

# SOME THOUGHTS ON DEVELOPING AGRICULTURAL TECHNOLOGY FOR THE CARIBBEAN BASIN

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## INTRODUCTION

The subjects referring to food-producing plants, but presently underutilized, and the ecological and socioeconomic factors that affect agricultural production and commercialization, were dealt with by CATIE researchers and scientists on several occasions. For this reason, it pleases us exceedingly that such matters constitute the essential part of an international forum such as this one.

Due to the amplitude of the proposed subject matter and to the diversity of the possible analytical approaches, it was decided to give a general treatment to both subjects, in a way that would serve as a reference framework to other analysts interested in the operationalism and in-depth studies of the concepts and statements.

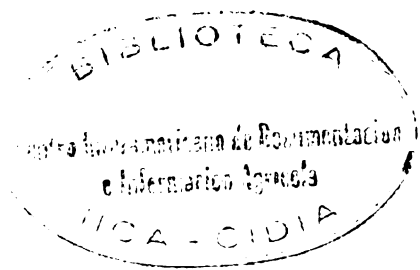
A non-exhaustive bibliographic review of the literature reveals the existence of a wealth of untouched information that has not yet been adequately exploited. Throughout the length and width of Central America and the Caribbean Basin, there is a wealth of knowledge pertaining to plant species of great potential

as a source of food, energy and other supplements. The protein, energy and mineral-producing species offer a wide spectre of utilization, that goes all the way from direct consumption as fresh food to the industrialization and the processing of other forms for exploitation.

The literature also reveals that there is a set of agricultural production techniques and technologies very characteristic of the region and that is deeply rooted in the customs and traditions of society of a bygone era, but tinged with concepts and practices introduced from the developed world.

Without a doubt, the above-mentioned aspects constitute key reference elements for agricultural researchers and decision-makers in the development of the Caribbean Basin.

The Tropical Agricultural Research and Training Center has wanted to participate in this meeting, providing some ideas and concepts, derived from its observations and experiences in the field of agricultural research, particularly in the Central American Isthmus.



# Identification of plants having great potential as food, but which are actually underutilized

In the Caribbean Basin, there exists potential plant germplasm, native or introduced, which can cover fully the needs for food in the region. These crops offer a wide range of genetic diversity because of the concentration of germplasm, on the one hand, by introductions or by exchange; and on the other hand, by the local native variants. Only in very few instances, as in the case of the breadfruit, the basic genetic material is so limited, it becomes necessary to import foreign material.

## Energy sources

In the developing countries, there is a very narrow correlation between the consumption of energy and protein foods to be able to make clear differences between them. However, the crops that do supply energy and those that supply proteins are treated separately, mainly in order to follow the traditional manner of focusing attention on their consumption.

The basic source of energy-supplying foods in the Caribbean lies more in the roots and tubers and in fruits, rather than in cereals; since the latter can only be intensively grown in countries having greater exten-

sive land areas. The roots and tubers were an important article of commerce at the regional level, but their cultivation has been gradually reduced to the family production level. Such crops as *Manihot esculenta*, *Xanthosoma sagittifolium*, *Colocasia esculenta*, *Dioscorea* spp. and *Ipomoea batatas*, are a first-class source of energy, with respect to yield and digestibility. The range of varieties existing in the area is such that any future work will be very difficult due to the amount of material that will have to be evaluated and analyzed. This work should be done to identify the superior clones, not only for their energy yields, but for their content of amino acids and minerals, and for their levels of digestibility. Only the systematic and intensive production of roots and tubers can generate the technology that will make it possible to utilize them to the fullest degree. This, in turn, will stimulate progress in agronomic and genetic improvement.

Among the less common roots and tubers and of the least genetic diversity, *Maranta arundinaceae* and *Calathae allouia* are well known in the region.

Among the fruits rich in carbohydrates, the breadfruit requires the introduction of more cultivars. The range of these cultivars in Polynesia will make it possible to obtain clones or offspring from seeds which



are superior to the existing few cultivars found in the Caribbean area. Another specie, the peach palm (*Gullelme gasipae*), with better planting material and more intensive cultivation, could supply more energy foods. In high rainfall areas of Central America, similar to some areas of the Caribbean, its production is twice that of corn, and the fruits contain appreciable amounts of provitamin A.

