transferred to developing nations with greater ease than is the case with dairy and beef cattle production. In the case of swine and poultry, and to some extent with dairy cattle, it is more feasible than with beef cattle to modify certain environmental influences and thus reduce the stress which these have on productive efficiency. Furthermore, our knowledge of disease problems, nutrition, physiology, and management permits the establishment of poultry operations almost anywhere in the world - limited, of course, by economic considerations. In addition, advances through genetic selection have been more rapid in poultry and swine than in other domestic species, and tremendous progress toward high reproductive efficiency (egg laying, farrowing rates, and rates of growth), has been achieved in these two species which, at the same time, have a rather broad range of adaptability.

Diseases - Enormous livestock losses, both perceptible and imperceptible, are caused by disease - perhaps up to 50 percent of potential productivity. The reduction or elimination of these losses would result in more economic and significantly increased livestock production. To achieve a condition of health in animals requires that we learn how to protect them from exposure to disease-causing organisms or situations,

how to stimulate and improve their defensive mechanisms, and how to treat them during the course of disease. To accomplish this, we need to study the physiological response of animals to tropical conditions, to investigate the nature of disease-producing agents, and to learn more about the vectors that may be involved, since these are the factors that will indicate which diseases are the most important economically.

Certain broad areas of research will include:

1) Study of means to reduce the devastating effect of disease on growth and reproduction.
2) Development of means for improving the effectiveness of prophylactic and therapeutic measures in the control of viral, bacterial, and protozoan diseases.
3) Assessment of the role which internal and external parasites play in bovine health in the tropics.

An excellent veterinary research laboratory is already in existence on the campus of the National University in Bogota, Colombia. Although this laboratory is associated with the Veterinary Faculty of the University, it is a part of the Colombian Agricultural Institute - ICA, and, as such, has responsibility for developing a country-wide program on animal diseases. Close collaboration between this laboratory and the animal improvement program of the tropical institute can be easily achieved on the basis of mutual interests.

Staff requirements for this program at the start would include one senior and two junior microbiologists, and one senior and two junior pathologists; as the programs progress, one senior and two junior epidemiologists should be added.

Nutrition - The full productive potential of animals in some areas is rarely achieved or, if it is, the time required is too long. Total productivity can often be substantially improved by reducing the period required to grow animals to an economically marketable age. We have found that even criollo or indigenous cattle can be made ready for market faster by an improved or more adequate nutritional level. In addition to determining ways of providing a continuous adequate supply of nutrients so that gains are rapid and efficient, it is necessary to focus on the land, plant, and animal relationships, to study ways of using otherwise wasted nutrient sources, and to study the role of micro-nutrients, particularly of range cattle, in different ecological situations. Normally, animals which are adequately fed, by whatever means, survive and reproduce better than similar animals which are inadequately nourished.

Research projects designed to permit economic analyses in this section would include:

1) Study of techniques and methods for obtaining maximum sustained utilization of the grasses and forages of tropical pasture and range lands and for improvement in the productivity of these areas as measured by total meat yield.
2) Investigation of growth patterns of bovines kept on pasture grasses as affected by seasonal changes.
3) Evaluation of feed additives (supplements, complements) in increasing growth and conversion efficiency.
4) Interrelation of nutritional regimen and reproductive efficiency.
5) Study of the use of agricultural by-products in bovine feeding.
6) Study of the nutritional requirements and feeding methods for improved milk production.

Two senior and two junior staff members would be needed to initiate these projects. As the institute develops, one senior and two junior specialists would be added. As with other investigations, cooperation with institute agricultural economists would be a part of the research design.

Physiology: Genetics and Reproduction - For the most part, the kinds of livestock encountered in the hot tropics are derivatives of early introductions of mixed breeds. Many indigenous types have developed, mostly by a process of natural selection. Their productive and survival value has been poorly evaluated. Their potential contribution to crossbreeding programs, to the formation of new breeds, and to selection pressure is unknown.

Recommendations to livestockmen concerning the improvement of their cattle should be based on knowledge and experience of the performance of these animals under the environmental stress of the tropics. Although at some future time large-scale breeding programs will need to be established, the research in the area of genetics, breeding, and reproduction should initially include:

1) Study of genetic compatibility of beef and dairy characteristics of cattle under tropical conditions.
2) Study of environmental stresses affecting the performance of dairy cattle in the tropics.
3) Improvement of calf crop production through fertility studies of beef and dairy cattle in a tropical environment.
4) Compilation and evaluation of growth, reproduction, and survival data relative to indigenous stocks.

One senior physiologist and one junior staff member in physiology would be needed to initiate the programs, and one senior geneticist would be added at a later date.

Agricultural Economics

The economics component of the institute should be production-oriented. The principal thrust of economics involvement here is not, for example, the derivation of new methodology or of a more adequate theory of economic development per se. It is hoped, however, that the institute's economics work can contribute to these important objectives both directly and indirectly.

The institute should recognize the critical role that indigenous institutions may perform in effecting structural and institutional changes within their countries - and in contributing significantly to conceptual, methodological and theory-of-growth problems. To such institutions, institute economists, like other institute scientists, should have meaningful, working, voluntary research and training linkages.

