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PROMOTION OF TECHNICAL AND ECONOMIC CO-OPERATION  
BETWEEN AFRICA AND LATIN AMERICA IN THE FIELD  
OF SCIENCE AND TECHNOLOGY \*

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## I N D E X

	<u>Page</u>
Introduction	1
I. Status of Co-operation in the Field of Science and Technology for Development	3
cII. Background Material for Economic and Technical Co-operation in given Sectors	
A. Technology in the Field of Food and Agriculture: Food Processing Preservation and Storage; Post-Harvest Technology (Specifically Pertaining to Tropical and Sub-Tropical Agricultural Foodstuffs Including Fish Products)	12
1. Specific Activities by Countries	13
2. Development of Food Technology in its Strategic Capacity	21
B. Forests and Forest Products: Wood Technology	24
C. Construction Materials Technology	26
1. Manufacture of Cement	27
2. Additives for the Manufacture of Concrete	27
3. Experiments on the Basis of Soil-Cement	27
4. Construction of Blocks	28
5. Others	28
D. Energy: New Sources of Energy from Agricultural Waste and Products	29
1. The case of Brazil: Energy Production from Biomass	29
2. Other Sources of Energy	33
III. Elements for Co-operation in the Institutional Sphere: The Formulation of Policies, the Planning of Science and Technology and the Systems and Infra-Structure to Regulate its Transfer	35
IV. Means and Instruments to Facilitate the Formulation and Setting up of the Recommended Technical Co-operation Initiatives	47
1. Exchange of General or Specific Information and Knowledges on Specific Topic or Problem	49
2. Establishment of Information Networks	49
3. Exchange of Staff	49
4. Joint Training Programmes	50
5. Joint Experimental Research and Development Programmes	50
6. Co-operation to Improve Bargaining Power with Suppliers of Technology	51
7. Schemes of Preferential Treatment for the Development and Transfer of Technology among Countries	52
8. Establishment of Regional and Interregional Centres or Mechanisms for Development and Transfer of Technology	52



## INTRODUCTION

The purpose of the present document is to provide background information, material and suggestions which may prove useful for the attainment, in the sphere of science and technology, of the final objectives pursued by the project on the promotion of technical and economic co-operation between Africa and Latin America (INT/80/908/A/15/52).

This project contemplates a sequence of several phases which should culminate in the stage at which the project proposals and recommendations jointly formulated by the CEPAL and ECA secretariats are submitted to the consideration of government experts in both regions. These proposals and recommendations in their turn must be based upon and stem from the consolidated report on the situation in the two regions. The meeting between the secretariats is envisaged, in the sequence indicated in the project document, as the occasion on which this consolidation will be effected, as a necessary first step towards the materialization of the aforesaid proposals and recommendations, which should also be the product of the secretariat meeting.

Thus the background material, data and suggestions set forth in the present document constitute the region's contribution, so to speak, which CEPAL and ECA, at the meeting in question, will consolidate with a similar document presented by ECA, so that, with information from both parties at their disposal, they may be in a position to draw up the above-mentioned proposals and recommendations on co-operation in this field for submission to government experts in both regions.

The approach adopted to meet these requirements was in keeping with the guidelines that were laid down, in the context of the project, for desk and consultant studies. It consisted basically in a more or less summary review of the state of co-operation between the two regions in the field in question -its recent evolution, problems, patterns, etc.-, to be followed by penetration into one of the essential aspects of the work: exploration of what the region -or rather the selected countries- would be in a position to offer as material to be used at the Meeting of Secretariats in shaping the specific proposals and recommendations on inter-regional co-operation projects.

Pursuing the lines indicated, this investigation was carried out in several technological centres in relation to the four sectors selected -food, lumber, construction materials and biomass energy- and in specific official institutions responsible for policy formulation and planning in the field of science and technology and for systems of regulating the inflow of technologies, this latter in order to meet the requirements formulated with respect to institutional spheres.

As regards the four sectors mentioned above, the object of the investigation was to try to assess the co-operation potential afforded by industrial research and technology institutes in the selected countries, in the sense of singling out -with no evaluative intention whatever- which activities seem to lend themselves to the practical co-operation with Africa that it is sought to promote.

The co-operation potential in question is to be found in three directions: firstly, in the technological developments generated in the above-mentioned institutes themselves, whether original innovations are involved or -as in most cases- adaptation of technologies devised elsewhere; secondly, and to a very significant extent, in the considerable capacity of these centres to undertake technical co-operation activities for the benefit of industry in very widely varying fields; and, thirdly, in all activities in general that have a direct or indirect bearing on the central objective of promoting the improvement of the technological level of industry, cases in point being training, extension services, etc.

As regards institutional spheres, a respect in which there is even less call than in the case of the productive sectors for evaluative considerations, it was decided to present the salient features of the current institutional order in each of the countries visited, with a few observations in some cases on the recent evolution of that order, all with a view to opening up possible areas of common interest and co-operation with the African countries.

It is felt that the result of this effort, even though it cannot be regarded as an inventory or exhaustive list of institutions and experience, is a reasonably accurate reflection of the real state of affairs, affording valid material and information for the subsequent phases of the project. It therefore goes without saying that any gaps or omissions that may be noted are in no way intentional and still less the result of applying specific selection criteria with respect to the institutions considered.

Once a sufficient stock of information was available for an approximate idea to be formed of the co-operation potential or capacity of the institutions visited, in the sectors and spheres of which mention has been made, the next step related to the media or mechanisms whereby possible co-operation activities could be put into effect. It would have been from every point of view desirable to be able to recommend media or mechanisms for specific fields or areas of co-operation. But as can easily be seen, such a proceeding obviously implied knowledge of this latter element -the fields or areas of co-operation- which it will not be possible to obtain until the meeting with the ECA officials takes place.

