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Report to the
Government of Ivory Coast

Agrotechnological Research in Ivory Coast

International Service for National Agricultural Research

The International Service for National Agricultural Research (ISNAR) began operating at its headquarters in The Hague, Netherlands on September 1, 1980. It was established by the Consultative Group on International Agricultural Research (CGIAR), on the basis of recommendations from an international task force, for the purpose of assisting governments of developing countries to strengthen their agricultural research. It is a non-profit autonomous agency, international in character, and non-political in management, staffing, and operations.

ISNAR is the youngest of the 13 centers in the CGIAR network, and it is the only one which focuses primarily on national agricultural research issues. It provides advice to governments, upon request, on organization, planning, manpower development, staff requirements, financial and infrastructure requirements, and related matters, complementing the activities of other assistance agencies. In addition, ISNAR has active training and information programs which cooperate with national agricultural research programs in developing countries.

ISNAR also plays an active role in assisting these national programs to establish links with both the international agricultural research centers and donors.

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Agrotechnological Research in Ivory Coast

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Summary

The ISNAR mission on agrotechnological research in Ivory Coast should be considered as an initial contact to develop some general ideas on the generation, transfer, and dissemination of technological progress, and on conditions needed for socioeconomic progress to parallel technological progress.

Although agrotechnology can be defined as all activities upstream and downstream of the production processes -- be they part of agriculture proper or related to artisanary or industry -- no attention has been given to such industrial factors of production as fertilizers, pesticides, machines, etc.

When well adapted to the socioeconomic context of the Third World, agrotechnology can play an important role in the expansion and improvement of the agrofood and agroindustrial sector. Agrotechnology would also benefit the economy as a whole through improvement of the nutritional status and health of the people, increased value given to agricultural products, improvement of the town-country equilibrium, improvement in the balance of foreign trade, and the spillover effects to other industries

In Ivory Coast, the state has played an important role in developing agrotechnology, mainly by creating powerful national (public and joint venture) companies and by encouraging foreign private investment. However, there have been two major weaknesses:

* limited interest in processing traditional agricultural crops and intermediary technologies that might be applicable in local or village agrotechnological activities (an attitude partly due to a lack of information on innovative, effective technology available elsewhere);

* absence of a comprehensive policy for the transfer of commercial technology; at present this has been replaced by the purchase of equipment and licenses and by foreign investments.

In the context of a liberal economy widely open to foreign trade of all sorts, the western production (even more so consumption) models are spreading rapidly; eating habits are changing faster than ever. The long parade of consequences includes: more food imports, poorer diets for certain strata of society, flight from the countryside, increased technological and economic dependency, etc.

To slow down, or to reverse, the worst aspects of this trend will require a long, foresighted, strongly resolved policy that bears on all the cultural, economic, and technical elements of the whole agroalimentary process from production to consumption. The technological aspects call for long-term priority attention, because herein lies the key to future impact of cultural (education and training of producers and consumers) and economic (investment assistance, customs policy, etc.) measures.

The State should provide support for the agricultural and agroindustrial production units, especially their information and research services.

Information services should be given top priority. All data on the national agrofood process (current situation, needs, and capacities of economic units active in technological supply and demand, consumer behavior patterns, etc.) and technology from abroad that could be of use for production, processing, preservation, present or future research, should be compiled, analyzed, and disseminated.

Since agrotechnological research is particularly expensive and risky in small industrialized countries, the technology adaptation and creation processes should be introduced or reinforced with great care, in order to avoid failures such as those registered in the past; for example,Institute for Technology and Industrialization of Agricultural Products (ITIPAT) in Ivory Coast, several Third World public research institutions, etc. This leads to suggestions that:

* Support should be provided for creating research-development units within the large national agrofood enterprises (public, joint venture, and private) and in groups of small or medium enterprises.

* Careful attention should be given to selecting research resources and themes. A programming procedure should be used that enlists the participation of research units and potential users, selects a limited number of operations, balances short- and long-term research, and leaves room for cooperation with foreign and international institutions whenever possible, -- in particular under the auspices of West African Economic Community (CEAO).

* A single, strong, public technico-scientific pool should be created which brings together the resources of Ivorian Centre for Technological Research (CIRT) and Ivorian Company for Tropical Technology (IZT) so that the sparse resourses in addition to their own research, the pool should play an important role in coordinating the country's agrotechnological research, in managing a service(s) for information, documentation, and international relations, with prime attention being given to the problems of transferring

technology. Such services should be available to all national institutions and enterprises and should be a driving force in postdegree and university training, etc.

The mission evaluated CIRT's activities and projects and its human and material resources. However, it will only be possible to make a thorough evaluation and detailed proposals, as was initially requested of the mission, when CIRT's functions have been defined in relation to those of other institutions and enterprises.

CHAPTER ONE: Introduction

1.1 Origin and Terms of Reference of the Mission

Subsequent to an initiative taken by the World Bank's Regional Office for West Africa, a delegation from International Service for National Agricultural Research (ISNAR) visited the Ivory Coast Ministry of Scientific Research (MSR) September 10-14, 1981, to explore possible avenues of cooperation between the Ministry and ISNAR. This meeting created a desire for broad cooperation. The initial phase was to consist of a mission by ISNAR to evaluate the Ivorian agricultural research system (structures, operating methods, etc.) and suggest ways of improvement. A later exchange of letters between the Minister of Scientific Research (December 24, 1981) and ISNAR's Director General (January 15, 1982) officially confirmed the principles and objectives of this evaluation-proposal mission. The agreement dated January 15, 1982 assigned the mission the following terms of reference:

* preparation of a document containing an analysis, an evaluation, and recommendations on the linkage between agricultural research and extension of results to farmers;

* contribution to the preparation of a master plan and program for future agricultural research;

* participation in the preparation of an integrated research program devoted to the intensification of food crop production in both the savanna and the forest zones;

* advice on research activities connected to the storage, preservation, processing, and increasing of the value of agricultural products through processing.

The present report relates to the last point in the terms of reference. It is a preliminary presentation of lines of action and future orientations for agrotechnological research in Ivory Coast. The first three points in the terms of reference are presented in a separate report entitled "La Recherche Agronomique en Côte d'Ivoire: Présentation, Evaluation Propositions d'Amelioration (ISNAR, Octobre 1982)

1.2 The Mission: Composition, Schedule, Objectives, Results

Composition and Schedule

The ISNAR mission was composed of a multidisciplinary team of seven persons who are named in Annex I to this report. Part of the time between March 28 and April 8, 1982 was devoted to agrotechnological research problems, which were studied at meetings with representatives from some agricultural research institutions under the Ministry of Scientific Research (MSR) or other ministries, with representatives from the Ministry of Agriculture, with agricultural development societies, and with a few private agrofood enterprises.

On April 7, 1982 the team made an oral presentation to the Minister of Scientific Research and his staff on its preliminary observations and proposals for an agrotechnological research program.

The schedule of the agrotechnology part of the mission's work program, and the list of contacts are presented in Annex I to this report.

Limits Imposed on the Missions and Objectives

Because a limited part of the total mission time had been set aside for agrotechnological problems, the team was obliged to be highly selective and to concentrate its attention on evaluating the Ivorian Centre for Technological Research (CIRT), which is the main national scientific institution in Ivory Coast active in research on processing, storage, preservation, and improving the value of agricultural products through processing both food crops and other crops.

The MSR harbors ambitions for CIRT, which needs new, durable, efficient impetus driven by a long-term activities program adapted to the needs and capabilities of the country. Building up such a program is complicated, sensitive, and risky; numerous efforts have been made to do this in many countries. Unfortunately, the score leans to the failure side. The mission therefore sought to evaluate CIRT and develop thoughts on the broader subject of the role of public research in the development of national industry and small-scale agroindustry. The structure of the present ISNAR report results from this attention.

The Report

This short mission-completion report (rapport de synthèse) is addressed to the Minister of Scientific Research. It has three principal parts: an introduction (Chapter Two), the present and potential role of agrotechnology in Ivory Coast (Chapter Three), and a conceptual evaluation of CIRT with program proposals and prerequisites for recommendations on organizing and operating CIRT (Chapter Four).

The mission team stresses the introductory character of its work, after thought has been given to the appropriate strategy, questions on operations, procedures, and structures will have to be studied thoroughly.

1.3 Expression of Gratitude

The mission received a warm welcome from and enjoyed frank and fruitful contacts with many institutions and their representatives, and would like to express its sincerest thanks. Special gratitude for cooperation and participation in the mission's activities should be expressed to Mr. Jean-Marie Michotte, Technical Adviser at MSR, who organized the mission's work program; Mr. N'guetta Bosso, Adviser to the Minister and head of research-development liaison; Mr. Abdoulaye Kone, CIRT scientist; and Mrs. Ya Diakite of the MSR Publications and Documentation Department.

CHAPTER TWO: Agrotechnology in Ivory Coast

2.1 Present Role of Agrotechnology in the Third World, Especially in Ivory Coast

After defining the agrotechnology field, some observations will be made on the importance of developing agrotechnology in Third World countries general, with special reference to Ivory Coast.

2.1.1 Definition of agrotechnology field

Agrotechnology involves activities and social participation that vary according to a country's level of economic and agricultural development. In the developed countries, agrotechnology entails an extremely broad range of activities downstream and upstream of agricultural production. Downstream, it includes storage, preservation and processing of agricultural products; that is, a diversification and extension in time of the uses of food and industrial agricultural products for human consumption and for the preparation of nonedible products. This is what agrotechnology generally means when the term is spontaneously employed. Upstream, it includes activities linked to the provision of factors of productions other than work and land; that is, factors produced industrially such as fertilizers, animal feed, etc. Further, in the developed countries, increasing division of labor has led to highly sophisticated specialization, in which agricultural production is limited to the production process proper, a process that is carried out with the assistance of outside enterprises providing means and services for producing and collecting the products. This specialization has been driven so far that the sector called agricultural and food industries covers -- depending on the definition used in national accounts -- all the artisan and industrial enterprises working for agricultural holdings, both upstream and downstream.

In the Third World, the situation is different. In the poorest countries, most agricultural holdings are operated in a more or less closed circuit, with a high degree of self-provision of means of production and of self-consumption of the products; they also develop certain related activities that fall in the field of agrotechnology, for example, making certain work tools, building storage facilities, conditioning and processing products, etc. As the cash economy develops, on-farm agrotechnology is joined by national or foreign artisan and village enterprises that operate upstream and downstream of agricultural holdings. In other words, these activities take place either within agricultural operations or within artisan or industrial enterprises related to them.

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Agrotechnology, as described above, is broader than what was intended in the terms of reference assigned to the ISNAR mission. Downstream agrotechnology will be discussed when attention turns to preparation of factors of production from agricultural products and by products, because this involves biological cycles found in all types of agriculture, such as plant matter used for animal feed and fertilization.

As a result of the energy crisis and the development of biotechniques, increasing attention is being given to using biological cycles to increase the autonomy of agriculture, to economize on industrially made factors of production (especially fertilizers and energy), and to produce energy from crops grown specifically to supply towns and industry.

2.1.2 The Importance of Agrotechnological Development

Via activities upstream and downstream of agricultural production, agrotechnology can be used in developing countries to improve the quality and quantity of the human diet, to develop the use of agricultural output for purposes other than food, to increase the value of agricultural products through processing, to improve job distribution and job levels, and to balance foreign trade better.