Functions - Within the institute there are important, full-partnership functions for the agricultural economists to perform as a part of the institute team. These functions include assistance in:

1) Defining or identifying high priority, researchable problems. It is recognized that relatively few technological breakthroughs are fully predictable. But through economic analysis, one can at least partially predict the consequence of one as compared to another production research success - both in the short and longer run. Such planning is presumably involved in rational research program development.

The process of resource allocation for the institute asks: Is the investment (in breeding, selection, testing, cultural practices) to obtain the capability of one more pound or bushel of output per production unit worth the input? This applies to the decisions of the researcher and indirectly to the practical operation at the producer level.

The above functions may in part be compared to market testing, drawing specifications for a product prior to its design and manufacture. It asks, what specifications must my research product meet to be successful? What will be the necessary price (cost of practice), the needed yield (performance), the required monetary product (physical quantity output x market price at farm level)?

To approximate answers to questions of the types raised above requires intimate knowledge of farm management, diffusion rates, incentives - the economics of production in the farming area the institute serves. It also requires that the institute's production research be so designed that economic analysis of findings is possible. Hence, additional functions are also relevant.

2) The statistical and economic design and interpretation of technical research of the institute. Here the economist's contribution can be major. As soon as possible, however, the institute should have a statistician on its staff.

3) The economic organization and operation of farm production units - existing and potential - size of unit, cropping and/or livestock systems, equipment, labor. Identify and understand

types of farming, understand the complementary and competing relationships among crop enterprises in each type of farming. Knowledge of this character is essential to the architecture of new technology, to furtherance of new practice adoption and estimation of production responses.

4) The identification of alternative means whereby purchased farm production inputs may be made available to farmer producers - seeds, fertilizers, insecticides, power, machinery, breeding stock, water - at what prices and with what degree of certainty.

5) The projection of market demand for the area's agricultural products - domestic, export market outlook and development, short and long run - prices, incentives, alternatives. What are the implications of food self-sufficiency to the capability, and t growth potential of the total economy, for example?

Obviously, performance of these functions will involve use of development theory; consideration of public policy matters. These should not be ignored by the institute staff. A suggested approach, however, might be to assist and encourage growing indigenous institutions to develop their capabilities in this as well as in the above outlined areas. At the same time, a portion of the institute economist's time should be available for working through theoretical constructs, improving measurement and analytical capability. He is located in a live laboratory in development. He is presumably constantly examining his own concepts concerning growth theory, for he must have a framework to guide his day-to-day work. An analyst

can and must contribute to the work of the planner. Thus in his own live laboratory and in his linkage to indigenous institutions, he should directly and indirectly make contributions to development theory and practice.

Staffing - Based upon the above, the following guidelines are suggested with respect to the organization and operation of agricultural economics within the institute.

1) There should be a minimum of two agricultural economists on the institute staff.

2) Like other scientists, these men should be working professionals involved in research and teaching. Their function is that of doers.

3) While the personal and intellectual attributes of the men come first, their specialty orientation should be toward production economics and farm management, broadly defined. One of them, at least, should be grounded in statistical design and analysis. If a third person were added, a specialty in marketing structure and institutions, broadly conceived, is suggested.

4) At least one of the economists should hold full membership on the institute's research committee (or policy committee or management committee) so that economics is represented from the onset in the decision-making process with respect to the distribution of the institute's resources.

5) The economists should have the same type of staff, career appointments that prevail in the institute. Their supporting infrastructure - graduate assistants, computational facilities, technicians, travel, enumerators - is also assumed.

6) Development, modification, expansion of the economics component of the institute should be based upon developing needs and demonstrated performance - in the community of fellow scientists. This may be the appropriate route for considering the need for other social scientists - sociologists, anthropologists, or for moving into public planning, policy, and related investigations directed to structural change.

7) Consideration should be given to the appointment of two or three "new" Ph.D's on staggered three-year terms. These men might be considered as postdoctoral staff. These men would complement the specialized talents of the senior economist, and would provide a reservoir for recruitment of experienced permanent staff people.

Agricultural Engineering: Experiment Station Planning and Development

One of the most frequent requests for assistance from research institutions in Latin America at present is for consultation and advice on the planning and development of experiment stations. There will be a need for such services for several years to come, as these institutions continue to expand. The institute itself will also need agricultural engineering services for the first four or five years, to plan and develop the experiment station at its headquarters location and to assist with production and storage problems.

It is proposed that, at the beginning, the institute have a small section in agricultural engineering concerned mainly with experiment station development. Mr. Roland Harwood, a specialist in this

field who has worked for the past 10 years in the Rockefeller Foundation Colombian Agricultural Program, could be considered for this assignment.

As time goes on, it is quite likely that the institute would wish to expand this section to include research work on farm machinery, water, and drainage problems. Practically no research work is being done to determine the appropriate machines and tools to use in the tropical lowlands, how to use them correctly for proper land preparation and correct tillage, especially for effective weed control, or how to modify them to adapt them better to specific conditions. The decision to expand in this direction could be taken two or three years after the institute is in operation; it would hinge largely on the calculated payoff on investment of resources required balanced against other attractive opportunities that the institute might have at that time.