For the time being, therefore, this specification is beyond reach. Accordingly, it was decided to present a brief analysis of the patterns or forms that might be assumed by such mechanisms, but without relating them to concrete instances of co-operation, this being a phase which -as already pointed out- can only be completed when the relevant information is to hand and has been consolidated with the similar data from Africa. The meeting between the two secretariats will provide an opportunity for formulating the specific project proposals and recommendations, for which purpose the information submitted in the present study constitutes an indispensable input.

The work ahead, therefore, is of a primarily factual nature, intended to permit the contemplated dialogue with ECA to be started, so that, the situation in both regions once known, consideration can be given to possible proposals for co-operation projects to be submitted to the meeting of government experts.

One last remark concerning the inclusion in the present study of Colombia and the Board of the Cartagena Agreement, in addition to the five countries -Argentina, Brazil, Mexico, Peru and Trinidad and Tobago- originally selected. As regards Colombia, the main motive was interest in adducing the experience of one of the most important centres of technology appropriate to the region -if not the most important-, i.e., the Centro Las Gaviotas, as well as that existing in the country's scientific and technological development centres and that acquired in the course of several years of control and transfer of technology from abroad.

With respect to the Andean Group, the decisive inducement to its inclusion lay in the so-called Andean Technological Development Projects (Proyectos Andinos de Desarrollo Tecnológico - PADT, which are sectoral development strategies with a substantial scientific and technological content, and which it is considered may be of interest to the African countries, as, for instance, in the case of the well-known and important action taken by the subregional agreement in this sphere of science and technology.

#### I. STATUS OF CO-OPERATION IN THE FIELD OF SCIENCE AND TECHNOLOGY FOR DEVELOPMENT

Generally speaking, the region has not much experience in the field of scientific and technological co-operation with other developing geographical regions. Particularly with respect to Africa, the activities identified are mainly concentrated in Argentina and Brazil and although some of them are on a fairly large scale and of a certain importance, most are more or less embryonic, or have not been in existence long enough for evaluation of their success or of the problems that have arisen to be possible. In any event, this experience shows that a favourable terrain does exist and that there are interesting opportunities for co-operation between the two regions as well as -most important of all- mutual interest in continuing to explore and even expanding the framework of the experience in question.

The situation and the level of experience with regard to co-operation within the region's own sphere are different, to be sure, although there are not yet grounds for speaking of great progress. Initiatives of regional scope exist, such as the Latin American Technological Network (Red de Información Tecnológica Latinoamericana - RITLA), the Regional Scientific and Technological Development Programme (RSTDP), and the Inter-American Institute of Agricultural Sciences (IICA); the Latin American Energy Organization (OLADE); the Programme of Research on Scientific and Technological Development in Latin America, participants in which are CEPAL, the Inter-American Development Bank (IDB) and the International Development Research Centre (IDRC) of Canada, as well as UNDP; and also the activities of the UNESCO Regional Office for Science and Technology in Latin America and the Caribbean. Attention may also be drawn to other undertakings linked to the various integration programmes, such as, inter alia, the Central American Technological Research Institute for Industry (ICAITI), the Caribbean

Industrial Research Institute (CARIRI) in the CARICOM countries, the Andean Technological Information System (Sistema Andino de Información Tecnológica - SAIT) and the Andean Technological Development Programmes (Programas Andinos de Desarrollo Tecnológico - PADT) under the Cartagena Agreement. Lastly, there are also bilateral agreements between countries or, more specifically, between technological institutes, which establish, according to circumstances, various forms and patterns of scientific and technological co-operation.

It is superfluous to point out that the region can also show all sorts of examples -more numerous than those mentioned above- of co-operation with developed countries and institutions created in these countries. In this connexion, it might almost be said that the administrative structures and experience in nearly all the countries of the region are better adapted and related to the reception of international co-operation in the field of science and technology.

In any event, in all this there is material which it would be of interest to bear in mind and evaluate in respect of the results achieved, for the sake of information and experience that may be very valuable in formulating specific agreements between African and Latin American countries.

It is possible, on the basis of study and analysis of the information collected, to formulate a few brief and very general considerations on the obstacles or conditioning factors observed which, in one way or another, tend to hamper co-operation between countries in the two regions and hinder it from enlarging its scope and producing more encouraging results.

In the first place, attention should be drawn to a factor which permeates virtually all structures in the sector, and which is even more pervasive in the mechanisms responsible for international co-operation in general; the tendency for their conformation, and even -in some cases- the attitudes of their personnel, to be geared to receiving co-operation, habitually from developed countries, rather than to providing it to other developing countries.

Financing -lack or shortage of available resources-, according to the views expressed in the countries which have progressed farthest in the activity under discussion, seems to constitute a considerable stumbling-block. To this is added another which seems much smaller, but whose negative effects makes themselves felt in practically all stages of the process: difficulty in communications. A good example of the problems that may arise in relation with this factor was noted in the case of Brazil, to which reference is made below. The persistence of specific ties with the ex-metropolitan countries contributes, in some cases, to the difficulties besetting the practical process of arranging with other developing countries, in this instance in the region, effective co-operation adapted to the real needs of the recipients. Mention was also made of the desirability of undertaking efforts to ensure that co-operation requirements be stated with the greatest possible precision and accompanied by as much material as possible on the basis of which they can be properly assessed. The problems which in some cases have prevented rapid absorption of co-operation by its recipients, and which are attributable up to a point to the shortage of skilled labour at the intermediate level, have also been an object of concern.



Although no particular stress was placed on this point, attention was also drawn to the barriers of language, customs, habits and so forth, as one of the factors that call for very careful consideration in formulating co-operation activities.

As regards the countries to which special reference is made in this project, the situation with respect to co-operation arrangements with African countries is as follows.

Argentina

The bodies primarily competent in this country in the field of international co-operation are the Ministry of Foreign Affairs and the Technical Co-operation and Resources Secretariat of the Planning Office, which is an institution pertaining to the Office of the President of the Republic.

Furthermore, the new Ministries Act (March 1981) lists as a specific function of the recently created Under-Secretariat for Science and Technology "participation in scientific and technological co-operation relations at the international level".