Another well-known food source in the Caribbean is the banana and plantain. In the case of the former, a tetraploid variety offers very favorable characteristics for eating it cooked. Among the plantains, there is such a number of cultivars in the Caribbean that their production can be increased, as has been done in Central America, more by the management of the dwarf varieties than by the introduction of new cultivars. However, it would be most useful to have a greater number of clones existing in collections, in case some new disease appears, or that one of the clones is found to have a high content of amino acids.

### Protein sources

The grain legumes that supply most of the proteins are already known in the area, and they offer such genetic diversity that their adaptability does not present any special problems.

The pigeon pea and the cowpea are two of the traditional legumes found in the region, and there is such variety among them that just a simple testing program could determine the better types. If it were

necessary, new germplasm materials could be introduced from international centers. By concentrating on developing the production of grain legumes of these two species, more progress can be made than by introducing others of doubtful yield or adaptability. There are, however, other grain legumes, that because of their drought resistance, could prove to be most promising, such as the tepary bean and the mung bean.

### Vitamin and mineral sources

It is very difficult to change social concepts in the region, especially in urban areas, with respect to the consumption of vegetables. The exotics: tomato, lettuce, eggplant and others, are associated with a higher social status, although the local vegetables are more nutritious and cheaper. Perhaps it would be more promising to intensify at the family level, the use of leafy vegetables, of species already existent in the area. The amaranths would take first place due to their quality and yields. A more intensive use of the tender leaves of the Araceae propagated by their underground stems, or of the "belembé" (*Xanthosoma brasiliense*), can supply a cheap and nutritious food. Other leafy vegetables, such as *Basella rubra*, *Hibiscus manihot* or *Ipomoea reptans*, of foreign origin, can easily be accommodated to production in home vegetable gardens. Although there is no cultural tradition in the Caribbean, the use of tender leaves and stems of cucurbits is highly recommended as one of the most efficient sources of vitamins and minerals.





In fruiting vegetables, christophine ("chouchou") is a source of cheap and abundant food, although its cultivation is restricted to certain altitudes. On the other hand, in *Cucurbita moschata*, there are varieties in Panama and Colombia adapted to low altitudes, that could be tried in the Caribbean.

It can be said that all the fruit species of the Caribbean are underutilized. Also the exotic fruits, even citrus and bananas, are going through a production crisis. In part, the abundance of species and the production system utilized (or the lack of a system) prevents the development of an orderly and remunerative production. One factor to consider is that the seasonal production of fruits varies with the specie and the cultivar. A few species, like papaya, produce year-round. The majority have marked periods, generally short, and frequently are of biennial production. A study of these characteristics is necessary, whether it be to introduce varieties that extend the production period of the specie, or to plan how to utilize the fruit products.

In summary, in the Caribbean there already exist plants having potential as food sources. Practically all of them are underutilized in most part because of cultural or social factors. Only an intensive production can stimulate the development of technology and the agronomic or genetic improvement that will lead to a reliable, sufficient and economic supply. This can be done without the need to introduce "miracle crops" from other sources. The available germplasm in the Caribbean is sufficient to develop production systems

adapted to the different ecological and economical conditions of the region.

# Some natural and socioeconomic aspects that influence the production and marketing of agricultural products

The Caribbean Basin has such a heterogeneous and complex structure in its natural and human factors, that whatever generalization made would have very limited value. It is a region as fragmented in its geographic as in its social and political constitution, at a scale found nowhere else in the world.

In spite of the efforts being made to unify, it seems that there is a trend to accentuate fragmentation. For this reason, all efforts and resources dedicated to the field of agricultural production in particular, such as the dissemination and exchange of information, planting materials, machinery, or whatever other technological development, should be directed toward consolidating the region as a programmatic unit and toward action for regional development, of course, respecting the special characteristics of each geographic entity.

## Ecology and human activities

The Caribbean is made up of two geographic arcs, one insular and the other isthmian, that unite the two continental land masses of the new world. These arcs cover limited and irregular geographical areas, one

being a chain of islands, and the other varying in factors of topographic relief. The natural conditions due to the interaction of relief, climate and soil in reduced areas result in the creation of a great diversity of environments. This can be seen in the natural vegetation, better than in any other aspect. Thus, the Caribbean is a region extraordinarily richer in plant species, than other much larger continental land masses in North America. But, at the same time, if the interaction of natural factors creates conditions which make it possible to produce a great diversity of crops, it also at the same time limits mass production, with the exception of some areas of Central America. The ecological framework determines, in a large part, the historic development of agriculture, as one can see in the example of Central America, where different production systems have evolved in each one of the ecological areas existing in the region.