Library and Documentation Services

All modern research is dependent upon a library and documentation service to keep the research staff and trainees informed of the vast body of printed matter published all over the world. No longer is it possible for a scientist to be well informed of the advances being made in more than a limited field of science. In technology alone it is believed that anyone whose training was completed more than five years ago is now technically obsolescent. Access to literature and help by trained librarians, documentalists, and language and subject specialists are needed to guide scientists and technologists to the information essential to the solution of special problems, for current awareness of

the state of investigations of their specialty, for a complete review of the history of investigations of a particular problem, and an awareness of the major developments in related fields. In the absence of such guidance, the scientist could spend all of his time reading without covering all of the literature he should read and without engaging in any research work.

The institute should have a carefully selected library collection containing the most-often-consulted bibliographies, abstract and review journals, monographs, and references covering the fields of interest to the institute. Little-used or rare materials should be collected in the form of photocopies, which are less expensive and occupy 90 percent less space.

In addition to the internal operational functions of selection, acquisition and processing of library materials, and of maintenance and binding, the library would furnish the readers services of reference and circulation; it should offer bibliographic service to the resident members of the staff, and develop the publication of some informative device such as an index, annotated bibliography or other tool both for the staff and/or other libraries engaged in tropical agricultural research. This latter service should be developed in cooperation with the International Rice Research Institute and the International Maize and Wheat Improvement Center, in order to provide an integrated and more complete approach than might be possible if each attempted to provide the service alone.

The staff needed for the library and documentation service should include a librarian-in-charge; a head of acquisitions and

technical processes (classification, cataloguing), and assistants; a person in charge of circulation and readers services, and assistants; a head of bibliography and documentation, and assistants; a head of the photoduplication department, and one assistant (this could be a part of the general photographic department.)

Information Service

To assist in the dissemination of institute findings and to handle visitors, the institute should employ one senior and one junior information specialists from the onset.

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The institute may wish to consider in the future adding sections of human nutrition and of food technology. Decisions to take such action or not, however, should rest on careful studies to determine if involvement of the institute in these two very important areas is highly desirable in comparison with other possible ways of achieving the desired results.

ESTIMATED STAFF REQUIREMENTS

	Initial		Future [1]	
	Senior Specialist	Junior Specialist	Senior Specialist	Junior Specialist
Crops Program				
Grain Legumes	2	1	1	1
Forage Legumes and Grasses (pasture and range management)	1	1	1	1
Corn	1*	1	-	1
Rice	1	-	-	1
Soils	2 (1*)	-	-	2
Physiology	1	-	-	1
Plant Protection				
Plant Pathology	1*	-	-	2
Entomology	1	-	-	2
Weed Control	1	1	-	1
Animal Program				
Animal Health				
Microbiology	1*	2	-	-
Pathology	1*	2	-	-
Epidemiology	-	-	1	2
Nutrition	2*	2	1	2
Physiology	1	1	-	-
Genetics	-	-	1	-
Agricultural Economics				
Production Economist (statistical design, analysis)	1	1	-	1
Production Economist (farm management analysis, planning)	1	1	-	1
Marketing Economist	-	-	1	1
Agricultural Engineer	1*	-	1	-
Library and Documentation Services	1	4	-	-
Information Specialist	1	1	-	-
Director	1*	-	-	-
Asst. Director	1*	-	-	-
	23	18	7	19

1 During the next 2 to 5 years while the institute is growing to the level of full operation.

* Individuals who may be considered for transfer from the present RF program in Colombia to the institute.

Training Program

Any long-range development effort in the agricultural sciences must make provision for a strong training program. Latin American scientists and technicians will be needed in large numbers to carry research results into frontier areas of the various countries as they are opened up, to apply and interpret new findings as development proceeds, and ultimately to staff the institute. The underlying goal of the institute - to help increase the efficiency and economic contribution of agriculture in the hot tropics - can probably be best achieved in the long run by accelerating the training of Latin American scientists and technicians.

The shortage of both professional and subprofessional personnel in all branches of the agricultural sciences in Latin America is critical. A few good schools of agriculture exist, but no university in the American tropics gives a Ph.D. in the agricultural sciences, and only a very few offer the M.S. degree. In some countries, such as Peru, where several new universities have been created in a short space of time there is an acute shortage of qualified personnel to staff them. Furthermore, much of the training in Latin American universities is not done in conjunction with field work, because of tradition and lack of facilities. A training program in tropical agriculture staffed by top-ranking scientists and planned along the lines laid down by the Rockefeller Foundation Mexican Program and the International Rice Research Institute could provide an important stimulus for education in the agricultural sciences.

The location of the institute in Palmira, Colombia, would permit in-service training at the experiment station to be combined

with formal instruction at the adjacent Faculty of Agronomy of the Colombian Agricultural Institute (ICA); candidates for advanced degrees at the University of Valle in nearby Cali could undertake individual research projects at the institute under the supervision of specialists. A system of scholarships would be worked out to enable outstanding young scientists from all over the Latin American tropics to study at the institute; advanced training for junior personnel would be bolstered by fellowships for study abroad and grants for travel and observation of experiment stations in other countries, and for attendance at international conferences and seminars.