With specific respect to co-operation with African countries, the mission undertaken in October 1980 by high-ranking Argentinian officials to Cameroon, Congo, Gabon, Ghana, Equatorial Guinea, Nigeria, Senegal, Togo and Zaire may be said to represent a great stride forward in the co-operation movement.

The objective of the mission was to establish new or closer economic links with the countries mentioned, mainly through scientific and technical co-operation and economic agreements, these latter covering principally the field of trade and finance.

Scientific and technical co-operation agreements were signed with Congo, Gabon, Equatorial Guinea, Senegal, Togo and Zaire; in the case of Zaire commercial, cultural and economic co-operation agreements were also concluded.

The scientific and technological co-operation agreements are more in the nature of frameworks in which provision is made for the insertion of co-operation activities that can be carried out by public or private bodies in both countries, the conditions being determined in each case by the governments themselves or by the institutions they nominate. According to the information available, the phase at present under way is precisely that of study and formulation of the above-mentioned co-operation activities, which comprise missions of experts, feasibility studies, training programmes, etc.

The experience deriving from this official action indicates that in Argentina the main stumbling-block in the way of putting this co-operation into practice is to be found in financing. Since there is no special TCDC fund, and the domestic resources available for this purpose are meagre, very serious delays and inconveniences are suffered in putting co-operation mechanisms into effect. Cases have been pointed out in which these delays have facilitated the appearance on the scene of a third actor - a developed (generally ex-metropolitan) country - which, on the basis of its ability to draw more rapidly on more plentiful resources and also on account of its linkages, has displaced the developing country, in this case Argentina.

In relation to the problem of funds, mention was made of the possibility of resorting to the OPEC Development Fund. This Fund's priorities are assigned to energy and foods, sectors which are among those covered by the project, and it apparently operates through joint ventures instead of making loans.

One of the obstacles mentioned by the private sector as among the most serious was that represented by the costs of goods and services, owing to which in many instances an African country's choice of providers of co-operation is slanted towards countries where costs are lower, mainly those of South-East Asia and India. A point worth noting, however, is that several private enterprises offering advisory and engineering services have been responsible for exports of technology to African countries in the form of plants under the turnkey system and civil engineering works of some importance, such as, for example, the construction of a hospital in the Ivory Coast, various rural electrification, irrigation and agricultural-livestock production projects (Cameroon, Ivory Coast, Nigeria, Zaire, Congo and Gabon), cold storage plants in the Congo, water purification plants in Zaire, etc.

#### Brazil

Since 1973, the Secretariat for International Economic and Technical Co-operation (SUBIN), dependent upon the Planning Office of the Office of the President of the Republic, has maintained a programme for the purpose of formulating and/or executing projects or activities relating to the provision of technical co-operation to other developing countries.

This co-operation may take the form of personnel training and teaching of skills in Brazil, through courses, seminars and fellowships, apprenticeship, short or medium-length missions; seconding of Brazilian technical experts to other countries; joint execution of research projects; and, in exceptional cases, donation of equipment or teaching and bibliographical material.

SUBIN works in close contact with the Ministry of Foreign Affairs, which, besides participating in the process of approving projects, from the standpoint of external technical co-operation policy, takes charge of their negotiation and offers logistic support for their formulation and execution.

SUBIN also concerns itself with financial support, since it has at its disposal for that purpose a federal budget allocation as well as contributions from such agencies as IDB. The more or less standardized mechanics of these co-operation activities consist initially in the signing of a scientific and technical co-operation agreement between the governments concerned. This is normally followed by an internal agreement between the Ministry of Foreign Affairs, SUBIN, or else the National Council for Scientific and Technological Development (CNPQ), and the institution or other body which is to play a direct part in co-operation.

Brazil is probably one of the countries that has shown most activity in the field of co-operation with countries in the region, perhaps in consequence of the scope and magnitude of its own scientific and technological development. Its principal contacts in Latin America include those with Argentina, Colombia, Costa Rica, Chile, Mexico,

Paraguay, Uruguay and Venezuela, as well as with ICAITI and OLADE. Generally speaking, it would seem that the co-operation efforts undertaken in this area of science and technology by public-sector agencies have not encountered insurmountable obstacles, although financing is frequently mentioned as one of those most difficult to overcome.

The undertakings in which the private sector participates are very numerous. Outstanding examples are a turnkey project for an alcohol distillery in Costa Rica, the transfer of alcohol fuel technology to the same country, and the feasibility study for a soya bean processing plant as well as the preliminary project for a paper factory, both in Trinidad and Tobago, etc.

Brazil is also the country which has built up the biggest stock of experience in co-operation with African countries, in the field of science and technology. Where the official sphere is concerned, basic technical and scientific co-operation agreements have been signed with the governments of Angola, Cape Verde, Cameroon, Ivory Coast, Dahomey, Gabon, Ghana, Guinea-Bissau, Kenya, Nigeria, Senegal, Togo and Zaire.

It should likewise be pointed out that since 1968 an Afro-Brazilian Chamber of Commerce has been in operation in Brazil; its creation has allowed reciprocal contacts to become increasingly frequent. In 1973 the first Brazilian trade mission went to Africa, its participants including entrepreneurs and government officials, and in the following years further missions were organized, both African and Brazilian, as well as fairs, exhibitions, symposia, etc., initially oriented towards trade but subsequently incorporating other themes, such as technical and economic co-operation.

Recently the Brazilian Minister for Foreign Affairs paid a visit to several African countries; one of its objective to which special interest attached was joint work on the exchange of technologies. The visit covered Angola, Mozambique, Tanzania, Zambia and Zimbabwe.

A country-by-country review of the status of co-operation in science and technology gives the following results.

Nigeria is Brazil's leading trade partner, in view of its exports of petroleum to the latter country. It has submitted a request to Brazil for a training mission. Brazil has offered to co-operate in respect of geology, geological prospection, and plants for the manufacture of alcohol and vegetable oils, synthetic and ethylene gas, electronic instruments, etc. It is also worth mentioning that a project is in course of execution for the provision of three manioc-processing plants under the turnkey system.