Qualitative and quantitative improvement of human diet

One of the prime targets for national leaders should be improving both the quantity and quality of the human diet; agrotechnological activities can be used as a foremost mover towards this goal.

Heavy losses are often registered after harvesting. Improved and expanded storage, processing, and preservation capabilities -- on the farm and in specialized localities -- can reduce these losses and hence increase the net agricultural output.

On the farm, part of the products that cannot be used for human consumption can be used for other purposes (animal feed, and organic fertilizer, for example). The losses can generally be reduced by applying well-known, inexpensive products and procedures that are effective in places where the traditional methods are well known (materials, methods of use, etc.), and where simple preliminary experiments have been carried out, followed by an effort in extension (information, availability of products, credit facilities, etc.).

Off the farm, the principle of using bigger granaries, silos, or refrigerators is not difficult; it involves making the best technological choice (industrial or intermediary installation) and proper financing (total or partial national manufacture or importation, possible manufacturing under licence agreement, etc.)

There is now even a microbial way to recover part of the protein found in hitherto abandoned -- or toxic -- residues; in some cases it can even upgrade the protein content. Research carried out in developed countries (e.g., detoxication of polluted groundnut cake) and developing countries (e.g., India) have produced interesting results that could be imported (equipment) or adapted (processes).

Substantial losses are often incurred through the use of traditional processing technologies, for example, home or artisan extraction of sugar from sugar cane, oil from palm kernels, etc. Industrial processing can double extraction yields. Modern industrial technologies for large scale production can be imported from developed countries or even from certain developing countries, such as Brazil and Cuba for sugar, and traditional technologies can be improved.

Agrotechnology can -- but does not always -- play a decisive role in increasing the quality of food for human consumption. Trends in the richest countries -- which are towards diversification and industrialization -- to various degrees and with some delay are showing the same results. Expansion of national and international trade, and technological and cultural exchanges, combined with rapid urbanization, changes in eating habits and food requirements, are accelerating these two trends. Cities need regular supplies of a large variety of not only fresh foods, but also processed foods that are easier to prepare and keep. Since traditional food crops often cannot meet modern standards, consumers are increasingly replacing them by new or imported foods. The old distribution circuits, in which foods pass through a whole host of intermediaries, who collect small amounts from scattered production sites, and then combine, screen, transport and sell these supplies, are becoming unable to supply large towns regularly.

The supply problem has been to some extent solved by the creation of national, foreign, or joint agrofood industries, and by constantly increasing food imports for direct consumption (e.g., rice, and tinned foods) or preconsumption processing by locally established agroindustrial enterprises. In the long-term, however these solutions can have harmful effects.

1. Foods originally intended for a select clientele in the higher income brackets appeal to the less wealthy, who tend to respond to clever publicity campaigns and who seek to copy the habits of the elite. This category of food products, which is usually profitable for the suppliers, includes:

   * Foods that are unquestionably nutritive but expensive, and are barely within the grasp of a large part of the population, e.g., milk and meat products. (The main risk is that the agricultural production system will concentrate more on these food products, to the detriment of the traditional foods that in some cases are equally nutritive and much less expensive).

   * Foods that are of low nutritional value but are appealing or considered to be a sign of social prestige, e.g., imported alcoholic beverages, carbonated fruit drinks, soda water, chewing gum, are all products that sway consumer choices made by low income, semiliterate people.

   * Foods of doubtful nutritional value that may be dangerous under certain conditions, e.g., powder milk or foods for babies.

2. The second category of foods with adverse long-term effects are widely consumed foods that may meet basic needs but which have to be

imported or made from imported commodities that cannot be produced within the country; e.g., wheat to make bread in tropical areas and rice or maize in dry regions where other cereals are grown.

Eating habits change quickly, and as the western food consumption pattern becomes more and more popular, it leaves behind it a trail of consequences such as disparagement of traditional foods, increased food imports, poorer diets for certain classes of the society, greater economic dependency, etc.

There are few countries that have been able to avoid these dangers and escape an evolution especially persuasive in the more liberal economies more open to foreign trade, multinational agrofood enterprises, and private advertisement. To reach the goal of promoting and improving food consumption patterns and to make optimal use of the national agricultural output, a long-term policy is required that includes all cultural, economic, and technological aspects of the whole agroalimentary chain from production to consumption. These three aspects will be discussed in detail in Section 2.2.2. However, although all three aspects are necessary to guarantee the success of a food improvement policy (both quantitative and qualitative), special attention must be given first to the technological aspects when considering the long term, because they condition the effectiveness of specific cultural and economic actions.

In other words, improving local foods and expanding outlets for these foods will the require adopting, adapting, or researching of new technologies that make local foods more attractive to consumers, especially to those who keep house. These foods must be easier to use, and stay fresh longer in order to replace at least part of the import market.

A few examples of innovations that need to be researched, urgently because of their impact on the Ivorian economy, are industrial processing of cassava so that the preparation of the traditional "couscous" dish would be greatly speeded up; processing locally grown millet and cassava into a flour suitable for combination with wheat flour to make bread; and processes for making rice or cassava "noodles"; cassava or plantain "rice"; and a "milk" from coconut, palm kernels, or local legumes.

Technological know-how is also needed to design large-scale operations to improve the health and nutrition of poor or vulnerable groups (especially pregnant women, infants, children, the old, the sick, etc.) by increasing the protein or vitamin content of staples, making special foods that can be distributed through outlets such as medical centers, school cafeterias, etc.

The development of nonfood products

As a result of technological and biological progress, an increasingly wide selection of nonfood products is being made from agricultural products in homes, cottage industries, and industrial enterprises.

Much is known about the processing methods for export crops, which are not grown or are grown only marginally for human consumption, and crops intended for human consumption the various by-products of which can be used for other purposes. The most common examples in Ivory Coast are:

* forest products, home consumption (house, energy, etc.), commercial uses (timber, plywood, furniture, package wrappings, paper, cardboard, etc.);

* coffee, the residues of which are used to supply energy for factories and the neighborhood, and nitrogen-rich fertilizer;

* cotton, the by-products of which can be used as animal feed (protein-rich cotton seed cake to make up for Ivory Coast's protein deficiency) and soon for human consumption (this is the main goal of IDESSA's genetic research on cotton without gossypol);

* oil palms can be used in the production of oil, soap, detergents, cosmetics, etc., all of which are highly developed in Ivory Coast;

* sugar cane the residues, by-products, and derivatives of which can be used as animal feed (leaves, juice, protein-rich yeast) and for manufacturing compressed elements, glue, chemicals, pharmaceuticals, etc.

For these and other more region-specific productions, there are homemade and artisan technologies that are either little known or misused or little known, but which lend themselves to improvement and could bring about considerable savings if they were made popular. In some cases, such improvements are already available and in other cases, they still have to be worked out. Examples can be found in the home palm oil extraction machines, traditional stoves used for making charcoal, home cooking devices using wood or charcoal that are much more efficient than those used in Ivory Coast and could help reduce depletion of national forest resources

Alongside these classical developments, other possible improvements are emerging that are based on biotechnology for artisan or industrial processing of agricultural and forest products and their by-products, and the industrial processing of agroindustrial by-products. Recent experiments, test-runs, and research suggest that soon it will be possible to produce:

* protein-rich food, mainly for animals, industrial production of torula yeast on bagasse and juice extract from sugar cane, bacterial hydrolysis of plant residues into starches (cassava, plantain for example) etc.;

* organic and nitrogen-rich fertilizers from residues containing ample glucides;

* bio-fuels -- the economic value of large-scale production of alcohol from biomass (especially from sugar cane) has not yet been proven (as can be seen from the problems encountered in the ethanol program in Brazil), but producing gas fuels (methane) through the anaerobic digestion of organic matter (residues from the agrofood industry, animal bedding and manure, and also the organic part of household refuse and waterwaste sludge) has considerable potential because of the sharp increases in the price of nonrenewable energy, the need for decentralized, self-contained sources of energy in rural areas especially in areas without electricity, and problems of environment protection.

Agrotechnology and economic growth

If agrotechnologies activities are well adapted to the socioeconomic conditions prevailing in the Third World, they can play a key role in improving and expanding the agrofood and agroindustrial sectors and thus contribute to overall economic growth by:

* improving the nutritional and health status of the people by stabilizing food flows and prices;

* increasing the value of agricultural products through processing;

* improving the balance of foreign trade by promoting the use of local products, increasing the value of agricultural exports, reducing imports of agricultural products and other factors of production for agriculture and agroindustry;

* bringing about a better equilibrium between the towns and the countryside, since agrotechnologies, by virtue of their rural location, will generate jobs and income;

* the spillover effects from the agrofood sector to other industry, that is, mechanics, chemistry, construction, etc.

Such progress can only be achieved if agrofood policy, and indeed the overall economic policy, receives the support deserved. In the following section various aspects of a progressive agrofood policy are discussed.

2.2 Development and Dissemination of Agrotechnological Progress

Agrotechnology progress accumulates and spreads according to a more or less complicated process that brings together different categories of present and future suppliers and/or consumers of technology produced by transfer, adaptation, or personal discovery.

2.2.1 Economic Circles that Generate and Use Agrotechnology

Agricultural units, and agrofood and agroindustrial enterprises of all sizes that in some way generate or use agrotechnology, and the technico-scientific institutions and services comprise economic circles that give impetus to agrotechnology.

Agricultural units

Agrotechnology affects all activities related to the storage, preservation, and processing of plant and animal products for home consumption as food or for other purposes (clothing, housing, energy, etc.), for the supply of factors of production, at the national level, and for foreign trade.

Traditional technologies, which are either not well known or are misunderstood, are worth knowing and inventorizing for two reasons:

* First the technologies and practices, the performances, or unique features which are of interest should be identified. This may entail scientific know-how to reproduce the technology at the original scale (for use in the same ecological conditions), or to use this technology as background in developing new equipment and processes if not at the household level, then at least for artisan or even industrial use.

  Agricultural units are potential sources of technology, but these technologies generally remain untapped by scientists who are either ignorant of their existence or comtemptuous of the small farmer's empirical knowledge or capacity to create or adapt technology. The world is full of examples of efficient household agrotechnology[2], and Ivory Coast certainly has a great wealth of traditions that have been developed or used both by the national ethnic groups and by emigrant populations.

* Second, it is important to learn more about these agrotechnologies because of the possibility of improving them without altering their main characteristics, when that is possible. There is a great potential demand for improvement of traditional technologies which, if satisfied, could have beneficial effects on large impoverished social classes.

Small and medium enterprises

There are not many small or medium enterprises in Ivory Coast, but the government aims "to promote smaller units created and run by Ivorians, in the wake of the large industrial projects."[3]

The agrofood sector is suitable for small and medium enterprises, especially for upgrading the many traditional animal and plant products and by-products which now, at best, are processed at the family or village level, and which the industrialized countries and the multinational companies have studied very little, if at all.

This explains the importance of the need to pool all active small and medium agrofood enterprises, to indicate how best their production methods and know-how can contribute scientifically, and to define needs and potential for these enterprises.