There is also a need to build up competence in tropical agriculture among United States scientists. Young agricultural specialists from the United States would be offered training at the institute at the pre-doctoral and postdoctoral level, in an effort to generate more interest in this important field in the U.S. A program of exchanges could be worked out with the cooperating institutions to give the widest possible impact to the training program. The institute itself, however, would not become a degree-granting institution. Degree-granting functions are considered to be within the province of existing institutions, both Latin and North American. It is expected, however, that the institute would become the locus for in-service, dissertation, and postdoctoral research experience for young scientists and technicians.

The information and documentation service would keep alumni and other collaborators in touch with research results and educational projects of the institute.

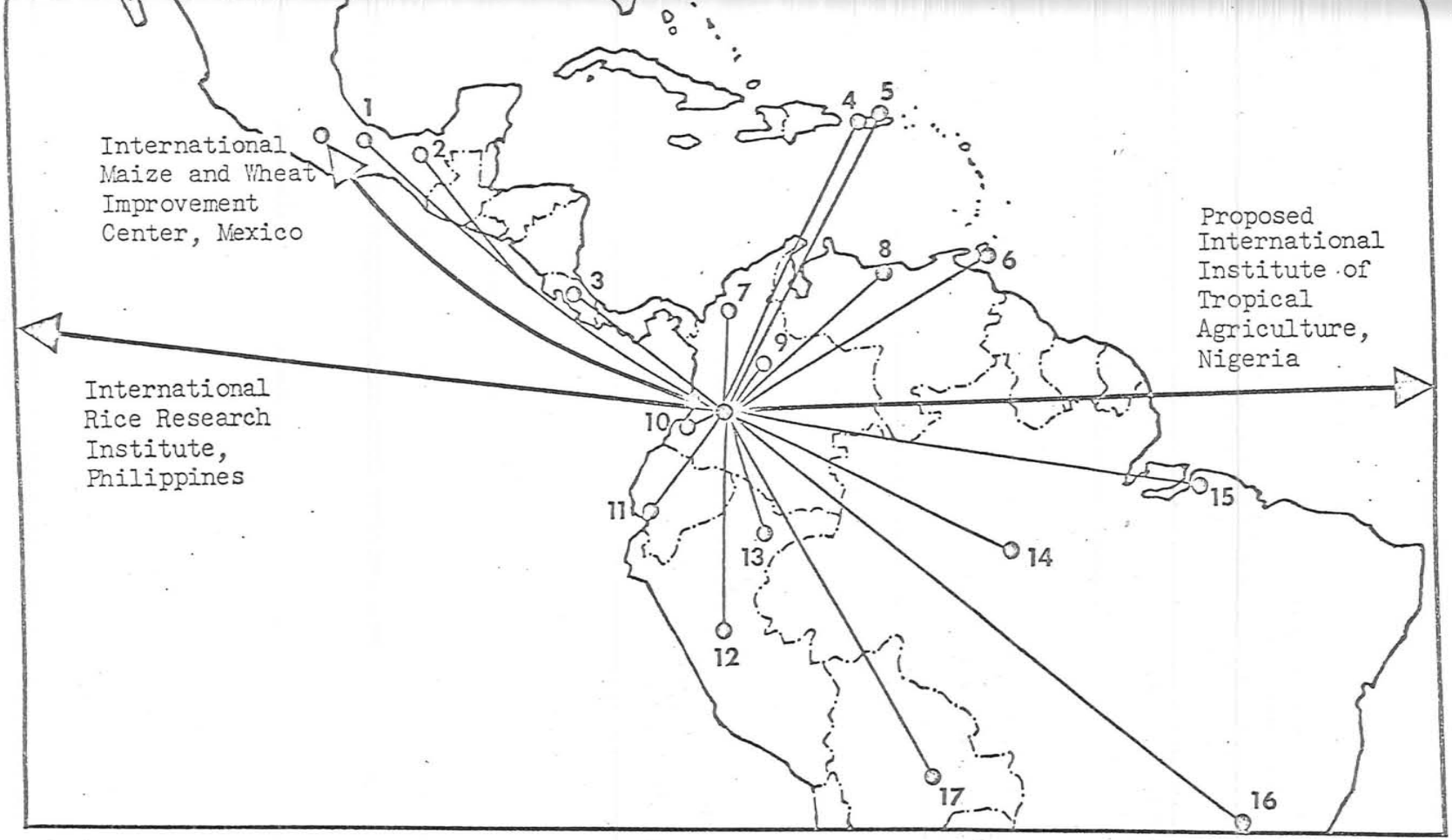
Cooperation with National and Other Latin American Institutes

Most of the Latin American countries in the hot tropics have established national agricultural research institutions to help meet the food and nutrition needs of their populations, to develop products for export, and to furnish raw materials for national industry. These organizations maintain experiment stations with research facilities for crop and animal production, forestry, veterinary science, nutrition, and related disciplines, some to a greater extent than others. Several of these national programs show promise of making important contributions to our knowledge of crop and livestock production. In some cases, The Rockefeller Foundation, USAID, the Ford Foundation and other assistance agencies have provided scholarships, capital, and technical assistance to help create a nucleus of research workers. These would be encouraged to establish a cooperative working relationship with the proposed institute.

