Series CE-7
September, 1975

Symposium on

# The potential of the lowland tropics

October 13, 1973

Centro Internacional de Agricultura Tropical

CIAT is a nonprofit organization devoted to the agricultural and economic development of the lowland tropics. The Government of Colombia provides support as host country for CIAT and furnishes a 522-hectare farm near Cali for CIAT's headquarters. Collaborative work with the Instituto Colombiano Agropecuario (ICA) is carried out mainly at its Experimental Centers at Turipaná and Carimagua. CIAT is financed by a number of donors represented in the Consultative Group for International Agricultural Research. During the current year these donors are the United States Agency for International Development (USAID), the Rockefeller Foundation, the Ford Foundation, the W. K. Kellogg Foundation, the Canadian International Development Agency (CIDA), the International Bank for Reconstruction and Development (IBRD) through the International Development Association (IDA), the Interamerican Development Bank (IDB), the United Nations Environment Programme, the Ministry of Overseas Development of the United Kingdom and the governments of the Federal Republic of Germany, the Netherlands and Switzerland. In addition, special project funds are supplied by various of the aforementioned entities plus the International Development Research Centre (IDRC) of Canada. Information and conclusions reported herein do not necessarily reflect the position of any of the aforementioned agencies, foundations or governments.

Centro Internacional de Agricultura Tropical (CIAT)
Apartado Aéreo 67-13, Cali, Colombia, S.A.
Cables: CINATROP

Ceremony of

# Inauguration of CIAT's New Facilities

(October 12, 1973)

Series C E - 7
September, 1975



and

Symposium on

# The Potential of the Lowland Tropics

(October 13, 1973)



Centro Internacional de Agricultura Tropical
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## Misael Pastrana Borrero

President of the Republic of Colombia

As leader of a country whose economy largely depends on agriculture, it gives me great pleasure today to inaugurate these facilities of the Centro Internacional de Agricultura Tropical. This center is immensely important, for it is here that science and research are united in the search for increased agricultural production and productivity.

Because it embraces diverse climatic, environmental and soil conditions, Colombia is privileged to experiment with widely varied crops and to initiate ambitious livestock development. There are areas of Colombia where the most advanced technology has been applied with visibly satisfying results; areas such as this Cauca Valley. Such technology enables us, not only to fulfill domestic needs, but also contributes greatly towards improving foreign trade.

Even so, vast portions of our country are still unexploited. These areas are similar to others found in Latin America and Africa. They are areas of colonization, only now being developed in a disorderly effort to extract their natural resources - flora, fauna, timber. With this type of exploitation comes the dangerous devastation of our country for the benefit of only a few. These areas, however, could well prove to be the agricultural future of Colombia. Their conquest poses a challenge we are obliged to meet.

The results of research conducted on lands similar to our Llanos Orientales, by centers such as this, indicate that these national territories can be converted to top food producing regions.

New vistas in our agricultural progress can be opened by utilizing existing varieties of the basic commodities, including beef cattle, swine, cassava, field beans, maize and rice, and by developing new ones especially adapted to our needs. The Colombian government is supporting with determination all efforts to improve and modernize our agriculture. Since we are faced with a population growing in size and in its purchasing power, as well as with the possibility of a spiraling world food crisis, we feel there is no more important task.

I am aware of the work which CIAT has carried out in our country over the last few years, and of its constant concern with crop, animal and economic development in the lowland tropics. In its short lifespan it can show a positive inventory of achievements which will not only benefit Colombia, but all of Latin America. Of all the contributions which can be made for the future welfare of our people, an increase in agricultural production and productivity is one of the most important.

**Production**

The government of Colombia is conscious of the fact that agricultural production is the foundation on which rests this nation's economy and the well being of most of its people. This is why the government is providing incentives for the development of such aspects of production as credit, input materials, technical assistance, national and international marketing. Also of primary concern to this administration is the search for socio-economic balances between the production and consumer sectors of the economy and between the traditional and industrial sectors of production.

In spite of unfavorable weather for the past two years, this firm and constant determination allows us to look forward to increased agricultural production. This increased production can be translated into greater price stability and this in turn benefits the consuming public. The Ministry of Agriculture recently brought together experts, from both the official and private sectors, for a high level technical seminar at Ibagué. Afterwards the ministry reported that this year's production of such important crops as potato, cocoa, plantain, cassava, beans, sorghum, vegetables, flowers, fruit and tobacco is significantly higher than that of 1972.

I do not exaggerate when I predict that this agricultural year will surpass the last one by about 15 percent. This, translated into production volume, represents around one million extra tons of the crops just mentioned. We can safely say that we are harvesting the fruits of a policy that has been carefully and clearly directed towards the farm and the farmer.

**Credit**

Credit has played a decisive role in enabling us to achieve our objectives; it's granted with adequate generosity but with judicial and guided criteria (designed to meet the farmer's needs), according to his productivity capabilities rather than his solvency. Largely because of the new statute in Law Five, of February of this year, the agricultural credit system in Colombia is one of the most technified in the developing nations. This law has generated inestimable benefits and progress. In it, the flaws of the previous credit structure are corrected, and lessons learned from valuable experience have been incorporated.

**Technical Assistance**

Colombian business is fortunate in that it can count on very highly developed technical assistance. At present we are establishing institutional services sufficient to enable us to reach rural businesses. As a traditional and essential component of Colombian technical assistance, the high income farmers and cattle breeders must bear the cost of this service as a prerequisite to the issuance of credit. But it is our wish that the small farmer receive this service from the state in adequate amounts and without cost, partly subsidized by

the large agricultural businesses. These businesses, however, receive government subsidies, in the form of tax exemption certificates, when they enter the export market.

The previously mentioned Law Five efficiently balances the needs of the farmers with the objectives of integral technical assistance, available just as much to the small farmer, as to the largest business.

## Inputs

Although much of the fertilizer used in this country is produced locally, prices are nevertheless affected by international variables through the raw materials used in its manufacture. Because of the world-wide scarcity and expense of inputs, especially fertilizers and insecticides, the government has been supplying them to the farmer. This is to insure that he is affected as little as possible by high processing and transportation difficulties.

Colombia is almost self-sufficient in its seed requirements, and the little importation that is required is mainly for patent protection. This imbalance is more than compensated by our export of other seed, such as rice and soybean, which evidence our sophisticated level of agricultural research.

## Marketing

Perhaps one of the greatest problems for the farmer and one of the biggest concerns of the consumer, is adequate marketing. Marketing obviously exerts a strong influence on prices and their abrupt variability. Many factors are involved in this process; transport, storage, silo space, warehouses, points of purchase, support and intervention prices, instruments of bonding, and in fact, all the regulatory apparatus available to the government for controlling commercial activities. Furthermore, opportunities for export or import, and decisions about them, demand timely and judicious governmental action to insure that market positions are not compromised or domestic supplies unbalanced.

The work of our Agricultural Marketing Institute acquires great importance during times such as at present. It is difficult to alter the mechanism of a marketing system, which has been operating exclusively under the pressure of scarcity, so that it can also deal with a situation of plenty, such as we are now experiencing in some areas of the agricultural sector. Whereas it is necessary to act in the defense of the consumer, it is also necessary to protect, and rapidly, the producer by restraining the dominating influence of the middleman. The network of refrigeration units recently established by the Institute will prove very useful in the near future because they will enable significant and decisive action in the marketing of perishable goods.

**Land Reform**

Day by day it is becoming increasingly more obvious that rural peace can only be attained when an adequate balance is established among all the parties involved in land tenure. Only when small, medium and large land owners, the tenants or share croppers and the rural workers equally and smoothly participate in the production process will the problems of tenancy, income and socio-economic levels be considerably reduced.

When land ownership is concentrated in but a few hands, or when land is not adequately exploited; when share croppers are cheated out of their rights; when land leasings are set by speculative means; when work is not correctly remunerated — then conflicts and confrontations, insecurity and uncertainty arise. There cannot be rural peace on a soil of inequalities sown with the seeds of injustice.

Law 4, of this year, modifies the existing agrarian statute and seeks a self-styled solution to the problems that have arisen in our country's rural area. It is a solution which fits our needs, without imported methodologies and free from useless demagogy and extremes. These, our experience has shown, bear more evil than good. This will not, however, prevent the continuing progress of an integral agrarian land reform, designed to allow the farmer to realize the land's potential by properly training him to plan both his work and life with greater hope and expanded possibilities.

In accordance with our philosophy of agrarian reform, we are placing special emphasis on community enterprises. We believe this formula is adequate for preventing land distribution from becoming a dangerous fragmentation of properties. This can generate inefficiency, under-utilization of resources and social frustration. We have just established standards for the regulation, promotion and stimulation of community enterprises. INCORA will focus its attention on these new societies and this, we hope, will unite the farmers, organize them efficiently, provide them with technology, so they may achieve their highest objectives for the betterment of their welfare and living conditions.

**Reseach**

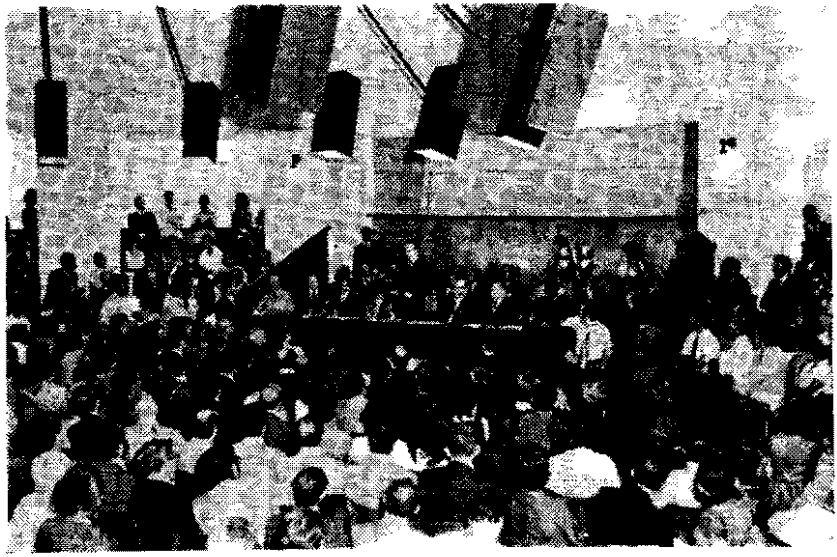
I am sure you are all aware of the activities aimed at the solution of rural problems which I have brought to your attention today — they form the basis of your work.

I refer, of course, to agricultural research, the basis for all processes of technification. I would take up too much time if I tried to evaluate the influence on modern agriculture of new breeds and varieties, modern methods of pest and disease control, new procedures for the maintenance and management of genetic material, and for the formation of germ plasm banks — practices designed and proven here, for distribution to the rural classes.

ICA and CIAT are working closely and in coordination on all these matters to insure the achievement of scientific and technical advances which our people today gratefully witness. It would suffice to say that thanks to the valuable help of the Centro Internacional de Agricultura Tropical, Colombia marches among the leaders with regard to matters pertinent to the responsibilities and untiring research of members of this institution.

A new variety of rice or an improved breed of cattle would more than justify the working costs of the scientists at this center. Colombia, or I should say the countries of the tropics, need that work. I expresss this by assuring you of the interest with which the work here is followed, and by stating my admiration for it.

These are, of course, propitious moments to express to Dr. Ulysses J. Grant, Director of CIAT, the gratitude of the government and of the nation for the dedication and self-denying effort his privileged mind and noble spirit have contributed to the mission that this organization is carrying on and for the self-denying effort he has put into organizing CIAT and establishing its objectives. In appreciation of his merits, the Government has conferred on him the Order of San Carlos, created for the recognition of services rendered to Colombia. It pleases me greatly to pin on him this decoration which he more than merits.



**The President of Colombia, Dr. Misael Pastrana Borrero, addressing the audience at the inauguration of CIAT's new facilities. (October 12, 1973)**

# Francisco de Sola

President of CIAT's Board of Trustees

On behalf of the Board of Directors of CIAT, I wish to thank His Excellency Misael Pastrana Borrero, President of the Republic of Colombia, for honoring us with his presence today where distinguished people from many parts of the hemisphere have gathered for the inauguration ceremony of the Centro Internacional de Agricultura Tropical (CIAT), in this pleasant and hospitable Cauca Valley.

At the end of my term as Chairman of the Board my feelings are numerous; on the one hand of satisfaction, on the other of deep gratitude. Both of them inspire me to share with you some of the considerations that come to my mind at the end of a journey so full of personal experiences, so rich in the formation of new and dear friendships.

At CIAT —this workshop of the Americas— where science is applied to the land and men are trained to extend to others throughout the humid tropics their scientific findings, is where I have come to realize, in its true magnitude, the importance of cooperation among individuals and collaboration among nations. At the same time, I have recognized the value of multinational efforts.

At CIAT, such multinational cooperation is clearly manifested in various aspects— the make-up of the Board of Directors, the same as in those of the other six centers, boards integrated by men from different parts of the world, with various interests and different experiences and capabilities. All of them have been invited **ad honorem** with the sole purpose of serving mankind. Multinational cooperation can also be seen in the structure of the administrative, research and teaching staffs throughout the centers. In the case of the two oldest centers, the Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT) and the International Rice Research Institute (IRRI), not only have they given the world improved corn and wheat varieties and the "wonder rice" but also their discoveries have crossed borders and oceans in order to serve other nations. Furthermore, staff members and technicians, trained in applying specialized methods, travel from country to country divulging the newly acquired technology.

Let us consider for a moment the importance of the existence of seven large research centers, four of them in full operation, dedicated to agricultural research with the common goal of increasing production of the largest basic food crops of mankind: corn, wheat, rice, beans, cassava, yams, sorghum and meat.

The adequate establishment of this network of autonomous centers guided by free-thinking men dedicated to research in its most transcendental aspects, is the outstanding product of noble efforts on the part of two honest men: Dr. George Harrar and Dr. Forrest F. Hill to whom we extend our respectful greetings and sincere gratitude.

The first centers were sponsored and financed **ab initio** by the Rockefeller and Ford Foundations with the material and moral aid of the national governments of each host country. Then, others collaborated as follows: the Kellogg and Kresge Foundations, the United States Agency for International Development (USAID), the Dutch and Swiss Governments, the Interamerican Development Bank, the Government of Canada and the International Bank for Reconstruction and Development. These foundations, governments and financial institutions form the "Consultative Group" which, counseled by the Technical Committee, meets once a year in order to examine their work programs and financial budgets, re-evaluating them so as to avoid costly and unnecessary duplication of efforts. Putting aside any nationalistic or discriminatory attitudes, this group forms a powerful fraternity which, for administrative purposes, meets at the International Bank for Reconstruction and Development, with the additional sponsorship of the United Nations Development Program and the United Nations Food and Agricultural Organization.

The group, without rigid statutes or juridical frame, and without contractual restrictions other than those considered imperative, has deserved the confidence of institutions and governments financing it generously without requesting other than a reasonable display of adequately applied funds and a positive attitude towards the goals that are to be accomplished. The delegation of confidence and authority upon the directing groups is something of great significance and serves as a beautiful example of the existing collaboration among individuals, institutions and nations to which I referred previously.

It is of common knowledge that man is an important change factor in history. In my opinion, the work carried out by the international centers is also an important change factor in development.

In the agricultural world changes occur slowly and are a product of man's knowledge applied to the land. Ever since man progressed, for reasons of survival, from his role of hunter to that of planter and then to that of farmer, the need of research was born; it lives in man, it is transmitted by him, it is perfected or it fails through him. The need for research is an intrinsic part of man; it is universal and eternal.

In its objectives, CIAT points out the importance of extending to others all successes achieved through production systems or agricultural practices under given circumstances. Hence, it is well

understood that the scientific advances must be transmitted through simple technologies, easily understood by the farmer and applicable in his agricultural, social and economic world, thus reducing as much as possible the uncertainty which surrounds the life of the small farmer.

For the achievement of this trial, CIAT trains personnel able to transmit these coordinated technologies, structured in viable, simple and effective production systems. CIAT also trains men dedicated to research whose mission is to fortify institutions in their native countries in order to further education with a multiplying effect. Furthermore, CIAT organizes important international seminars yearly where men of science from all parts of the world may gather,

If the work carried out by the international centers is to be effective, it must be coordinated with the programs of the Ministry of Agriculture, the planning centers and the development organisms of the different governments.

Only through national programs —adequately structured— will it be possible to achieve the public acknowledgement, confidence and reliability necessary to transfer the new technology, methods and break-throughs in science to the farmers, so that they may be accepted and applied with a sense of urgency towards solving problems in each country or regions of influence of each center.

The centers must maintain close contact with government programs, understand their needs, respond to their calls, orient, participate and share their problems as CIAT is doing in several countries, maintaining at all times their juridical, economic and scientific autonomy.

The agricultural economist, the sociologist, the politician, the researcher and the anthropologist are recognizing more clearly every time the rural strength, dignity and training of the family unit as the most important factor in the socio-economic change necessary to achieve a maintained increase in production and assure equitable consumption and adequate utilization of the advantages offered to the individual by modern society.

Any new agricultural system introduced must keep in mind the importance of the family factor, must be advantageous to the beneficiary, must offer economic returns, personal and social satisfaction and, at the same time, guarantee protection and preservation of the national patrimony, that is to say, the replaceable natural resources.

To be precise, this does not mean that we should hoard these resources. They should be utilized intelligently and wisely in order to deliver them intact or improved, to posterity. This idea implies the acknowledgement that the unchecked population growth must not continue at the accelerated pace of the past century, increasing

the population by 1 billion people. But of even greater concern is the projection of this curve which will increase substantially the world population now of 3.7 billion, duplicating itself in the next 33 years.

There staggering statistics show the imperative need for a massive increase in food production in order to maintain and improve the standard of living of today's population and that of the future. Let us not forget the dramatic experience that we are living at the present time, since the world food balance has evolved from surplus to deficit due to a combination of adverse climatic conditions and to exceedingly large basic grain transactions among world powers. Evidently, the most serious problem facing mankind in social development is the unchecked population increase. The United Nations has unanimously recognized this fact, declaring 1974 as the "Year of Population"; its 130 members will meet at Bucharest in order to examine the problem and its scope and to search for corrective measures.

I leave you with these thoughts that have been on my mind for five years during which I shared with my fellow directors the work entrusted us. I hope that CIAT will continue to carry out this important mission, with the acknowledgement that the increase in productivity is only one step towards the improvement of human conditions, something of universal concern. I will be satisfied if, during CIAT's initial stage, we have been able to create a mystique that gives spiritual strength and encouragement and serves as a creative force in the task filling the gap between the science of production and production itself.

My final words are of gratitude. They are addressed to those institutions and people who have participated in the creation of this center; to our host government; to the people of Colombia for their generous and spontaneous collaboration; to all the international, official and semi-official, education and financial institutions; to the Foundations and people who have given us their generous support and understanding of the importance of this mission; to my fellow board members, both present and absent, for their generous collaboration, for the many hours unselfishly devoted to this great task, giving it priority at all times; for their openness and honesty in constructive debates and their high sense of responsibility; to our Director General Dr. U. J. Grant and to each and every one of the members of the professional-scientific teams who in collaboration with the Administration, have carried out such significant works; to the scientific staff; to each one of the CIAT employees and to all those who not forming part of our organization, have identified with us; to the architect Jaime Ponce de León and his staff; to our contractors, who are the builders of this extraordinarily beautiful and functional campus.

Finally, I wish to render my personal and respectful homage to the wives of our staff members, who have contributed silently, patiently and effectively to the culmination of this center, symbol of cooperation among people and nations.

Thanks to all, many thanks.

# John H. Knowles

President of The Rockefeller Foundation

I am deeply honored to be invited to participate in the dedication of CIAT - an honor I do not deserve but which I accepted happily on behalf of the Rockefeller Foundation. On my own merits I am scarcely qualified to discuss a subject, the language and concepts of which I have only recently come to know. I cannot, however, lay valid claim to complete ignorance in this introductory apologia - for as a physician and scientist I do understand the scientific method and the benefits as well as the hazards of technological developments, and, as an administrator heavily involved in public and private policies in the field of health services and biomedical research over many years in the United States, I believe I may have some reasonable observations to offer about such diverse subjects as the development and stabilization of institutions, the balance of interests between research and technical development on one hand and services on the other. Having said this, I do not believe I can say anything that all of you here have not thought of, or, in fact done. I have only one advantage - that of the non-expert, and, alas, time is running out on this protective device - for I have over the past 18 months visited each one of the International Agricultural Institutes and I have studied under a series of private tutors that few men are privileged to enjoy - starting with my predecessor, George Harrar, and continuing on through such experts as Jerry Grant, Jocko Roberts, John Pino, Sterling Wortman, Clifford Hardin, and finally, Lowell Hardin who tutored me on the flight here. I must also admit that over the past year since my joining the Rockefeller Foundation we have undergone an extensive review with our trustees of our past and present programs and policies with the aim of setting the compass for the next five years. These programs will continue to stress agricultural development, population stabilization, public health, university and other forms of education for development, the reduction of destructive conflict, and the arts and humanities in the international sphere.

I speak to you with two major convictions:

1. There will be no two futures for the world - there will be one or none at all; and, as the world shrinks, our interdependency is rapidly becoming complete and our fate is one.

2. There is a universal concern that human misery be alleviated and there is a universal language which binds us together in common cause - the language of science and technology tempered by the language and concepts of the social sci-

ences and humanities which study and describe our unique differences, allow us to understand our differences and facilitate the use of knowledge and technology in the quest for social melioration.