Large agroindustrial enterprises

For the last 20 years, the Ivory Coast government has encouraged the establishment of large agroindustrial enterprises based on national (especially public), foreign, or mixed capital. During the 1960s, most industries worked on import substitutions (for example, flour and milk). Then came industries using modern technologies that improved large-scale processing of local agricultural products for the export market (textiles, cocoa, coffee, etc.). Examples of such industries with a turnover in 1979 of over 5 billion CFAF in descending order, are: the BLOHORN-UNILEVER group, UNICAFE, PALMINDUSTRIE, CIDT (Ivorian Textile Development Company), SODESUCRE, CAPRAL-NESTLE, SALCI (Ivory Coast Pineapple Corporation).

All these enterprises are young, and their capacities for information, adaptation, and technological innovation vary considerably, depending on the origin of their capital. Often the main problem facing the specifically national enterprises, such as SODESUCRE, SODEFEL, and PALMINDUSTRIE, is the irregular supply of adequate quantities of agricultural products and the gradual assimilation and control of modern industrial technologies being implemented from abroad by foreign technical assistance. With time, these enterprises will need to develop their own technological services, operated by national technicians. These technicians will need to be capable of carrying out most of the maintenance work independently; of adapting and improving equipment and processes; and of making optimal use of untreated raw materials and industrial waste through the total or partial transfer of foreign technologies, (which implies adaptation of these technologies to the local situation) and (but less probable) national research and experimentation by agroindustrial enterprises working alone or in conjunction with scientific institutions.

Joint enterprises, such as CIDT or SAPH (rubber), are better off since, officially, they are entitled to support from foreign enterprises that often have consultancy or research-development services with technological experience. This situation should be fully used to train skilled nationals whose ranks need to be reinforced in order to guarantee sounder and broader Ivorian participation in the technical and, with time, economic management of these enterprises.

In the sectors served by these large national or joint agroindustrial enterprises -- that is, the processing of major tropical products -- it would seem difficult for a relatively small country like Ivory Coast to build up a national capacity to develop independent technologies, be they partial (adapting imported technologies) or total (finalization of new technologies). The traditional importers of these products, that is developed countries and the large developing countries such as India, Brazil, and Mexico have long experience with ultra modern or intermediary technology, and big national and international markets. Ivory Coast would have to make considerable costly and strenuous efforts to improve the technologies of research and development enough to be able to compete with the enterprises and countries that supply these technologies. Such efforts would be conceivable, preferably in association with carefully chosen partners, for processing the country's three major exports: cocoa, coffee, and wood. Ivory Coast has an unquestionable comparative advantage with these three products because of its leading role in the international market for raw materials, the importance of upgrading and diversifying raw products for sale abroad, and the potential size of the national market for industrial technologies that are better adapted to local conditions, less costly, labor intensive, and thrifty on foreign currency.

This means that the wisest solution for the large national and joint venture enterprises for major agricultural products grown for the export, regional, or national markets would be to restrict operations to setting up efficient services to compile information on and to study foreign technologies as preparation for making the best choices of technologies to be transferred to meet their needs and capabilities.

Foreign enterprises, especially the multinationals, such as BLOHORN-UNILEVER, CAPRAL-NESTLE, employ production technologies designed

partly or fully abroad, and they conduct most of their research-development activities in industrialized countries. They are only prepared to relocate some of their activities in developing countries if such countries have:

* a growing market, either national market alone or regional market within an interstate trade or customs union;

* a domestic or regional market that requires adaptation of products or processing methods to accommodate site-specific factors;

* national scientific and technical institutions (especially public), the pace of development of which makes them potentially worthwhile partners.

Since these large foreign multinational enterprises[4] generally have a solid scientific and technical background and potential, it may be questioned whether the time has really come to build up the national research-development capacity and further cooperation in the fields covered by these enterprises. Such national undertakings have little chance of being competitive, and any results obtained will be quickly purloined by the large enterprises. In any case, cooperation and trade can never be "fair and square", and once again the multinationals may obtain the greatest benefit, in particular by attracting the best national scientists.

At best, apparently, a cooperative effort of national undertakings can be envisaged as part of an active international effort, preferably with countries within the region or in Africa on well delineated themes considered to be of overriding importance, for example, on the qualitative improvement of the basic human diet or reduction of food imports. Decision-makers and scientists from countries interested in such joint actions might concentrate on using local products -- such as palm oil, cocoa, cereals, legumes, tubers, roots, and traditional vegetables to make a "milk", or a protein- or vitamin-enriched food, etc. For such products, research must be developed far enough to generate results that can be made available at no cost to the national enterprises in the cooperating countries.

Agrotechnological research-development and information in national, foreign, and international institutions

Ivorian Technological Research Center (CIRT) and Ivorian Tropical Technology (IZT) are the only two Ivorian institutions specializing in research-development devoted primarily to agrotechnology. Both institutions are small (six scientists and agrotechnologists) and have ambitious programs despite present problems with program design, orientation, financing, and overlapping interests. These institutions are dealt with only briefly in this section because CIRT is discussed in more detail in Section 3.2; and the team spent too little time (one morning) at IZT to obtain enough information.

In 1981, CIRT succeeded the Institute for the Technology and Industrialization of Agricultural Products (ITIPAT), which had been established to conduct "studies, research, and pilot experiments on preserving and processing tropical products of biological origin to

improve dietary conditions and the nutritional value of foodstuffs, as well as to increase the economic value of these products and expand export markets." ITIPAT was to work both alone and together with other institutions. Despite the substantial resources that were released to this institute, results were scanty (Annex 2), and their impact on the development of the country's agrotechnology was negligible. This was probably largely due to the fact that research was not adapted to the country's real and potential needs and problems. The reasons for this failure -- which are certainly worth studying in depth -- are not dwelt on; the fact is that at the outset CIRT had to take over some of ITIPAT's staff, equipment, and research design. CIRT's wider mandate made this difficult. Theoretically, CIRT is to cover all technological problems in general, with special attention to agrotechnology akin to that covered by ITIPAT, especially as concerns "improving the nutritive quality of foods in order to improve the health of the Ivorian population, advancing research, preparing new food products, and identifying new outlets for agricultural products" (MSR, Program Committee 1981a).

CIRT is fully controlled by the Ministry of Scientific Research, which finances all operating costs and equipment. Staff salaries are paid by the Ministry of Public Works.

I2T was created at the end of 1979 as a joint venture the shareholders of which are the Ivory Coast Government (55%); and the French organizations, Caisse Centrale de Coopération Economique (20%), TECHNIP engineering corporation (15%), Commissariat à l'Energie Atomique (10%). In the beginning, its work was complementary to that of ITIPAT, and later to that of CIRT, because theoretically the institute was expected to test the research results of ITIPAT (and then CIRT) and to introduce these results onto the national and even the international market. However, its role in agriculture and agro-industries is broader (Ministere de L'Economie, des Finances et due Plan, 1981). Its statutes include:

* the study of all technological problems;
* the development of applicable machines and processes;
* direct or indirect construction of equipment and factories;
* direct or indirect usage of confirmed results;
* any work that can increase the value of its means of production;
* in general, any industrial, commercial, or financial venture -- in particular participation in companies based in other countries, that are directly or indirectly related to the social goal or could facilitate extension or development.

As the functions of CIRT and I2T overlap, and as their statutes and custodian ministries are different, may lead to competition between the two. Arbitration and decisions may be needed to tighten cooperation (with a clear division of duties), or even bring about a merger of the two institutes. One of these two solutions would have to be applied to ensure optimal use of the sparse human and material resources allocated specifically to research and development in agrotechnology.

Other important Ivorian and Franco-Ivorian scientific institutions working on agrotechnology. GERDAT institutes, which are expanding agricultural research on production problems to embrace agrotechnological problems, with a view to:

* Better orientation of research on production or factors of production: in plant improvement research certain characteristics of the product must be considered, such as, suitability for human consumption (e.g., cereals and root crops), industrial processing (e.g., cotton and canned pineapple); and in animal nutrition research, attention should be focused on the technological properties of cattle feed, etc.

* Improvement of industrial processing techniques used for agricultural products and their industrial residues (this research can be done alone or together with other research or development institutions).

* Offering to agroindustrial processing industries services related to quality control and chemical and technological analyses (e.g., rubber and cotton).

All the GERDAT institutes working in Ivory Coast have acquired important skills in their particular fields, especially in oils, oil-yielding plants, coffee, cocoa, and cotton, which are important to these institutes' overall understanding of the problems of production, which is their main vocation.

Foreign and international scientific and technical institutions: Ivory Coast, mainly through CIRT and I2T, should strengthen relations in agrotechnology -- hitherto meager or nonexistent -- with international and foreign information and research institutions. By keeping up-to-date with new technologies and on the progress and programs of agrotechnological research institutions, the Ivorian institutions will be better equipped to define their national research orientations and to arrange the most beneficial regional and bilateral cooperation.

Two international institutions can offer special services on information. The first is United Nations Industrial Development Organization (UNIDO) Austria, which has the most complete documentation on all technology problems, including agrotechnology of interest to the Third World. One of its functions is to provide support for technology transfer, e.g., creating and strengthening technology training centers, and north-south and south-south technical and scientific cooperation.

The second institution is World Intellectual Property Organization (WIPO) based in Geneva, Switzerland, which assists developing countries to obtain international patents for specific processes or products (using a worldwide collection of published patents) or international registration of national patents (see WIPO 1977). Other international institutions worth mentioning here are: United Nations Science and Technology Bureau, New York; World Bank, Washington; UNESCO, Paris; FAO, Rome; and UNCTAD, Geneva.

UNIDO has detailed information on institutions in Africa and other parts of the Third World, as well as institutions in developed countries

specializing in agrotechnology in the hot tropical regions. Such institutions include:

* Tropical Africa: Organisme de Recherche sur l'Alimentation et la Nutrition Africaines (African nutrition and food research organization -- ONARA) which is a regional organization, Institut Sénégalais de Technologie Alimentaire in Dakar; the Food Research Institute in Accra; the Kenya Industrial Research and Development Institute in Nairobi; and small specialized institutions in Ethiopia, Tanzania, Zaire, and Zambia.

* Other regions of the Third World: the Central Food Technology Research Institute in Mysore; the Kadi and Village Industries Commission in India; the Bogor Technology Institute in Indonesia; National Biotic Research Institute (INIREB) in Mexico.

* In the industrialized countries: in addition to French institutes which are well known to the Ivorians, whether or not they are represented in Ivory Coast, mention should be made of the Tropical Products Institute in London, the biggest organization specialized in tropical agrotechnology outside the Third World[5]; the German technical assistance service (GTZ), Eschborn near Frankfurt, and various private institutions in the Federal Republic of Germany; several agrotechnological and agricultural research institutes in the TNO Organization (research in applied physics), and other state institutes in the Netherlands; and several institutions in the United States, including, the Denver Institute of Technology in Colorado, and the USDA Southern Utilization Laboratory in Georgia.

2.2.2 The Leading Role Played by the State in Agroindustrial Development and Progress

The state is one economic force that plays an essential role in the agroindustrial development and progress, but so far has only been mentioned in connection with public institutions and enterprises. It represents all the economic forces mentioned previously, and also the public at large, in production and consumption of agricultural products (problem of employment). Since dissemination of every development and innovation involves contradictory social and economic interests, the primary function of the state is to serve as a referee, and if possible to reconcile these interests, with special attention to protecting the nation's long-term interests. This is the purpose of the state's economic functions, which is expressed through the application of global, sectoral, regional, and social economic policy in the broadest sense, and through all types of economic, fiscal, customs, legal, and administrative measures. In agroindustrial development, this policy has certain weaknesses that need to be analyzed, before the role and functions of the state in information, technology transfer, and development can be stipulated.