## Cultural aspects

Agriculture in the Caribbean Basin reflects the cultural mixture that has been developing in the region during the last centuries. This ethnic factor can not be

Ecological zones	Percent of total Area	Human Population		Farms	
		Per Km <sup>2</sup>	e/o of total	Per Km <sup>2</sup>	e/o of total
A. Atlantic basal and premontane belt 1. Lowland Humid Tropics (LHT)	40.1	19	22	1.9	20
B. Pacific basal, premontane and montane 1. Semi-Arid Tropics (SAT)	22.6	44	28	3.5	27
2. Wet-Dry Tropics (WDT)	37.4	47	50	6.6	53

The wet-dry tropics include half of the population and farms, while the lowland humid tropics cover 170,000 km<sup>2</sup> (40.1% of) of the region.



put to one side, because whatever the technological development may be, the former will always have an influence on the latter. In many communities, cultural mixture will always be present as a dominant factor, since technology is but a product of the society and environment in which it is developed.

In the Isthmian arc of the Caribbean Basin, the production systems that are practised, mainly in the humid-dry and semi-arid areas, are strongly influenced by indigenous cultures that extended their domain over the whole region.

The indigenous background of agriculture in the Caribbean has suffered from the influence of ethnic groups, European and/or African, which brought their preferred crops and their own agricultural practices. This combination of influences has resulted in the polarized development of two extremes: subsistence farming, in general at a very low level of development and, the plantation as an extensive system, often highly technified. There exist some intermediate stages between those extremes, of small farms with high productivity, especially in the intermediate highlands of Central America, but their number constitutes a small fraction of the whole. Traditionally, the efforts devoted to research and to the development of technology in the Caribbean Basin has been dedicated to extensive agriculture. During the last decade, the national, regional and international institutions, among which CATIE is included, have devoted their attention to the search for technical solutions for the low-income farmers that practice a type of agriculture approaching

subsistence agriculture, but who produce a large part of the foods consumed daily in the region.

Before discussing the possible approaches for improving the production conditions of the farmers of limited resources, it is necessary to look at the situation of scientific and technological development as the basis for making changes in the agricultural systems existing in the region. The fundamental basis for making those changes consists of the support from research, or the improvement of certain empirical practices. Without underestimating the contribution made by the first, it should be emphasized that in areas of relatively underdeveloped agriculture, as in the Caribbean, certain improvements in growing the crop, in the selection of cultivars and/or in the processing of products made by the farmers themselves, have provided considerable contributions to the agricultural development achieved.

But, both with the appropriate usage of empirical knowledge of the farmers as with the results of basic and applied research, ways have to be found to make useful technology available. The transference of this technology presents, however, particular problems. In the Caribbean, political domination in the past, ethnic and cultural differences, and particularly language, have been the barriers that have hindered the fluid and more intensive exchange of information, techniques and human resources. If one considers that in the Caribbean area, four European languages are spoken, and in some places in the Antilles several indigenous dialects, one can understand one of the difficulties of



exchange, even at the level of trained personnel.

Of the two international agricultural magazines of the region, one publishes summaries in English of the articles written in Spanish and vice versa; the other is published in English only.

If, to the instability of the research institutions, which is a reflection of the socio-political situation of the area, one adds the fact that the results can not be effectively disseminated due to the lack of adequate communication media or to the limitation of illiteracy, one can see that for the conditions for improving small-scale farming, there are serious obstacles in the Caribbean.

### **The system of subsistence agriculture**

In order to appreciate the importance of the farmers of limited resources, the following data reflect the situation in Central America. Seventy-six percent of the population lives on farms of less than four hectares, under extremely complex conditions, as much in the ecological aspect as in the socioeconomic aspect. The vulnerability of these production systems is very high, both to the inflationary changes in the prices of inputs as to the market fluctuations of the products, and to the difficulties in adapting better technologies, originating from a high-risk production situation.