The development of the agricultural institutes and CIAT in particular exemplifies the conviction that global interdependency and one future for us all is now widely recognized, that the alleviation of human misery is of much more central concern to many nations and international agencies and that the language of science and technology knows few cultural barriers. Having said this, I must also say that the international institutes will not reach their full utilization without the rigorous help of the social scientists.

What are the key elements in the development of CIAT?

**First.** The Rockefeller Foundation was established in 1913 with the express mandate to "promote the well-being of mankind throughout the world" thus recognizing the common fate of all mankind and very early establishing the international character and the interest of the Foundation. The policy of the Foundation was and is simple, to stress the acquisition of knowledge, to provide for the transmission of that knowledge through the development of institutions and through an extensive scholarship program which recognizes the supreme importance of trained individuals, and to focus long-range efforts on the leading issues of human concern. In order to carry out its policies and program, it immediately established the fact that it would be both a granting foundation as well as an operating foundation. Therefore prime emphasis was placed on the quality of its staff, their technical and scientific competence, their desire to both know and do, and their sensitivity to their partnership with people of many origins, many cultures, many nations. George Harrar exemplifies these qualities and began his work in Mexico in the early 1940's at the request of the Mexican Government.

**Second.** The will of the leaders of those countries in need of assistance resulted in the request for the assignment of field staff and in 1950 such a contract was made with the Government of Colombia and Dr. L. M. Roberts was assigned to Colombia's Ministry of Agriculture. Over the next sixteen years extensive research programs were initiated and a network of experimental field stations was established. Real problems were identified and work in the field was established first, followed by institutionalization of scientific and technical advances — specifically DIA which became ICA — today a sterling tribute to the efforts of Colombia's leaders.

At this juncture, both the field staff of the Rockefeller and Ford Foundations and the leaders of the Colombian Government recognized the international need for the development of the lowland tropical regions of the world - and this leads to my third principle.

**Third:** The institutionalization of international needs in agricultural development was established in a region where the needs existed.

Colombia, and this, coupled with the generosity of the Colombian Government in making available the land for the Institute, could leave no doubt in the minds of those tropical countries most in need that CIAT was in fact designed to meet their needs - non-partisan, non-political, non-ideological and with only humanitarian motives.

**Fourth.** An international board of trustees, largely those representatives of the countries in need, guaranteed the international and fully responsive and responsible nature of the commitment.

**Fifth.** Both research and technological interests and extension services were established as co-equal partners in the grand effort. Service — the utilization of knowledge — was to be as important as the acquisition and transmission of knowledge through research and training.

**Sixth.** The move from bilateral support, i. e., the Colombian Government and several American foundations — the Rockefeller and Ford Foundations first and later the Kellogg and Kresge Foundations— to multilateral support guaranteed the autonomy— initially vouch-acted by the composition of the Board of Trustees of CIAT — to pursue its stated goals and guaranteed the interest, cooperation and help of many nations and organizations. As of 1974 this will include the United Kingdom, Canada, The Netherlands, Switzerland, Colombia, the United States, the World Bank, and the Interamerican Development Bank, in addition to the Rockefeller, Ford and Kellogg Foundations.

Let me summarize the cycle of success in the development of CIAT.

1. Establish priorities of need for scientific and technical development;

2. Work in the field with real problems and begin an extensive program of advanced training and education for individuals;

3. When a critical mass of knowledge and technique and trained individuals is reached, institutionalize them;

4. Guarantee the international interests and autonomy of the institute by the selection of a governing board of trustees, the majority of whom will represent the needs of those countries for whom the institute was established and further guarantee international interest and help by moving quickly from bilateral to multilateral support.

All this is not news to you and I apologize for the exuberance of a neophyte who has just seen the light but far too few people understand this cycle of success in our shrinking, interdependent world; and I firmly believe that the model could be replicated in the fields of health, population problems, and education with great benefit to

mankind's new search for international peace and well-being. Furthermore, I believe the start-up time can be and indeed must be reduced for there is no need to relive history.

One page on the evolution of CIAT is worth more than a volume of logic. During this year I have participated in two conferences involving national development agencies, international funding groups, representatives of the less developed countries, and the Ford and Rockefeller Foundations which have considered the possibility of achieving the same position in population problems and in education at all levels that the agricultural institutes have attained. All I can say at the moment is that I am optimistic.

* * *

Now I must turn from celebration to criticism and caveat.

First, the hazards of institutionalization. The world is littered with ossified organizations which have forgotten that they are means to an end and not ends in themselves. Research and training in agriculture are means to the ends of improving nutrition and health and fostering economic development which means jobs — the dignity of work — and disposable income with which to improve the quality of life through the support of essential services. Inevitably this must involve experiments with extension services and multi-disciplinary approaches to integrated rural development. I am distressed to say that such efforts have lagged behind the research efforts in some of the agricultural institutes. It is far easier to stay in the lab or the adjacent experimental plot than it is to wade into a remote village with a package of agricultural practices - far easier to stick to genetic manipulations than to analyze the vagaries of human behavior and understanding.

Similarly, when research overwhelms service, and inward looking "faculty" may attempt to limit the numbers of trainees as teaching is resented for the time and effort it has to borrow from research. And while on the subject of training, is it really possible to train individuals from such a wide variety of nations and cultures without sure knowledge of the values, attitudes and beliefs of those cultures. Certainly science prides itself on its universality and its value-free base but science (or knowledge) and technology cannot be used or even introduced effectively without a thorough knowledge of the culture - the values, attitudes, beliefs and expectations of those whom it is designed to benefit. How can such trainees be given the scientific and technical tools of modern agricultural practices and a thorough grounding in the economic and cultural determinants of the best use of those tools? What are the motivational factors that determine success in such trainees when they return to their own countries? Finally, what are the best ways to reach those 800 million rural people who have been bypassed by economic growth and whose members will continue to swell despite their peripheral migration to swollen and abscessed cities? What are the best packages of agri-

cultural and public health practices, educational and family planning services and is it possible to integrate these concerns and tailor them to the multiplicity of the world's cultures? These are our social concerns. Unfortunately, man's wisdom has been outstripped by his numbers, life cheapens in its abundance, and man has succumbed to the beauties of sciences and technology while neglecting the beauties of the social and humanistic elements of life - these elements which foster understanding and empathy, quicken the ethical sense, bring civilization out of savagery, and create beauty and dignity from that which is degrading.

Enough! On with the work of CIAT, the finest example of international cooperation in the quest for quality in life, and for improving the well-being of all mankind.

## Ulysses J. Grant

Director General, CIAT

I wish to extend my most cordial welcome to all of you present here. Some of you have made special efforts and have traveled great distances to be at these dedication ceremonies today, and on behalf of the CIAT Board of Trustees and staff, I welcome you. I sincerely hope that you enjoy your stay in Colombia and in this lovely Cauca Valley. We are happy that you could come.

CIAT was established as the fourth in what is now a series of seven international agricultural research centers. Two more are being formed and an additional one has been proposed for the middle east. The original four centers were organized by and received support from foundations. Today, however, many governments, four foundations and four international and regional banks support agricultural research at all the centers.

CIAT'S general objectives are to accelerate agricultural and economic development by increasing the production and productivity of the tropics; to improve the nutrition and welfare of the people of the world; and to improve the economic and social well-being of the farmer.

The capital for the CIAT facilities was supplied by the Rockefeller Foundation, the W. K. Kellogg Foundation and the Kresge Foundation. Currently, the operating budget is supported by the governments of Colombia, the United States, Canada, The Netherlands, and Switzerland; the Rockefeller, Ford and W. K. Kellogg Foundations; and the World Bank. In addition, special project funds are received from some of these donors, as well as from the Interamerican Development Bank, and the International Development Research Centre of Canada.

CIAT was incorporated under the laws of the Republic of Colombia (Resolution No. 4939, December 4, 1967). It is located on land purchased by the Colombian government and made available to CIAT on a long term lease costing the nominal sum of one peso per year. The initial period is for ten years.

CIAT is governed by a Board of Trustees composed of people from many nations. The present senior staff was brought together from thirteen countries. A number or additional professionals are employed, most of them Colombian, but other nationalities are being added. In addition, we provide employment for 500 other Colombians.

To accomplish our goals we identify problems which limit agricultural production and create solutions for them. We train both research and production specialists who carry this newly acquired know-

ledge and technology to their own countries where it will be utilized and modified as circumstances demand. We support their work, and the continuing work of the CIAT staff, with an information and documentation center, a germ plasm bank, an active conference program, and a variety of cooperative and collaborative outreach projects.

We at CIAT are especially proud that we have been invited to collaborate with both old and newly established national institutions and to assist them in their work. These include not only agricultural agencies, but also universities, hospitals, and other organizations whose interests center around improving human welfare and nutrition. We also feel it important to mention the cooperation between CIAT and the many private enterprises engaged in the production, processing and marketing of nutritious foods derived from farm products.

We also have an effective joint program with ICA, the Instituto Colombiano Agropecuario. While we recognize that the objectives of ICA and CIAT are not always identical, we make the most of those that are held in common. Our most important work with beef cattle, for example, is being undertaken on ICA stations at Carimagua, in the Colombian Llanos, and at Turipana, on the Northern Coast.

Just about all CIAT projects at these stations are being conducted with the full collaboration of ICA - sometimes with an ICA professional as project leader and sometimes with a CIAT staff member. In every case, the two institutions cooperate fully whenever their priorities allow.

This cooperative system between ICA and CIAT allows ICA to utilize highly skilled CIAT specialists for their staff training, while CIAT has available to it the facilities of ICA experimental stations. CIAT has obtained capital funds for facilities at Turipana, and it helps pay overhead expenses at both ICA stations.

With special project funds from the Rockefeller Foundation, our first outreach program with resident CIAT staff is in Guatemala. The focus of this project is not only on research and production, but also on helping Guatemala to build an effective national agricultural organization, ICTA, embodying research, training and production.

Outreach programs are beginning in Bolivia and Costa Rica thanks to the generosity of the International Development Research Centre of Canada. These programs are primarily concerned with assisting these nations in the establishment of adequate swine research facilities, and in the training of specialists capable of helping farmers organize economic swine production units of all sizes, though the emphasis is on small farms.

CIAT places emphasis on training. Training is important because it is the first step towards effective collaboration with nations. In 1972 CIAT had 118 trainees, in four major categories, from twenty nations.

1. Postgraduate Research Interns. We borrowed this title from the medical profession - you wouldn't want a doctor to perform an operation on you if he had never done this operation before - or if he had never even seen it or assisted in it - would you? There is, however, a similar phenomenon occurring in the agricultural profession today. Many young men and women, from both America's, are graduating from agricultural schools and programs without having had practical on-the-farm or direct production experience. Yet, these people are sometimes expected to diagnose production problems, design and carry out sophisticated research, and communicate their results to farmers. There is a real gap here that must be closed. Therefore, we place great emphasis on the practical how-to-do-it in all our training programs.

2. We conduct training courses in livestock and crop production. Here, young men actually live on farms and ranches and participate in farm and ranch development for a period of one year. We are finding these training courses to be effective in producing capable, production-oriented, people who can deal effectively with farmers and ranchers. We must convince institutional administrators to fully utilize these people when they return to their parent organizations.

3. We are supporting a small number of graduate students for training at the MS level, and lastly...

4. We have a number of MS and PhD candidates from several countries who are completing coursework at their universities and undertaking thesis research at CIAT.

Now, all of this means little unless we can accomplish more than just training people. We must produce and increase productivity in the agricultural sector or all our other efforts are for naught. This new technology must reach and benefit the farmer or our work will have been only an academic exercise. I would like to briefly review what has been accomplished in just a few short years at CIAT to help keep us on the road to realizing our goals.

**RICE**

Our rice program was first started in mid-1967, two years before this land was made available to us. Through foundation enabling grants, equipment was purchased, an irrigation well dug, and a rice research and training program was launched in full cooperation with ICA at their Palmira research center just next door. Almost all of our rice work continues to be done on this station. Utilizing IRRI germ plasm, CICA 4, an acronym for CIAT-ICA, was the first variety jointly produced by the CIAT-ICA research team.

In the first semester of 1973 the results could be seen in the fact that 80 percent of the lowland rice acreage of Colombia was planted to the improved varieties CICA 4, IR8, and IR22. Colombian

rice yields average two tons per hectare over 1970 yields; and other countries in Latin America are reporting similar experiences. The several man-years of training in plant improvement and seed production for researchers from most rice producing countries is paying great dividends.

**MAIZE**

Our maize program is coordinated with that of CIMMYT and we have agreed to limit this program to the Andean zone. Activities are centered around the search for broadly adapted germ plasm (from sea level to 2,000 m). From such material we hope to develop varieties which possess such desirable characteristics as lodging resistance and high protein content with a culturally acceptable grain texture. We have made substantial progress towards realizing these goals by selecting from within opaque-2 populations for grain types with a hard endosperm. I hope that while you are at CIAT you will take an opportunity to look at some of this material which can be seen growing behind the laboratory buildings.

Experimental variety No. 21, a hard endosperm yellow opaque-2 selection, has been widely tested with excellent results. Because of CIAT's broad range of plant and animal programs, probably no other maize program has had such an excellent opportunity to integrate agronomic research with the biological testing of both animals (rats and swine) and humans. We especially acknowledge our rewarding collaboration with the staff of the Universidad del Valle and its work on the introduction of opaque-2 maize into human diets for improved human nutrition. We acknowledge as well the cooperation of commercial organizations for the utilization of high protein maize in human foods.

Improved germ plasm has been introduced into the improvement programs of several countries. Uniform trials in both the highlands and lowlands of the Andean zone are being coordinated by CIAT, and we are holding international workshops for maize research workers

**SWINE**

The CIAT swine program concentrates on the improvement of meat production on small farms. It is on small farms that 80 percent to 90 percent of Latin America's 100 million head of swine are produced. High feed costs, especially for grains and protein supplements, plus inefficient production practices, combine to make pork production on the small farm a marginal venture at best.

We know that cassava and bananas are excellent swine feed - if the rations are balanced. A method has been devised for the feeding of whole cottonseed after only relatively simple treatment. Cooked cowpeas can be utilized as a good protein supplement.

We think that the small swine farmers of Latin America can be helped and we are well on our way to doing so.

## BEANS

The CIAT Field Bean Program has only recently begun, but we are moving ahead rapidly towards increasing productivity, production and consumption of field beans, (**Phaseolus vulgaris**). Most of the necessary personnel have already been assembled on the CIAT staff. A collection of more than 9,000 lines from all over the world is being tested to determine disease resistance, insect vulnerability, and characteristics relating to agronomy and nutrition. The pathology group concentrates on the production of virus and bacteria free seed possessing a high degree of resistance to the most damaging Latin American pathogens. Likewise, entomologists contribute to the development of insect resistant strains.

We are extending a special effort to coordinate the work of the many bean improvement programs being conducted throughout Latin America. To this end a bean seminar was held in February with 150 bean workers from twenty countries and five continents attending. Given support and some time we expect to produce results similar to those shown with rice and maize.

## CASSAVA

Fresh root yields of more than 45 tons per hectare, and dry root yields of more than 19 tons per hectare have been obtained at CIAT with cassava. These yields compare favorably with the best rice yields obtained with intensive management. Even higher yields have been obtained on small plots with varieties that have high harvest indices and good leaf retention.

Cassava blight is a problem, but the bacteria responsible for this problem do not survive long in soil. They are spread mainly by rain, but only over short distances. Infected stalk pieces used for planting serve as a major source of infection. A new method of producing bacteria-free stakes, coupled with the use of highly resistant strains now available could lead to the virtual elimination of this problem.

We possess in our germ plasm collection strains with good resistance to diseases caused by Cercospora, Taphira and Phoma. We have also found strains which are remarkably resistant to an insect pest called 'thrips', which attacks the apical buds and prevents new leaf formation.

Weed control is the major factor of labor input for cassava. It is even more costly than harvesting. Without adequate weed control, yields are minimal—less than two tons per hectare. Cheaper, easier methods of weed control are being sought.

Without special treatment, cassava deteriorates rapidly after harvest. Simple straw and soil silos have been developed which allow cassava to be stored for periods up to eight weeks without deterioration. This furnishes the farmer with more flexibility in the market-

ing of his product. A demonstration model of one of these silos can be seen on our demonstration plot.

Cassava is vegetatively propagated. About twenty-five planting stakes can be cut from one plant. A rapid method of propagation has been developed which will increase planting material from one plant to one hectare of plants in one year.

Cyanide toxicity is a serious problem with cassava. Some low cyanide lines have been found and their low cyanide characteristics will be introduced into high yielding strains. Another severe criticism of cassava is its low protein content. In trials with cassava foliage production, five tons of high protein dry matter per hectare have been produced in a three-month period.

Cassava is an important tropical food crop. We are confident that we can significantly contribute to its improvement, and therefore, to the improvement of human and animal diets.

**BEEF**

There is a vast area of soil, comprising several million hectares, in this hemisphere which has a low fertility and a high acidity. CIAT's beef program is largely directed to the development of these lands. The first step in the economic utilization of these areas is the development of techniques for food crop production which will sustain a farm family. We are actively engaged in the solution of this problem and are confident that foodstuffs can be produced on these soils.

But the great potential of these lands lies in beef pasture. A legume species native to the area, **Stylosanthes guyanensis** (La Libertad variety), in mixed stands with **Paspalum**, **Hyparrhenia,** and **Brachiaria** grass species shows real promise in furnishing year-round pasture with good nutrition - and this is the major key to animal production on these lands. Beef production on these improved pastures is five times greater than on native grass pastures.

Heifers fed mineral supplementation (mainly P and Ca), mixed with salt, mated twice the number of times as did heifers receiving no supplementation. Only five percent of wet cows were found to be pregnant under conditions of poor nutrition. Improved supplementation can account for 40 percent of the annual average calf crop.

Data collected in farm surveys, and from slaughterhouses, indicate a low incidence of common reproductive diseases. Reproduction rates, however, are low, abortion rates often high. The complex factors involved are still ill-defined. An area of intensive concern to us is the feeding and management of cows to maximize reproduction. One of the primary causes of poor reproduction appears to be malnutrition, and this can be corrected by providing a higher quality forage on a year round basis, and mineral supplementation, as needed.

To check the feasibility of solutions to these problems, a family farm unit was established on the station at Carimagua. This farm will be developed to a support-subsistence basis, and the family will be expected to live on small crops and the animals produced. We expect this unit to provide the answers to such questions as whether a farm family can subsist, produce most of its food, and convert its labor into capital improvements (such as housing and fencing from local materials) and improved pastures, until a sufficient cash income is forthcoming from a beef cattle operation. We don't have all the answers yet, but you can be sure we are working hard to get them.

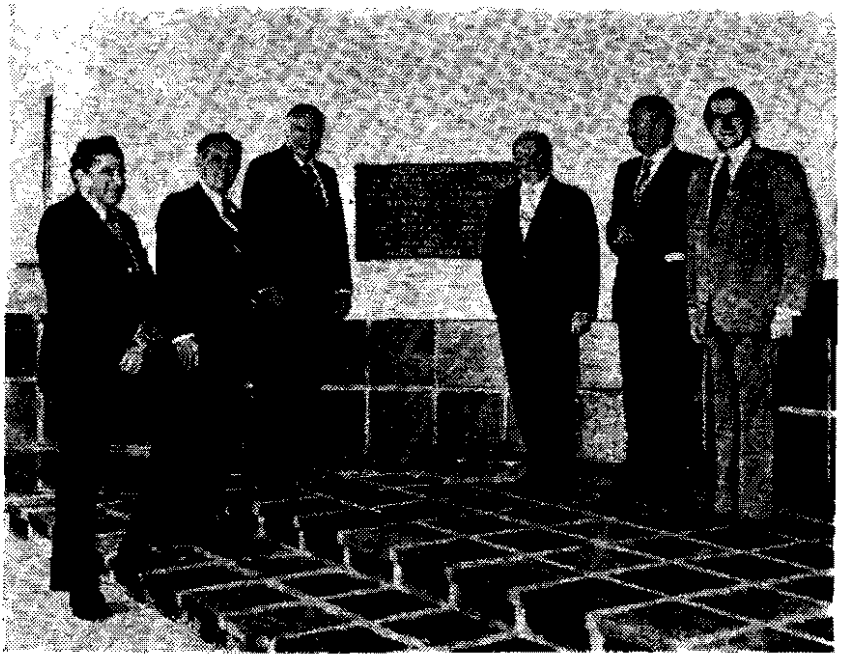
## AGRICULTURAL SYSTEMS

CIAT is assembling an integrated team of specialists from several disciplines which will undertake an investigation of farm systems with special emphasis on small and subsistence units. The team will study typical agricultural sytems in tropical America, first, to identify relevant components and to determine why such systems have persisted over time; and secondly, to seek improvements within these systems for quantity and quality of output and the standard of living which they support.

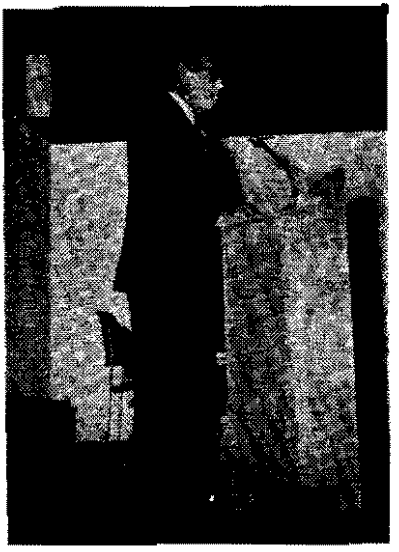
* * *

We are happy that you could be with us today; we are heartened by the interest you have shown in our work. We are proud to have you see our facilities, but we are much more eager to demonstrate our concern for the rural peoples of this hemisphere, and our ability to help them. You can be assured that we will do everything possible to accomplish this end. But this is not something which we can do by ourselves; nor should we. CIAT represents an additional resource and facility in a world-wide community of scientists, research programs and educational institutions. We trust that we are a worthy member of this network.