Weaknesses in the industrialization policy

In the Ivory Coast, the agroindustrial development policy has up until now been mainly a subsidiary of an industrialization policy, the main provisions on statute, size, location for enterprises, types of products, and target markets of which have already been briefly mentioned. The

state's special participation has already been cited as the encouragement to foreign private investment and the creation of both public and joint venture national companies. However, two comments on this should be discussed.

First, until now, little interest has been shown in processing traditional agricultural products and in intermediary technologies applied at the household- or village-level. A key explanation for this weakness lies in the non-availability or lack of understanding of innovative efficient technologies. Information dissemination therefore seems to be a priority in order to stimulate the interest of various ministries and public and professional institutions in the need for the introduction of adequate technology and research-development.

New industrial activities to upgrade traditional products, or derivatives of these products, using known or easily available technologies could readily be developed with the help of organizations such as the Société Nationale de Financement (SONAF) or the Office de la Promotion de l'Entreprise Ivoirienne (OPEI).[6] The role of these organizations could be modelled partly on that of the Indian Kadi and Village Industries Commission, which created village and artisan activities that generated over three million jobs.[7]

Such activities can only be promoted if measures are taken to reduce the risks devolving upon the existing or new enterprises concerned. This implies investment assistance, at least temporary customs protection, a reduction in publicity on competing imports or local products that have been only slightly processed, and monopolies of certain special markets such as school cafeteria for foods made from enriched local products.

As concerns research-development on processing traditional agricultural products and intermediary technologies, after general guidelines have been worked out with the potential users, the system of operations and financing has to be finalized with a commitment from the state for public programs, and support for programs entrusted to professional or private institutions or enterprises; this falls under a "support-to-innovations policy."

Second, in the industrialization policy there is no clear general policy for visible or commercial transfer of technology using direct foreign investments, equipment purchased abroad, or licensing agreements. The Foreign Investments Code focuses primarily on the financial aspects of the establishment and operation of foreign enterprises (tax scheme, local reinvesting, exporting profits, etc.). Clauses on the use of imported technologies do not include a schedule for their transfer to national users.

At present, national or joint venture enterprises transfer technology (equipment, licenses) at their own discretion, subsequent to individual contacts and according to specific needs, customs regulations, etc. A more structured policy would seem to be required. Other Third World countries, for example, in Latin America (Brazil, Mexico, and Andean Common Market for example) and in Asia (Korea, Taiwan) have set up national agencies[8] to register and study all pending technology agreements. The objectives of these agencies are to improve the apprenticeship capacity, to allow for the independent use of imported

technologies, and to strengthen the bargaining power of national users in their relations with foreign suppliers and secondarily, to export innovative technology developed by national research institutions for further refinement abroad. Ivory Coast would do well to draw inspiration from these initiatives.

This visible technology transfer policy could well complement the nonvisible, noncommercial technology transfer policy. This could be implemented via a state training policy for senior employees and technicians within the country and abroad, whether covered by bilateral agreements or not. The two policies could be systematically combined, and the training received would provide better preparation to fulfill the needs of the economy. Furthermore, this is the only way to accelerate national mastery and control of foreign dominated modern technologies.[9]

The function of the state information services, project evaluation and formulation, technology development

The preceding remarks can be useful in preparing a definition of the normative function of the state in short-, medium-, and long-term agrotechnological development.

The provision or dissemination of information is a top priority that bears on the whole agrofood sequence and the available foreign technologies. The state should be able to compile, analyze, and disseminate information on the current situation in the agrofood industry, the needs and possibilities of technology suppliers and consumers, and on the consumer behavior patterns. This is a massive undertaking that will entail thorough research on:

* The channels followed by agricultural products: only a few CIRES scientists are working on this theme (ISNAR, 1982), and more needs to be done in collaboration with concerned enterprises and technologists studying technologies currently being used (application, quality, drawbacks, further work needed considering available technologies, and future research).

* Food consumption, ORSTOM and the Faculty of Medicine, among others, have done some work on this subject; but more needs to be done by multidisciplinary teams (medical doctors, nutritionists, and technologists), starting by identifying the groups most quantitatively and qualitatively undernourished and then formulating measures to alleviate or eliminate the observed deficiencies, using agricultural products grown within the country whenever possible.

Findings should be reported in scientific and technical publications, which could be used as the basis for the work done by the Planning Committee on agroindustries in preparation for major economic decisions.

Information is needed on foreign technology that could be of use to:

* National enterprises that want to diversify and improve their production and be kept uptodate on the benefits of current technologies; the information function should lead onto an advisory-support function during negotiations with foreign suppliers of technology, a function that would actually be a service to all national enterprises, especially small and medium enterprises that cannot fare alone.

* Public and private research centers anxious to identify possible areas of adaptive and original research and joint actions with foreign institutions.

These information-documentation services could be handled by a special agency similar to those established in Brazil, Mexico, etc., or by a special bureau of an institution with a broader mandate. In either case, close cooperation with UNIDO, WIPO, etc., would be necessary.

Project evaluation and formulation. Any development project, be it the creation or the expansion of an enterprise, must be evaluated by the state if public funding is involved or if strong labor or infrastructural requirements, etc., are involved in a private project. Evaluation could be assigned to a public engineering bureau (working alone or in partnership)[10] which would be given responsibility for designing major projects for submission to the planning committee on national or foreign financing and perhaps also for assisting and advising small and medium enterprises.

The development of technology. The state can further the development of technology by increasing resources for public research centers, by supporting research conducted in national enterprises (different methods to stimulate innovative research), and by encouraging cooperation between national entities and later between national entities and foreign institutions and enterprises, especially those found within the Economic Community of West Africa (CEAO).

This function obviously requires an adequate number of competent national senior staff (cadres) and technicians in biology, mechanics, etc., and also in commercial fields. This explains the need for greater attention to training, which can be adapted to meet needs if potential users and research centers remain in close contact with each other. But the state's function to develop technology can only serve the national economy well if adequate consideration is given to the specific problems of the agrotechnology research-development process in developing countries.

2.2.3 Difficulties in the agrotechnology research-development in Ivory Coast

In the developing countries, the costs and risks of the agrotechnology research-development process are exceptionally high. Agrotechnological research, wherever it is undertaken, is much more costly than agricultural research because expensive equipment is required for laboratories and for making industrial prototypes; highly qualified technicians are required to use and maintain the equipment. In countries such as Ivory Coast, most equipment has to be imported, and there is a dearth of technicians. The outcome of research that might initially seem interesting may be difficult to disseminate, regardless of the type of innovation proposed.

For innovative technologies that could be used with a minimum of industrial inputs in homes and villages, industrial investments and the profit-making potentials are too limited to obviate the need for state aid for information dissemination and technical supervision. Since the

earliest effects of such innovations will probably be improvement of the nutritional status of the people and the quality of rural life (before bringing about increased trade), state contributions will only increase the money flow slightly. During an economic crisis, it is unlikely that the state will agree to financial commitments that are not likely to be profitable, even if profit is forthcoming in real and social terms.

If new industrial processes are required, capital investment of some level will be needed, in any case, much more than during the experimental phase or for the final development of the prototypes. In a country like Ivory Coast, where the industrial fabric is lightweight, much of the required material has to be manufactured abroad. Delivery times are often long, which means that the process may become known and competition may develop. If the innovation concerns a new consumer product, additional material investments may be required, and the risks of a narrow market (small population, usually not wealthy) and difficult access will have to be dealt with, especially if the new product does not fit into the "occidentalization process" (Toure, 1981, p. 276) that the Ivorian society is already undergoing.

Considering these difficulties, the development of technology should be initiated or intensified with great care, in order to avoid failures such as the well-known ITIPAT experience in Ivory Coast and others encountered by similar institutions in other developing countries. A small measure of success when the research results are adopted is essential to ensure the continuation of an activity that may be vital in the long-run to renovating development geared to decreasing dependency and increasing autonomy.

CHAPTER THREE: Agrotechnological Research in Ivory Coast

A number of general principles on the objectives, conditions of development and institutional aspects of agrotechnological research have been presented in the previous sections. A reiteration of these principles can bring out the limits of an evaluation of agrotechnological research on the basis of a single institution, in this case CIRT.

3.1 General Principles of Agrotechnological Research

3.1.1 Summary of the objectives of agrotechnological research

Agrotechnological research must work towards promoting agrotechnological development that is in keeping with the country's needs and capabilities (Section 2.1.2). By proposing meaningful innovations, research should contribute to the quantitative and qualitative improvement of the human diet, expand outlets for agricultural products other than through food sales and thereby contribute to upgrading national agricultural products, provide more rural jobs (and downstream jobs in related sectors), and improve the town-village balance. Finally, agrotechnological research can play an important role in implementing better controlled rural development schemes that are less dependent on technologies, consumer habits, and even foreign enterprises.

3.1.2 Conditions needed for harmonious development of agrotechnological research

Considering the potential long-term role of agrotechnological research, constant awareness is needed of the many failures encountered by this type of research -- because of the great difficulty in building up and disseminating agrotechnological progress in any developing country. The continuation and growth of agrotechnological research can be guaranteed only if such research embraces broader functions, is discriminating in its scientific choices, and ensures a certain degree of compatibility with development.

Widening the research functions

Agrotechnology has developed in the Ivory Coast without help from national research. The difficult straits that constituted the early beginning of public agrotechnological research show that the first goal should be to justify its existence and to confirm its acceptance. With

this in mind, a wise strategy would be for research to display its qualities through information programs, project evaluation-promotion, agrotechnological planning and training, which can attract the immediate attention of public and private Ivorian leaders and command decisions to be made of importance for the medium and long term future.

Scientists should not, however, devote excessive amounts of time to these activities that are basically not part of their jobs, but simply they should be critical and contructive, active and worthy of esteem, in order to establish links between their work and the related research. On these meeting grounds, the research scientists must ensure that their analyses and syntheses live up to the greatest scientific rigor. This requires courage and modesty to recognize shortcomings in available data, and proposed projects and research, and also to win recognition for the importance of increasing understanding of present situation, and of introducing research into national agroindustrial enterprises with, as a final aim, overcoming the fallacious impression that research is omnipotent and can solve all problems.

Only the most experienced scientists, should undertake these activities, but not at the expence of research itself. This requires an intense professional commitment, substantial consolidation of scientific information (documentation, consultants' visits, study tours, etc.), a multidisciplinary approach including socioeconomic aspects which Ivorian partners in this exercise consider to be essential.

Careful planning of research

Because of high costs and risks, themes and resources for agrotechnological research and development must be chosen with the greatest of care. Scientists should not have to select research priorities alone. On the contrary, it would be advisable for such choices to emanate from political decisions that reflect politicians' commitment to the themes selected, provision of the resources needed, and possible use of the outcome of the research. In this scenario, choices would be made, bearing in mind the capabilities and needs of the potential users, and the following:

* A priori, there has been little opportunity for research on modern technologies for storing, preserving, and processing the major traditional tropical products.