By working closely with selected tropical stations, the institute could provide an important stimulus to research, and serve as a hub from which to help coordinate the efforts toward improving tropical agriculture throughout Latin America. A central clearing-house for information would facilitate rapid dissemination of experimental findings and eliminate duplication of work; a central bank for genetic materials could help speed up plant breeding programs throughout the area; meetings and seminars sponsored by the institute would help Latin American scientists keep abreast of developments in tropical agriculture throughout the world.

Centers with which the tropical institute might cooperate are located in ten different countries and represent a wide range of

ecological conditions. The map on page 44 shows the location of these institutes and their relation to Palmira, Colombia, the suggested headquarters site (see page 52 ff.) They span the entire tropical belt of Latin America, reaching from the state of Veracruz, Mexico, to central Bolivia, and from the mouth of the Amazon to the Pacific coastal jungles of Colombia. All the main hot tropical regions with which the institute will be concerned (see pages 5 to 9) are represented:



RELATION OF COOPERATING INSTITUTES TO PALMIRA, COLOMBIA

1. Cotaxtla, Mexico
2. Chiapas, Mexico
3. Turrialba, Costa Rica
4. Mayaguez, Puerto Rico
5. Rio Piedras, Puerto Rico
6. Trinidad
7. Cerete, Colombia
8. Maracay, Venezuela
9. Villavicencio, Colombia
10. Colombian Pacific littoral
11. Pichilingue, Guayaquil, Ecuador
12. Tingo Maria, Peru
13. Iquitos, Peru
14. Manaus, Brazil
15. Belem, Brazil
16. Belo Horizonte, Brazil
17. Santa Cruz, Bolivia

1) In the northern coastal plains of Colombia, the collaborating institution would be the Turipana Experiment Station of the Colombian Agricultural Institute (ICA) located in Cerete in the province of Cordoba.

2) Cooperating stations in Mexico and Central America would include the Campo Cotaxtla (Centro de Investigacion Agricola y de Industria Animal para Zonas Tropicales) in the state of Veracruz, Mexico, which is well advanced in its experimental program in tropical agriculture; and a government station that is just being started in the state of Chiapas. The well-equipped Inter-American Institute of Agricultural Sciences (IICA) maintained by the Organization of American States at Turrialba, Costa Rica, offers a third possibility for collaboration in this region.

3) Two stations located on the Pacific littoral of Ecuador would offer their facilities for collaborative work with the institute. These are the Pichilingue and Santo Domingo stations operated by the National Institute of Agricultural Research (INIAP). The Pichilingue station in particular is well launched on various research programs: it has 800 hectares with plantations of bananas, coffee, and cacao, and experimental work is in progress on corn, beans, forages, and beef cattle. Santo Domingo is a substation of INIAP, in the same general region.

4) Three stations in the Caribbean region would be potential collaborators: two are in Puerto Rico - one at Rio Piedras, just south of San Juan, and the other at Mayaguez on the western coast of the island. The third Caribbean station would be that of the University of the West Indies School of Agriculture in Trinidad.

5) Several national institutes maintain stations in different parts of the Oriente, or eastern Andean foothills: The institute would cooperate with the national agricultural research center run by the Ministerio de Agricultura y Cria (MAC) at Maracay in Venezuela, which has a broad crop and animal program. In Peru, a branch of the Servicio de Investigacion y Promocion Agraria, located at Tingo Maria, offers possibilities for collaboration, as does the Universidad Nacional de la Amazonia Peruana in Iquitos, created six years ago by the government to serve this region.

Santa Cruz, Bolivia, is a center of developmental activity which holds several possibilities for cooperative efforts: the veterinary faculty of the University of San Simon is located here. (The other faculties, including the Faculty of Agronomy, are at Cochabamba.) The Servicio Agricola Interamericano (SAI) operates a crop improvement program and a livestock center at Santa Cruz. The Bolivian government is sponsoring immigration and development in this area as part of its agrarian reform.

6) In the hot humid tropics, two Brazilian institutions would be potential cooperating stations. One is the Instituto de Pesquisas e Experimentacao Agropecuarias do Norte (IPEAN) in Belem, which the Brazilian government has operated for 25 years. It has 3,000 hectares, 200 of which are used by the Escola de Agronomia da Amazonia, for their research and training program. The other institution in this region would be the University of the Amazon located in Manaus.

7) The campo cerrado, or central plateau of Brazil, is at the present time the object of research and development plans being drawn up

by a consortium of Brazilian institutions with which a group of American universities known as the Midwest Universities Consortium for International Activities (MUCIA) is cooperating. The Brazilian institutions involved include the University of Minas Gerais, the Rural University of Minas Gerais, the University of Sao Paulo, the Agricultural University and Research Institute at Km 47, and the University of Brazilia (CEPETEC). They are supported by the Brazilian National Research Council and other private and public organizations. The American members of MUCIA are the University of Illinois, Indiana University, the University of Wisconsin, and Michigan State University. This important undertaking, once it gains momentum, would offer the proposed tropical institute opportunities to collaborate in developing agriculture for this area as well as for other regions of Brazil where cerrado conditions prevail. Already under development with Ford Foundation and USAID assistance is a new station in the Triangle area of western Minas Gerais. A part of the station network of the Rural University of Minas Gerais, this institution should be linked cooperatively to the proposed tropical institute.