Please let me know how we can help, and we will do so limited only by the bounds of our resources. Our success is measured in terms of the successful achievements of your countrymen. We must succeed - and quickly.



**After the inaugural ceremonies for CIAT, a symposium on "The Potential of the Lowland Tropics" was held on October 13, 1973. Participating speakers, seen from left to right, are Dr's. Paulo T. Alvim, Lewis M. Roberts, Galo Plaza, Raúl Prebisch, Benjamín Viel, and Armando Samper. In the background can be seen the plaque unveiled by the President of Colombia, Dr. Misael Pastrana Borrero, during the inauguration.**



# Introduction

**Lewis M. Roberts**

Associate Director, Agricultural Sciences, The Rockefeller Foundation.

On behalf of the Board of Trustees and the staff of the Centro Internacional de Agricultura Tropical, I extend a most cordial welcome to this symposium held in conjunction with the inauguration of the Center's facilities. The inauguration ceremonies yesterday were enjoyable, inspiring, and informative. The illustrious, speakers on that milestone occasion gave us a clear picture of the philosophical base and mission of CIAT, the history of its creation and development, and the collaborative framework within which it is supported and operates. I know that all of us here wholeheartedly share the aspirations envisioned for it in the international community whose aim is to improve the quality of life for as many of the members of the human family as possible. This, I am sure we all agree, has to be the ultimate, fundamental objective of all of the Center's efforts.

CIAT has a specific geographic, institutional and programmatic role in these global efforts, as we heard yesterday. CIAT is concerned with the agricultural and economic development of the lowland tropics, with particular attention, initially, to the hot tropics of Latin America.

To the Board of Trustees and the staff of CIAT it seemed only logical to take advantage of this opportunity to discuss **The Potentials of the Lowland Tropics** with the knowledgeable and concerned group that has assembled for CIAT's dedication ceremonies. We genuinely appreciate your presence and we invite your full participation in the discussion periods.

We will undoubtedly focus most of our attention today on the lowland tropics of Latin America although we will not exclude the hot tropical regions of Africa and Asia from our discussions.

The hot or lowland tropics, as the term is used by CIAT, are arbitrarily defined as those regions of the tropics at elevations between sea level and 1,000 meters or approximately 3,000 feet. These areas, which range from dry to very wet, represent the world's greatest remaining potential for adding to present agricultural production. More than 85 percent of all Latin America is lowland, that is to say, less than 3,000 feet in elevation; yet, only a small percentage of the population lives in this vast area.

The three main objectives of this symposium are stated in the program. They are:

First, to provide opportunities for a mutual exchange of knowledge and insight on how the potentials of the lowland tropics are being realized, as well as the course of continued and concerted action.

Second, to stimulate realistic appraisals of this potential, and to encourage effective interaction between agricultural scientists who are seeking solutions to critical production problems and those who are preparing plans, allocating resources, and providing continuity of direction in national development efforts.

Third, to introduce CIAT as a new working partner in the development of the lowland tropics, to demonstrate how its programs, staff, resources and facilities might relate to the activities of symposium participants.

We are indeed fortunate and honored to have such distinguished speakers present the five papers scheduled on the program and to lead subsequent discussions. Their topics are all closely interrelated, as they must be in order to provide a broad, coherent insight and understanding of the potentials of the lowland tropics of Latin America, and a view of what might be done to develop these potentials as rapidly as possible.

Increased agricultural productivity is an important element, perhaps the most important, in advancing the economic growth and development of the Latin American lowland tropics.

What is needed to bring this increased productivity about?

What is the state of our present knowledge about the natural resources and environments in the lowland tropics and their potential for development? What should be done to fill the voids in our knowledge as quickly as possible?

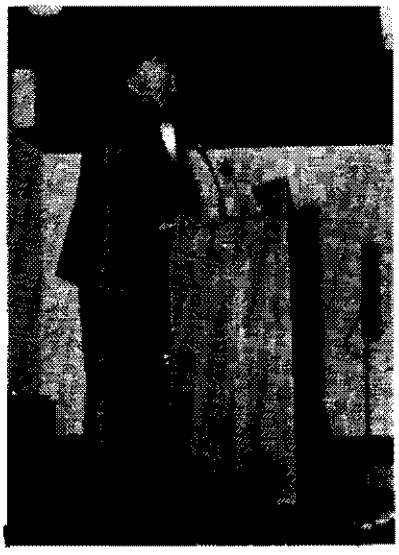
The development of any given geographical or ecological sector, be it the hot, humid lowlands of the Amazon basin or the

cold highlands of the Andes, cannot, of course, be looked at in isolation from the total development process and the developmental infrastructure of a given country in particular, and also of the region and the world.

Economic development, important as it is, however, is not an end in itself; it is a means to the real objective: improvements in the quality of life for those who reside in the hot tropics or, for that matter, anywhere else. It is only logical, therefore, that the human element receive a prominent place on this program.

Effective economic and human development depends in large measure on functional institutions that have varied and often interrelated responsibilities for the different aspects of the overall process. These include national as well as regional and international institutions. In seeking solutions to developmental problems we come face to face with the question of what should and what can be done to improve the institutional structure that is required for achievement of the desired results.

These represent just a small sample of the kinds of important and interesting issues our speakers will be addressing. It is going to be a full and fruitful day, I am sure, and you will help to make it so by freely sharing your ideas and questions with us during the two general discussion periods that are scheduled — one at the end of the morning and the other at the end of the afternoon. Please jot down any comments and questions that occur to you as we go along so you will not forget to bring them up when we come to the discussion periods.



# Accelerating development through increased productivity: the Latin American case

**Galo Plaza**

Secretary General, Organization of American States (OAS)

I was pleased to accept the invitation to this symposium which affords me the opportunity to express some ideas on agricultural productivity, a subject of vital importance for Latin America's economic and social development and a matter of great personal interest to me. My modest contribution to the symposium will consist of some general observations on factors affecting productivity in the region, especially in the lowland tropics, and a story drawn from my own experience which illustrates the application of the concepts I am going to put forth.

Agricultural development depends on many closely interrelated factors: the system of land tenure, facilities for transportation, storage and marketing, the availability of credit, as well as the element that will be the principal focus of my remarks, productivity. Obviously, it would be futile to spend huge sums of money to teach the best methods for cultivating the new varieties of the Green Revolution if the farmer lacks suitable land to cultivate or the necessary means to be able to take advantage of any increase in productivity. New practices for increasing productivity must be within the farmer's grasp. Improved yields should be considered as part of an overall strategy that seeks to improve the quality of life of millions of human beings in Latin America who are presently victims of social injustice and malnutrition.

Differences in agricultural productivity among the countries of the world are all too evident. The time needed to produce a given quantity of food in a developed country is reckoned in minutes; to

produce the same quantity of food in the less developed countries requires whole days of work. Even more serious is the fact that according to statistical projections this productivity gap is expected to widen.

Latin America's problem is how to increase productivity without increasing the already alarming rate of unemployment and accelerating the migration to the cities. Obviously the capital intensive techniques employed in developed countries. which always aim at replacing people with machines, are not appropriate for the countries of our region.

The process of increasing productivity can be regarded as a triangle with three complementary and indispensable sides: planning to set goals and guidelines; research to discover the most suitable technology; and extension to permit effective use of the new techniques. Without a balanced, sustained process of planning, research and extension, it will be very difficult to increase productivity at a satisfactory pace.

Vast regions of tropical lowlands, with great potential for agriculture and forestry, are virtually untouched in Latin America. They comprise an enormous reserve that should be adequately utilized to increase production for export and for domestic food consumption. These regions were never densely populated, not even in pre-Columbian times. The settled areas, generally the riverbanks, were decimated from the diseases brought by the conquerors for which the natives had no defense. Therefore, the humid tropical forest remained sparsely populated and one might say almost abandoned.

In some regions accessible by road, people of the densely populated temperate highlands have emigrated to the lowlands. Adaptation and acclimation of these immigrants to their new surroundings are difficult and sometimes painful. It is much harder for a farmer from the mountains to change from the temperate zone to a tropical climate fifty miles away than it is for a Swede to move thousands of miles to till the soil in Minnesota.

Heretofore the inhabitant of the lowland tropics has generally been left to his fate in precarious living conditions. Exposed to tropical diseases for which they have no defense, new immigrants are in an even more difficult situation.

The migratory movement often begins when a new highway is built through the jungle. At this time, the government's action cannot stop in these vast unexploited regions because there is a need for schools for the children, medical and sanitation services to protect the health of the inhabitants against tropical sicknesses, experimental stations to introduce or improve crops appropriate for the region. and agricultural extension to transmit to the farmer the know-how that he needs for optimum use and conservation of the soil. Also

needed are suitable agricultural credit to finance the operation, and, facilities for marketing the new production.

This is the great task that the countries must accomplish in order to take maximum advantage of lands that can be a key factor in their economic development.

One of the weakest links in the whole process is agricultural extension. There are not enough properly trained extensionists capable of bringing results from the laboratory and experiment station to the farmer. It is not an attractive type of work for college-age youth because they have to overcome some hang-ups that date back a long way. Ever since the colonial period education has been selective and aristocratic, so that a student who learned how to make use of his talents considered himself freed from the bondage of working with his hands. Manual labor was always considered denigrating and beneath the dignity of the social and economic elite. Even today, when education in Latin America has become more democratic, the young person of modest means who earns a college degree considers himself liberated from any sort of manual work.

Agricultural extension has to be in the hands of specialists who understand the processes of agricultural modernization, and can explain it and demonstrate it in a practical way so that the farmers can put into practice the recommendations from the research centers and experiment stations and maximize the yield of their lands.

It is not true that traditional ways of the farmers are the major roadblock to change. The well-known Israeli expert, Dr. Raanan Weitz, has observed that even when the proposed changes imply radical transformations in the farm structure, farmers will accept them if they are convinced that the changes will lead to the fulfillment of their aspirations. Weitz says that the biggest problem is not inherent resistance on the part of the farmers, but ignorance about the way of disseminating techniques on the part of those responsible for it.

One of the most effective vehicles for transmission of new concepts and research results is rural youth. Some 400,000 rural youths in the Latin American countries, members of rural youth movements, represent an increasingly potent force for promoting greater productivity. Although the full benefit of their work will only be reaped in the future, when they take over for their parents, their current efforts in pilot projects are undoubtedly having a strong influence on traditional practices and methods.

Promising experience in this regard has been obtained with a program financed by the W. K. Kellogg Foundation and administered by the Inter-American Institute of Agricultural Sciences of the OAS, in cooperation with the Inter-American Rural Youth Program and the National 4-H Foundation of the United States. The Kellogg Project's purpose is to demonstrate the positive contribution that

rural young people can make to increasing the production of foodstuffs and improving levels of nutrition. Two or three examples suffice to illustrate this program's effect on productivity. In Guatemala young people have obtained yields of beans that are five times greater than the normal ones for the region. In Paraguay they have been able to quadruple the normal yield of corn and double the yield of soybeans. In Costa Rica droughts affected the corn yield, but the experience with swine has been impressive. In Venezuela the program has produced a sharp increase in the production and consumption of tomatoes.

It is now up to the national agencies that support the rural youth movements to take advantage of the experience of these pilot projects and expand extension services to make effective use of rural youth's potential for accelerating agricultural productivity.

It would be highly desirable, as I see it, to strengthen cooperation between institutions like the Centro Internacional de Agricultura Tropical and rural youth movements, so that the worthwhile research conducted in the laboratories and the experiment stations has a more immediate and profound effect on the farmers of the Americas, through the dynamic innovative effort of youth.

* * *

As an indication of the productive potential and utilization of the lowland tropics, and as an example of the importance of planning, research, and extension, I should like to recount a personal experience.

During World War II Ecuador had become an important producer of rice for export, filling the gap that resulted from the involvement of the traditional rice suppliers of Southeast Asia in the war. In the post-war period, as traditional agricultural production began to return to normal, Ecuadorian rice was in a very vulnerable position in world markets. I had to deal with this problem during my term as President of the country, starting in 1948. If we would not have had an export product to replace rice, the country would have suffered serious economic consequences. Ecuador was producing bananas on a modest scale. There was an operation of the United Fruit Company which was small by comparison to its activities in Central America, but served to show that Ecuador's lowland tropics were well-suited to the cultivation of bananas.

One day the president of the United Fruit Company visited me, accompanied by experts who had just visited their plantations to determine whether Ecuador had been hit by the terrible plague known as Panama Disease, which was destroying banana production in Central America. The experts found no traces of Panama Disease in Ecuador and they told me that even if the blight were to appear the next day Ecuador would still have ten good years for bananas. With this diagnosis we set about to replace rice with bananas as rapidly as possible.

There was a prevalent notion in those days that banana production called for large plantations to justify costly investments, especially installations for fumigation against another serious disease, Sigatoka. Experiments with spraying from a backpack, or from a helicopter or light plane using a high-volume, low-pressure system offered us the alternative of assigning banana cultivation to small farmers instead of the large firms.

The easy way out would have been to promote the establishment of a few large corporations, which would operate on a scale like that of the United Fruit Company and Standard Fruit Company in Central America. On the other hand, we wanted to inject a social content as well as an economic one in this new process of agricultural production, which offered such great promise of immediate results. The new spraying method permitted us to opt for a plan that would not establish huge plantations but instead promote small-scale farm units. We did this through guided credit. The Development Bank offered farmers loans up to the equivalent of $4,000, with reasonable interest rates and repayment periods, and based on an emergency agricultural extension service organized exclusively to teach basic concepts about banana growing. We took the loans to the country without waiting for the farmer to apply at the bank. With this approach we were able to achieve in short order an extraordinary increase in the land planted with bananas.

The program began in 1948 and by 1952 Ecuador had become the world's number-one banana exporter. The plan that we put into operation with the assistance of the dynamic, and far-sighted Minister of Agriculture, Clemente Yerovi Indaburo, brought into the productive system and improved the living conditions of tens of thousands of small farmers who produced bananas for export, instead of creating twenty multimillionaires and a model agricultural operation. The area under cultivation was 400,000 acres in the hands of 40,000 families. The country's banana exports, which were only 138,000 tons in 1949, reached 1,350,000 tons in 1971.

The experience showed us that it is possible to introduce new practices and change the activity of a rural sector that is tradition-oriented and resistant to change, because the farmers are willing to change when they become convinced by what they see with their own eyes. The primitive farmer of the lowland tropics knows almost no other tool besides the machete. He is not even familiar with a moldboard plow, let alone other elements of modern farming. But in his new agricultural activity of banana production, the primitive farmer became acquainted with fertilizers, with practices and methods for spraying against diseases, and with the helicopter and light plane as indispensable tools for his work.

The banana variety most widely raised in all areas producing for export was the Gros Michel. In Central America the researchers of the large corporations had developed a variety called Cavendish,

resistant to Panama Disease and with a much greater yield per acre, given the much smaller size of the plant, but the fruit is delicate and easily damaged in transit. Years later, with the introduction of the cardboard box that made it possible to handle the banana much more carefully and transport it in a more protected manner, it was possible to replace Gros Michel with Cavendish and replant huge areas in Central America that had been totally abandoned because of Panama Disease.

It was easy for the large corporations in Central America, the United Fruit and Standard Fruit, to convert their plantations to Cavendish, but it was extremely difficult to do this in a systematic and orderly way among the tens of thousands of producers in Ecuador. Nevertheless, in a relatively short time Ecuador switched its export production from Gros Michel to Cavendish. Whereas Cavendish represented only 7 percent of the total production in 1967, it is now more than 80 percent. And since the yield of the new variety is much greater —an average of 30 tons per hectare for Cavendish compared with 10 tons per hectare of Gros Michel— with less land under cultivation it has been possible to maintain the same production levels to keep Ecuador in first place among the world's banana exporters. The surplus lands are being rapidly converted to livestock raising by transforming the banana fields to pasture land and importing appropriate breeding stock. If this new exploitation of the tropical lowlands is carried out on the basis of planning, research, extension services, agricultural credit and proper marketing facilities, as was the case with the bananas, I know that it will also be a success.

I might mention the Ecuadorian experience in marketing bananas, since it does no good to increase productivity if there is no way to sell the product. The principal market for bananas was the United States, where the large American corporations had established their distribution networks and used advanced marketing practices. Competition was therefore difficult. The second market was Europe, although some of the countries were supplied with bananas from their colonies in the tropical zones. Thanks to a systematic and positive effort, Ecuador was able to increase its sales in the United States, increase them substantially in Europe, and even start to sell behind the Iron Curtain and export bananas to Japan, which is one of its best clients today. In 1971, 32 percent of the country's banana exports went to Japan, 21.5 percent to the United States, 18 percent to Germany, and 28.5 percent to the rest of the world.

I am impressed by the way this delicate tropical fruit is exported over great distances in modern refrigerated ships that are faster than the destroyers of World War II. The banana originated in Southeast Asia and was brought to the Americas during the colonal period. Now refrigerated ships cross the Pacific to take bananas from the Americas to Asia.

There is an important lesson in Ecuador's experience with bananas. The concept is obvious, but so frequently overlooked by planners that it bears stressing. Productivity is not an end in itself, and it would be pointless if it did not contribute to an improvement of man's well-being. If our goal is to accelerate agricultural productivity with a human dimension, our criteria for selection of the best strategy should never be efficiency alone, but should take into account very seriously the needs and abilities of the farmers. They are insistently demanding the fruits of increased productivity. At this point in time there is no reason to deny them. We can and must encourage a significant increase in agricultural productivity with a deep social impact in favor of the people.

The Centro Internacional de Agricultura Tropical (CIAT), dedicated to accelerating agricultural and economic development, increasing production and the level of productivity of tropical lands to improve diets and contribute to the well-being of the people of the tropics, is a valuable initiative of men of vision and deep social conscience, who have wisely chosen to establish their research center in the hospitable country of Colombia, thanks to the important contribution of the Colombian Government.

Having been for many years a member of the Board of Directors of Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT), CIAT's sister agency for agriculture in the temperate zone, and having seen its valuable contribution to wheat and corn farming in particular, I am confident of what CIAT can accomplish for agriculture in the tropics.

I should like to thank you for the opportunity to participate in this symposium and to be present at the inauguration of these important facilities. As Secretary General of the Organization of American States, I offer the enthusiastic collaboration of the General Secretariat in this work that is so intimately related to agriculture and economics and is so important for Latin America's future.

# The lowland tropics of Latin America: resources and environment for agricultural development

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I wish to congratulate the organizers of this symposium for their selecting as the main topic of our discussion, a subject that is of great interest to the future of mankind: What is the potential of the lowland tropics? No other theme could be more appropriate for a meeting called on occasion of the dedication of the laboratories of a new institution studying tropical agriculture. We will be talking here for several hours on the problems of an immense region of the world, where agricultural and industrial development are virtually unknown and where its inhabitants still suffer one of the earth's lowest living standards. We will, unquestionably, have to analyze some of the reasons that have made difficult the economical development of the tropical regions. I hope we will also have the opportunity of discussing some plans of action that will be able to bring progress to the region and, consequently, improve the living conditions of its people. I sincerely hope that the discussions and recommendations that result from this meeting will serve to strengthen the programs of this great research center, which we inaugurate today, in its struggle for the advancement of agriculture and the welfare of the people who populate the tropics.

I wish to start my presentation by introducing some statistical data on the requirements of the man of the future, with regard to cultivated areas and crop productivity.

The total world's area of land that is utilizable for man's food production is estimated at, aprroximately, 3.2 billion hectares (10), which represent 20 percent of the continent's total area. According

to estimates made by the United Nations, half of this available area is being cultivated, that is to say, 1.6 billion hectares. Since the world's population is estimated at 3.5 billon people, each person is today using an average of 0.45 hectares for the production of the food he requires. According to the demographic growth registered in recent years, it is said that the world will double its present population within the next 30 years. Supposing the world average of 0.45 hectares per capita remains unchanged for that period, we reach the frightening conclusion that the 3.2 billon hectares available for agriculture would be completely used up in the first years of the next century.

New conquests in agricultural science developed in the research laboratories and experimental plots, as well as the efforts carried out worldwide to modernize agricultural production methods, will undoubtedly contribute to the improvement of crop yields and reduce considerably, the area of land necessary per capita, for the production of food. Therefore, it would be wrong to forecast a complete lack of space for agriculture, by the time the world will have doubled its population. It would be equally wrong to expect that the need for food, for a population that increases at the present rate of 3 percent per annum, can be indefinitely satisfied by increasing productivity alone, per unit of cultivated area. If this rate of population growth continues, the world's inhabitants will number 100 billion people, within 200 years.

The conquest of new areas for agriculture is as essential to the future of mankind as is the increase of productivity per cultivated area unit. It is important, in a short term program, to define which of the two options has greatest priority, for a determined region, at a given moment. On a long term basis, however, the definition of these options becomes meaningless, since, one day, we will require the whole utilizable area for agriculture. This is why it is necessary for the agricultural research institutions to work not only on searching for methods to improve crop productivity within the traditional agricultural areas, but also in searching, as well, for economical solutions to wipe out the barriers that affect the expansion of agricultural frontiers, especially in the humid tropical regions. In this presentation I will try to focus principally on this aspect of the problem, undoubtedly the more difficult of the two, due to the little research that has been made on the subject.

The lowlands of Latin American (Fig. 1), including the mountainsides and the region of the "Chaco" or "swampland", cover an area of approximately 1.2 billon hectares (8).