* Interest exists for technologies that could be used by the small and medium agro-industrial enterprises, rural artisans, and agricultural units.

When research priorities have been defined, the scientific institutions will need to finalize their programs and actions according to human and material resources they have in-house and can secure through international cooperation. These institutions should concentrate on a limited number of undertakings, and maintain a calculated balance between long- and short-term research, since the latter should generate early results that can guarantee obtention of resources needed for the former.

Coherence between research and development

Considering its late beginnings, research should grow faster than development. Yet each activity or sequence of processes needs individual

study to ensure that the national users are able to incorporate the innovations coming from research. This explains the value of having representatives of both direct and indirect[1] users as well as organizations promoting Ivorian enterprises (SONAF, OPEI), participating in programming, and evaluating agrotechnological research. It would be better if these users could actually participate in research by setting up research units within the large enterprises or through professional groups attached to the small and medium enterprises. The state could play a preponderant role by granting innovation-encouragement bonuses or by financing certain types of research.

3.1.3 Diversified financing and statutes for agrotechnological research

The preceding remarks suggest that gradual shifts will occur in which not all agrotechnological research will have the same legal status, that public research centers such as CIRT and I2T, the GERDAT institutes, and private confidential research conducted by a few foreign enterprises such as UNILEVER and NESTLE, will be accompanied by private research units belonging to large state and private enterprises and professional units belonging to interenterprise groups. It is a responsibility the state must face through its ministries, especially MSR to see that diversity does not mean dispersion and fragmentation.

A little time should be allowed to tighten cooperation between public scientific institutions, in particular between CIRT and I2T. For public, private, and professional research, programs funded fully or partly by the state should be harmonized through a programming-evaluation procedure covering all research thus financed. Lastly, the state should finance a joint information-documentation service available free of charge to all possible national users. In this family of institutions, it seems that the public research institutions should be solicited to play an especially important role, and consequently should be expected to display all-round interest in the whole agro-industrial scene.

3.2 Limits to the CIRT Evaluations

The Ministry of Scientific Research asked the mission to devote to CIRT a large part of the short period it had set aside for agrotechnology. The mission evaluated CIRT's activities and projects and its human and material resources. However, few recommendations and proposals can be made until CIRT's functions have been defined in relation to those of other institutions and enterprises. This applies not only to research but also to information, project evaluation and formulation (that is, planning), and training services.

3.2.1 CIRT's present situation

CIRT is a young and strictly national research institution. Circumstances in which it was established and its objectives have already been discussed. Its organizational structures are not yet clear, and its small staff (only six scientists, but the number is expected to be increased soon) is mainly concerned with selecting future research activities for the center.

Programs and operations proposed by CIRT

The small team of CIRT scientists have, on the basis of their center's general objectives, prepared a thorough research program document containing over 200 dossiers on project proposals for various fields (Ministry of Scientific Research: Programs Committee 1981a).

This document is evidence of the open-mindedness and the sense of discrimination of the Ivorian scientists, who are seeking as exhaustive an approach as possible to the agrotechnological problems that could be studied in Ivory Coast through related research programs. The document even indicates the duration and unit costs of each operation and the names of interested resident scientists. In its present form, it can only be considered as preliminary document; it will have to be edited because of weaknesses, most of which the authors seem to acknowledge readily. The main weakness is inadequate grouping and classification of programs and operations.

The document would have been much clearer and credit-worthy had it sought to fit research themes into major theme groups, according to priorities, economic targets, and scientific problems.

* Economic targets: At first glance at the main problems in agrofood development approached through the main agricultural products of national origin and the products consumed within the country, it is obvious that there is a lack of information, and that there is a need to carry out more comprehensive studies (together with other organizations, such as ministries, national enterprises, and other research centers) in order to define problems and rank priorities better. It is instructive to see that there are few research operations and programs geared to increasing knowledge of realities, both technological and socioeconomic. Acquisition of such knowledge implies multidisciplinary and multiinstitutional approach which is at present all too absent.

* Scientific approach: Research operations and programs set out in the document involve numerous disciplines that are not well enough defined, but which are expected to be controlled adequately by versatile scientists. This is not a realistic perception of scientific research, which indeed needs such scientists but which also requires monodisciplines, such as cellular biology, microbiology, biochemistry, nutrition science, physiology, thermodynamics, mechanics, and social sciences. If the technico-economic approach to problems had been coupled with a scientific approach, it would have been possible to identify the disciplines that are required to examine given problems and, at the same time, to suggest more joint actions or division of responsibilities with other national institutions and a better evaluation of staff needs within CIRT.

Insufficient organization of programs and operations has resulted in:

* A multiplicity and dissemination of programs and operations focusing on identical or related themes, which explains the numerous repetitions and endless overlapping in work to be done by groups of

scientists. (This also forces scientists to "spread themselves thinly" -- some are programmed to work on as many as 15 projects at a time!);

* Imbalanced research projects; some operations are of considerable size but receive scant resources, for example, the study of sugar cane and pineapple stalk and waste processing and utilisation operations have been assigned to one research scientist plus a technologist and a technician for three years with a research budget of four million CFAF.[12] Other operations require complicated basic research that can only be carried out by a team of experienced scientists, for example, the selection of cellulose assimilating yeasts. There are other operations that cannot even be called research, for example, the analysis and definition of the physicochemical characteristics of agricultural products and by-products.

Finally, no effort has been made in the document to place the proposed research in the international scientific context. There should have been a brief presentation of research and results obtained in other countries, at least in African institutions of the same type, so that the originality of the envisaged programs and operations can be judged and, where appropriate, cooperation with foreign institutions can be suggested. It is obviously that certain projects are nothing more than repetition of research already conducted, and in some cases successfully completed elsewhere. This is the case, for instance, for most of the research that has been suggested for cereals, rice crops in particular.

Because of the above situation, it was difficult to judge accurately or update the dossiers. Considering only the three main criteria, for instance (economic viability, possible impact on the future of agrotechnology, and current capability at CIRT), there seem to be about 30 projects (65 research operations) that are suitable for adoption (Annex 4). Evaluating these programs in terms of the other eight criteria, using three levels of priority, reduces this figure to less than 15 (Annex 5). Going further, the CIRT professional capacity at present is probably not strong enough to conduct the research needed for the proposals that fall in the categories of acceptable projects, and to carry these projects to successful completion. This evaluation, however, is too superficial. The project proposals should be evaluated more systematically before they are submitted to MSR for programming.

Research personnel

The CIRT scientific staff includes 24 highly trained and specialized research scientists; presently six of them are working on food technology, microbiology, nutrition, and biochemistry and 18 are presently abroad attending scientific training courses (Annex 6). When these scientists reurn from aborad, CIRT will have a team of scientists specialized in:

* food technology	5
* new energy sources (biomass)	3
* microbiology	4
* nutrition	5
* solar energy	4
* other disciplines	3

The following comments are made about the staff that will soon be available at CIRT.

* The scientific staff is, or will be, composed of young researchers with good theoretical background but little or no professional experience.

* Except for general economics and social sciences, the main fields are covered. Food technology and biomass, which are subjects specifically covered by CIRT (there are microbiologists in the Faculty of Science and nutritionists in the Faculty of Medicine) and most adapted to applied research, are insufficiently represented. There are four specialists in solar energy. The Economic Community of West Africa (CEAO), to which Ivory Coast belongs, has recommended that a regional research center for solar energy be established in Bamako.

* The technical staff has received far less attention than the scientific staff. No training or early recruitment schedule has been planned for technicians. This is most serious and could quickly become the major cause of delay in scientific work.

Infrastructure, laboratories, and equipment

CIRT has inherited the infrastructure, laboratories, and equipment of ITIPAT. Some of the basic equipment required for a technological research center is available but is not in good condition. Most of the laboratory equipment needs to be repaired, and some is totally out of commission (Annex 7).

There is no precise inventory of the material available to CIRT. Because this type of equipment is expensive, a detailed inventory of available equipment and spare parts should be made as soon as possible, and repair work should be started without delay.

3.2.2 Preliminary issues and initial proposals

The analysis of the current situation should lead to the preparation of recommendations and proposals, but this can only be done after certain issues concerning the functions and context of CIRT have been considered, at least summarily. Consideration should be given to the following:

* The division of responsibility between the future of CIRT and I2T.

* Government policy on innovations and support for private and professional research, especially how such research is to be monitored, and what role CIRT or CIRT and I2T are to play in monitoring research.

* Whether the present information and technology-transfer policy should be maintained, or whether a special agency or a service attached to an existing political institution (such as ministry or CIRT) should be established;

* The policy on postgraduate and ongoing training in agrotechnology.

For reasons explained earlier, initiall establisment of a single or unified public sector scientific pool of specialists in agrotechnology, working closely or integrating with CIRT and I2T, would seem to be the best solution. The next stage would include the promotion of private (beginning in state agro-industrial enterprises) and professional research, which would lead to research being contracted to CIRT-I2T with joint public and private financing. In this context, the public sector scientific pool could have the following responsibilities:

* It could serve as the secretariat for an interministerial committee for programming agrotechnological research, with the responsibility of defining research priorities and allocating programs and the corresponding public fundings to the public, private, and professional research centers[13].

* It would be partly or fully responsible, together with other institutions and enterprises, for preparing a preliminary budget for the pool, with various phases for selection, and evaluation of new and ongoing programs (management of departments, programming and scientific committees open to outside experts).

* Implementation of research programs and operations.

* Creation and management of an information, documentation, and technico-scientific relations service open to all authorized institutions and enterprises working on agrotechnological development.

* Creating and running a training service which, in the beginning, would be limited to an ongoing system for retraining senior national officers, specialized seminars for students, and advanced instruction, etc.

When national scientists have acquired enough experience in research and development, it may be possible to cooperate more closely in a postgraduate training scheme designed and operated by the specialized agronomy and technology faculties (grandes écoles) and the university (biology, economics). In certain disciplines, this postgraduate training could be linked to training offered by the research training center suggested in the ISNAR report on agricultural research.

Initial proposals

The question of structures and the development of human and material resources (especially) must be treated with some degree of caution as long as preliminary issues of the state policy on information, research, and training in agrotechnology and the responsibilities beholden on CIRT have not been settled. CIRT could take the initiative of carrying out an analytical study on Ivorian agrotechnological activities in order to enlighten the national decision-makers.

The structures and organization of CIRT cannot remain fluid, even during a transitional period. These must be specified, however, without compromising the flexibility the center needs to accommodate change

whenever necessary. As programs develop, as new specialists are hired, and as new resources for research are made available to cope with increasingly varied problems, CIRT will build up more sophisticated structures, equip its laboratories better, and improve its managerial system (planning, programming, implementation, communications, specialized services, training, administrative and scientific management, etc.). It should not be forgotten that it may be difficult to change programs, but it is often more difficult, if not practically impossible, to change structures, systems of management, well-rooted activities, senior job assignments, etc.

This explains the need to avoid the premature establishment of a large number of departments, research laboratories, and services. In the first phase, two subject-specific units could be set up: technological engineering (génie technologique) and biology. This would not present problems if, as preferable, the scientists in these units were to work with other research scientists in multidisciplinary teams. A service to analyze or test products will be required by internal research and to cater to outside partners; a service for information, documentation, and scientific relations, and training will also be required..