With respect to Mozambique, three co-operation initiatives exist: two with private enterprises and the third with a public enterprise, in the framework of a UNIDO project. A request is being submitted to the Sao Paulo Institute of Technological Research (Instituto de Pesquisas Tecnológicas - IPT) for the preparation of a project on the installation of a laboratory for testing construction materials, mainly wood.

One of the private enterprises has also consulted IPT on the possibility of providing technical assistance in connexion with a textile project, the installation of a wooden-furniture factory and training of personnel for the textile and machine industries.

The Ministry of Industry and Handicrafts of Senegal has asked for an IPT mission in connexion with a biomass energy programme. In its technical report IPT recommended that a survey of the biomass potential should first be carried out, to which end four technical experts will need to visit the country. SUBIN and the Ministry of Foreign Affairs are making the appropriate arrangements for the materialization of this mission.

Zambia invited IPT to participate in an international submission of tenders for an alcohol-producing plant. This invitation reached Brazil after the date of closure of the bidding, but the tender was nevertheless sent to Zambia for possible consideration. This experience serves to show that communications are a serious handicap to co-operation today.

In addition to all the undertakings reviewed, which pertain to the official area, brisk activity has also been displayed by the private sector in respect of exporting engineering services to African countries. Worthy of special mention are the construction of highways and railways in Mauritania; a telephone and microwave interconnexion network, a railway bridge, and management of the telecommunications system in Nigeria; and industrial processing of tropical fruit in Mozambique.

To this must be added efforts in the field of training, in particular the training of personnel for public administration, agricultural work, hotel-keeping, etc. A very significant indicator is the considerable number of African students enrolled in the Brazilian universities.

The lesson taught by experience in both public and private co-operation activities is that the main obstacle to be overcome is the lack or shortage of funds for financing them. Mention might also be made of some difficulties in communications and of those arising out of the diversity of languages, habits and customs.

Allusion has also been made to problems that sometimes arise in the process of absorption by the African countries, since in some of them certain deficiencies are noted, particularly in respect of skilled manpower at the intermediate level.

Another feature susceptible of improvement is the statement of co-operation requirements. Here there is room for raising standards of precision and providing background material and information in such a way that demand and its justification may be clearly apparent.

Lastly, reference must also be made to the difficulties involved in competition with the developed countries, the ex-metropolitan countries in particular. In many cases they have preserved mechanisms and structures which are extremely useful to them in getting ahead of the developing countries, over which this fact, combined with their experience and larger fund of resources, frequently places them at a considerable advantage.

#### Colombia

Activities relating to co-operation with other developing countries have not been very numerous in Colombia and are almost exclusively confined to those carried out in the context of the Cartagena Agreement. An outstanding case in point is the Andean Programme for Development of

Food Technologies for which the main executive responsibility has been assigned to the Technological Research Institute (Instituto de Investigaciones Tecnológicas - IIT), an agency which also gives advisory assistance to the Board of the Cartagena Agreement on other aspects of the question and provides direct assistance to other countries members of the Agreement. Contacts of this type also exist with IPT and the Food Technology Institute (ITAL), both Brazilian. They were formerly maintained with the Mexican Institute for Technological Research (Instituto Mexicano de Investigaciones Tecnológicas - IMIT).

The only identified forms of co-operation with African countries were activities carried out by the Centro Las Gaviotas <sup>1/</sup>and related to the management of laterites as construction materials and to the transfer of technology for the processing of manioc starch. Solar heaters technology is currently being transferred. There have also been attempts at co-operation with Ethiopia, but they have come to nothing.

#### Mexico

International co-operation in the technological field is centralized through the National Council for Science and Technology (Consejo Nacional de Ciencia y Tecnología - CONACYT) and specifically through the Technological Development Office (Dirección Adjunta de Desarrollo Tecnológico - DADT), and within that by a unit to serve the purposes of liaison between these departments and other projects that have an international or fellowships component. Mention must be made of the fact that up to now both international co-operation and the CONACYT system of fellowships have been particularly oriented towards the academic sector, and that one of the future priorities of DADT is the designing of mechanisms to rechannel these forms of support into the industrial sector. CONACYT participates in 72 bilateral technical co-operation agreements with 43 countries, and it is considered that great potential exists in this quarter for the provision of technical assistance to Mexican enterprises and the development of existing agreements or new ones that could be established in the next few years.

Only in the 1960s, concurrently with the consolidation of the legal and administrative institutionality of science and technology in Mexico, was a deliberate start made on scientific and technological co-operation with countries at equal or lower levels of economic and social development, and in this movement Latin America has naturally been a primary object of concern.

#### Peru

The administrative structures and the corresponding experience relate exclusively to the reception of international co-operation in the field of science and technology. The Andean Group activities, in particular those connected with the Andean Programmes for Technological Development, are possibly the most significant effort as regards

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<sup>1/</sup> This is an autarchic semi-public body which fulfils, among other functions, those of a research centre, oriented towards appropriate technologies.

provision for joint action directed towards a specific purpose in this sphere of science and technology, i.e., scientific and technological co-operation initiatives.

In this area there is no experience with the African countries, with which, moreover, virtually no trade links exist. However, some experiments in co-operation with other countries and agencies in the region have been undertaken, such as work on a few hydroelectric micro power stations, carried out jointly with OLADE and Haiti, and supported by IDB.

#### Trinidad and Tobago

In Trinidad and Tobago it falls to the Ministry of Foreign Affairs to determine international co-operation policy, and to the International Technical Co-operation Division of the Department of Planning and Development of the Ministry of Finance to co-ordinate its implementation.