Working with soil maps and information from several sources, FAO carried out a study on the production capacity of the soil of this immense region and estimated that in only six countries of South America (Brazil, Bolivia, Colombia, Ecuador, Perú and Venezuela), there are approximately 340 millon hectares of plowable land, which

represents five times the area that is at present being cultivated in these countries, and about one-fifth of the total area still available for agricultural purposes in the whole world (8). This is the region in which the greatest reserve of lands in the world that can produce food and fibers is found. It is important to stress that this gigantic reserve is situated within precisely the world's ecological belt in which biological activities are most intensive and the primary productivity of the ecosystems reach the highest value (1, 11, 12, 16). We are therefore, before a paradox of nature. Undoubtedly, the problem has not yet received the attention it merits from the institutions charged with studying the agro-economic problems of the tropics.

Why have our countries not been able, up to now, to transform the high biological production potential of the tropics into an economical productivity that is proportionally as high? What are the reasons that have held up, so far, the development of agriculture in that huge region? What are the reasons for the evident backwardness of the tropics with relation to the higher or more temperate regions? Which factors contribute so that our colonizers, initially optimistic regarding the potential of the soils of the lowland tropics, later relegated these soils to second priority, in their attempts to promote the development of our countries?

Literature contains many answers to these old questions but, unfortunately, none satisfy the scientific mind. It is not my intention to analyze here everything that has been said on the subject, and far less to discuss theories that are considered outdated, such as the "climatic determinism", a theory which states that tropical climates diminish the productive capability of man and, for this reason, would

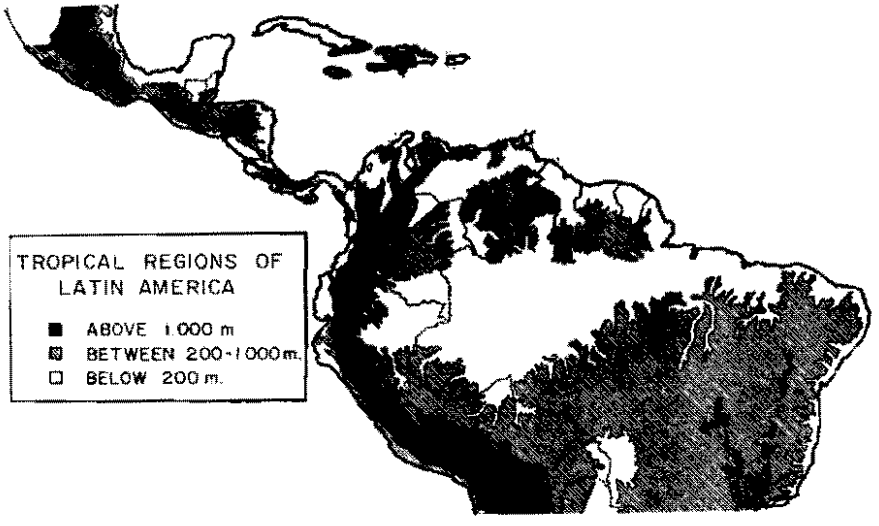



Figure 1. Distribution of lowlands in Latin America.

be the principal factor responsible for backwardness in the tropical regions. This theory had many adherents among some geographers and economists at the turn of the century, one of whom wrote that the distribution of wealth and energy would depend more on climate than on any other factor and, to prove this statement, gave a hypothetical comparison between "the energy of industrialized people of the temperate zones and the inertia of the inhabitants of the tropics" (9). I do not feel we should waste time in analyzing the merits of these theories, which have no scientific foundation.

Before considering some of the important factors which have held back in the past, and continue doing so in the present, the progress of agriculture in the lowland tropics of Latin America, I think it would be an appropriate moment to say a few words on the mechanics of plant production and the effects of the environmental conditions within these mechanics. I think this is important to help form a good idea of the potential production of the tropical regions. I apologize to my listeners if they consider my treatment of this subject to be superfluous in such a meeting, where that which is obvious or probably so well known should perhaps not even be mentioned.

Chemical analyses show us that the biomass or dry matter of the plant contains an average of about 44 percent carbon, 45 percent oxygen, 6 percent hydrogen and only 5 percent of other elements (Fig. 2). The first three elements are absorbed by the plant's organism during the process of photosynthesis which extracts carbon and oxygen from the air, in the form of carbon dioxide, and combines them with the hydrogen from the water. The amount of nutrients absorbed from the soil is approximately 20 times less than the amount absorbed by photosynthesis. This leads us to conclude that, from a strictly quantitative point of view, plant nutrition is much greater through the leaves than through the roots. In other words, air with the aid of solar energy and chlorophyll contributes far more towards nutrition and constitution of the plant organism than soil. These elementary and well-know facts justify the preference of some to define agriculture as the science of utilizing light, rather than the science of cultivating the soil.

Ecologists and physiologists agree on considering the quantity of solar radiation on a region as the ecological factor that, in fact, determines the potential primary production. Obviously, some negative factors do not allow potential production of a region to manifest itself fully. Some of the factors are shortages and excesses of water, low soil fertility and the incidence of diseases and pests. However, these negative factors, of edaphic or biological origin, do have technical solutions that are often economical, depending on the profitability of the crop.

On the other hand, there are no known viable technical and economical resources to increase the intensity of solar radiation

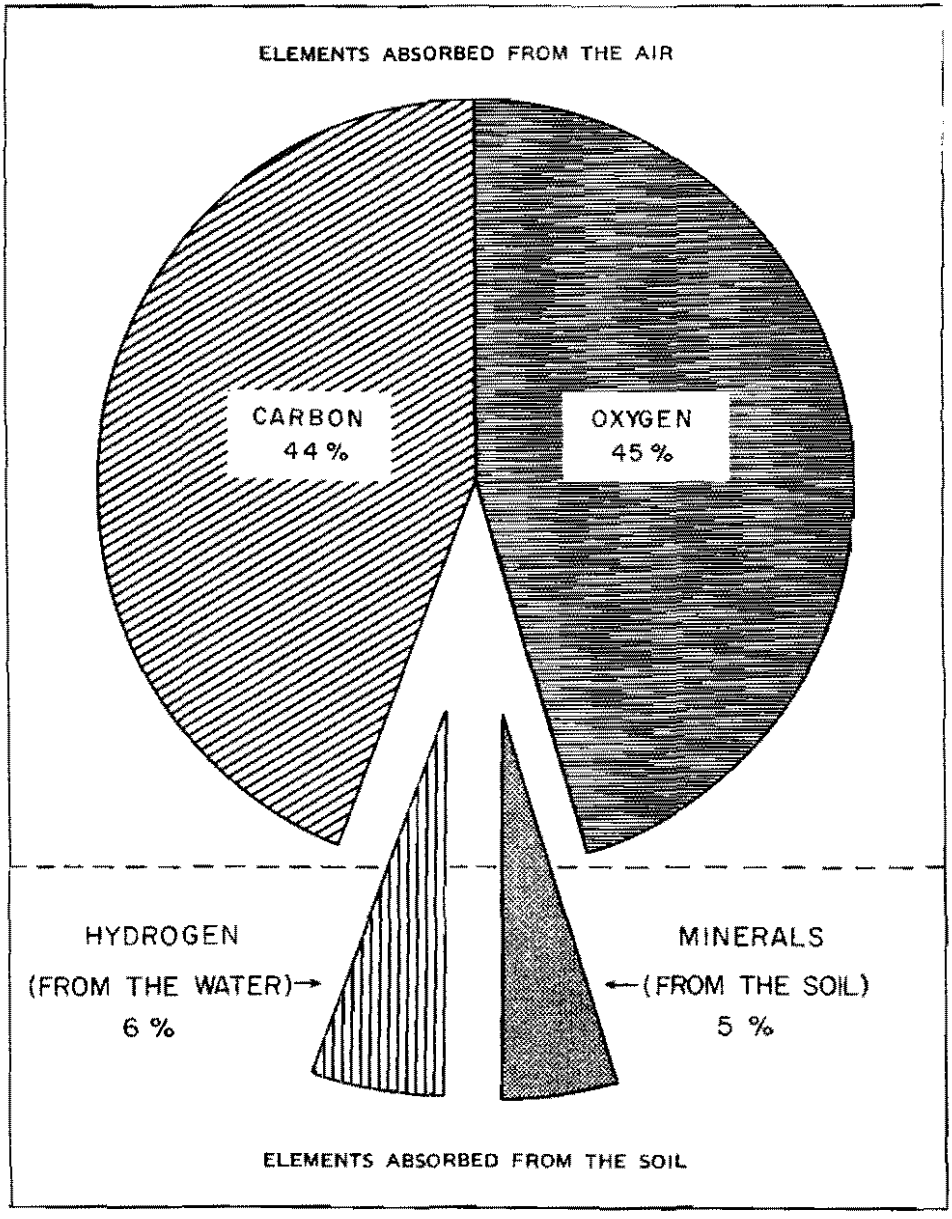



Figure 2. Percentage of the principal plant constituents according to their origin (air and soil).

under field conditions. Theoretically, then, it can be stated that the amount of solar energy corresponding to a region becomes the ecological factor that limits the maximum primary production that can be hoped for in that region.

The plant's efficiency in using solar energy for its development and production varies considerably, according to the genetic characteristics of the species, its adaptability to the conditions of environment, and, naturally, it is very much influenced by management practices employed in its cultivation. These factors regulate the growth of the plant's photosynthetic surface or its total leaf area and, in reality, that is the parameter that is most related with the capability of usage of solar energy in crops. The development of foliage is generally measured by the relation between leaf area and soil area, a relation which is known as "leaf area index" (LAI) An LAI with the value of 5, as an example, means there are 5 $m^2$ of foliage over every 1 $m^2$ of soil.

Figure 3 represents the growth of the leaf area in theoretic values of LAI, in a densely seeded plot, of a perennial such as sugar cane, elephant grass, eucalyptus, etc. The LAI increases with the age of the plant until it stabilizes at a maximum value, which varies according to the species. Generally, the maximum value increases according to the intensity of solar radiation and is always greater in species that have leaves that are predominantly erect or at an acute angle, in relation to the rays of the sun, as well as those that possess low "compensation points", that is to say, those that have greater

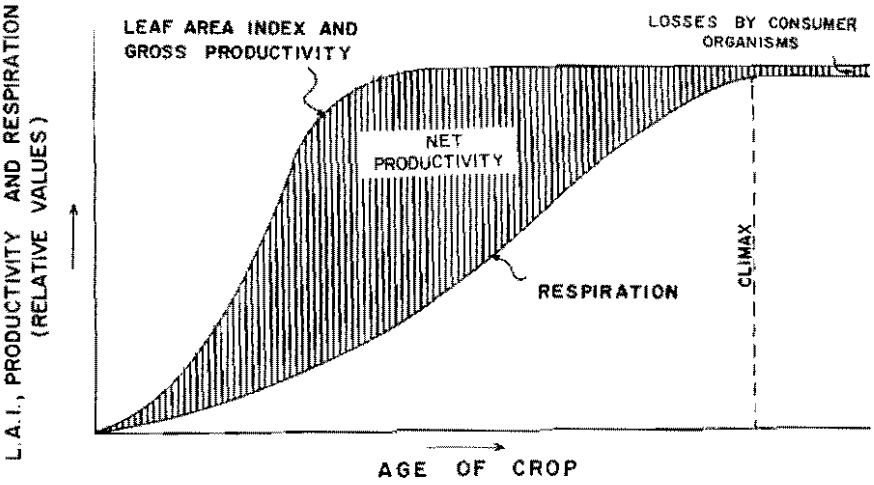



Figure 3. Relative values for leaf area index (LAI), gross productivity (total photosynthesis), respiration and net productivity (difference between gross productivity and respiration), according to the age of a perennial crop.

tolerance to shading. Total photosynthesis or gross productivity of a cultivated field follows the same LAI curve and maintains the same relation to the factors mentioned previously. Net or primary productivity, however, results from the difference between total photosynthesis and respiration, and follows a curve that is totally different, with an initial ascending phase, until reaching maximum values, followed by a descending phase. In time, the productive reduction results from the gradual increase in the proportion of non-photosynthetic or purely respiratory tissues, when the plants are not harvested at the proper time. When the respiratory and total photosynthetic curves approach each other, they become parallel, and primary productivity is practically void. In this state, the crop is in dynamic balance with the environment and is said to have reached climax. The unexplored Amazonic forest is in such a state of climax, that is to say, it has no productivity in terms of biomass increment.

Figure 4 schematically shows how solar energy that affects a crop is distributed, as the plants develop their leaf surface. This figure shows that about 20 percent of energy is lost by reflection; the remaining 80 percent is divided between the plant and the soil. During the plant's initial phase of growth, the major part of the solar energy is absorbed by the soil; consequently, there is a great waste of solar energy. As the LAI increases progressively, energy, absorbed by the leaves, becomes gradually greater. The efficiency used by the leaves when taking in solar energy depends on the rate at which they cover the ground. Naturally, the life span of the leaves is also a very important factor since the LAI cannot increase rapidly if the leaves drop off prematurely.

By means of special treatments, such as fertilization, irrigation, disease and pest control, etc., man can accelerate growth and give longer life to the foliage. In fact, these treatments constitute the basis of scientific crop management. Obviously, there are marked genetic differences between species and varieties, referring to the rate of growth, adaptability, production levels and internal division of the photosynthesis products. On the other hand, geneticists are aware of the importance of foliage development in the mechanics of production and are working hard to reduce the size of the plant and change the leaf architecture, especially the leaf angle. These resources allow an increase in crop density and high LAI values, within a relatively short time.

My objective in treating these concepts of the physiological mechanics of plant production is that of seeking to define more precisely the nature of the factors that limit agricultural productivity in the tropical regions, as compared with the cold or temperate. The low intensity of solar radiation during the winter months, and, according to the latitude, during part of the autumn and spring as well, constitutes the principal limiting factor of potential vegetative production. In tropical regions, the abundance of solar radiation throughout the year (lack of winter) greatly favors foliar

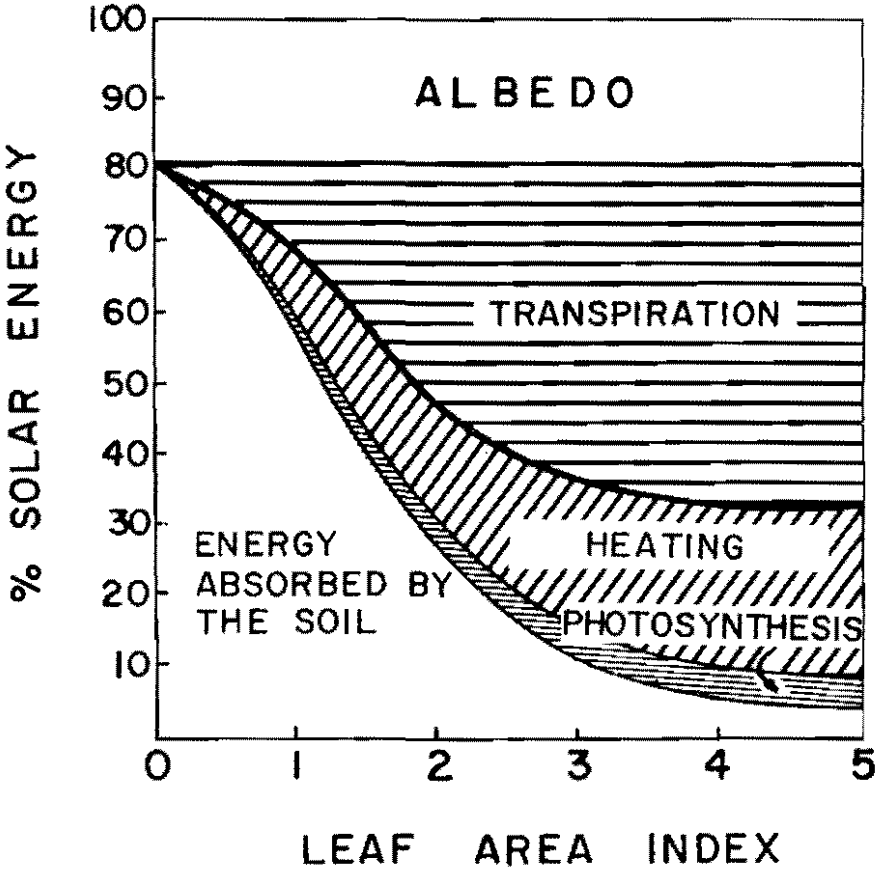



Figure 4. Schematic representation of the distribution of solar energy in relation to leaf area expressed in L.A.I.

growth, making it considerably greater than in temperate climates. Of course, the temperate regions receive as much or more solar energy during the summer months as do the tropical regions, and can as proportionately react to fertilizers and other treatments. This is, however, a relatively short period of time in the year, whereas, in the tropics, favorable conditions occur during almost the whole year. This leads us to conclude that the increase in plant yield, by means of adequate treatment, is, from the physiological point of view, more accentuated in tropical areas than in cold or temperate regions.

To end these theoretical considerations on the productivity potential of the tropics, we present, in Figure 5, the distribution of the incident solar energy and the estimated productivity potential, according to latitude (6). Unfortunately, measurements of photosynthetic efficiency in the tropics are relatively scarce. Data contained in Figure 5 were attained taking as a base an efficiency of incident energy fixation of 1 percent, for latitude 50°, and 2 percent, for the tropical latitudes (10° - 20°). The average values found up to the moment are lower, but some isolated cases are known of highly efficient crops, such as sugar cane in Java, which showed a primary productivity of 90 to 94 thousand tons of dry matter, per hectare, per year. Equally efficient are grains that can be cultivated two or three times a year in the tropics (maize, rice, etc.), showing an annual primary productivity of 60 to 80 tons per hectare, per year (16). These data highlight the superiority of the tropics over the temperate areas, relating to the potential production.

Let us now see which are the principal problems that have hindered the usage of that great agricultural potential of the tropical regions.

Undoubtedly, the factor that is most recognized as a barrier for the development of agriculture in the humid tropics is the low fertility of the soils. It is known that the soils that are most frequently found in this region, covering probably more than 90 percent of the area, are the forest latosols, also known as oxisols or ferrasols. Mostly, these soils possess good physical characteristics but are chemically poor, as will be seen later on. Alluvial soils (entisols or fluvisols) that are found by the riversides, in estuaries and islands, cover a relatively small area, probably about 1 percent of the region, but are generally preferred by farmers because of their relatively good fertility. The big problem with alluvial soils, known as "várzea" soils in Brazil's Amazon region (Fig. 6) are flooding and bad drainage, during considerably long periods of the highest rainfall months. Those two edaphic problems —low fertility of the oxisols and bad drainage of the alluvial lands— are really consequences of the climate, or to be more precise, of excessive rainfall in relation to the evapotranspiration. Therefore, I consider that a few general observations on the climatic characteristics of the humid tropics will help us to better understand the agricultural problems of the region.

Figure 7 represents rainfall and evapotranspiration values (according to Thornthwaite's measurements) for certain areas of the American humid tropics. An annual rainfall of over 2,500 mm. is common in most of the region, where the following two general climatic characteristics prevail: continuous rainfall or no appreciable dry season (Af. climate in Koppen classification) and the monsoon type, with two to five relatively dry months (Am. climate). The mean annual temperature is 23°C to 26°C, with daily variations of 7°C to 12°C, and an annual variation between monthly average of 1°C to 4°C. Relative humidity remains high throughout almost the whole

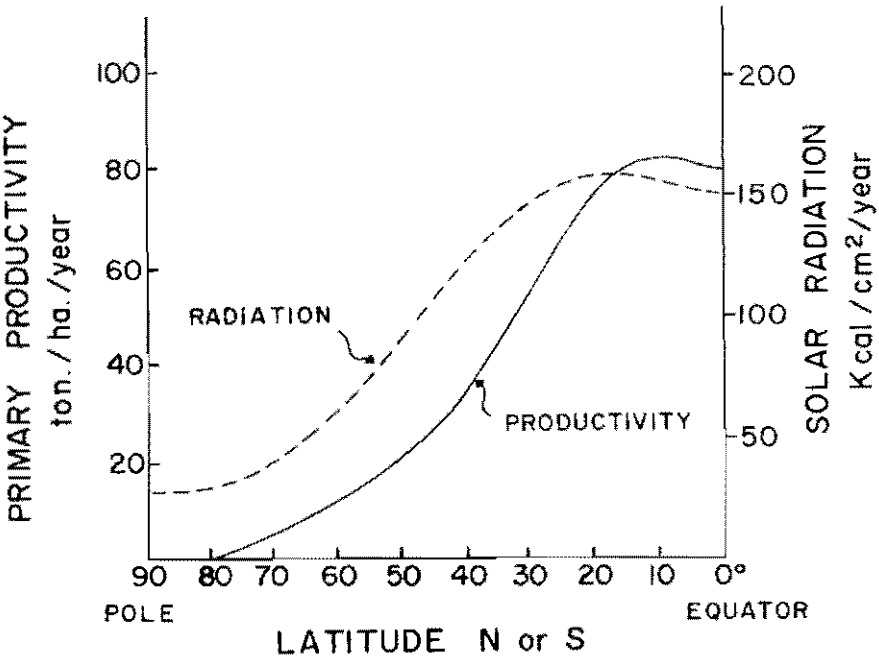



Figure 5. Primary productivity potential and total solar radiation expressed as a function of latitude. Source: Golley and Lieth (6).

year, generally between 70 to 80 percent during the day, and 97 to 100 percent at night.

Obviously, the climatic conditions favor not only the development of crops that are useful to man, but also those that are not, such as weeds. They also stimulate the proliferation of parasitical insects and microorganisms that cause diseases in plants and man himself. This makes us think, as mentioned previously, that "the backwardness of the tropical civilizations may be a manifestation of man's impotence against the impetus of tropical life itself" (1).