It is not possible to give precise numbers of staff and the scientific orientations of staff required for CIRT's future needs without having a more complete program of research and other activities. Because of the importance of socioeconomics in studies, programs, and evaluation of research, it will be necessary to recruit a small number of researchers (at least three in the immediate future) who are specialized in the agrofood channels, business management, and socio-agronomy (to study home and village agrotechnology).

A complete inventory will have to be made of the installations that CIRT inherited from ITIPAT, followed by an evaluation of rehabilitation costs. A similar inventory of installations and equipment in other institutions (I2T, ENSA, Faculty of Science, Pasteur Institute, etc.) will be needed, in order to study the feasibility of sharing the most expensive equipment. Equipment and facilities specific to work in given agrotechnological enterprises should be purchased by these enterprises through contracts or their internal research units.

The most pressing need seems to be for a <u>synthesis-diagnosis study of Ivorian agrotechnological activities</u> in order to define better the research priorities and ways of implementing them. This study should seek to present as complete a picture as possible of these activities, to pinpoint the most serious information gaps, to identify the main problems and then, in view of the available technologies, to generate: (1) proposals and thoughts on the development of national agrotechnology and (2) program proposals for research, experimentation, and adaptation, with an indication of national and foreign participation.

The main value of such a study would be to provide information and to arouse awareness of Ivorian leaders in agrotechnology, both in the public and nonpublic sectors. Issues raised earlier should be defined so that early solutions can be found. Such a document should be instructive for senior employees, teachers, students, and future scientists; for this purpose, full references should be made to all earlier work and publications in Ivory Coast and to the main foreign research of interest to Ivory Coast.

The research program proposals, preferably after having been reviewed by the public authorities in charge of agrotechnology research and development, should enable CIRT to define its scientific activities and, insofar as possible during the early stages, to hold down the number of research operations and programs by assigning multidisciplinary teams and by soliciting assistance from without.

This analytical study might prove to be decisive for the future of agrotechnological research in Ivory Coast and for CIRT. This institution should take the first step, but every care should be taken to guarantee the quality of its work and to enroll cooperation from other public institutions concerned (e.g., I2T, GERDAT, ORSTOM, ENSA, CNRS, BCET, etc.) and the main state rural development agencies. Assistance and support from qualified foreign experts would be most useful.

CHAPTER FOUR: Conclusion

The ISNAR mission on agrotechnological research in Ivory Coast was designed to initiate contacts that could be of use in developing general thoughts on (1) the process of building up and disseminating technological progress and (2) on conditions needed for technological progress to parallel socioeconomic progress. These thoughts are worth furthering and qualifying, so they can serve as a reference for better definition of Ivorian agrotechnological research and development policy.

This initial cooperation could be followed by a second phase focused on the preparation and implementation of an analytical study of agrotechnological activities and, thereafter, problems more specific to the management and organization of agrotechnological research that may be carried out as a followup to the study.

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Notes in Text

1. Solar energy is beginning to be used for ventilation and refrigeration and is especially well adapted to the needs of regions without electricity networks.

2. Examples: techniques for the preservation of fish, meat, and liquid milk in Tropical and Sahelian Africa; and potatoes in the Andes Mountains, production of corn pancakes using lime water to facilitate protein digestion in Central America, etc.

3. Ministry of Economics, Finance and Planning. "Côte d'Ivoire en Chiffres", 1980-81 edition, p. 187. "No modern economy can be satisfied with merely a few factories, regardless of their size. It requires an industrial fabric which must be tight-woven and must branch out in order to be sound. It must include a large number of small units that only employ a few dozen workers...usually managed by the owner and possessed with a spirit of enterprise and innovation. Considering the above and in order to overcome the handicaps just mentioned, Ivory Coast is striving to redirect its industrial policy in order to make its industry less dependent on foreign sources and, secondly, to build up a class of Ivorian executives, leaders, and entrepreneurs."

4. As an example, UNILEVER employs about 750 university graduates in its laboratories, especially in the United Kingdom

5. For other organizations specializing in agrotechnology in EEC and the signatory countries of the Lomé agreement, see the Compendium of Industrial Food Research Centers published by the Center for Industrial Development, EEC, Brussels, 1980.

6. SONAF is a public finance company that tries to obtain national funds to lend to Ivorians who wish to start an enterprise. OPEI is a public organization, which encourages the Ivorian intelligentsia to undertake enterprises themselves, and then acts as an adviser in the preliminary phases (La Côte d'Ivoire en Chiffres, 1980-81, p. 188)

7. activities included: 80,000 "gobar" gas installations (methane produced from anaerobic fermentation of cow dung and other waste) for lighting and cooking (a technology that is now exported to other countries), and the support for the artisan production of textiles, leather goods, farm tools.

8. The National Institute for Intellectual Property of Brazil, the National Register for the Transfer of Technology in Mexico, etc.

9. OECD -- North-South Technology Transfer -- the Adjustment Ahead, Paris, 1981-82, 2 vol, 338 pp.

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10. This bureau could of course maintain relations with Bureau d'Etudes Techniques des Projets Agricoles (BETPA) of the Ministry of Agriculture for all rural development projects, with foreign bureaus (evaluating jointly financed agro-industrial programs), and with national research institutions. The mission learned too late of the existence of Bureau Central d'Etudes Techniques (BCET) a public engineering bureau to include further discussion in this report.

11. The only direct users who might appoint representatives would be the agroindustrial enterprises. The agricultural units, because they do not have strongly supported professional groups, can only be represented by ministries concerned with agrotechnological research (Scientific Research, Industry, National Education, Agriculture, Food Production, Animal Production). Indirect users are national enterprises (e.g., ABI for iron and steel production), capable of participating in the manufacture of new industrial equipment designed by research, or parts that are assembled locally as the result of individual and artisan innovation.

12. By way of comparison, the Sugar Cane Derivatives Research Institute (ICIDCA), of Cuba employs over a hundred research scientists.

13. The principle of the proposals on programming agricultural research (processes, structure) presented in the ISNAR report (Section 4.2) also apply to agrotechnological research.

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MEMBERS OF THE ISNAR MISSION

Annex 1

Prof. Isaac Arnon	Specialist in Research Organization and Administration, Former Director of the Volcani Institute, Israel; ISNAR Consultant March 27 to April 6, 1982
Prof. Arie Beenhakker	Specialist in Agro-industrial Technology, University of South Florida, Tampa, Florida, U.S.A.; ISNAR Consultant March 28 to April 8, 1982
Mr. Joseph Casas	Agroeconomist, Specialist in Research and Training, INRA Research Scientist, Montpellier, France; ISNAR Consultant March 14 to April 8, 1982
Dr. Rudolf Contant	Geneticist, Specialist in Research and Training Organization, Senior Research Officer, ISNAR March 14 to April 8, 1982
Mr. René Devred	Agronomist and Forester, Specialist in Research Development, Senior Research Officer, ISNAR March 19 to April 8, 1982
Dr. Juan Carlos Martinez	Specialist in Research on Production, International Center for Maize and Wheat Improvement (CIMMYT), Mexico; ISNAR Consultant March 30 to April 5, 1982
Mr. Alexander von der Osten	Economist, Executive Officer, ISNAR, Head of Mission March 14 to April 8, 1982

SCHEDULE OF VISITS CONCERNED WITH AGROTECHNOLOGY

Annex 2

Sunday, March 28, 1982

Arrival of Dr. Beenhakker

Monday, March 29, 1982

Visit to IRHO Marc Delorme Coconut Station at Port Bouet
(Von der Osten and Beenhakker)
Visit to the plantation and discussions with Mr. G. de Taffin de Tilques, Station Director

Lunch at the home of Dr. de Taffin (von der Osten and Beenhakker)

Tuesday, March 30, 1982

Discussion at the Ministry of Scientific Research (MSR) on the present situation at CIRT with Mr. Jean Marie Michotte

Discussion at the (MSR) on processing and publications, with Mr. Abdoulaye Kone, research scientist at CIRT (Beenhakker and Contant)

Wednesday, March 31, 1982

Visit to MSR to review the current situation.

The ITIPAT precedent, the CIRT objectives as defined in 1981 -- discussion with Mr. Abdoulaye Kone and Mrs. Ya Diakité, (MSR), and Mr. Jean-François Poulain, IDESSA Director

Review of the CIRT objectives and research program

Discussion with Mr. Abdoulaye Kone and Mrs. Ya Diakité

Thursday, April 1, 1982

Visit to MSR to study research projects and to identify viable projects; discussion with Mr. Abdoulaye Kone and Mrs. Ya Diakité

Friday, April 2, 1982

Visit to the CIRT Technology Hall with Dr. Abdoulaye Kone

Visit to MSR; discussion on the research project files with Mr. Abdoulaye Kone and Mr. Michel Lingami

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Saturday, April 3, 1982

Review

Sunday, April 4, 1982

Review

Monday, April 5, 1982

Discussion with I2T management, Mr. Philippe Potot, Technical Director, and other discussions on CIRT and I2T

Discussion on CIRT with Mr. Jean-Marie Michotte, Technical Adviser at MSR

Discussion on CIRT with Dr. Kouame M. Miezan, Chargé de Mission

Discussion on the CIRT budget program with the financial controller of the MSR

Meeting with Dr. Balla Keita, MSR. Presentation of the mission's conclusions and recommendations

Dr. Balla Keita, Minister of Scientific Research
Mr. Antoine Kouadio Kirine, Directeur de Cabinet
Prof. M. Alassane, Technical Adviser (International Technical Assistance)
Mr. Jean-Marie Michotte, Technical Adviser (Science Policy)
Mr. Jacques Sarraute, Technical Adviser (Evaluations and Finance)
Mr. N'guetta Bosso, Technical Adviser (Research-Development Liaison)
Mr. Mathias Coulibaly Dogněněna, Director of Research and Programs
Mr. Noël N'guessan Kanga, Director of Training
Mr. Kouamé Miezan, Chargé de Mission, ORSTOM geneticist

Tuesday, April 6, 1982

MSR, discussion on the formulation and evaluation of research projects, with Mr. N'Guetta Bosso

Lunch offered by Dr. Balla Keita, Minister of Scientific Research for:

the Minister of Youth and Sports
MSR Directeur du Cabinet
MSR Department Heads
MSR Technical Advisers
Representatives of the World Bank
ISNAR Mission

Discussion on the role of CIRT in Ivory Coast with Capral executives (Nestlé), Mr. Georges N'dia Koffi and others

Wednesday, April 7, 1982

MSR, discussion on conclusions and recommendations for CIRT, with Mr. Jean-Marie Michotte and Mr. Abdoulaye Kone

Discussion on the role of CIRT in Ivory Coast with Blohorn (Unilever) executives

Meeting with Dr. Balla Keita, Minister of Scientific Research
Presentation of the mission's conclusions and recommendations on agrotechnological research

Dr. Balla Keita, Minister of Scientific Research
Mr. Antoine Kouadio Kirine, Directeur du Cabinet
Prof. M. Alassane, Technical Adviser (International Technical Assistance)
Mr. Jean-Marie Michotte, Technical Adviser (Science Policy)
Mr. Jacques Sarraute, Technical Adviser (Evaluations and Finance)
Mr. N'guetta Bosso, Technical Adviser (Research-Development Liaison)
Mr. Mathias Coulibaly Dogněněna, Director of Research and Programs
Mr. Noël N'guessan Kanga, Director of Training
Mr. Kouamé Miezan, Chargé de Mission, ORSTOM geneticist

Thursday, April 8, 1982

Visit to PALMINDUSTRIE agro-industrial complex at Eloka
(Contant, Beenhakker, and Devred)

Mr. H. Abdou Boa, Head of Plantation; the Director of the Factory

Departure of the ISNAR mission to Europe and U.S.A.