No experience in technological co-operation with Africa exists. But interesting experiments in co-operation in the Caribbean area have been carried out by various national or regional bodies, as in the case of CARIDE, a government centre for technological support of the industrial sector which offers its services and extension programmes to the rest of the countries members of the Caribbean community; the University of the West Indies, a regional study centre characterized by a large-scale interchange of teaching personnel and students among the various Caribbean countries; the Caribbean Agricultural Research and Development Institute (CARDI), an autonomous institute established by the Caribbean Community governments and intended for the development of research and the execution of projects bearing on the agricultural sector; and the Caribbean Council for Science and Technology (CCST), recently created under an agreement among the governments members of the Caribbean Committee for Co-operation and Development (CCCD), an auxiliary agency of CEPAL. It enjoys the support of UNESCO and its mission is to co-ordinate regional activities in the area of science and technology, after a preliminary phase of formulation of more precise objectives, identification of common problems, establishment of priorities, etc.

#### Cartagena Agreement

Under the Cartagena Agreement various decisions have been adopted with respect to science and technology which may be of great interest to the African countries both on account of the principles and mechanisms they establish and because of the co-operation possibilities they open up.

Under Decision 24, which was one of the first relating to science and technology, common rules were adopted for the treatment of foreign investment and for the transfer of technology, with the essential aim of improving the terms on which Andean enterprises (national and mixed) receive capital and technology. Algeria and Nigeria have shown interest in the provisions and mechanisms comprised in this Decision, with a view to the possible incorporation of some of them in their own legislation. This might give rise to specific co-operation in the co-ordination of the norms in question, in which several African and

Andean Group countries would participate. In this connexion, it should be recalled that UNCTAD and the Andean Group organized a visit by African officials for the purpose of familiarizing themselves with the system of registering industrial property in the subregion.

Another important Decision is no. 84, which contains the broad bases for a subregional technological policy, relating specifically to the processes of generation, importation and assimilation of technology as well as to the support that should be given to industrial programming. Among the many provisions of this Decision may be singled out here those referring to the aid aggregation of "packages of technology" in order to permit identification of central and peripheral technologies contained in imports, so that a distinction can be drawn between what must necessarily be obtained from abroad and what could be supplied locally. Of particular interest, too, are the provisions creating the Andean Technological Development Programmes (Programas Andinos de Desarrollo Tecnológico - PADT), which consist in a form of horizontal co-operation geared to the resolution of common problems through the joint use of human and infrastructural resources of the subregion. In this sense, they can be regarded as practical mechanisms for the generation of technology. Up to now those in process of implementation relate to copper metallurgy (Decisions 86 and 87), tropical forest resources (Decision 89) and food (Decision 126), and others are being prepared with respect to coal and to technologies for the rural environment. Although there have been as yet no instances of participation in these PADT by countries other than those of the Andean Group, the form in which they have been drawn up would seem to leave the way clear for such an eventuality, especially since participation can take place at very diverse levels.

## II. BACKGROUND MATERIAL FOR ECONOMIC AND TECHNICAL CO-OPERATION IN GIVEN SECTORS

General information is presented below on some of the main technological developments carried out in selected Latin American countries in connexion with the sectors indicated in the project, namely: technology for the processing, preservation and storage of food products; wood technology; construction materials technology; and new sources of energy on the basis of agricultural products and waste.

The information given is by no means exhaustive, and simply constitutes a sample of the activities and developments most representative of technological work; a sample which, apart from its illustrative value, is considered to comprise, up to a point, the areas within the selected sectors in which the said countries would be in the best position to enter into co-operation agreements. As a supplement to this list, it was thought desirable to record in an annex some information on certain institutions responsible for these technological activities or development, in view of the possibility that the institutes or centres concerned may play a very important role in whatever co-operation process might emerge as a result of this project. It seems likely from every point of view that the mechanisms

and proposed methods for carrying out co-operation activities in the fields or areas identified will involve the active participation, in one way or another, of institutions of this type.

Apart from the development of technologies of the region's own and the adaptation of technologies from abroad, the institutes' activities are largely oriented towards advisory and technical assistance and services to the productive activities concerned.

Thus, the central effort is aimed at acquiring a good level of experience and knowledge of the state of the art or know-how in the various developments and specific fields, so as to be in a position to support the activities producing goods and services.

A. TECHNOLOGY IN THE FIELD OF FOOD AND AGRICULTURE: FOOD  
PROCESSING, PRESERVATION AND STORAGE; POST-HARVEST  
TECHNOLOGY (SPECIFICALLY PERTAINING TO TROPICAL  
AND SUB-TROPICAL AGRICULTURAL FOODSTUFFS,  
INCLUDING FISH PRODUCTS)

Generally speaking, in most of the Latin American countries there are agricultural research programmes under which, with diverse degrees of intensity and effectiveness and varying orientation, a stock of scientific knowledge has gradually been built up, differing widely according to the ecological, economic and social conditions of the countries concerned, their idiosyncrasies and their consumer habits. Fairly widespread in the region, too, are extension services which fulfil, among other functions, that of liaison work between research centres and farmers and industrialists. In this connexion, Latin America possesses a broad and diversified range of know-how and experience which may prove of great interest to other regions, within the general framework set forth in the foregoing paragraphs, inasmuch as this is an activity largely focusing on the adaptation of technology with a view to technical assistance to users.

In addition to technical assistance activities, some centres have engaged in developing new food formulas and products, designing and manufacturing certain equipment for the food industry, organizing nutritional guidance campaigns and programmes, and providing training for personnel in the food area.

With respect to nutrition, it should also be pointed out that an object of universal concern in the countries' research centres and institutes is the promotion of programmes for processing and testing low-cost food stuffs with a high protein content which are adapted to national conditions and needs, use being made of locally available natural resources. This, of course, does not imply neglect of other lines of technological research and development aimed at meeting the requirements of the food sector in its various phases.

In full awareness that the improvement of food production, storage, marketing and distribution are essential concomitant factors - together with others of a different kind - in raising levels of consumption, various national and subregional programmes have been drawn up and



set in motion, with the object of tackling on integrated and co-ordinated lines the satisfaction of the population's increasing food and nutritional needs, while at the same time seeking to maximize food production. In experimentation of this kind, too, it is felt that there is a broad and fertile terrain for collaboration between the two regions. The second part of the present section gives a synthesized picture of current planning efforts in selected countries; this information is supplied as a contribution to a clear understanding of the overall framework in which the centres or institutes mentioned in the first section carry on their technological activities.