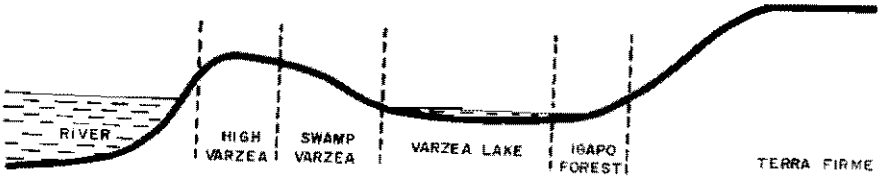



Figure 6. Schematic presentation of the "varzea" (alluvial) and "terra firme" (oxisols) soils on a cross section through a South American white river valley. The high varzea is utilized more for food crops whereas the swamp varzea is principally used for crops tolerant to inundation like rice and jute.

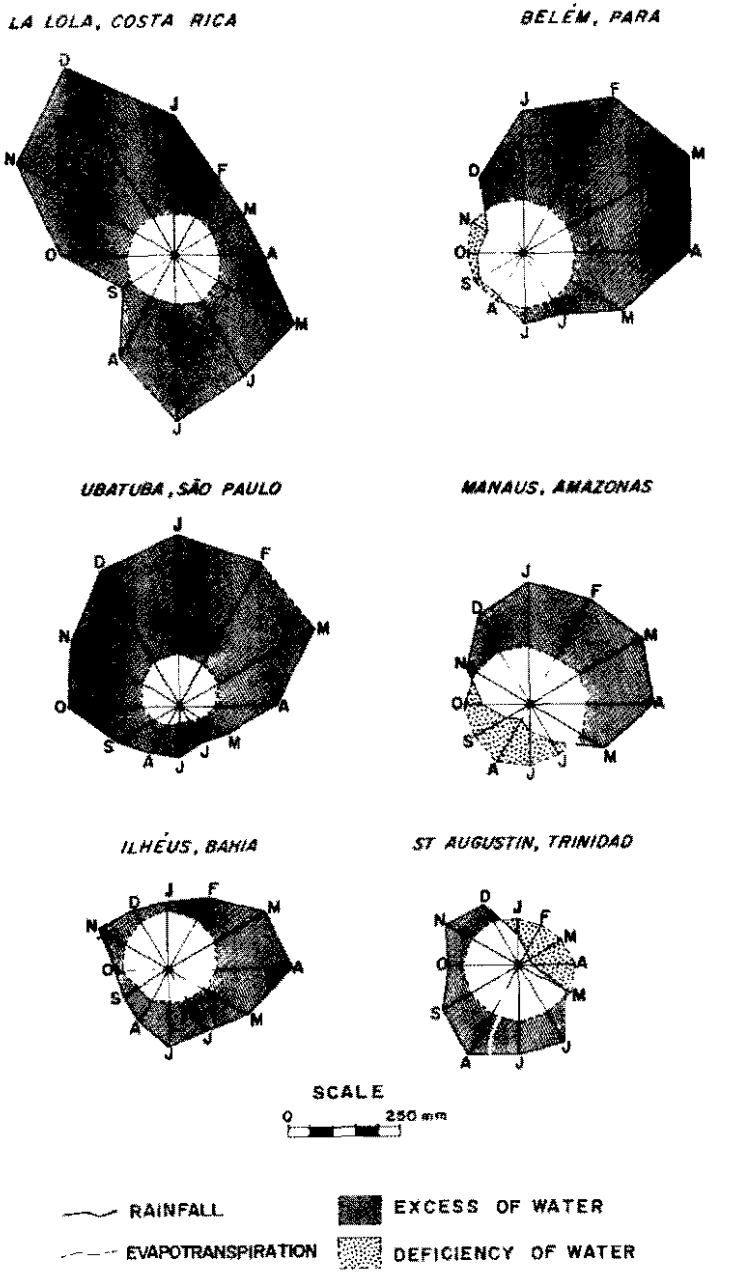



Figure 7. Monthly rainfall and potential evapotranspiration distribution patterns for six distinct areas of the lowland tropics, showing the periods of water surplus and deficiency.

Of course, the technical resources developed in the cold climatic countries to fight weeds, insects and diseases are also used in the tropics and are helping our new farmers in their struggle against the enemies of agriculture. However, although technical results are usually satisfactory, the economical results are often disappointing. This is not only due to the relatively high costs of the imported technology, but also to the poor efficiency of many methods when used under high rainfall conditions. If tropical agriculture is to take full advantage of the conquests of modern technology in the field of mechanization and the control of weeds and diseases, it will be necessary to promote the development of agricultural industry, interested in creating a technology that is compatible with the problems of the tropics. To illustrate this point, I give an example related to the cultivation of rubber in Latin America. Rubber is natural to the Amazonic region, but is now cultivated principally in the tropical countries of the Orient and Africa, from where about 95 percent of the world production originates. Altogether, the Latin American countries contribute with less than 2 percent of the world production; they are all importers of rubber and are very interested in increasing their production. Rubber cultivation failures in Latin America are due exclusively to a fungus, Microcyclos (Dothidella) Ulei responsible for the disease known as "leaf sickness", non-existent in the producer countries of the other continents. There are highly efficient fungicides, as was shown experimentally a few years ago at the institution I have the honor of heading. The great problem is developing a sprayer that can be adapted to the condition of the crop and the topography of the production areas. This sprayer must be portable and have sufficient power to reach a height of 25 meters, using low volume solutions. This type of mechanism does not exist on the market. Were it possible to develop a sprayer with these characteristics, all barriers to the expansion of rubber production in Latin America will have been removed.

Regarding soil fertility, it is a well-known fact that the excess of rainfall over evaporation, together with the relatively high temperatures throughout the whole year, are conditions that cause the impoverishment of the soils by leaching. This is undoubtedly one of the most serious problems facing farmers of the humid tropics. To avoid irreversible changes in the chemical composition of tropical soils, it is necessary to employ different managerial practices to those in use in the regions of temperate or relatively dry climates. The difficulty of transferring the cultural practices developed in areas of other climates to the humid tropics derives precisely from the loss of nutrients which occurs when these practices are adopted in regions of high rainfall.

It is obvious that the development of special management procedures that are capable of counteracting the losses caused by leaching, must be among the top priorities of research at the agricultural institutions working in the humid tropics. Based on their personal

experiences, the farmers of the region have developed a management system considered quite effective against the excessive impoverishment of the soil. This system has been used for many years in the majority of the regions of low demographic density. It is the system known as "shifting cultivation" or "slash-and-burn" and consists of cultivating the soil for three or four years and then leaving it to rest for several years until the forest grows on it sufficiently to restore the fertility lost during the years of cultivation. In the opinion of many specialists (8), after the natural forest is cut down and burnt for planting food crops, the soil looses about 60 tons of biomass (especially dead roots) and 12 tons of humus, per hectare, per year, in the course of the first 12 to 24 months. This shows that shifting cultivation should be used with caution and only in sparsely populated areas, where each family can have relatively large properties to adopt this method, without causing damage to the environment. When demographic pressure increases in an area where only shifting cultivation is used, there is a tendency to lengthen the cultivation periods and shorten the rest periods, with disastrous effects on the soil fertility and crop yield. This problem created serious economic crises in some areas of the Brazilian Amazon, as in the region of Bragantina, near Belem.

At a meeting that recently took place in Maracaibo, Venezuela, on ecological research, and sponsored by the Inter-American Institute of Agricultural Sciences of the OAS (IICA-Tropics Program), a recommendation was approved to promote, on a multinational level, basic research to be carried out in several areas of the humid tropics of Latin America, with the objective of analyzing the ecological changes, especially those of edaphic characteristics, caused by different agricultural systems, and determine management techniques that would be most indicated, from the economical and ecological point of view, to best take advantage of the region's resources (3). We consider this type of research to be of fundamental importance in the orientation of any plan of action in the tropics regarding agriculture. It gives me pleasure to inform the participants at this symposium that the National Research Council of Brazil has already allocated resources for the immediate initiation of the project, in three areas of the Brazilian Amazon. It would be highly desirable that other tropical countries also immediately promote the carrying out of this important project.

Unfortunately, we will have to wait several years before we can define, on a scientific basis, the management practices that best insure success in the different soils that are found in the tropical regions. While waiting for the results of this project, I believe we can recommend actions that are obviously important to the advancement of tropical agriculture, and I would like to dwell on only three of these. They are perhaps conservative and unoriginal recommendations that do not promise any revolutionary or immediate effect, but they are certainly important to the economical and social future of the people of Latin America.

The first recommendation I wish to make is connected with the research programs of the institutions that work in the tropics or, more specifically, the need to include in these programs intensive research for new products and new ways to obtain maximum usage of the region's resources. It should be emphasized that the need to broaden agricultural frontiers in the tropics is not limited to conquer new areas, but, more importantly, to acquire new knowledge of the environment, its resources and the best ways of using these for the benefit of man. In fact, now we feel more need for in-depth knowledge than information obtained from the traditional field experiments, comparing varieties, fertilizer formulae and other routine studies duplicated elsewhere. The traditional research that is directed at perfecting crops is obviously essential for any region, but in the humid tropics there is a need to be concerned with the solution of problems that are relatively new to agronomic science. This requires more attention on behalf of researchers in lines of work that might be considered unconventional. For example, the development of new agricultural systems that will function as natural ecosystems of the tropics, imitating their perfect balance with the environmental resources, without necessarily depending on the application of fertilizers and other chemicals. The development of rational methods for the culture of native species of accepted economic value and with unquestionably more tolerance to poor soils of the region than the traditional crops, such as the Brazil nut **(Berthcletia excelsa)** "guaraná" **(Paulinia cupana)**, "palmito" **(Euterpe edulis, E. oleracea)**, "andiroba" **(Carapa guianensis)** "pupunha" **(Guilielma speciosa)** and many others.

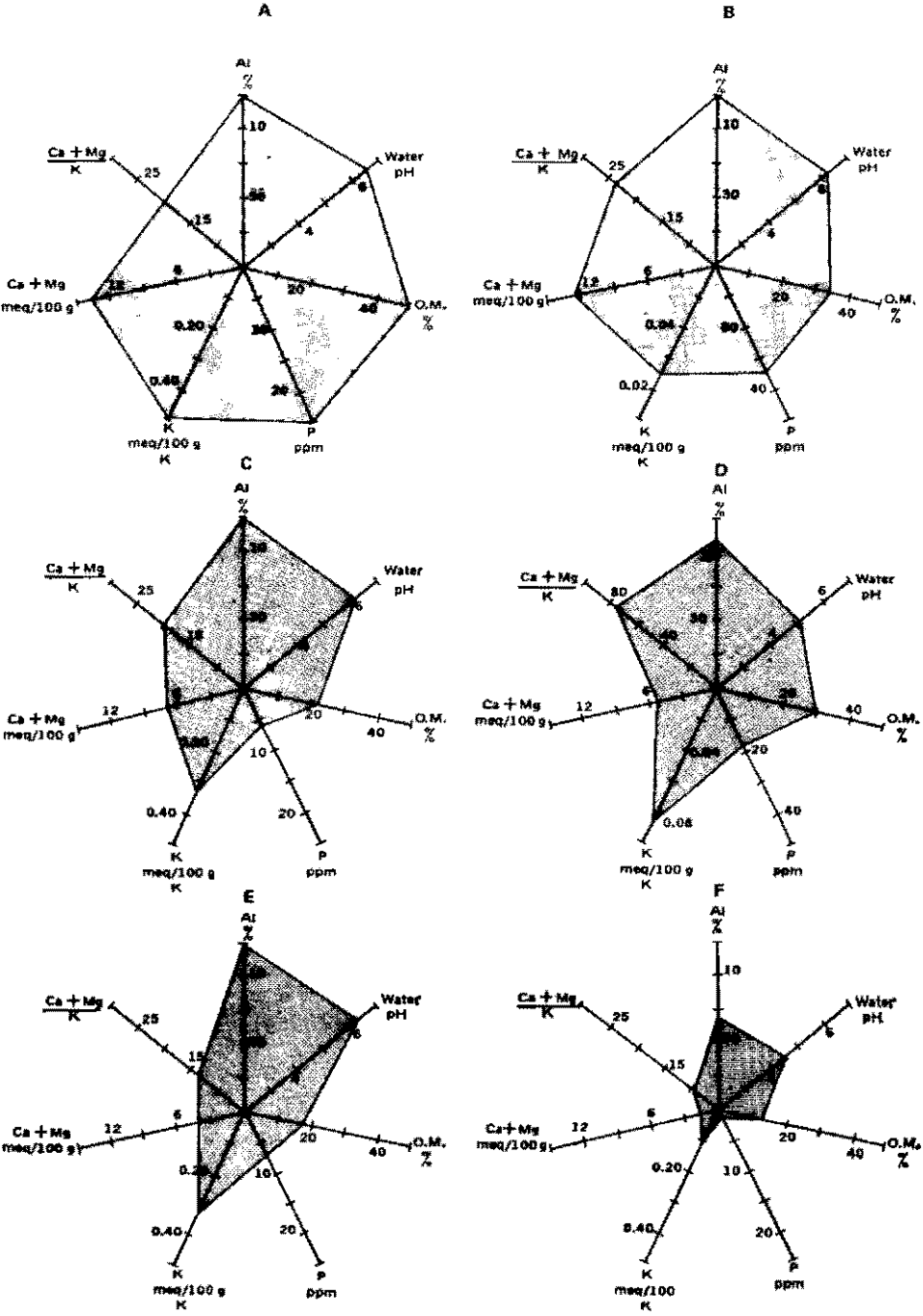
Equally advisable are the studies of new industrial applications for the innumerable tropical woods, a task that should include basic research on the best usage of the gigantic quantity of cellulose produced in this region. In this field, one of the apparently promising tasks for research would be that related to the use of cellulose, specially treated for animal feed (13), including its protein enrichment, by means of fungus innoculations (7).

My second recommendation stems from the urgent need for a major participation of agricultural experts, especially pedologists and ecophysiologists, in government programs that are directed towards the development of lowland tropical agriculture. It is important to avoid, as much as possible, the execution of colonization plans on lands which we still do not know how to cultivate, and would therefore suffer the risk of failure, compromising the future of the region. It is recognized that one of the most important fields of research is that of soil usage capability, based on what we know today of the demands of tropical cultures of recognized economical value. This research has received major impulse in Brazil during the latter years, especially in the Amazonian region and in the south of the State of Bahia. Soil fertility is, of course, very variable in these regions, as can be seen by results shown in Fig. 8 (2). In Amazonia, where we previously thought soils were almost totally unusable or of very low

fertility latosols (Fig. 8F, 8H, 8I), research is revealing the existence of considerably large areas of soils of lime origin (Fig. 8C, 8E), of the type that is known in Brazil as "terra roxa" (alfisol), very similar, regarding capability, to the best soils found in Sao Paulo, Paraná and Minas Gerais. According to Falesi (4), over one million hectares of "terra roxa" have been found in the area that is now being studied by several institutions, covering about 10 percent of the region. The greatest area estimated at 750,000 hectares, is found in the south of the State of Pará. Recently, it was estimated that the "terra roxa" area of the Territory of Rondonia, originally estimated at 40,000 hectares (4), is actually 10 times greater (14).

The institution that I direct has estimated that the area of high fertility soils, in Bahía, is 500,000 hectares of which 400,000 hectares are dedicated to cocoa (Fig. 8A, 8B, 8D). It must be pointed out here that it was the good quality of the soil of South Bahía that motivated the introduction and rapid expansion of cocoa tillage in that region, the first seed being brought in from Amazonia, where the plant is native. Today, Bahía produces around 200,000 tons of cocoa, compared to 3,000 to 4,000 tons for the whole Amazon region. Until recently, there were only very low producing, semi-wild cocoa plants in the Brazilian Amazonia. In subsequent years, it has been possible to establish some rational plantation of cocoa in the low fertility latosols of the region, with the help of lime and fertilizers, in relatively strong doses. A planting system for latosols, that is more economical and is being tested successfully without strong fertilization, is that carried out under the secondary forest, one year after cutting and burning the original forest, planting the cocoa every two meters, in parallel rows separated by four meters between each row. These rows are dug one meter wide, initially, and are gradually widened as the plant grows, until a plantation is formed under the shade of trees that are practically of the same age as the cocoa plantation. The number of trees is gradually reduced, year by year, until it reaches 40 to 50 trees per hectare. This seems to be the type of management that is most appropriate for poorer soils.

In the more fertile soils of Amazonia, as the alfisols of Rondonia (Fig. 8C), cocoa, as any other tropical crop considered to be soil demanding, is cultivated with great ease and it is possible to adopt the traditional planting methods employed in Bahía and other cocoa areas. Rondonia's high quality soil undoubtedly makes easier the introduction of technology developed in other regions of Brazil and that is generally known by the farmers who come into the area. This fact is definitely contributing to the success of the colonization project that is being carried out today, especially in the region of Ouro Preto, under the sponsorship of the National Institute for Colonization and Agrarian Reform (INCRA). Unfortunately, the same cannot be said about all the colonization projects carried out in Brazil and other Latin American countries.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Al %
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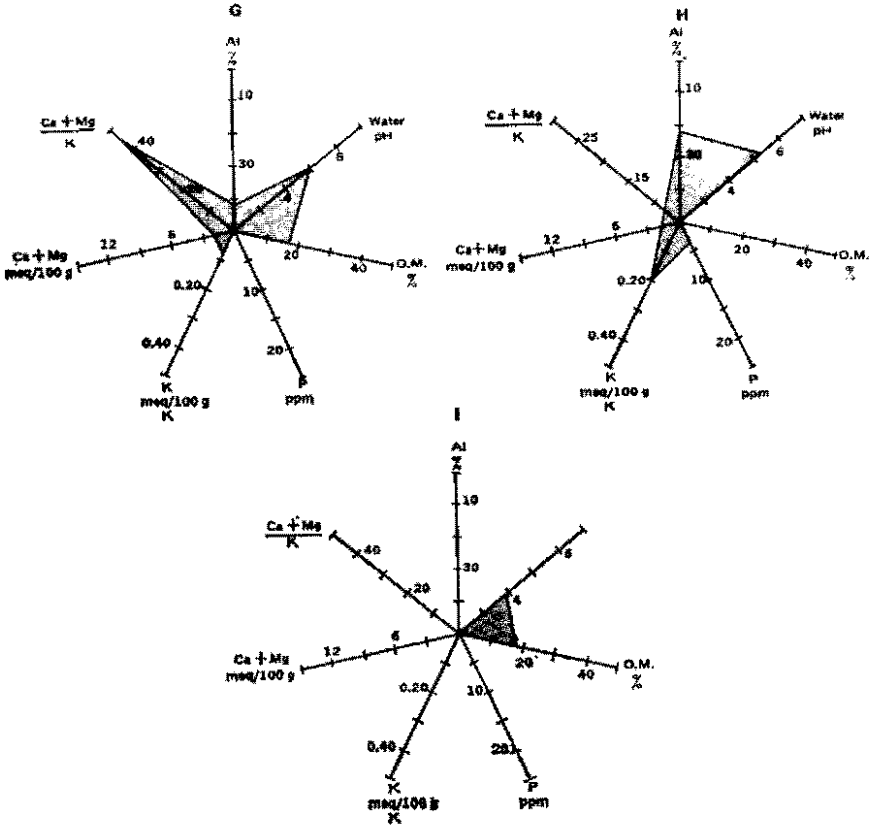


Figure 8. Polygonal graphs representing the fertility levels of various types of soils found in tropical regions of Brazil. A: CEPEC soil (alfisol) in Bahía; B: Rio Branco soil (inceptisol) in Bahía; C: Ouro Preto soil (alfisol) in Rondonia; D: Itabuna soil (alfisol) in Bahía; E: Xibiu soil (alfisol) in Rondonia; F: Vermelhao soil (ultisol) in Rondonia; G: Colonia soil (oxisol) in Bahía; H: Paraíso soil (ultisol) in Rondonia; and I: Itaituba soil (oxisol) in Pará.

Political and social problems are also important to the colonization programs of the tropics, especially in countries as vast as Brazil, forced to care for its national integration and territorial tenure. For this reason, it is not possible to be too critical and, least of all, combat some of the government plans developed somewhat hastily, without allowing time for the essential basic studies. This happened recently in Brazil with the construction of the giant Transamazon Highway. Fortunately through the recently created Program of Humid Tropics of the National Council for Research, the Brazilian government is accelerating soil studies, not only on the Transamazon but

also on the transversal and north perimetral highways. This study is done to be able to define, as soon as possible, the usage capability of the soils and, based on this, the occupancy structures most indicated for the areas that are newly opened. The orientation that is announced for the future follows the lines of our first recommendation, focusing on colonization of lands that are more fertile and preserving intact the natural coverage of the poor soils, at least until a developed technology is proven to be capable of drawing economical advantage from these soils, without compromising the future.

My third and last recommendation is, in fact, the one that occupies first place in the vital actions for the progress of tropical agriculture. It is with sincere emotion that on this day, October 13, 1973, I see this recommendation become reality, in this charming region of Colombia.

Obviously, we will never have the conditions to transform the extraordinary potential of biological production of the tropics into economical production if we do not have top-notch institutions such as the one we inaugurate today, in this Cauca Valley, under the sponsorship of the Rockefeller Foundation and the Government of Colombia. I sincerely hope that in the near future we will have other centers as important as CIAT, in other regions of the lowland tropics of Latin America.

I end these words by requesting the applause of this distinguished group for the creators of this great Centro Internacional de Agricultura Tropical, which is today officially inaugurated and to which I wish many successes in its noble mission of helping us build a better future for the tropical countries of Latin America.