LIST OF PROJECTS COMPLETED BY ITIPAT IN 1970 AND PATENTS FILED

Annex 3

Projects completed in 1970 were as follows:

* Agro-industrial complex for the Sassandra Region, a project led by the French group, Les Grands Moulins de Paris. As a result of which a consortium for Ivorian citrus and fragrant plants was created.

* Attiéké Project, taken over by Chicaya, an Ivorian company located at Anyana.

* Foutou Prêt Project (cereal).

* "Valorization des écarts de triage de banane" project (banana selection).

ITIPAT also filed for the following patents:

* Patent No. 4408-717 of February 3, 1964 -- process for making a dry food product out of precooked cassava and fruit pulp.

* Patent No. 1395-654 of February 18, 1964 -- process for making a dry food product out of precooked tropical products using cassava, yam roots, and plantain bananas.

* Patent No. 1395-964 of March 18, 1964 -- Foutou Prêt.

* Patent No. 1585-399 of November 21, 1968 -- process for stabilizing perishable foods and products obtained from this process or similar processes.

* Patent No. 23/044-542 of February 8, 1971 -- instant food products made from fermented cassava e.g., attiéké, gari, etc., and the processing method.

* Patent No. 2051-072 of March 22, 1971 -- process for obtaining a completely stabilized fresh kola nut extract, rich in compound caffeine (only patent available at ITIPAT)

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Table 4.1. Proposed CIFT projects meeting three main criteria[1]

Project Number	Title Program	Objective	Title Operation	Duration (years)	Cost (CFAF)	Equipment	Personnel
01	Biochemistry and nutritional value of cereals	Food selfsufficiency (quantity + quality)	* Biochemical components	1	600,000	Complete column chromatography and slab gel electrophoresis units	A. Kone, 1 biochemical engineer
			* Comparative analysis of protein content	1	500,000		1 international level technician
			* In vitro digestibility of flour	1	500,000		
02	Nutrition, food control, nutritional value of foodstuffs		Analysis of vitamins in unprocessed and processed food	Permanent	1,450,000	See above	Lingani 1 biotechnician (to be recruited)
03	Last stage of research on food made from ripe plantain bananas		Tests: analytical organoleptic, clinical acceptability, preservation	1/2	1,450,000	Construction of an animal facility	Lingani
04	Ivorian foods based on cassava	Improve the Ivorian diet	Inventory of varieties of cassava eaten in Ivory Coast	2	400,000	See Project I	A. Kone
			* Traditional technology used on cassava	2	200,000		2 UTI level technicians to be recruited
			Biochemical characteristics of cassava varieties	2	1,000,000		
			Chemical preservation of processed foods and changes caused by hygrometric conditions in Ivory Coast	2	1,500,000		
			Toxicological problems and nutritional value of different varieties of cassava	2	300,000		

1. The proposed projects which meet the three main criteria for CIRT research -- economic viability, possible impacton future agrotechnology, and the current capability of CIRT

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Project Number	Title Program	Objective	Title Operation	Duration (years)	Cost (CFAF)	Equipment	Personnel
05	Sauce made from oil palm seed	Improve consumption of oil palm products	* Study chemical characteristics	2	1,000,000	See Project I	A. Kone + 2 technicians
			* Adding protein and vitamins to the sauce	2	1,300,000		
			* Making a seed sauce from a melanococca hybrid	2	1,400,000		
			* Nutritional value of the oil palm seed sauce	2	1,000,000		
06	Biological extraction of banana juices (plantain, poyo)	Alcohol produced locally		short-term	300,000		Zaguehi + 1 microbiologist + 1 biotechnician
07	Final design for a fermentor for industrial processing of cocoa				500,000		
08	Study on germination and malting of local varieties of rice		Finalize a rice germination technique		250,000		Zaguehi
			Producing flour for infants from malted rice				
09	Methanization of wastes and residues from palm oil refineries	Residual oils from pulp could be studied for value as fuel for diesel engines or light internal combustion engines	Selection of yeasts that can assimilate cellobiose	Medium-term	800,000		
			Optimization of culture	Medium-term	600,000		
			Identify appropriate amylase				
10	Food yeast cultured on cellobiose						
11	Upgrading cereals and starches of Ivory Coast				400,000		

Project Number	Title Program	Objective	Title Operation	Duration (years)	Cost (CFAF)	Equipment	Personnel
12	In vitro cultures of the organs, tissues and cells of the higher plants. Study of certain local varieties of rice				500,000		
13	Preparation of compound flour from cereal	Improve the nutritional value of local foods	Animal feed	2	800,000		A. Kone 1 biochemical eng.
			Fish feed	2	700,000		
			French production system	2	1,500,000		
14	Effects of technological treatments of cereal flours		Study of physicochemical properties	2	450,000		
			In vitro study of changes in digestibility	2	450,000		
15	Biochemical and nutritional analysis of cassava and yams	Improve the nutritional value of local foods	Biochemical components	1 year	450,000		A. Kone + 1 UIT technician
			Variety description through electrophoresis of cassava and yams	2 years	500,000		
16	Promotion and upgrading of starch foods		Chemical and enzymatic hydrolisis of starches	2	600,000		A. Kone + 1 nutritionist 1 technician
			Study on supplementing with cowpea flour	2	550,000		
			Technology for processing yams	2	1,200,000		
			Technology for processing cassava	3	1,200,000		

Project Number	Title Program	Objective	Title Operation	Duration (years)	Cost (CFAF)	Equipment	Personnel
17	Information and upgrading of starch foods		Rheology of different "foutous" (yams, cassava, sweet potato, taro yam)	2	500,000	1 special kneader (to be designed and built)	L. Kone 1 technician
			Rheology of "placaly"	2	200,000	"	L. Kone 1 technician
			Rheology of flour made from tuber and root crops	2	300,000	1 gluten dryer	
			s/prog. 2. Upgrading cassava				
			Isolating, selecting, and producing ferment from attiéké and from placaly	3	,000,000	1 pilot fermenter	L. Kone 2 technicians
18	Biochemical study of fruit		Biochemical composition of kola varieties	2	400,000		A. Kone 1 technician
			Enzymatic darkening occurring in pineapples and plantain bananas	2	1,000,000		
			Biochemical phenomena occurring in plantain banana	2	1,000,000		
19	Upgrading by-products from pineapple and sugar cane	Upgrade local use of local byproducts	Use and processing of pineapple and sugar cane (stalks and residue)	2	2,000,000		A. Kone 1 technologist 1 technician
20	Information on edible tuber and root crops	Improving the Ivorian diet	Development of the nutritive quality of tuber crops, from root formation to maturity and also during storage	3	2,000,000		L. Kone 1 technicians 2 laborers
		Mutagenic effect of x-ray on yam seed		3	3,000,000		1 technician 2 laborers
		Nutritive and rheological quality of derived tubers					

Project Number	Title Program	Objective	Title Operation	Duration (years)	Cost (CFAF)	Equipment	Personnel
21	Upgrading cereals		Evaluate the milling value of cereal flour	2	1,000,000		L. Kone 2 technicians
			Byproducts from milling rice: nutritional value and introduction into the diet	4	3,000,000		L. Kone 1 technician
22	Biochemistry and nutritional value of mushrooms		Biochemical composition	2	350,000	See Project I	A. Kone, Kossa, L. Kone 2 technicians
			Varietal characteristics of edible mushroom				
23	Upgrading cake and flour from oily plants	Animal feed preparations	In vitro study of solubility and digestibility of cake and oil plants	2	200,000		A. Kone 1 Food technologist
			Process for preparing animal feed	2	800,000		1 UIT technician
24	Study of edible mushrooms	Improving the Ivorian diet	Isolate and cultivate a cellulolytic mushroom from termite mounds	5	5,000,000	1 pilot fermenter	L. Kone 2 technicians
			Select and cultivate the edible mushrooms of Ivory Coast	5	5,000,000		L. Kone 1 technician 2 laborers
25	Chemical properties of agroindustrial waste	Upgrade by-products from agroindustrial complexes	* Analyze agroindustrial waste	3	700,000		Kossa + 1 chemical scientist
			* Seek traces of pesticides	Permanent			
			* Detect and extract flavonicides	2			+ 2 technicians
			* Identification and purification of food molecules				

Project Number	Title Program	Objective	Title Operation	Duration (years)	Cost (CFAF)	Equipment	Personnel
26	Preparation of weaning foods from local products	Control malnutrition (protein, energy) rampant in Ivory Coast	Food made from tubers, roots, and legumes	2	5,000,000		Kossa
			Food made from cereals	2	3,000,000		
27	Gasification of waste and residue (pods, pulp, shells)	Biogas production to save conventional energy resources		5	1,400,000	Build a digester	2 biotechnical scientists 1 chemist 3 technicians 2 laborers
28	Produce pharmacy alcohol from plant by-products	Reduce costly imports	Distill residue from pine-apples, bananas, etc.	2	4,000,000		1 research scientist 1 biochemical engineer 2 UIT technicians
29	Conservation of stock	Cover national food requirements and, in the medium term, build up reserves	Inventory of traditional conservation methods	1	2,000,000	1 commercial motor vehicle	L. Kone 1 technician 1 biotechnologist 1 mechanical engineer
			Utilization of modern conservation techniques	2	1,200,000	Equipment for and construction of a cold room	
			* Build experimental silos	2	6,000,000		
30	Final design of improved ovens	Save firewood, reduce deforestation	Build various types of ovens using local raw materials	2	1,400,000		1 mechanical engineer 1 technician 1 bricklayer

PRIORITY RANKING OF PROPOSED CIRT PROJECTS

Annex 5

The 30 projects (Annex 4) selected on the basis of meeti the three main criteria for CIRT research have been ranked below:

Priority	Low[1] (Project No)	Medium[2] (Project No)	High (Project No)
	02	01	03
	05	08	04
	10	11	06
	12	13	07
	14	16	09
	15	17	19
	18		21
	20		15
	22		16
	23		17
	24		18
			19
			30

[1] Low priority, projects which do not fit in with CIRT's eight objectives and therefore have little chance of being useful.

[2] Medium priority, projects which could perhaps be useful to CIRT, but they do not seem to be overwhelmingly important.

[3] High priority -- the potential results from these research projects could probably be beneficial when used in work directed towards the achievement of the eight objectives adopted by CIRT.