1. Specific activities, by countries

Argentina

The technological advances identified in Argentina pertain mainly to the sphere of the National Institute of Industrial Technology (Instituto Nacional de Tecnología Industrial - INTI) and its research centres, and to that of the National Institute of Agricultural Technology (Instituto Nacional de Tecnología Agropecuaria - INTA).<sup>1/</sup>

(a) Simultaneous extraction of oils and proteins from oilseeds

A technological innovation which is being tested at the pilot plant level and is designed for use primarily with sunflower seed, but which is also applicable to groundnuts, soya beans, etc. The flour or meal resulting from the extraction can be used for human food (INTI).

(b) Extrusion of flour, concentrates and protein isolates from oilseeds

Texturing to give them a consistency appropriate to their intended use, by means of high-temperature and short-time heat treatment and subsequent expansion (INTI).

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<sup>1/</sup> To the post-harvest technologies which have been defined as of the greatest interest for the food sector, have been added likewise some that are typical of agricultural or livestock production, because it is felt that they have certain characteristics which might make them especially appropriate for use in African countries.

Pasture management in semi-arid areas: this technology is being applied and consists basically in the conversion of pastureland that is utilized very little or not at all into meadows with a much larger carrying capacity (INTA).

Soil management and fertility: this is a matter of erosion control through cultivation practices such as crop rotation and no tillage farming (INTA).

Soil studies: methodologies for the interpretation of satellite images constituting a valuable aid in determining -in conjunction with the field study- what is the most efficient method of soil use (INTA).

Herd management: a group of technologies relating to genetics, nutrition, reproduction and animal sanitation which might be transferable, with the necessary adjustments and limitations contingent upon the differences in breeds of cattle and natural environments (INTA).

(c) Meat industry

Capacity has been developed for advisory assistance on process selection, design of layout for equipment appropriate to different types of product, development of product formulas, and putting plants into operation, all this in relation to such lines of production as charcuterie, preserved meats and by-products, as well as quality control (INTI).

(d) Chilling and preservation of fruit

INTI has developed a procedure for chilling and maintenance of low temperature during the transport of fruit (apples) from the Rio Negro valley to the ports of loading. This is a very simple process, using canvas subjected to some form of chemical treatment.

(e) Tomato concentrate

This technology consists basically in separately concentrating the pulp and the juice in order to obtain pre-preservers or powder. By mixing and homogenizing the pre-preserved juice and pulp in different proportions an equal number of different tomato concentrates can be reconstituted. This innovation forms part of a much broader development aimed at improving the entire agro-industrial process in respect of the preservation of fruit and vegetables and their adaptation for export. It also includes the treatment of waste water from the canning industry, the results of which are being tested at the pilot plant level (INTI).

(f) Dairy industry

Protein enrichment through concentration of milk proteins by ultrafiltration (under way, in the framework of a technical assistance agreement with the Federal Republic of Germany) (INTI).

(g) Fish products

Work has been done in connexion with the influence of storage in ice, prior to freezing, on the final quality of frozen hake (merluza); similarly, experiments have been conducted to compare moist and dry salting processes, advantages having been found in the former. There are also developments in respect of preserved fish, treatment of effluents and machine and hand production of fillets of hake; in this last case a model was prepared to provide information on comparative rates of return and make it possible to forecast what volume of output places the advantages on the side of the one or the other procedure. A machine for classifying fish by size has been designed and patented (INTI/CITEP).

(h) Balanced foodstuffs for cattle

Private enterprises have developed technologies for using coffee-berry skins and orange peel for this purpose.

Brazil

In this country there are several centres and institutes which carry on a wide range of activities relating to food technology, outstanding cases in point being the Brazilian Agricultural Research Enterprise (EMBRAPA) and its Centre for Agricultural and Food Technology (CTAA) and the Campinas Institute of Food Technology (ITAL).

Without claiming that the list is exhaustive, a few of the technologies developed are presented below, or in some instances simply areas of work where a good level of technical knowledge of the state of the art and of know-how exists in the above-mentioned institutes

and facilitates their maintaining permanent activities in the fields of training and advisory assistance to the productive sector.

(a) Technology for the preservation and industrial processing of fruit

Various technologies and studies relating to storage and preservation, control of ripening, preparation of juices and concentrates, extraction of oils, preserves and sweetmeats, enriched products, beverages on the basis of fruit juice, etc., applicable to various kinds of fruit and in particular to tropical species such as avocados, pineapples, bananas, cashew nuts, coffee, Brazil nuts, guavas, mangoes, pawpaws, passion-fruit, coconuts, etc. (ITAL).

(b) Technology for cereals and enriched products

(i) A wide variety of products has been developed on the basis of the soya bean, such as mixtures with wheat flour, manioc, <sup>1/</sup> and maize for making bread and pasta; proteinized beverages and extracts; enriched dehydrated soups; compound products and food formulas for babies and school children; blends with various kinds of meat; integral and defatted soya flour, etc. (ITAL-CTAA).

(ii) Maize too has been the object of various studies, ranging from techniques for pre-cooking and use of corn flour for making bread, pastries and pasta in general, to the manufacture of various derivatives and canned products (ITAL).

(iii) Cassava (manioc) is another product to which a great deal of study has been devoted, and procedures have been developed for its preservation and conversion into pellets, for various uses of it as food, and for its utilization as raw material for the production of ethyl alcohol and glucose syrup (ITAL).

(iv) Various experiments are also available with respect to the preparation of flour and meal and their application in bakery products and pasta, use being made for this purpose of different varieties of wheat and substitutes such as sorghum, potatoes, white corn, sweet potatoes and other products (ITAL-CTAA).