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# Economic development and infrastructure: the means and ends of development

**Raúl Prebisch**

Economic Mission for Latin America (ECLA) of the United Nations

When I had the pleasure of being invited to participate in this important meeting, because of the great significance I ascribe to CIAT, I did not hesitate to accept. I am convinced this Center should have been created in Latin America many years ago. Mr. Lewis M. Roberts eloquently told us this, this morning, when he stated that 85 percent of all Latin America's exploitable land is located in the tropics. At this point, however, the problems present in the lowland tropics have not been studied in depth or breadth.

Some time ago, I had the opportunity of reading a report on the failure of colonization projects in the tropics, which left me amazed. How is it possible that vast sums of money have been spent and the few existing resources ruined, because of lack of knowledge of the ecological conditions characteristic of the regions opened to colonization?

Consequently, I am convinced of the fundamental role that this and other similar institutions can play in the development of tropical Latin America; and perhaps, later, they may also extend their activities to other continents. Judging from what I heard this morning, the problem you are facing here is philosophically similar to the one confronting those of us working on the problems of Latin American development, that is, how to become free of intellectual dependency which reaches us from outside. The problem you have is being unable to transfer agricultural technology, developed in the temperate countries, to the tropics. We as economists, sociologists and other social science specialists also face the problem of not being able to transfer,

at least not without a preliminary process of selection and assimilation, the concepts evolved in the large industrial centers, in respect to economic development, most of which are incompatible with the objective reality of the Latin American countries, that is, the countries of the Latin American periphery.

To understand the nature of this problem, I wish to stress that Latin American development is fundamentally an emulative development, not original, not genuine; it is emulative with respect to production and other techniques. We inherit considerable technology from other latitudes but we cannot use it in its original form without adapting it and without developing our own technological research. Dr. Paulo de T. Alvim spoke to us, with great certainty, this morning on the need for technological research on different aspects of agriculture. The same statement could be made about other aspects of productive technology and about the utilization of other techniques, for instance, the technique of mass communication. In these transfers of techniques, ideas and institutions, we find ourselves, in Latin America, faced with a number of contradictions, well-defined and manifest, between the kinds of elements that are transferred to Latin America, within this emulative process, and the objective conditions prevalent in the medium. Regarding productivity, we are adopting techniques which require considerable capital per man; techniques that have been developed in countries where the concern is precisely to economize on manual labor, which in other countries is expensive and scarce, whereas in our countries it is plentiful but capital is scarce. This is the first contradiction.

A second contradiction, emulation advances, is greatly influenced by the massive techniques of communication, and touches the consumer habits we are rapidly adopting. Another aspect of the situation with regards to technique is that we are increasingly assimilating the consumer habits of the great industrial centers, in which high per capita incomes prevail, in contrast to the relatively low per capita incomes of the Latin American countries.

Finally, a further contradiction exists which is related to technology and to scientific advancements, in their positive and negative aspects. I refer to the effect of these scientific and technological advancements on population growth; that is, the contrast between these techniques and the cultural base, especially among the lower classes. Without having the opportunity of changing their cultural patterns, these people from the lower class will not be able to reduce their birth rates within a given time period.

In addition, a differential phenomenon exists: the higher and middle income classes have developed gradually in Latin America and, consequently, mortality has decreased at the same rate as the changes in individual attitudes regarding birth control. This has not been the case in the lower classes.

How has the contradiction that exists between advanced technology and advanced consumer habits and a mass population which grows at an extraordinary rate, never witnessed before in history, except for some fleeting moments in the life of the United States, been solved? It has been solved precariously, by concentrating, circumscribing it and limiting the benefits of development to a segment of society, that is, to the higher and the middle classes that have been familiar with the evolution of science, with the technical progress of industry, and, in part, with agriculture.

Therefore, an imitation of the production and consumer trends of the great centers has been reached, making up sub-centers in which development is being continuously limited. These are emulative subcenters where production habits and consumer habits are being adopted. Here lies Latin America's big problem. How can all the levels of society be reconciled? Why have the lower classes, which make up on the average in Latin America, 40 percent of the population, not received the benefits of development or not received them except on a minimal scale?

In this way, the concept of society as consumers, is rapidly penetrating the medium, but only among the community's higher levels, whereas the lower levels, remain in an infra-consumer state, that is, within the infra-consumer society. Between the consumer and infra-consumer societies, lies the aspiring consumer society of the middle classes, where aspirations are only partly satisfied.

But this contradiction that I refer to is not formed only in productive technology. It also appears in areas such as social investment, especially in education and health investments. In this respect, we have again copied the methods of the developed countries: in education, we try to imitate, and imitate increasingly, those large centers that offer a secondary level education and even a higher one, the latter being costly in relation to the size of Latin America's educational problem. It does not reach the mass population except on a minimal scale; we are all aware of the high degree of illiteracy and the lack of technical education in Latin America. Technical education is required to renew concepts, to increase agricultural productivity and to more efficiently employ capital in all the sectors of the economy.

Some time ago I was discussing health with Dr. Horwitz, eminent director of the Pan American Health Organization. He made analogous comments on the expensive training systems in Latin America, for doctors and their aids. The forementioned organization is trying to develop less costly systems to operate several services which do not require high specialization nor costly university training but which can achieve this program objective at a lower cost. The same consideration can be applied to other sectors of social and administrative activity. We are striving to assimilate technologies without designing methods which apply to the economic and social reality of Latin America.

I will not enter into a field unfamiliar to me, such as that of the military, but I feel that Latin American armies are also trying to assimilate, at considerable cost, the technologies of more advanced armies, in marked contrast to the low economical possibilities of our countries. I fear that, soon, the fantasy of costly nuclear research for military purposes will crop up in some Latin American hothead.

Other signs of this emulative lust exist, which do not relate to material reality in the different aspects I have mentioned, but rather relate to the imitation of social and economic ideologies and theories that, in turn, bear no relation to Latin American reality. What happens in Latin America with these ideological phenomena is that we have faith in certain ideologies which originated in Europe, in the extreme right as well as in the extreme left of the political scale, during the latter of the 19th Century, and which have limited basis in the Latin American medium, totally different from that of European ideologies. Not one of these ideologies has witnessed the contradictions that are evident regarding production, consumption and diffusion techniques, consumer habits and political conscience molding in Latin America. In brief, I would say that the benefits of development (because of the methods of technique and a series of social, cultural and political elements) are concentrated basically among the higher classes; they are increasingly penetrating into the middle classes but do not reach, except on a small scale, that 40 percent of the lower class population. To strike a parallel with an agricultural topic, the diffusion of development benefits resembles an irrigation system that is applied to a terraced crop which, because of either poor water management or lack of the system's adaptation to the ecological conditions, water is distributed only in the high and intermediate terraces. The recipients exert no effort to see that water reaches the lower levels; it is possible that the intermediate recipients reach an agreement with the higher levels but those on the lower level are excluded from irrigation's benefits.

In Latin America an identical situation exists with economic and social development, which have the advantage of offering us vast welfare possibilities because they contain the benefit of additional income which this technique, in its ambivalence, feeds to the economic system. The advantages are channeled to the high and intermediate stratas through the economics system, by means of political, social and cultural elements. We know that a series of compromises between the economically powerful higher classes and the politically strong middle classes have been developing, nurtured principally by the industrialization process. These compromises have been made to distribute the benefits of technical progress and the development of natural resources. This is why the direct distribution of income not only remains on the intermediate terraces, without descending to the lower ones, but also the so-called social conquests — social security, housing, health, and education — are absorbed mostly at these levels and do not reach the lower ones. Such as in technology, these con-

quests are absorbed at a high cost but do no reach, with sufficient intensity, the community's lower class because the enormous capital accumulation potential, that is, modern technological productivity, is diluted on consumer products or on laudable social investment procedures that do not meet the economic and social requirements of Latin America.

The question of capital accumulation is one that I have frequently repeated. We will not solve the problem of Latin American lower classes if we do not accumulate large amounts of capital. This procedure is necessary but not sufficient because we need to study the ways this capital acts on the technological alternatives that are most suited to Latin America, the methods which permit its best utilization and, of course, the fundamental and technical education of the Latin American masses, both for economic as well as cultural ends. The tendency to believe that the basic problem of the lower classes is one only of income redistribution is highly dangerous. Please do not consider me a reactionary for stating this. I do not consider myself as such, although I maintain the theory that a direct and immediate income redistribution (time limits its effects) will be of limited value if sufficient capital is not accumulated which will include the community's lower classes within the productive scheme.

I will now refer to three requisites for achieving social progress through increased agricultural production.

Increased productivity was discussed this morning, and rightly so. This is an essential factor, in other words, the first requisite. It was also stated that increased productivity alone is insufficient. Galo Plaza affirmed this in an example that he was privileged to mold with his competent hands; if the technical advancement that he has introduced into banana harvesting, which incorporates the most recent technology, had been carried out for those twelve or more companies that he mentioned, the landowners would have received the benefits of this technical advancement. This always happens, gentlemen, when technical progress is not accompanied by an integral agrarian reform, inspired by elementary principles of distributive equity which allow the small farmer to claim a major portion of the benefits of increased production. In India I observed how adopting dwarf varieties of wheat, developed in México, solved an urgent productivity problem but how distribution was not accompanied by a rational agrarian reform program. As pointed out by Mr. Chester Bowles, U. S. Ambassador at that time, a small share of the productivity increase fell into the hands of the small farmer and a large proportion was used to form and benefit a new social class.

Therefore, we have the first requisite: increase in productivity. Second requisite: an integral, fair and politically undistorted agrarian reform. I will now advance to the third point. The third requisite for positively increasing agricultural productivity, from the social and political standpoint, is the absorption or integration of the people

who become redundant on the farms, because of the introduction of technical advancements in agriculture, into other activities. Many fantasies exist on this aspect as well. I have even witnessed them in a report from the OECD, prepared in Paris by capable technicians, where the statement is made that, by emphasizing biological technology, that is, by increasing productivity through biological means, and putting aside mechanization (which I believe cannot be totally discontinued) the problem of manual labor in agriculture would be solved. This problem cannot, in reality, be solved so easily. Some estimates have been made in Santiago, Chile, which, like all estimates made on this subject in Latin America are questionable and a little imaginative, but one must resort to these "intellectual life rafts" when smoothly running ships are not available. Nevertheless, these estimates show that for every one percent increase in productivity per land unit, employment increases by only half. If a one percent increase in employment is added to the one percent, what significance, from the social viewpoint would increased productivity then give? If the figure presented this morning by Dr. Alvim, on the duplication of the production of the cultivable area is not accompanied by large technological innovations, it is possible that we may have to employ more peope, to produce less. But I hope this situation does not arise because the concept would cause the entire experiment on social elevation of the rural masses in Latin America to fail.

I accept that the increase in productivity per land unit helps to retain more people on the land than has been possible in Latin America for the last 30 years. Nevertheless, the most elementary estimates show that the exodus will continue. The problem is whether this exodus is towards other farming activities (as was mentioned this morning). For many reasons, I believe this would be more convenient than transferring human redundancy from the rural areas to the cities, since this action is detrimental to the social configuration of a country. People are transferred from a rural type economic and social medium to the cities, where they do not integrate. This unadaptability creates serious problems from the human, social and political viewpoints.

Therefore, the problem is that it is necessary to combine an increase in agricultural productivity with agrarian reform and with a productive absorption of the people who become redundant in agriculture, not necessarily in the large cities (an idea which horrifies me) but rather in the smaller towns. This is not a development program unique to certain economic and social systems; the problem is equally present in both socialist and capitalist countries as well as in other peripheral ones, such as those of Latin America. The same phenomenon occurs in them all: technology appears, agriculture produces more and since the demand for agricultural products does not grow at the same rate as the demand for industrial products, an imbalance in the economy is established. When increased productivity and slow demand growth occur (except for in a country,

such as Ecuador, as mentioned by Galo Plaza, which has a tremendous export potential for one specific product), the proportion of the rural work force fatally continues to decrease in relation to the work force of the cities, occupied in other activities. In other words, reducing the agricultural work force, as opposed to that of other rural or non-rural activities, can be socially self-defeating. We cannot modify this factor and the alternatives are clear: either technical progress is introduced through increasing agricultural productivity (by which the agricultural work force is reduced), or, to avoid rural exodus and urban congestion, precapitalist attitude is maintained in agriculture which prolongs the precarious social state. Neither alternative is acceptable. There may be an intermediate alternative, increasing agricultural productivity and finding an acceptable economic and social absorption, so that people displaced from agricultural activity do not merely transfer the locality of their redundancy and social isolation. The method of ascertaining an acceptable solution to this situation constitutes our countries' major problem.

For this reason I am pleased that this Center, the activities of which will undoubtedly contribute to increased productivity in the lowland tropics, has framed its objectives within a concept of economic development. I believe that establishing this Institution with the aim of achieving a link between the agricultural problem and the general economic development program was an act of wisdom; without this link, you would all fail, both economically and socially. You might have great technical successes but, in the end, you would fail because of failure to adapt that technology to the rural sector. Without this link, CIAT would be one more element of social unrest in these countries, one more of the many that already exist because of lack of planning, that is, for not having linked technological development with the economic plan, as in the way you have correctly organized your program.

I congratulate CIAT for the global concept they have given to the agricultural problem. In fact, no economic problem can be considered apart from the global context. No economic development problem can be considered solely as economic development: it is a problem in which the technical elements are integrated, inserted and classified — with reciprocal relations— with the social, economic, cultural and political ones. Any concept of development that does not take into account this global aspect, is a false concept.

I have mentioned not only the problem of accumulation of capital but that of technology as well, for reasons I could not elaborate upon because of lack of time. The Latin American executive's rationale, like those of other latitudes, leads him to select methods of technique that, in his opinion, are the most efficient. But, in fact, which are the most efficient? Not only those that produce new and better products but those that conserve manual labor. This is the sense for profit to which the businessman of any economic and social regime responds; it indicates efficiency from the agricultural sector's view-

point but not from that of the country's overall economy. Any capital investment that displaces manual labor or does not absorb its increment (an important factor in Latin America because of its high birth rate), and any investment which economizes labor without sufficent capital to absorb it in the same or other sectors, is irrational from the standpoint of community welfare, even though it may be perfectly rational from the individual businessman's point of view. Therefore, a contradiction exists between rationality concepts: what is good for business is not always good for the country. Consequently, there is a need for seeking other productive techniques which, with less capital, will achieve the same product even though they may absorb more labor, which is required in order to obtain social balance.

We have been discussing these problems in Latin America for more than 20 years. I believe CEPAL was the first organization to focus on the subject. The problem remains: alternate technologies which are suitable for Latin America must be employed. However, to my knowledge, nothing important has been achieved on this subject. When Dr. Alvim spoke on the phenomenon of leaching which occurred because of the introduction of technology in the tropics, which are not adequate for the native conditions of these lands, I reflected, by analogy, on that vast region of tropical intellectuality where we live in Latin America (including countries, like my own, which are formed by temperate regions). Therefore, this is not a phenomenon which occurs only in the tropics. In all Latin American countries a lush tropical flora grows in the minds of our leaders and in them, leaching also occurs: certain ideas and techniques and consumer and production habits are introduced, which as in leaching of the soil, diminish the productive capability of the mind. With this mental capability of thinking for oneself being diminished, of searching for formulae adaptable to the reality of Latin America, an energy loss of intangible value is produced. Consequently, Dr. Alvim, leaching is not a problem that you must study only in the soils of Latin America but also in economists and sociologists, and other groups of specialists that are not necessary to mention now. Leaching is not only a problem of finding new techniques.

In this respect, it is worth mentioning that two years ago the Massachusetts Institute of Technology designed a large research project on this type of technique. A foreign entity had to take this initiative, of course, in light of our own incapacity to take initiatives of this nature and convert them into something positive; I accuse myself for this grave downfall and all we Latin Americans must feel guilty. The results of this research are not yet known but, regardless, we can point out that an area exists in Latin America in which little research is required and in which we are committing basic errors with respect to the use of technologies.

There are factories, for example — textile factories, in which the equipment or machinery may be capable of 10 to 15 years more

use, but the owner has accumulated funds for renewal and, naturally, led by his legitimate sense for profit, displaces this still usable equipment and imports more advanced pieces which allow him to reduce the employment of manual labor. That's commendable from the businessman's viewpoint but not from the standpoint of the country's social balance, if there is not sufficient capital to absorb this labor. This same problem exists with agricultural mechanization or with those firms which increase their capital, their investment, to meet rising demand. They do not pause and consider that if they organized work in two or three shifts, with the same capital investment, they could produce more. The same capital — with more manual labor and a better organization — would increase production.

During a visit I made to this country a few months ago, some Colombian friends informed me that the increase in Colombian textile exports was mostly because the textile industrialists understand the problem of the maximum utilization of their equipment and are working in three shifts. They have reached an agreement with the syndicated workers and, in Colombia's case, with the Roman Catholic Church, so that no problems arise from working on Sunday. Therefore, with the assentment of industrialists, workers and spiritual leaders, a considerable economic advantage was achieved for the producing sectors. Faced with this example of efficiency, how can this concept of production be disseminated throughout Latin America? This is one of today's most acute problems; since this type of problem has not arisen in developed countries, no information or literature exists from which we can learn what to do, because the mental leaching that we mentioned previously does not permit us to use our minds to solve this problem ourselves.

But this is not all, gentlemen. In several countries of Latin America, small and medium size, the problem exists, in varying importance, of craftsmanship and the small and medium size industry. It is logical that such a problem will someday disappear in the same manner as Latin America's pre-capitalist agriculture. It is essential to study the rate and in what way small industry disappears. For instance, to destroy it, substituting the small shoe manufacturer with a great factory and thrusting thousands of small manufacturers and workers into the street is socially inadmissible while these people cannot be used or employed. Economically, the substitution also constitutes a loss but, because these peoples' political power is small and the intellectual gravitation non-existent, we have not considered the problem. We have not paused to think how the small shoe manufacturer, working with inexpensive equipment, could improve it for increased production: how the availability of raw material to him and the distribution of the finished product could be improved, that is, wholesaling, perhaps through cooperatives. Some day, the small producer must be absorbed or eliminated, but he should be given a lengthy enough transition period that will enable him to settle into new industrial situations. Therefore, measures of incentive and pro-

tection for the small producer, with respect to the economic conditions and within the technological progress pattern, should be introduced.

Modern techniques and industrial production efficiency have penetrated a nation's way of thinking, to such an extent that a great proportion of the technicians in economy reject any protective measures for small industry because they are dazzled by the mirage of mass production.

At a recent meeting in New York, at the United Nations Secretariat, we heard the presentations of some large company leaders. One of them eloquently expounded on the method of manufacturing a car with less money and less manual labor. They do not contemplate the possibility which we pursue; they only seek efficiency, using any manner to accomplish the work. What puzzled me most was that a prominent leader of an industry in a socialist country had the same opinion. In other words, socialist countries also have the same concern and are looking for the most efficient production system which requires the least manual labor. This made me realize that a great resistance exists in recognizing the fact that certain conventional and transitory production methods must be combined with advanced technological methods, especially when the manufacture of products for export is concerned.

Unemployment and redundancy in the farms and in the cities are two of the most serious problems in Latin America and which concern you, because, it there is no effectual and efficient absorption of the work force that agriculture displaces, if there is no absorption in agro-industries and in rural financing works, we will be creating a serious social problem to add to others that Latin America is now experiencing because this is not a transitory problem.

By observing the problem of slow or faulty absorption of labor which is displaced in agriculture, we see that the growth and development process in Latin America is following paths that are different from those followed by the large industrial countries during their historical development. In their case middle classes grew steadily, gradually absorbing the lower classes as a minimum section of the population. That is, today's middle classes are the lower classes of yesterday and so on. But this slow development process is not occurring in Latin America.

There are powers created by emulative technology and development that are inclined to intensive development in the higher and middle levels, detrimentally affecting the lower levels where the low income agricultural population of Latin America exists. That is, the problem's solution requires, fundamentally and inevitably, a large process of capital accumulation, increased training of the masses with a great social awareness and accelerated development, but for every one. To speak of high development rates in Latin America which include only a portion of the population, is to falsify the vision of the

development process, with serious social and political consequences resulting when distorting the reality of the facts. The ideal would be achieving progress at all levels and not only for the privileged classes. When all sectors of the population manage to participate in a nation's integral progress, then we can feel satisfied with a job well-done.

# Population growth and standards of living in Latin America

**Benjamín Viel**

Executive Director, Western Hemisphere Region, International Planned Parenthood Federation.

Latin America is often considered a continent formed by relatively small countries united by Spanish tradition, with a common Roman Catholic religion, and with only two languages, Spanish and Portuguese, whose common roots facilitate ideological exchange. Nothing is farther from reality. Latin America was formerly and is still a true mosaic of nations, with characteristics as varied as those found between Albania and Sweden, in Europe.

**The pre-Columbian period.** If one accepts that Americans populated the continent by means of successive migration through the Bering Strait, one should also bear in mind that the developmental level of these migrations differed, despite their similar characteristics.

Two pre-Colombian zones attained high levels of development: what today is Mexico, Guatemala and Honduras, and the vast Inca Empire which extended from Ecuador to Central Chile. Doubtlessly, groups with an intermediate level of development existed in the area that is now Colombia, but the remainder maintained levels of primitivism and still lived in the era where man hunted food rather than produced it.

It is interesting to note that, despite the high developmental levels attained in mathematics, astronomy, architecture, sculpture and other arts and sciences, neither of the two cultural groups previously mentioned developed the wheel although they used round logs to move heavy stones. The absence of the wheel and the lack of beasts of burden, with the exception of the llama in the highlands of the Inca

Empire, resulted in man as the only source of power. Labor was required, both in the highly developed areas and in the primitive villages which subsisted on hunting, not only to obtain food but also as a means of transportation to facilitate commerce.