CIRT RESEARCH STAFF

Annex 6

List of Present Research Staff:

Name	Specialization
Abdoulaye Kone	Food Technology
Lancine Kone	Microbiology
Firmim Aboua	Nutrition
Anatole Kossa	Nutrition
Michel Lingani	Biochemistry
Mr. Zaguehi (subject to confirmation)	Microbiology

Staff who received training outside Ivory Coast with field and place of training:

Name	Field	Place of Training
Georges Agbo N'zi	Food technology	U.S.A.
Jacques Moulot	Solar energy	U.S.A.
Augustin Yao Koffi	Biochemistry	U.S.A.
Frederic Konan Kouakou	Food technology	France
Jean Labme Meless	Food technology (nutrition)	France
Adopoachille N'da	Food biochemistry (nutrition)	France
Francois Yeboua Aka	Food nutrition	France
Jacques Boa Mian	New energy (biomass)	Canada
Gabriel Kouadio Kouman	New energy (biomass)	U.S.A.
Abou Kamagate	Chemical engineering (petrochemistry)	U.S.A.-Canada -France
Antoine Ahua M'bia	BAC geological engineering	Canada
Dominique Anon Kokoty	Engineering	U.S.A.-Canada
Martin Diby Gnagne	Solar energy	U.S.A.
Abahehous Kamagate	Solar energy	Canada
Anatole Gbongus Made	Food/Nutrition	France
Mrs. Christine Ebequoi	Microbiology (conservation)	U.S.A.-France
Nicaise Ehoue Bleoue	Food technology	U.S.A.
Kouakou N'Dri	Technology (microbiology)	France

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LABORATORY EQUIPMENT TO BE REPLACED AT CIRT

Annex 7

Stablilization station for steam cooking
Grinders, homogenizers, cylinder grinders, heaters, filter presses
Industrial autoclave, concentration-evaporation system
Filtration pump under pressure
Pulp extracter, tammy, hydraulic press
Crimper, industrial centrifuge and super-speed centrifuge
Distillation and redistillation column
Pilot plant for juice concentration and aroma stripping
Spray drier with dosing pump
Drying chamber
Infrared tunnel drier
Freeze-drier
Vibro-tammy
Vacuum packing machine
Deep freezer
Cold room

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IDENTIFICATION OF AGROTECHNOLOGIES IN THE PRODUCTION-CONSUMPTION CHAIN

Annex 8

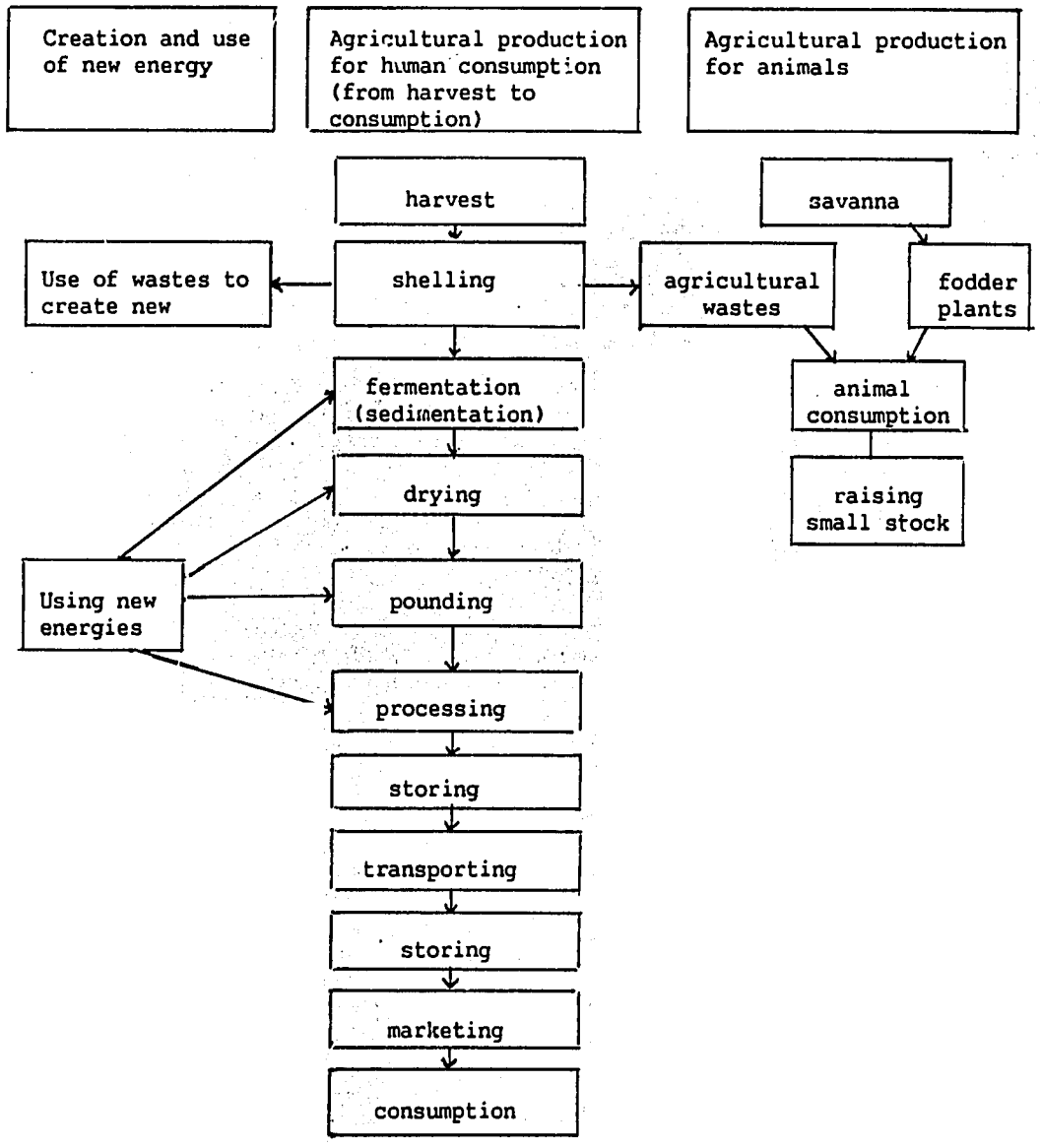

Figure 8.1 Production-Consumption Chain for Cocoa in Ivory Coast

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Explanation of preceding chart on the identification of agrotechnologies in the production-consumption chain

Most agricultural products progress wholly or partly through various steps between the harvest and the consumption stage. For each product a summary can be made of the various steps, possible uses of the by-products and the consumption of new sources of energy. The preceding table on cocoa can be used to identify themes for research projects aiming either to improve existing local technologies or to create new ones. A systematic study should be made in order:

* To determine, for each main agricultural crop (cassava, yam, cocoa, etc.), the exact chain of steps from harvest to consumption and to identify the points at which processing occurs (study of sequences) and, where applicable, lateral sequences (by-products, waste, etc.).

* To indicate which links in the chain seem to have problems or weaknesses, possibilities, and constraints, and to survey present and exceptional production levels (tonnages).

* To identify problems or constraints that could be overcome through the transfer of technologies that are available or have already been incorporated into research programs in other national or foreign institutions.

* To determine the steps to follow in order to test or adapt the technology-transfer process mentioned above, when such technology is available;

* To define and solve the problems that have been identified in the chain, in preparation for a detailed study of the research that needs to be conducted in order to optimize chances of providing an effective solution -- if a careful review of the literature shows that no technology seems to be available.

* To formulate research projects referred to in the preceding paragraph after BEPP has made a detailed evaluation.

* To take note of possibilities of creating and using new energies;

* To identify and do research on the link in the chain that could benefit from new forms of energy.

* To identify by-products that could be used for animal feed and other purposes; and to identify and do research on the lateral chains and the agro-industrial processing methods for the by-products.

* To identify where on the chain there is a need for storage and the related problems; to prepare research projects and activities related to the storage of processed or unprocessed output, by-products, etc.

* To identify phases in processing, methods, and technologies that could generate profit -- there are numerous outlets since Ivory Coast has few industrial processing units -- and to prepare research projects related to the above.

* To pinpoint weaknesses that exist in transportation and marketing and work out adequate solutions.

AGRICULTURAL AND AGROTECHNOLOGICAL RESEARCH

Annex 9

Agotechnical Research Activities in Ivory Coast

Product	Research	Quality Control	Processing
Cocoa	IRCC	IRCC	Nestie (CAPRAL)
Coffee	IRCC	IRCC	IRCC-SATMACI
Palm oil (Blohorn)	IRHO	IRHO	Unilever
Coconut	IRHO	IRHO	IRHO-PALMINDUSTRIE
Rubber	IRCA	IRCA	(specialization)
Cotton	IDESSA	IDESSA	CIDT
Sugar cane	IDESSA	Fiber plants	
Banana	IRFA	SODESUCRE	SODESUCRE
Pineapple	IRFA	IFRA-COFRUITEL	SALCI
Cassava	IDESSA, Food Crops Dept.		
Yam			
Rice			

Acronyms

IRCC	Research Institute for Coffee and Cocoa
IRHO	Research Institute for Oils and Fats
IRCA	Research Institute for Rubber
IRFA	Research Institute for Citrus and Other Fruits
SODESUCRE	State company for the development of sugar cane plantations and the industrialization/marketing of sugar
COFRUITEL	Producers cooperative for marketing fruits and vegetables in Ivory Coast
CAPRAL	Food preparations company
SATAMACI	Technical assistance company for the modernization of agriculture in Ivory Coast
BLOHORN	Oil, soap, and fat-chemistry plant
PALMINDUSTRIE	Management of industrial palm oil and coconut plantations and industrialization of oils and fats.
CIDT	Ivorian Center for the development of textiles
SALCI	Pineapple company of Ivory Coast

CIRT POTENTIAL CLIENTELE

Annex 10

CIRT's potential clientele is composed of economic development agencies (SODES) and other companies, viz.:

SALCI	Pineapple company of Ivory Coast
SIACA	Ivorian pineapple and canned foods company
SAFCO	African fruits and marketing company
LITPA	Processing plant for agricultural products
SACO	African cocoa company
CAPRAL	Food preparations company
APISA	Processing industries for agricultural products
FINUMA	Ivorian MAN manufacturers
SIPAR	Ivorian fishing and shippers company
CIPI	Ivorian fishing and industry company
SCCI	Ivory Coast canning company
BLOHORN	Oil, soap, and fat-chemistry plant
SIIT	Ivorian industrial textile company
STIPA	Company for industrial processing of agricultural products
PROCACI	Cocoa products of Ivory Coast
SIPRA	Ivorian company for animal production (feed for livestock)
CHOCODI	Chocolate preparation of Ivory Coast
NOVALIM	Manufacture and sale of Maggi cubes
SABI	African biscuit company
SATMACI	Technical assistance company for the modernization of agriculture in Ivory Coast
SODEPALM	State company for the development of oil palms
PALMINDUSTRIE	Management of industrial palm oil and coconut plantations and industrialization of oils and fats
CIDT	Ivorian center for the development of textiles
SODEFOR	State company for the development of forest plantations
SODEFEL	State company for the development of fruits and vegetables
COFRUITEL	Producers' cooperative for marketing fruits and vegetables in Ivory Coast
SAPH	African company for rubber plantations
CIMA	Ivorian center for agricultural machinery
ITT	Ivorian company for tropical technology
MOTORAGRI	State company for the development of agricultural motorization
BETPA	Technical consultancy agency for agricultural projects
BCET	Central technical consultancy agency
SODESUCRE	State company for the development of sugar cane plantations and the industrialization/marketing of sugar
SODEPRA	Development agency for animal production
SODECI	Water distribution company of Ivory Coast
EECI	Electric energy company of Ivory Coast