8) For collaborative research in the llanos, the institute would work with the Colombian Agricultural Institute substation of La Libertad, located at Villavicencio. Here ICA has field and laboratory facilities which it would be pleased to share with the institute on a cooperative basis.

Cooperation with International Institutes

Close contact would be maintained with the two major international institutes which deal with tropical agriculture: the

International Rice Research Institute in the Philippines and the International Maize and Wheat Improvement Center in Mexico. Since the proposed tropical institute will be patterned basically along the same lines as these institutions, since it will serve the same goals, and possibly involve some of the same people, cooperation among the three organizations would be a logical development. Such contacts would be important for pooling research results on an international level, as well as for sharing new techniques of management and communication, and coordinating collections of breeding materials for the major tropical crops. To maintain ties with the world scientific community, exchanges of students and specialists might be worked out as research priorities are established and programs begin to take shape. The special character of the Latin American tropics, both their similarities to Africa and tropical Asia and their differences, will contribute to deepening and diversifying knowledge of how agriculture in all these areas can be developed to contribute more significantly to world food needs.

Organization of the Institute

It is proposed that in general the basic pattern of organization be adopted for this institute as is used by the International Rice Research Institute and the International Maize and Wheat Improvement Center. Modifications of this basic structural pattern will be made as needed, and as indicated by previous experience in the IRRI and IMWIC, to adapt this proposed institute to the Latin American setting.

From the onset the institute would be an autonomous organization under the general direction of an international board of trustees.

The board would consist of up to 12 members carefully selected for their capabilities, interest, and the contributions they could make to the institute's development and management. The Ford Foundation and The Rockefeller Foundation would be represented on the board.

The director of the institute would be selected initially by the two Foundations jointly, subject to the approval of the board of trustees.

The technical staff would be international in character. Care would be taken not to "overload" the staff with U.S. scientists. It is planned that highly qualified agronomists, animal scientists and economists from Latin America will be attracted to help staff the institute in such numbers that these countries will be well represented. It is clearly recognized, however, that the national institutions and programs in Latin America are short of well-trained scientists at present and will continue to be so for several years to come. Consequently, the institute must be very careful not to toll the key personnel away from the local organizations and thus in a sense compete with the very institutions it is designed to help. The institute will help provide advanced training and in-service experience for a large number of young or junior agricultural scientists from Latin America, and from among these select the best for permanent appointments, so that after a few years it will have developed its own good staff with well-balanced representation from the Latin American region.

There are many highly qualified Europeans and Japanese with experience in tropical agriculture in Africa and Asia. These should

definitely be taken into account, as should individuals of other nationalities, as the institute recruits its staff.

Estimated Cost

Technical Staff - The table on page 39 summarizes the estimated professional staff requirements for programs, 1) at the time of the initiation of the institute, and 2) at the stage when it is in full operation (perhaps five years after its creation).

Approximately 23 senior specialists and 18 junior scientists would be needed at the beginning. About $30,000 annually would be required to pay the salary, perquisites, and transportation of each senior staff member, and $20,000 for each junior scientist. On the basis of these calculations, approximately $1 million per year would be needed to pay staff salaries, perquisites, and transportation.

It is, of course, somewhat presumptuous to attempt to project staff needs for the future with a high degree of accuracy. These will depend on many factors, such as the success and results of different research programs, and on needs and opportunities which arise as the institute moves forward. To give a general idea of possible additional staff requirements as the institute develops to the point of full operation, estimates of approximately seven senior and 19 junior specialists have been arrived at. This would represent about $600,000 annual increase in budget for technical staff costs.

Operating Expenses - A fairly sound rule of thumb is that approximately the same amount is required in operating funds to support adequately

the work of a technical staff member with field and laboratory workers, supplies, equipment, etc., as is needed to pay his salary and perquisites. On this basis, it is estimated that the operating expenses for the institute would be approximately $1 million annually during the initial stage, and that this sum might step up to about $1.6 million per year when the institute is fully developed.

Capital Costs

Land - There are good reasons to believe, if Colombia is selected as the site, that the Colombian government will provide the necessary amount of land as part of its contribution to the institute. There is a very good block of land of some 500-600 hectares immediately adjacent to the Colombian Agricultural Institute experiment station and within a quarter of a mile of the Faculty of Agronomy at Palmira of the National University. It is held by one owner, and apparently a part or all of it can be purchased according to the need. It would appear almost certain that the Colombian government would be willing to buy whatever portion of this farm is needed, and lease it to the institute for a long term (25 to 50 years) on a peso-per-year basis.

At the moment, it is difficult to estimate the amount of land that would be desirable to fulfill the needs of the institute. Careful studies of the requirements of each research program will have to be made to reach a sound conclusion on this question. It would seem advisable that the institute not become saddled with the responsibility of developing and maintaining any more land at its headquarters site than is reasonably needed for the activities to be

based there. From the very start, the staff should establish a pattern of conducting as much of their research as is feasible in collaboration with, and on the premises of the different national research institutions with which the institute will be cooperating. It would be undesirable for the staff to form a habit of sticking too close to home base, which they might tend to do if there were an excess of land over the essential needs at the headquarters station. In the light of these general considerations, we venture to make a rough estimate that around 200 to 250 hectares will be needed at the headquarters of the institute.