Efforts have been made to estimate the population at the close of the pre-Columbian period. It is relatively easy to estimate the population of primitive peoples in the non-developed areas where men hunted for survival; by calculating the area capable of supporting a man, one can determine the approximate population. It is more difficult to estimate the population of the developed, highly urbanized areas where the existence of roads indicated trade among large groups.

In the fascinating field of historical demography, the book **Essays in the History of Population** by Sherburn Friend Cook and Woodrow Borah, concludes that prior to the arrival of Hernan Cortéz, 25 million people inhabited the area which is now Mexico. It is difficult to comprehend that the entire continent, from the present northern Mexican border to the Cabo de Hornos, was then occupied by less than 50 million inhabitants.

**The Conquest.** The previously mentioned authors, after stating their reasons for estimating México's population at 25 million in 1518, report that in 1600 the native population decreased to one million. Within only 82 years, the native population suffered a more intense depopulation than that of Europe's during the "black plague".

Explanations of abuse have been given for this demographic catastrophe such as the conquerors' cruel teatment of the conquered; Montezuma's feet burned with coals, Tupac-Amaru's body tortured to bits, Galvarino's death after the dismemberment of his arms, etc. It is generalized that cruelty was inflicted on the entire population rather than only on the leaders. Accepting the existence of cruelty, cannot, in itself, explain depopulation.

The high mortality which resulted in the death of the majority of the native population may be more logically attributed to the diseases introduced by the Spaniards. These diseases, beneign to the Spaniards because of their own natural inmunity, however decimated the natives. A similar phenomenon was observed several centuries later when Captain Cook introduced measles to Polynesia.

Paradoxically, potatoes, which America imported to Europe, facilitated population expansion there, while the diseases the Spaniards introduced to America decimated its native population.

This phenomenon, well-known in Mexico, was undoubtedly widespread throughout the continent. Unlike the Anglo-Saxons who settled on the North American Atlantic Coast without moving to the interior for many years, the Spaniards and Portuguese traveled through

the whole continent during the first hundred years following Columbus' discovery. Today, without aircraft, it is difficult to travel from Guayaquil to the mouth of the Amazon River in the Atlantic Ocean; Orellana made this journey at the beginning of the Conquest.

This expansionist rush of the Spanish conquerors must have disseminated diseases throughout the continent which desolated Mexico and resulted in similar catastrophes in other areas. In a study on the Island of Jamaica, the forementioned authors reach the same conclusions. There is evidence that a similar phenomenon occurred in Chile. In Francisco A. Encina's **History of Chile** he relates that the Spaniards who attempted to colonize the area which today is the city of Concepcion, were defeated by the Indian chief, Lautaro. Following this victory, Lautaro became the "owner" of almost the entire country and moved to Santiago where 130 Spaniards resided. Possibly because of the diseases that decimated his army, Lautaro returned to the South losing his victory. When the Spaniards reconquered the area they had lost, farms formerly inhabited by thousands of Indians were occupied by less than one hundred.

Although no reliable statistics exist, it may be stated that the first 100 years of Conquest brought devastating epidemics that resulted in the death of nearly the entire native population and whose tragic effects were strongly experienced in the urban areas because of the ease of contagion.

The conqueror, first a soldier, and later a bureaucrat or an artisan but rarely a farmer, became the owner of a vast continent whose population was disappearing. Lacking the laborers to develop the land he had conquered, he was forced to induce migration from Africa (slave trade) and to make maximum use of the fertility of the Spanish the African or the native women. Human propagation was stimulated in the same manner that livestock reproduction is brought about today.

**Independence.** The war of independence did not signify a major change in the Spaniard's pro-birth policy. A fruitful or creative peace did not succeed their defeat. As a tragic sequel of the war, armies were formed that divided the continent into sections and that frequently destroyed the countries through civil wars, guerrilla warfare and revolutions. The demand for soldiers was added to the demand for laborers for production purposes, and the woman was still considered as a reproductive machine.

Despite the strong pro-birth policy and the migrations to the continent, the total population at the beginning of this century is calculated at slightly more than 60 million and in 1920, with better statistics, at only 87 million, not even double the total estimated population at the time of Columbus' arrival.

The 87 million people estimated in 1920 cannot be attributed to a progressive increase of births over deaths during a calendar year.

This number includes massive migration from Europe at the close of the last and the beginning of the present century, primarily to Argentina and Uruguay, which were already politically stable and which offered favorable working conditions.

Why did Latin America have such a low population in 1920 with a birth rate of 50 per every thousand, which is the maximum rate of human fertility? Simply because there was a high birth rate but also a considerable number of deaths before reproductive age. At the beginning of the century, with the exception of the social classes with high standards of living and of Argentina and Uruguay which quickly achieved the European living standards, on the average, of every ten births, four deaths occurred before one year of age, three deaths before five years and only two survived until working age.

The average vegetative growth of the Latin American population most likely did not exceed 0.5 percent in the second half of the 19th century. The improved living standards of the southern countries in addition to the migration previously mentioned, probably increased the growth average to 1 percent per year during the first 30 years of this century.

If a population specialist had attempted to predict the future population of Latin America in 1920 based on the annual growth rate of 87 million at that time, he would have concluded that by maintaining this rate, the population would reach 174 million by 1990 and 194 million by the year 2000.

Beginning in 1930, all of the Latin American countries show a progressive decrease in mortality rates. This phenomenon was a result of many factors such as improved health practices, better income distribution, ameliorated medical services through the establishment of social security and, since 1950, the progress made in controlling malaria (DDT) and in the treatment of contagious diseases (sulfa drugs and antibiotics).

In 1970, in a brief 40-year period, Latin America's mortality rates decreased to the European levels. Europe registered a similar decline in a 150 to 200-year period. Unlike the European continent, birth rates did not decrease in Latin America. High birth and low mortality rates resulted in a population explosion in Latin America almost simultaneous to or a few years after the Industrial Revolution.

In the search for reliable and useful statistics which illustrate this phenomenon, the following graph shows birth and death rates per every thousand inhabitants in Santiago, Chile, between 1920 and 1964. Usually, urban statistics are more valid than overall national statistics. The graph depicts a situation that is not restricted to Santiago. The entire continent appears to have the same characteristics, with the exception of Argentina and Uruguay, where the migration from Europe was responsible for a birth decrease really parallel to the mortality decrease.

Decreasing mortality rates that began in Santiago in 1937, had repercussions when approximately 15 years later birth rates increased considerably, a true "Baby Boom" as the North Americans called the augmented number of births in the United States after World War II which they attributed to the return of the troops that were anxious to recover lost time. In our continent, where a war has never taken place and there is no need to regain lost time, higher birth rates are the logical consequence of decreasing mortality rates and, as expected, this occurs exactly 15 years later. If mortality decreases, half of the lives conserved are females and as a large number of them reach reproductive age, a massive increase in the number of births results. If mortality is considered high in our continent and therefore susceptible to a major descent, birth rates might increase even more, raising the already high percentage of annual increase.

The increase in the annual percentage of population growth gives Latin American, which in 1920 had an increase of only 1 percent, an annual average growth of 2.9 percent in 1960. If the same population specialist who, in 1920, forecast a population of 194 million by the year 2000 would have recalculated his work in 1960, he would have found that his previous estimate of 212 million people would be changed to 636 million for the year 2000. Four-hundred-and-forty-two million more than the figure predicted in 1920.

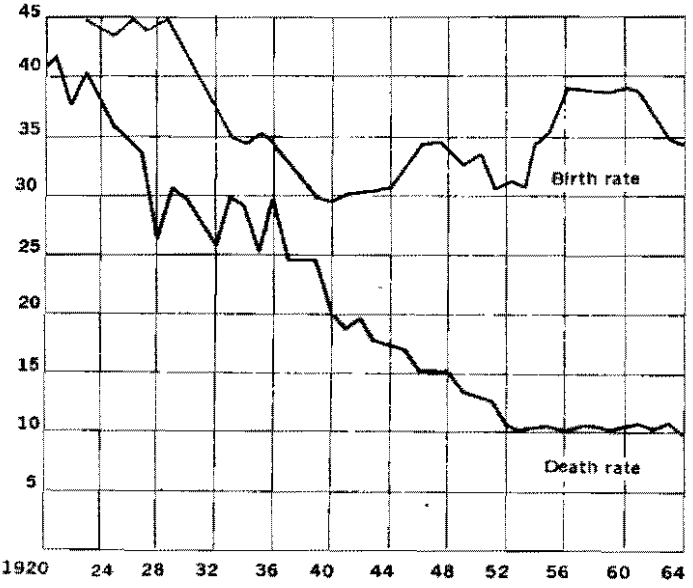



Figure 1. Birth rate and death rate per 1,000 inhabitants of Santiago, Chile, 1920-1964.

The human mind is not accustomed to seeing the real dimension of the problem in terms of percentages. A growth rate of 2.9 percent does not seem to be excessive for those who are not familiar with this type of information. The problem would be easier to visualize if we hypothesized that in 1969 a new country of 7.9 million people, the size of Guatemala and El Salvador, were added to the Latin American continent, not with their actual production but as countries with one year's existence in an incipient stage which is equivalent to incurring expenses for a period of 18 years for each new generation.

In the history of mankind an increase of 2.9 percent per year is a unique phenomenon which has not been previously observed and which is at present restricted only to our continent. During the peak of the European population explosion, statistics did not exceed 1.3 percent. Europe's neighbors across the oceans — America and Australia — needed laborers and their birth rate began to decline almost parallel to the decrease in mortality. Africa, Asia, and Latin America are victims of population explosion, however this phenomenon has occurred less intensely in the two former because they have not experienced the marked mortality decrease of Latin America or the family planning in countries such as Korea.

Today, China has a population of 800 million and an annual growth appoximating 0.5 percent. At this rate, its population could reach 1,600 million by the year 2100. In the same year, Latin America, at its current rate, will attain a population of 10 billion people. This estimate, which we hope never becomes a reality, gives us an idea of the danger we are now facing.

It is not a case of discussing whether this phenomenon affects the standards of living, because I do not think this can be analyzed. Some topics already being clarifield, even by those not accustomed to observing their own environment, should be emphasized as the reason for fearing the future.

Man has been conditioned to think in terms of cause and effect— one cause, one effect. A force of a determined magnitude applied in a specific direction to a mass would be capable of causing the displacement of the mass in the direction of the force.

The vagueness of the term "standard of living" which for some means only material possessions while for others holds a spiritual connotation, helps us to think of the effect of population expansion in a more modernized fashion, not only as one cause and one effect but as one cause and a system of effects which when linked to each other will change man's relationship to his environment.

At the beginning of population expansion, the producer was pleased to see an increase in the number of potential consumers. Today, he realizes with deep concern, that advertising his product has created a need for it but not everyone can afford it. Logically, he fears that those who need it might take it by force.

The farmers challenged by a greater demand for food, mechanized agriculture in order to increase production. Each new tractor resulted in an additional unemployed laborer who subsequently migrated to the city giving origin to the shanty town, which did not have potable water, sewage or street paving systems or housing fit for human living. In the Stone Age, contagion was limited because of low population densities, whereas in the present return to cave life conditions, the outbreak of new diseases is being gestated which will cause a decrease in population through increased mortality rates.

The governments that considered large populations a factor of progress and increased political power, are aware of the increased number of unemployed and underemployed which carry the seed of socal revolution that will eventually destroy them. No economy can create new work sources with an annual rate of 3 percent; therefore, unemployment will become an increasing phenomenon.

The demand for minimum housing is an obligation that no government eludes. Housing units are constructed but in order to maximize their number they must be small. Even these small houses cannot be built at an annual rate of 3 percent and therefore the proportion of the homeless progressively increases. Those who obtain them, see them deteriorate rapidly because a house that is suitable for three persons becomes dirty and crowded for eight.

The medical doctor deals continously with the health problems of a woman who has borne many children, with high infant mortality which is common in those mothers who have had four or more deliveries, and with child malnutrition and its irreparable consequences. He has also seen the serious syndrome resulting from the lack of affection during childhood and observes the epidemics of illegal abortion and child killing. When confronted with all this, he begins to doubt that his contribution to decreasing mortality has been as beneficial as he had hoped 30 years earlier.

There is increasing anguish among today's youth. First, they do not have the necessary educational opportunities and illiteracy increases or remains constant. At 18 years of age, they do not know if they will be able to find work and there is an increased percentage of unemployed and underemployed.

For the unemployed, the excessive number of dependents becomes a heavy burden. Percentage-wise, the working population is small and each working person has additional dependents to feed. V. Urquidi points out that, at present, Latin America's working population can be estimated at 30 percent with each worker having two dependents. In the industrialized countries of Western Europe, the working population reaches 50 percent and each worker has one dependent. The longer a high birth rate is maintained, the greater the index of dependency in our countries.

If neither the young nor the experienced workers have hopes, they will suffer from discouragement which will destroy their spiritual life. Some will escape through alcohol or drugs, or through violence, others will become introverted and will hide in their own insecurity and, overall, they will depict a sick society where every factor that contributes to the standard of living suffers from progressive deterioration.

It may be stated that the apocalyptical vision described above is exaggerated and only occurs in marginate populations. This criticism may be partially true but what I am trying to emphasize is that a marginate population tends to increase and that efforts to decrease it will never succeed if a high birth rate is maintained.

Europe has doubled its population three times in the last 200 years and, therefore, it may be argued that Latin America should be experiencing the phenomenon that is occurring today. The basic problem lies in the analysis of what has taken place in Europe during the last 200 years and in Latin America during the past 40 years.

Mortality has been decreasing in Europe for 200 years, followed closely by a decline in births. As expressed by the theory of population transition, the equilibrium between man and his environment has changed from a period of high birth and mortality rates, with minimum population growth, to a period of low birth and mortality rates also with a minimum increase in population. Europe achieved this transition through an expansion period during which the continent prospered from economic growth brought about by the Industrial Revolution and of two nearly unpopulated continents which invited migration. The progressive decrease in the number of deaths between 1780 and 1940 is a phenomenon which should be interpreted carefully. Undoubtedly, such a decline was not a result of medical success because scientific medicine did not exist during this period. It was the result of the conquest of the environment through increased understanding of its relation to man, environmental improvement, improved housing to diminish crowded living conditions and, consequently contagion, better equilibrum between working and non-working hours, ameliorated use of free time and, most important, improved nutrition caused partially by increased crop yields and largely by greater food imports to Europe from other areas of the world because of the expansion of world trade. Beginning in 1940, the discovery of antibiotics created great impact in the field of contagious diseases and the existing mortality rate became even lower.

Between 1780 and 1940, Latin America showed high, fluctuating birth and mortality rates like those of Europe in the 16th Century. Latin America lacks the economic resources for man to conquer his environment even in the cities; environmental improvement is still deficient, and infection is the principal reason for death. In an unconquered environment, mortality begins to decrease, not because of environmental improvement, better nutrition or improved health con-

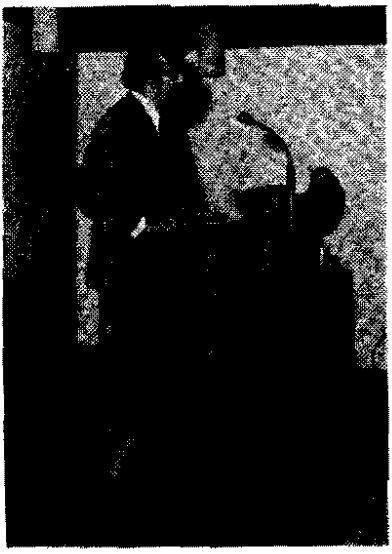
ditions but mainly as a result of artificial elements, antibiotics and insecticides, which control infection without modifying the environment. The success is spectacular and in 30 years a 1 percent annual increase changes to approximately 3 percent per year. Countries that would have doubled their population in 70 years, duplicate it in only 23 years today.

With this present situation, the Latin American nations still maintain a pro-birth policy and envision industrialization as the solution that will solve the consequences of the population explosion affecting the continent. Their production increases but the magnitude of the marginal population advances even more rapidly. More schools and houses exist than did 30 years ago but there are more illiterate and homeless. Agriculture is becoming more mechanized and production is utilized more for exportation rather than for internal consumption. A smaller number of men work in agriculture but only a limited number of those who migrate to the city find work. The unemployed and underemployed population is increasing.

In an unconquered environment, malnourished children are constantly susceptible to infections; they do not die because of antibiotics but the number of diseases does not diminish. Infection will be a constant threat unless the ecological equilibrium is not basically changed to protect human beings.

Progress does not only mean an increase in production rates, but also the improvement of living standard. Such an improvement could be stated in statistical terms by measuring the annual percentage of farmers and proletarians that attain middle class standards of living. If the percentage is larger than the overall population increase, progress results. If the percentage is lower, deterioration will be the consequence.

In Latin America, the percentage of those attaining a higher standard of living is less than the population increase. With this situation, the governments still maintain their pro-birth policy and believe that the solution lies in economic expansion. Perhaps if they thought more in terms of their people's fulfillment rather than the cold statistics of exportable production, they would listen to the requests of women who would prefer having small families and consequently men could relax and children would be able to smile.



# Institutional innovation for the development of the lowland tropics of Latin America[1]

**Armando Samper**[2]

Sub-director General, Regional Representative for Latin America, United Nations Food and Agricultural Organization (FAO), Santiago, Chile.

When the organizers of this symposium on "The potential of the lowland tropics" of Latin American invited me to discuss the subject "Institutional innovation and cooperation: international, regional and national," I accepted the assignment with fear and doubt.

On one hand, the invitation was an honor which I could not decline because it was part of the program for the official inauguration of the excellent facilities of the Centro International de Agricultura Tropical, in Colombia, my native country. Also, I have maintained close contacts with CIAT since its inception. On the other hand, I was asked to speak about a relatively new subject which cannot be expressed in simple ideas or given easy solutions because there is nothing more complex than man, and therefore, than the society in which he lives and the institutions he creates.

The challenge accepted with this assignment is partially explained by the interest I have always had in institutional development. Looking back at my professional life as an agronomist — which often has led me to act as an economist, communicator, educator and exec-

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1. The author would like to thank Dr. Francis C. Byrnes, Leader, Training and Communications, CIAT, for his efficient cooperation, for his contribution of ideas and publications related to this subject and for the revision of the text.

2. During the Dedication ceremonies CIAT Board met, at special meeting, at which it elected Ing. Samper as its chairman, for a therre-year period

utive — I see it has had a common denominator: institutional architecture. Actually, I have dedicated my professional life to establishing the groundwork for, as well as realigning and managing, institutions. Twenty-five years ago, I contributed to the development of communication in Latin America — then an institutional innovation — through the Service for Scientific Exchange of the Instituto Interamericano de Ciencias Agrícolas (IICA). Later, I was the leader of a team which directed the realignment of IICA to give it a new dimension in continental approach, establishing a network of national institutions dedicated to agricultural research, advanced education and rural development. Back in Colombia, I collaborated with President Carlos Lleras Restrepo in reorganizing the agricultural and livestock sector.

Now in FAO, my efforts are dedicated to giving the Regional Office for Latin America a new orientation towards accomplishing its own task within the great worldwide effort to promote agricultural development and improve nutrition.

I have had close links with CIAT since its inception and also have been a member of the Board of Trustees of the International Institute for Tropical Agriculture in Nigeria. These activities have given me the opportunity to participate in the development of a new concept in institutional innovation and coordination represented by the network of international agricultural research centers.

First, I would like to refer to those institutions that link innovation and change: institutional innovation at the national, regional and international levels; the anatomy and physiology of the institutions and institutional innovation as a regulated change.

**Institutions which serve as a link between innovation and change**

With words being only concrete symbols to express abstract ideas, we must, first, clarify the concept of institution. For the administration specialist, the concept of institution differs somewhat from the sociologist's and from other specialist's. The family, the State and property are institutions; a youth movement, a library or a charitable organization are also institutions; as likewise are an asylum, a university, or a ministry. In my opinion, the first group are intitutions in a sociological sense, that is, they regulate individual behavior; the second, service institutions; and the third, organizations.

Fairchild[3] refers to "configuration of a lasting, complex, integrated and organized behavior through which social control is exercised and the basic social needs and wishes are satisfied." The regulating institutions "emphasize the compulsory standards and serve as a model or a social vehicle for human behavior in ordinary relationships such as in the family, the State or property."

3. Fairchild, H. P. Diccionario de Sociología. México. Fondo de Cultura Económica. 1963

Here, we are basically interested in those institutions that Fairchild defines as "organizations which are public or semi-public in nature," that is, an organization that has "an executive body and, normally, a building or physical facilities in some form, with the aim of serving a socially recognized or authorized cause."

Our interest in these institutions falls within the framework of a wide social context, that is, as regulators of individual human behavior. We are also interested in them as variables which respond to the dynamics of economic development, as indicated by Theodore W. Schultz[4]. And we are interested in them as organizations embodying an ideal, because, as Sir Eric Ashby[5] has eloquently stated, "in order to survive, an institution must fulfill two conditions: it must be sufficiently stable to sustain the ideal which gave it life and sufficiently responsive to remain relevant to the society which supports it."

Development is a complex process. It covers technical (natural, biological, physical, etc.), economic, social, cultural, institutional and political aspects. It begins with man's utilization of natural resources with the objective of attaining well-being for mankind. To obtain this goal, other entities such as technological innovations derived from research, physical capital investments for construction purposes, capable human resources and dynamic institutions, are required. The institutions are a link between innovation and change, between new technology and its utilization by man.