The improvement of small-scale agriculture should deserve then the highest priority, both for social as well as for economic reasons. On it depend the basic foods

to a very high degree; and with a population of 15 million in 1970 and increasing to 35 million by the year 2000, in order to allow an increase of ten percent in the annual per capita consumption of grains without increasing imports above the 1980 level, 61,000 tons of corn, 7,000 tons of beans, and 9,000 tons of rice will have to be produced within the next 20 years. This can not be solved by expanding the extension of cultivated land, since this has reached its limit; but rather by increasing yields.

The problem of subsistence agriculture, as it now exists in the countries of the Caribbean, is to introduce positive changes or adjustments to the production system which will make it possible for the farmer to receive a better income. Experience shows that unless there is governmental support, the farmer can not expect a rapid economic improvement, nor can there be any guarantee to the countries that this system is going to produce the quantity and the quality of necessary foods to feed adequately and steadily a population that is continuously increasing. At the same time, the countries of the Caribbean are facing the need to produce more food under more pressing conditions, and in greater volume. But it is necessary to continue with the small producers, because this is the most conciliating alternative and it is in agreement with the present needs of the region. Since there will always be a large number of small farmers, adaptive research should be continued.

Aware of these very complex technical and socio-economic problems, CATIE has followed a line of



action to develop better production technology that consists basically of the characterization of the principal production systems; design and modeling of better technical options and production prototypes; field trials using production alternatives with farmers, and evaluation and later validation of this technology with a larger number of farmers. All this work was done at the farm level with the farmers' active participation, in selected areas in Central America and in coordination with and support from the national institutions dedicated to research and transference of technology. This systems approach for developing technology implies an acceleration of the natural evolution of production, by means of a gradual addition of technological components, and is based not only on the technicians' capacity to design technologies, but also on the integrative capacity of the farmers. This evolutionary approach, depending on the potential ecology of the area and on market conditions, could lead to the complete replacement of the traditional system by a new one. However, in marginal areas, and without institutional support from the government, it offers limited prospects.

### **Large scale production and volume**

In contrast with subsistence agriculture, a large part of the agricultural production, or production for exportation, present other types of problems. In the first place, the problems refer to markets and prices, which are not relative to this meeting. But there are

other problems more related to production; one of which is the tendency to develop a new crop simultaneously in several countries, which results in increasing competition in the international market.

In general, extensive monoculture or a few production items in the tropics deserve close attention because of the implication it has in the maintenance and stability of the environment. Since diversified ecology is the main characteristic of the tropical areas of the world, the establishment of extensive monocultures implies the intensive use of energy in the form of fertilizers and pesticides, which increases dependence on fossil derivatives and implies risks in the natural ecological balance.

The concept of commercial agriculture utilizes advanced production technology, and encounters serious difficulties if it is applied indiscriminately to the small land holders dispersed throughout the region. For that reason, there is a need to adapt agricultural production technology to the prevailing conditions of the small farmers.

# Conclusions

A worthy approach would be to study the development of intensive and self-sustaining production systems in reduced areas, which could be managed by a family (coffee, cocoa, citrus, for example) that would allow the employment of available family labor utilizing adequate inputs rationally in order to maintain high productivity. These systems are practiced in some areas of Central America.

A self-sustained and intensive production with evolutionary technology most appropriate for small farms, with a few or a variety of products could supply local needs and could lead to the production of competitive exports in world markets.

If the producer acquires the capacity to advance further and to manage larger fields of production, with more exacting crops and technologies, he should advance in that direction up to where his potential would make it possible to obtain better production and utilization of resources.

In the energy-producing foods, the situation does not appear to be bad, since cereals, roots, tubercles and some fruits offer an enormous potential for supplying the required energy. In roots and tubercles, it is possible to modernize and to make the products more attractive.

With respect to protein, agricultural production contributes with a fraction less than the requirements,

and it is going to continue to depend on grain legumes especially beans, pigeon pea, and cowpea. The fruits, with their spread out production, can supply the necessary vitamins and minerals.

There is much to be done in this field, even though there already are planting materials and acceptable technologies for the largest plantations, but to reconcile this with land resources, hand labor, capital and prevalent production capacity, requires great efforts.

In conclusion, what researchers have achieved in their work, the experience of the extension specialists and the contributions from those who have analyzed the economic and social situation in the Caribbean, all help to form an ample and solid basis for future work. CATIE, on recognizing the value of these contributions, hopes that they can be utilized in a more intensive, organized and permanent way.

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