(c) Technology for the preservation and industrial processing of miscellaneous products

It is worth while to call attention to the use of dry yeast for food purposes and for protein-vitamin enrichment of food stuffs; microbial resin for the manufacture of cheese; amylolytic bacterial enzymes and fungi for the production of alcohol and glucose syrup; processing of sorghum, maize and sugar-cane alcohol, etc. Also deserving of special mention is a procedure for storage in low-cost and easily-assembled underground plastic silos to take small volumes, applicable to cereals and grains in general (ITAL).

(d) Production of essential oils of real and potential economic value

Production of essential oils on the basis of various industrially unexploited vegetable varieties (CTAA).

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<sup>1/</sup> The terms manioc and yuca are indiscriminately used to designate cassava (manihot esculenta Crantz).

(e) Oils, fats and proteins from grain and other sources

These are studies covering diverse vegetable varieties, including hog-gum (babassu), diacara, tucuma palm or spine club palm (tucum), etc. (CTAA).

(f) Others

Other work is oriented in different directions:

(i) Consideration of problems of the ageing of distilled liquors, in which connexion an attempt is being made to use domestically-produced instead of imported woods (CTAA);

(ii) Study on the utilization of the sweet potato. Apart from the research already mentioned, this product is also of interest as a substitute for manioc in cassava flour (CTAA);

(iii) Lastly, attention may be drawn to the experience accumulated by ITAL in the following respects: technology for the storage, preservation and industrial processing of meat and milk, as well as of vegetables and pulses; technology for preservation and industrial processing of fish and shellfish, smoking techniques, etc.; research in an experimental laboratory in Guaruja; technologies in course of development for the utilization of food industry waste, both in order to reduce pollution problems and for recycling purposes.

Colombia

Technological research and development in the food sector is tackled in Colombia on several fronts and covers practically everything on the way from harvest to consumer. Several institutions are particularly active in this field, among which the following are worthy of mention: the Technological Research Institute (Instituto de Investigaciones Tecnológicas - IIT), the Centro Las Gaviotas, the Colombian Agricultural Institute (Instituto Colombiano Agropecuario - ICA) and the International Centre for Tropical Agriculture (Centro Internacional de Agricultura Tropical - CIAT), situated close to the town of Palmira.

(a) Vegetable proteins

A wide variety of research is under way on new sources of vegetable proteins and on the application of industrial processing techniques for the improvement of their quality and their utilization in blends with various foods.

(i) The greatest progress has been made in blends with meat, in order to reduce its costs. The experimental phase was carried out within the framework of an OAS project, <sup>1/</sup> and demonstrated the feasibility of mixing up to 30% of vegetable protein with meat, textured as sausages. This technique is applied at the industrial level, but work is continuing with a view to the establishment of norms for delimiting proportions and types of proteins that can be used, minimum levels of animal protein, and its microbiological quality;

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<sup>1/</sup> Technology for starches, proteins and lipids. OAS Multinational Programme on Food technology (ICAITI, Universidad La Molina, ITAL, IMIT and IIT).

(ii) One of the answers to the problem of milk shortfalls has consisted in developing blends with vegetable products to ensure a biological value adequate in proteins. A technology has also been developed for obtaining a milk powder that contains soluble soya bean proteins. The possibility of adding these soluble or isolated soya proteins to milk is only in the preliminary experimental phase and it will be necessary to complete certain acceptability studies, design the mixer plants and evaluate the possibility of using other protein isolates. It should be pointed out here that a Colombian technology relating to soluble soya proteins used in industrial production of final consumer goods or intermediate products and for compounds with other ingredients is being applied in other countries of the region;

(iii) Considerable progress is being made both at the laboratory and at the market level in the production of mixtures of cereals with vegetable proteins and their enrichment with minerals and vitamins;

(iv) Consideration has been given to the possibility of enriching other foods besides cereals, such as yuca or manioc starch and flour, bananas, and sugar or sweetened products (unrefined sugar, fruit juices, etc.). Yuca starch is the type to which most study has been devoted, but what is still pending is the improvement of the drying process, either by traditional methods or by means of solar energy, which is also applicable to starch obtained from other species not at present marketed.

In its turn CIAT has accumulated a great deal of experience in technological developments connected with the utilization of yuca (cassava).

(b) Compound flours for bread and pasta

Much of the available experience was acquired in the execution of a research project whose essential objective was to find ways of replacing wheat -almost entirely imported- by Colombian raw materials. It has been established that up to 30% of soya bean and rice can be substituted for wheat in the manufacture of bakery products. Another possibility that has been checked is that of using soya flour without defatting it, which has the great advantage that a good-quality flour of this type can be prepared by means of a very simple process. In pasta it has been shown that in the case of maize or rice flour a higher proportion -even up to as much as 75%- can be substituted for wheat. If this is done simultaneously with soya bean flour, foods of better nutritional quality are obtained, with a high protein content. Research in this field is continuing with experiments in other economic and nutritionally acceptable foods, the maximum possible levels for substitution of other products for wheat being established in relation to the final use of the product, etc. (IIT).

(c) Oilseeds

Research is being conducted, mainly in the private sector, on the African Palm (Elaeis guinensis), in view of its usefulness in the production of edible oil. A point worth noting in this connexion is the recent creation of an international network of institutions responsible for experimental research and development activities in relation to this product.

(d) Unrefined sugar in blocks (panela)

Studies are being carried out, chiefly in the field of mechanical engineering, with a view to improving the yield of sugar-mills and of the methods traditionally used by artisan industry in processing this product, which is of great importance above all in the lower population strata (IIT, ICA).

(e) Semi-processed banana products

Studies and experiments are under way in connexion with the processing of these products in order to preserve them for reasonable periods and put them on the market, every attempt being made to maintain the traditional forms in which they are presented for consumption (IIT).

(f) Storage and transport of fruit, vegetables and tubers

In view of the high incidence of post-harvest losses, IIT has designed wooden crates adaptable to each type of fruit or similar product (potatoes, yuca). The crates can be dismantled and used up to 8 or 10 times over. Technologies have also been developed for the preservation of tropical fruit, converted into pulp or juice, for periods of six months to two years. This procedure is beginning to be used on an industrial scale, half the processing being done in the production area (IIT, ICA). The Centro Las Gaviotas has devised a technique for storing yuca with a view to its subsequent use as food or for dextrin, since it is a product that deteriorates after 48 hours.