Myrdal[6] correctly affirms, that development is not the mechanical process of adding capital, human skill, technological knowledge and workmanship but is a process of institutional change, of change in behavioral patterns and attitudes and in other intangible elements. He indicates that only in this manner we will be able to break the circle of poverty. A low work productivity brings low salaries; if salaries are low, incomes are low; if incomes are low, savings are low; if savings are low, investments are low; if investments are low, productivity is low. This completes the cycle.

Apparently, man's development of productivity requires investments to finance research, to train researchers to develop technological innovation, to commercially produce new technology, and to carry this technology to the farmer for application. Regardless, research centers are among the basic institutions necessary to break the circle of poverty by improving man's productivity per unit of cultivated land and of capital investment.

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4. Schultz, T. W. "Institutions and the rising economic value of man." American Journal of Agricultural Economics 50 (5) 1113 - 22, December, 1968.

5. Ashby, Sir Eric. Universities: British, Indian and African. Cambridge, Harvard University Press, 1967.

6. Myrdal, Gunnar. "Asian drama." Pantheon Press, New York, 1968.

Byrnes[7], however, has pointed out that institutions form part of a total system and can only reach their goals if one recognizes:

> While research results may dramatically demonstrate how yields can be increased through new varieties and improved management, these findings do not remove the serious human, economic and social obstacles to establishing these new varieties and practices in the farming areas of the various countries. Regardless of the extent to which it engages in the solutions to these other problems, the institute or center staff must see itself as a new entity in a total system — a system which must be modified or improved in many ways before permanent, effective changes are possible.

He adds that the major components of such systems almost invaribly involve new technology, improved training of personnel, innovations in, and realignment of organization and bureaucracy, and effective participation of the governmental and private sectors responsible for infrastructures, credit, markets and necessary technical inputs.

F. F. Hill[8] warns of the frustrations resulting from institutional development efforts limited to one or a few institutions. He states that in order to sustain increased production, developing countries must depend on institutions that allow the farmer to adopt new practices and on incentives that lead to that adoption. Among these institutions he mentions those dedicated to education and training; agricultural research and experimentation; input supply, credit, storage, transportation and marketing; and those providing incentives to production and extension institutions.

Blase[9] and others analyze the role of ten types of institutions in agricultural development: land tenure, production factors, marketing, planning, education, research, extension, credit, rural government and legal systems.

In other words, agricultural research institutions are essential for the promotion of development, but their work alone is not sufficient. Their impact on production requires the combined effort of

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7. Byrnes, Francis C. "Toward an analysis of the dynamics of an international institute or center for research and development in agriculture" Manila Philippines. International Rice Research Institute, May, 1967.

8. Hill, F. F. "Developing agricultural institutions in underdeveloped countries". Agricultural Sciences for the Developing Nations. Albert H Moseman, Ed. Publication 76, AAAS, Washington, 1964.

9. Blase, Melvin G. ed. "Institutions in agricultural development." Ames, Iowa. The Iowa State University Press, 1971. 247 p.

other entities such as land tenure, research, education, credit and marketing institutions.[10]

The demands of development and of technological innovation have put traditional institutions on trial. When formally established organizations are unable to solve development problems, governments frequently launch "crash" programs to cope with persistent problems which require institutional innovation. Fortunately, during the last few years, important efforts have subsisted in Latin America in institutional innovation at the national, regional and international levels. Let us look at some examples:

**Institutional innovation at the national level**

Everyone knows that today, man is both the subject and the objective of development and that above all change means human development. Little attention, however, has been given to institutional development, as a basic component of development.

Important efforts have been made at the national level. Blase affirms that part of the economic aid provided by developed countries has been given through technical assistance. A large portion of the international technical assistance has been used in institutional development projects. However, the part dedicated to institutional development has been limited in proportion to the total assistance provided. Blase reports, among the productive efforts made to develop institutions which can efficiently promote agriculture in developing countries, several research institutions have recently become prominent because of the impact created by new crop varieties; also several universities have been established or improved and credit and extension institutions have been reinforced.

Several foreign entities have contributed to the development of national institutions through bilateral programs; among them, the Government of the United States through its foreign aid agencies and through contracts with universities; the governments of other countries, especially European; several regional organizations such as the General Secretariat of the OAS, the Instituto Interamericano de Ciencias Agrícolas and the Interamerican Development Bank; international organizations such as the FAO, the United Nations Development Program and the International Bank for Development and Reconstruction, and philanthropic private foundations such as Ford, Kellogg and Rockefeller.

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10. Samper, Armando. "El desarrollo agrícola de América Latina en la próxima década." Desarrollo institucional y desarrollo agrícola. San José, Costa Rica. Instituto Interamericano de Ciencias Agrícolas de la OEA. 1969. Vol. 1, pp. 101 - 114.

My intention is not to analyze these sources, which differ in nature and character or to study their comparative impact on national institutions. I only wish to point out that they have contributed, in different degrees, to institutional innovation at the national level. For example, they have helped to functionally relate research, education and extension, under varying institutional conditions, to developed countries as in the case of the Center in Chapingo, México, the Instituto Nacional de Tecnología Agropecuaria (INTA), in Argentina, and the Instituto Colombiano Agropecuario (ICA); to link extension to technical assistance and credit, for instance, in the Asociacion Brasileña de Crédito y Asistencia Rural (ABCAR); and to convert the university into a dynamic development center as in the situation of the Universidad Agraria in Peru. Recently, the Brazilian Government created the Empresa Brasileña de Investigaciones Agropecuarias (EMBRAPA), a new type of institution to promote agricultural research, with an innovating institutional character.

**Institutional innovation at the regional level**

The Instituto Interamericano de Ciencias Agrícolas (IICA) is a good example of institutional innovation at the regional level. This organization has always recognized the importance of institutions. Its second director, Ralph H. Allee, stated that there are no underdeveloped countries, but rather countries with underdeveloped institutions.

I mentioned previously that the development of research institutions (to create technological innovations), of advanced education institutions (to disseminate these innovations) and of rural development institutions (to apply the innovations) was the main purpose of the so-called New Dimension built in IICA. We believed that IICA should be a catalyst, an innovating, promoting and multiplying agent to set program priorities according to these criteria. We established regional cooperative networks with agricultural education, research and rural development (primarily agrarian reform) institutions. We channeled our institutional development efforts through these networks so that the national institutions themselves, grouped in this way, could diagnose their institutional weaknesses, establish priorities and manage self-help programs.

> Formerly, I summarized IICA's philosophy of action as follows11. We have been pioneers in promoting Latin America's institutional development as an efficient means of accelerating agricultural development. We have successfully carried out a campaign to demonstrate that agricultural research is fundamental to the discovery and introduction of technological innovations which are essential to the improved productivity of land, capital and the individual himself; that the bottleneck to Latin America's agricultural development is the lack of qualified professional personnel; that, therefore, education should have priority in development programs; and that it is only

through helping the member states improve their own institutions that permanent and effective contributions can be made for the acceleration of agricultural development, a pillar of economic development whose final objective is the improvement of the individual himself.[11]

"Training" national institutions to enable them to carry the burden of development efforts continues to be one of IICA's basic approaches within the humanistic and hemispheric projection given to the institution by its present director, José Emilio Araújo. What was formerly a pioneering approach is now a systematic, professionally organized effort.

**Institutional innovation at the international level**

The major innovation, however, has occurred at the international level. A step forward was taken with the establishment, by initiative of the Ford and Rockefeller Foundations, of the International Rice Research Institute, in the Philippines, of the Centro Internacional de Mejoramiento de Maíz y Trigo, in Mexico and of tropical agricultural centers in Nigeria and Colombia.

The results obtained with new varieties and cultural practices, which eliminated yield problems and started the "green revolution," were dramatic. Through these efforts, investments made in new institutions where one crop was stressed, had high returns in all aspects; a highly qualified research team was formed which had access to the most advanced systems, methods, processes and instruments of research; an applied training and communication program was organized and a direct diffusion network was established through institutions in interested countries.

This institutional experience is well documented. Examples can be given, particularly in relation to the training and communication and research coordination programs in various countries by citing excerpts of the work accomplished by two scientists who were formerly with the International Rice Research Institute and who later became CIAT staff members: A. Colin McClung and Francis C. Byrnes. [12]

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11. Samper, Armando. "La nueva dimensión - Séptimo Mensaje". Desarrollo Institucional y Desarrollo Agrícola. San José, Costa Rica, IICA, 1969. Vol 3, pp. 502-532.

12. Byrnes F. C. "The IRRI trainee returns home" Los Baños Philippines. 1964, memorandum report. Where does change begin? IRRI seminar paper, 1967. Insumos necesarios y estrategias en programas nacionales de arroz. In Políticas Arroceras en América Latina, Cali, Colombia, CIAT. 1972.
McClung, A. C. Organizational and institutional opportunities of food legume programs in South America, Cali, CIAT, 1973, seminar paper. This paper describes the establishment and functions of the coordinated rice research program in interested countries.

The situation is somewhat different in the case of tropical agriculture institutes. Although research has been concentrated on a few priority crop and animal sectors, these institutes have the difficult task of incorporating results into agricultural systems, appropriate for various types of enterprises, in different tropical regions.

**The anatomy and physiology of institutions**

The medical student should have a thorough knowledge of human anatomy and physiology in order to learn to treat and cure man. The same holds true for institutions. We cannot expect to accomplish innovations in an institution if we are not familiar with its own organization (anatomy) and functions (physiology). The same principle applies to those national and international institutions which will cooperate in achieving desired changes.

However, I will not make a systematic analysis of those aspects. I will consider only a few points through illustration.

I have always believed — as man and civilization — institutions are living organizations that are born, grow, multiply, become old and die. [13] José Marull has made a thorough biological analysis of institutions. [14] As man, institutions are a product of the environment and they change with time. The Marxists, for example, affirm that in the capitalist countries, the institutions serve the "elite" that control the means of production; they are a product of the system and are used to maintain it.

Despite the differences among institutions, several common factors must be analyzed to determine their ability for innovation; first, their objectives; second, the potential for action, that is, their ability to exert leadership, the capability of their personnel, their organization and internal communication; and, third, their external projection. [15]

Irineu Cabral [16] lists ten requirements for an efficient organization: 1) a governing body which can achieve executive leadership; 2) a programming mechanism; 3) flexible legal regulations; 4) an

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13. Samper, Armando. "Factores institucionales comunes a las organizaciones del sector público agropecuario." In Desarrollo Institucional y Desarrollo Agrícola, San José, Costa Rica, IICA, Vol. 1, pp. 470-488.

14. Marull, José. "Desarrollo de las instituciones de educación e investigación agrícola en América Latina. In Instituto Interamericano de Ciencias Agrícolas Consejo Técnico Consultivo. Décimotercera Reunión. Mesa Redonda. April, 1968.

15. Samper, Armando. "Factores institucionales comunes a las organizaciones del sector público agropecuario." op. cit.

16. Cabral, J. I. "Importancia de las instituciones nacionales en el desarrollo agrícola." In Instituto Interamericano de Ciencias Agrícolas. Consejo Técnico Consultivo. Décimotercera Reunión. Mesa Redonda, April, 1968.

adequate organic structure; 5) specific and well-defined objectives; 6) work methods and processes in accordance with the needs of the rural media; 7) a continuous evaluation system; 8) a coordination mechanism; 9) a financial system that can mobilize resources; 10) adequate means of diffusion.

Esman [17] points out that the principal agent of change in an institutional development pattern is **leadership.** That leadership must have a series of professional, executive and political qualifications which allow 1) the definition and diffusion of the **doctrine,** that is, the values, objectives and operational methods of the organization for internal and external purposes; 2) the conversion of the doctrine into **programs** (products) through policies and actions which involve the selection of tactics; 3) the mobilization and development of **resources** (inputs) of personnel, financing, information and physical facilities; 4) combination of personnel and equipment into **structures** of authority, communication and technical conversión which permit the organization's programmed activities and reactions conditioned to the environment.

Byrnes [18] has concretely analyzed the dynamics of international institutions. Among the operational factors affecting an international institute's efficiency, he lists: 1) how institutional objectives are expressed; 2) physical design and layout of the center; 3) organizational structure; 4) staffing pattern; 5) orientation of the staff; 6) priority of operations; 7) flexibility of budget; and 8) basis of evaluation.

He points out the importance of how the institute or staff members establish the objectives, mission or goals. The establishment of an organization to study a crop or animal species differs considerably from the incorporation of those materials into programs aimed at improving production and productivity in several countries, at the international level.

Byrnes also emphasizes the importance of having competent personnel in their respective research fields who can also understand and perfom other duties. While performing research these scientists may supervise the research of others, work on cooperative projects in different countries, serve as thesis advisors, teach courses, participate in training programs, act as consultants and work in many additional ways such as in briefing professional visitors. The exec-

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17. Esman, Milton J. "Some issues in institutions building theory." **In** Institution building: a model for applied social change. Cambridge, Massachusetts, Schenkman Publishing Company, 1972. pp. 65-90.

18. Byrnes F. C. "Toward an analysis of the dynamics of an international institute or center for research and development in agriculture." International Rice Research Institute. Working draft, 1967.

utive body must be conscious of this need and should have a permanent program to help researchers perform their various duties.

**Institutional innovation as a regulated change**

I realize that instead of expressing institutional innovation as a simple concept, I have shown its complexity. I had no alternative. Agricultural development is complex and there are many institutions striving for the same goal. It is difficult to adapt institutions to development programs.

However, social innovation is complex in itself. As indicated by Drucker [19], "unlike reform, it (social innovation) does not aim at remedying a defect; it aims at creating something new. Unlike revolution, it does not aim at subverting values, beliefs and institutions; it aims at using traditional values, beliefs and habits for new achievements, or to attain old goals in improved ways that will change habits and beliefs. But it also aims to accomplish something neither reform nor revolution can do: to give us not only a method for defining the new that is possible or necessary but also means to achieve it."

History reveals many instances in which creative individuals devised new ways to link humans and resources in order to solve problems or to realize opportunities. At present, we have instruments such as operational research, systems analysis and management processes as well as examples of new governmental and private organization — in themselves a social innovation — which have demonstrated that multidisciplinary efforts can consciously and deliberately be integrated to attain development and social change. The acceptance of regulated change as a directed human activity, with defined purposes, is in itself, a social innovation.

Unfortunately, as indicated by Whyte [20], we are inclined to operate with a limited number of institutional organization patterns. Advances have been made in the study of the development process in relation to the behavioral changes of the individual with respect to himself, to the farm or to the community but we are just beginning to study the interaction among institutions.[21]

International agricultural research centers represent one of these patterns. It would be impossible here to analyze the advantages and disadvantages or the achievements and limitations of the "green revolution," that was brought about by these institutions and on which extensive literature exists.

19. Drucker, Peter F. "Landmarks of tomorrow." New York, Harper and Row, 1969.

20. Whyte, W. F. "Models for building and changing organizations." Human Organization 26 (1-2), 1967.

21. Byrnes, F. C. "Where does change begin?" **op. cit.**

I mentioned previously some of the advantages of institutional innovation. Lazaro [22] describes some of its limitations derived from technological transfer and application based on products. He emphasizes the convenience of research institutes acting as "technology factories" aimed at delivering production processes rather than products, with the objective of serving local research institutions without replacing them.

Byrnes [23] has proposed a "communication approach" to the development, administration and execution of international research, education and extension programs. That is, it should be recognized that the purpose of administration, training and dissemination of information is to influence human behavior; hence, the important key of communication in institutional innovation.

"We must realize", —states Dr. Byrnes,— "that simply achieving a technical goal is not the ultimate objective of international development; but rather, we need to institutionalize methods and organizations to accomplish the objectives in these countries in the future, without our physical presence or our aid, whether it be material, economic or technological. We are developing people and, at the same time, helping them build institutions."

By including the topic of institutional innovation in this program the organizers of the symposium have shown that today's needs are both an opportunity and a challenge for the present patterns of institutional organization. For example, if we have qualified, motivated professional personnel — which are the basis of success in any organization — they must have institutions that facilitate and stimulate their work. The network of international agricultural research centers established in the last decade offers new working relations and greater opportunities for regional and international cooperation with national programs.

We have achieved a considerable amount but still have much to accomplish especially in those centers aimed at promoting agricultural development in the lowland tropics of Latin America. I wonder if we have the innovational ability to achieve the necessary innovation in national institutions.

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22. Lázaro, Constancio. "En qué medidas son necesarios los institutos de investigación". Santiago, FAO, Oficina Regional para América Latina, Documento Informativo de Política, 1973.

23. Byrnes, F. C. "Toward an analysis of the dynamics of an international institute or center for research and development in agriculture." Manila Philippines. International Rice Research Institute, May. 1967.

# Resume

**Lewis M. Roberts**

This symposium on the **Potential of the lowland tropics** has been fruitful. Important ideas and information have been exchanged in both the formal papers and the discussions. I shall limit my closing comments to a relatively few points that were emphasized in the presentations today.

In the future the lowland tropics will continue to be primarily agrarian areas and thus economic growth and social development will greatly depend on increased agricultural productivity.

The technological knowledge which might permit rational utilization of the lowland tropics for food and fiber production remains to be developed. Consequently, our efforts to appraise the true potential of the warm tropics, particularly in Latin America, are largely speculative.

The Latin American lowland tropics comprise a wide variety of ecological zones, each of which will require specific and adaptive research in order to capitalize upon its inherent productive capacity.

The allocation of funds for research and training in much of the tropics constitutes an investment in areas with undefined potential. However, the risk of such an investment is so high that we cannot continue this type of financing unless it is carefully studied prior to its assignation.

Under the pressure of a rapidly growing population, many Latin Americans are moving into lowland tropical areas that previously

were sparsely settled. In the majority of cases, they find life extremely difficult. For man the hot lowland tropics are usually an uncomfortable and unfriendly environment in which to live and to make a living.

First, the farmer in the tropics, with the exception of these who work on extremely specialized crop plantations, has limited access to modern agricultural technology. Even if technological knowledge were available to him, he probably would not have access to credit, to a market where he could buy the improved seeds, fertilizer, etc., required to modernize his production techniques, to a market where he could easily sell his products at a reasonable profit and to health, education and other social services for himself and his family.

A major question, therefore, is: Given the world's present and prospective food and fiber needs, through modern science, can man develop a knowledge of production, marketing and distribution and familiarize himself with the institutions, and techniques whereby a more intensive agricultural utilization of the lowland tropical areas becomes economically feasible? From what we have heard today, the answer to this question seems to be positive for a major portion of Latin America's lowland tropics.

The biological and technical scientists seem rather confident that they can produce the scientific and technical knowledge required to increase production in the tropics. Whether this can be accomplished economically at this time in the various ecological zones should be considered keeping in mind the generation of the knowledge itself. This urgently demands closer collaboration between the biological scientists and the economists.

True development of the warm tropics, reflected through the improvement of the quality of human life in this area, will greatly depend on the concerted actions of many people from a vast number of fields and from a wide range of institutions —national, regional, and international— who are working in close cooperation. These include the political leaders or statesmen who are key figures in influencing the overall development processes of a country as well as a region. They are instrumental in establishing government policies, allocating funds, and setting priorities for goals and development programs. Also included are scientists from all areas of the biological and social sciences, educators, engineers, private entrepreneurs such as merchants, bankers and manufacturers, and others.

The rate of development of Latin American lowland tropics will vary from one ecological zone to another, but generally it appears that this will occur slowly. It will be quite expensive to construct the physical infrastructure of roads, communication and power systems, houses, drainage and irrigation systems which are required to foster the overall development process. To achieve this, will involve a considerable amount of time as well as an enormous capital investment.

Probably the most important and most expensive to construct is the institutional infrastructure. This includes institutions for research and training, for education, for health services and for other closely related areas. In general, the physical and institutional infrastructures are a national responsibility. The task is so large and complex, however, that regional and international collaboration, on a greatly increased scale is urgently needed to resolve the broad array of developmental problems facing the hot tropical areas of Latin America.

It is encouraging that such collaboration has become evident during the past few years which can be observed in various ways. National institutions and programs are growing stronger with much of the impetus coming from the constant improvement of the institutions or agencies responsible for the overall planning strategy and development programs in each country. This point is of vital importance because the development problems of the lowland tropics must be considered in the context of both the overall development of a country and of the surrounding region. Various external sources support the strengthening of national institutions. These include multinational institutions, such as the Organization of American States and its different agencies such as the Instituto Interamericano de Ciencias Agricolas, the Interamerican Development Bank and the International Bank for Reconstruction and Development; the United Nations and its filial entities such as the FAO, and the World Health Organization (WHO); and government assistance agencies and private organizations.

As national institutions and programs grow in strength, cooperation is facilitated on a regional level for the mutual benefit of the countries involved.

But we must ask ourselves whether this process, however encouraging, is advancing as well and as rapidly as is necessary for it to satisfy the actual needs. From what I have heard today, I presume that it is not. It was precisely this same conclusion that led to the creation of CIAT It was felt that an international institute of this type was greatly needed in Latin America, to train Latin American scientists and to provide the mechanism to promote cooperative work on problems particularly common in this area. CIAT's major goal is the training of scientists and the development of technology to serve in building strong national programs and institutions.

I am confident that this symposium has given us a better understanding and appreciation of the lowland tropics, especially in Latin America, as well as ideas on how to develop their potential for the benefit of mankind. I hope it has also impressed upon us the urgent need for closer international collaboration in order to solve the complex problems involved. For these and many other benefits derived from this conference, we are particularly indebted to our distinguished speakers. Thank you Dr. Plaza, Dr. Prebisch, Dr. Alvim, Dr.

Viel and Dr. Samper for your valuable contributions. I would also like to thank all those present for their active participation in the discussions that contributed considerably to this meeting.