Buildings and Equipment - The capital costs of the International Rice Research Institute have been approximately $7.5 million, including land. The costs of buildings and equipment for the proposed institute should be only about three-fourths those of the IRRI; i.e., between $4 and $5 million. The main reason for this is the fact that the Latin American institute will not need as large a headquarters set-up: it can and should accomplish a great deal of its research work through collaboration with research institutions in the various tropical regions as previously described. (Pages 45 to 47).

Financing

Land - This should present no problem since, as mentioned above, the site will almost certainly be provided by the Colombian government, if the institute is located in that country.

Capital and Operating Costs - It is proposed that initially The Rockefeller and Ford Foundations share equally the capital and operating costs. The operating expenses of the proposed new institute

in Colombia, including staff costs, would represent an expenditure of about $1 million annually for each Foundation if these costs are shared equally.

The institute would be organized and established in a manner that would enable it to attract and accept financial support from other sources, such as governments, private individuals and institutions, international agencies, etc., as time goes on. It is hoped that soon after the institute begins operations it would be successful in seeking additional funds from other sources to assist with operating costs, and especially with operating and other expenses connected with possible future expansion.

Recommendation of Palmira, Colombia, as Headquarters Site for the International Institute

For a number of reasons, which are reviewed here, it is suggested that the tropical institute's headquarters be located at Palmira, Colombia. In selecting the site for an institution of the type and quality envisioned in the present proposal, criteria must be taken into account which may be decisive factors in the effective functioning of the institute. Some of the considerations which determined the choice of Palmira follow:

1) The institute should be located within the ecological zone on which its work will be focused. The institute must be in the tropics; however, common sense and experience dictate choosing a spot located toward the more favorable end of the spectrum of tropical conditions, from which to spearhead a gradual and rational conquest of the harsher and less tractable regions. Palmira is located at an altitude of 1,000 meters, has a mean annual temperature of 75°F,

and an average annual rainfall of 40 inches. It is subtropical rather than torrid, but any crop, incluling forages, that is adapted to tropical and sea-level conditions can easily be grown with normal development in this region. And, most important, it will be easier in most instances to propagate and maintain germplasm collections at Palmira than at lower elevations under very high temperatures and heavy rainfall conditions.

Obviously, no one site will be representative of the wide range of ecological conditions previously described for the major hot tropical areas of Latin America. To do its job properly, the institute will have to conduct a large part of its work away from the headquarters site, in collaboration with national research institutions located in these different areas. Research activities at the institute's headquarters should be restricted to the work that best lends itself to the immediate environmental conditions.

2) The location of the institute should be geographically convenient.

Colombia is at the crossroads of the Americas. Map 2 (page 44) graphically illustrates this point. Palmira is located in the position of the hub of a wheel whose spokes extend to the several research stations with which the institute would collaborate.

Within Colombia itself, Palmira is likewise very favorably situated geographically with respect to ease of access to and communication with areas that represent the total gamut of ecological conditions found in the hot tropics anywhere in Latin America. From Palmira, it takes only about an hour and a half by car to reach the heartland of the tropical jungle area of the Pacific littoral where the average annual rainfall is about 350 inches and the mean annual

temperature is 80°F. This area is just as tough as the heart of the Amazon or Orinoco River basins and is in fact quite similar to them in many ways. By plane, one can arrive in Cerete, Colombia, in less than two hours. Here ICA has one of its five major regional experiment stations (Turipana) with 1,800 hectares (4,400 acres) of land typical of the benign hot tropical areas as described on page 5 under the section "Northern Coastal Plains of Colombia." Similarly, a flight of less than two hours' duration will take one from Palmira to Villavicencio, where ICA has another of its principal regional stations (La Libertad), which is representative of the vast llanos region of eastern Colombia and southern Venezuela. ICA would welcome collaborative assistance from the institute in the research efforts to solve the principal agricultural problems of this vast and potentially important hot tropical area. La Libertad has approximately 1,300 hectares (3,300 acres) of land, and ICA would be glad to share this and other facilities of the station with the institute.

3) The institute should be located near an existing college of agriculture, a strong agricultural experiment station, and a dynamic university. Many advantages would be derived from locating the institute immediately adjacent to the existing Faculty of Agronomy at Palmira of the National University, and to the neighboring agricultural experiment station of ICA. The college and the experiment station figure in cooperative plans made by ICA and the National University to launch postgraduate training in agriculture. Although the headquarters for the postgraduate college will be in Bogota, most of the training pertaining to tropical

agriculture under this program will be done at Palmira. While the proposed tropical institute would be autonomous and independent, it would want to establish close cooperative links with the Faculty of Agronomy and the experiment station of ICA at Palmira both in research and graduate training.

Another important advantage in locating the institute at Palmira would be the fact that it would be near (only 40 minutes by car on an excellent highway) to one of the most dynamic and progressive universities in Latin America. Distinct benefits would ensue from proximity to this viable academic community. The University of Valle in Cali could contribute a great deal to the institute, and vice versa, over time. The Faculty of Medicine of the University of Valle is deeply concerned with problems of health, nutrition, and general welfare of the people in the region. Its main pilot project in public health is at Candelaria, only 15 minutes by car from Palmira. The personnel of several sections of the proposed institute could work in close cooperation with the public health division of the Faculty of Medicine, to their mutual benefit. The University of Valle also has made a good start in developing a group of trained agricultural economists in its Faculty of Economic Sciences. Seven have advanced degrees from United States universities, including five in agricultural economics and two in rural sociology. Arrangements have already been initiated whereby this group is working with the Faculty of Agronomy at Palmira, and it should be a simple matter to expand these cooperative relationships to include the tropical

agricultural institute located nearby. As formal course work in the sciences as well as in the social sciences improves at Valle, students involved in institute training programs may draw directly upon the University's faculty.

Although the existing training potential is not ideal (e.g., the Veterinary faculty is at Bogota not Palmira, the sciences at the University of Valle are reported to be weak, graduate programs in agriculture are only now being developed and they are centered in Bogota, not in Palmira) with careful planning much can be accomplished within these limitations.

4) The institute must consider suitability of location from the standpoint of living conditions for staff. The success of the institute will hinge largely upon the quality of international staff it is able to attract and hold over a relatively long period of time. The Cali-Palmira area is attractive as a place to live from the standpoint of comfort, health (hospital facilities and doctors), schools, and cultural attractions. As a matter of fact, no other location within the hot tropics of Latin America can equal Cali in this regard.

5) The host country must have a real interest in the institute; it must sincerely want it and be willing to contribute to it. While several countries would like to have the institute located within their boundaries, Colombia probably has as strong an interest and desire as any to have it established there - perhaps even stronger. In informal conversations about this, the present Colombian Minister of Agriculture has essentially stated that the Colombian government wants the institute very much and would be willing to make substantial

contributions to it if it were located there. The leading officials of ICA have expressed the same viewpoint. In fact, the executive committee of ICA has informally stated that the Colombian government would provide the necessary amount of land as part of its contribution. They have repeated on various occasions their willingness to have ICA's facilities used cooperatively by the institute, whether it be located in Colombia or in some other country.

Discussion

It is recognized that the proposed Cauca Valley location for the institute has limitations. If an institute is located there, these shortcomings will need to be researched and management plans evolved to minimize their influence on the institute's effectiveness.

The institute may, by its location, tend to slight the large campo cerrado area of the Planalto in Brazil. But linkage to and support for the new UREMG (Rural University, Minas Gerais) experiment station in the Minas triangle near Uberlandia may help overcome this problem. Additionally, the U.S. and Brazilian consortia reports on the campo cerrado are not yet in. It is likely that additional research activities will evolve from this effort.

Theoretically, a larger country such as Brazil, were the institute to be located within its boundaries, might in time be better able to take over an institute than Colombia. However, search in Brazil identified no site judged to be equivalent to Palmira.

This location and plan of operation emphasizes the hot to hot-humid tropics to the exclusion of the temperate-like areas of Latin America. Thus the institute itself ignores the "quick" production increase potential believed by many to exist in Argentina, Chile and similar

temperate-like areas. However, the International Maize and Wheat Improvement Center and careful work with indigenous institutions provide alternate routes to temperate-zone assistance.

This proposal is for the creation of a new autonomous institution under North American direction; it does not develop an existing Latin American institution into a pacesetter for later national or regional take-over. Thus the institute's complementary role in assisting indigenous institutions must be constantly stressed. The long-run need is for quality Latin institutions under Latin management and support.

The institute proposes to work alongside ICA, the National University at Palmira, and the University of Valle. Concurrently, the Foundations sponsoring the proposed institute are attempting to help these Colombian institutions grow. The institute would be autonomous, but would expect to call on these Colombian institutions for collaboration. Care would therefore be exercised that too many outside programs are not centered in Colombia with too great an outside-assistance infusion. There is danger that well-intended assistance, if provided in excess, could hinder rather than help Colombian institutional development. Preliminary investigations would also have to be made into the extent to which these institutions can realistically be expected to assume financial responsibility for programs initiated by the institute.

General Comments

The proposed institute as conceived stresses the low tropics where knowledge is scant, where presumably the greatest gap exists in

man's theoretical and practical scientific capability in the agricultural production sciences. Much of the geographic area to be served has in it few people and tremendous shortages in the necessary infrastructure.

Emphasis is not on a single crop or enterprise as in the successful IRRI model. Several food and feed crops plus ruminant animals are to receive attention. However, the intent is to concentrate on those that are clearly most important in tropical regions. While social science as well as technological investigations and training are involved, a direct frontal attack on national structural problems of resource ownership and income distribution is not planned. Because of the many faces of the economic development problem in the Latin American tropics and the multifaceted approach of the institute, spectacular short-run achievements are improbable. Essentially, the institute takes a long look ahead and says: the hot tropics in South America will in time need to be used much more intensively. If agricultural productivity can be increased, this should help accelerate economic growth. Hungry, diet-deficient people can be better fed, clothed, housed and educated. Let's try systematically to learn how.