(g) Fish industry

Progress is barely incipient, and what has been achieved is confined to relatively small projects sponsored by COLCIENCIAS, which have made it possible to technicalize low-cost methods for the preservation of fish by salting and sun-drying, while at the same time the microbiological quality of the product has substantially improved. A start has been made on work in connexion with the utilization of morralla (fish residues of no value) (IIT and Universidad de Magdalena) and with technicalized breeding of fish in tanks.

Peru

The Universidad Nacional Agraria and the National Institute of Agro-Industrial Development (Instituto Nacional de Desarrollo Agroindustrial - INDA), this latter a dependency of the Ministry of Food and Agriculture, have played a particularly active part in the development of technologies in the sphere of food. The following are the most outstanding cases in point:

(a) Obtaining of protein concentrates on the basis of baker's yeast

The aim was to obtain a protein concentrate with a flavour similar to that of meat extract. Optimum conditions for the autolysis of baker's yeast were determined, and soluble proteins were isolated by centrifugal processes. The conclusion was reached that it was feasible to obtain a protein concentrate with agreeable organoleptic characteristics (smell, colour, taste) (INDA).

(b) Replacement of wheat flour by substitutes

Studies were carried out on bread making on the basis of various mixtures of wheat flour with yuca flour, and the conclusion was reached that it is feasible to incorporate the latter up to a maximum of 10%.

Research has also been extended to the possibility of using flour made from soya and from an annual plant called quina. In the case of soya, it was found that as much as 10% can be used, whole and defatted (INDA).

(c) Cold storage of fruit and vegetables

The experiments were conducted with mangoes and with lemons and onions. The results varied according to whether fungicide polyethylene bags and solutions with specific suspensions were or were not used, in certain conditions of time and temperature (INDA).

(d) Yuca flour

The feasibility study made by INDA seeks to demonstrate the possibility of exploiting the production potential of yuca in a specific area, and consideration was given to the idea of assigning areas exclusively to this crop. The industrial plant would also have an agricultural department to provide technical and financial assistance to the participating agrarian co-operatives (INDA).

(e) Obtaining milk substitutes on the basis of soya bean

Research has consisted in the preparation of soya beverages based on integral flour, including bottling, sterilization and storage. During cold storage the soya beverage behaves similarly to cows' milk, and the results of tests of acceptability to the public have been positive.

(f) Potato flour processing plant

Study have been devoted to the feasibility of industrial processing of part of the potato output in the form of flour, as a substitute for wheat flour in bakery products, pasta, biscuits, etc. Peru is the host country to the International Potato Centre, which has garnered a considerable amount of experience in developing potato technologies.

(g) Oilseeds

With respect to oilseeds, special mention should be made of the research that is being conducted by the mixed enterprise EMDEPALMA, on the utilization of the African palm (Elaeis Guinensis).

Mexico

The development of food technologies for the post-harvest stages is to be found in different institutes, outstanding among which are the National Laboratories for Industrial Development (Laboratorios Nacionales de Fomento Industrial - LANFI) and the Centre for Technological Research and Assistance of the State of Chihuahua (Centro de Investigaciones y Asistencia Tecnológica del Estado de Chihuahua - CIATECH).

(a) National Industrial Development Laboratories (Laboratorios Nacionales de Fomento Industrial - LANFI)

Here work is directed towards everything that may represent packing and packaging problems, and there are various specific projects and programmes for each of the items mentioned, ranging from standardization to the development of specific prototypes. LANFI pursues two basic lines of research: on the one hand, food technology and, on the other, technologies for chemical products. In each instance it concerns itself with problems of industrial raw material, processing, preservation, containers and packaging, transport, storage and distribution, so as to obtain a finished product. The development of

containers and packaging materials constitutes the most important field of research, since in one way or another this is the point of liaison between the two areas of work indicated: i.e., food and chemicals.

LANFI has recently been restructured, and other elements and other institutes have been incorporated. Its development objectives for 1981 are as follows: (i) to consolidate the various stages of putting into containers and packaging, mainly with application to food and chemicals; (ii) to strengthen laboratories and pilot plants concerned with food technology and execute projects in conformity with the strategies of the Mexican nutritional system (Sistema Alimentario Mexicano (SAM)); (iii) to consolidate the chemicals areas, particularly in the case of chemical and pharmaceutical products, and to strengthen industrial fermentation laboratories and pilot plants.

LANFI provides services to some 300 Mexican institutions, the bulk of them -about 80%- being extended to small and medium-sized enterprises.

(b) Centre for Technological Research and Assistance of the State of Chihuahua (Centro de Investigaciones y Asistencia Tecnológica del Estado de Chihuahua - CIATECH)

From the time of its creation to the present date, the Centre has focussed its attention on applied research in the area of food technology and, in particular, on the development of new low-cost food products of high nutritional value, based on grains and cereals such as soya bean, oats, maize, wheat, etc.

As regards the establishment of industrial plants, CIATECH is qualified to carry out every phase of the work, from the technical and economic feasibility studies to the development of manufacturing technology and processes, basic and specialized engineering, purchase of machinery and equipment, supervision of the construction of plants, promotion for the purpose of forming associations and supervision of entry into operation.

In addition, the Centre has engaged in the development of new food formulas and products, the design and manufacture of certain equipment for the food industry, organization of campaigns and programmes of guidance on aspects of nutrition, and training of personnel in the food-stuffs area.

Currently CIATECH has a line of research and other work on soya, coconut oil and powdered milk. Its principal areas of work have been three in number: (i) industrial processing of soya for human consumption; (ii) cooking of grains by the extrusion method; and (iii) beverages with an integral soya basis.

(c) Fishing industry

As regards technological research and development for the fishing industry, and in accordance with the guidelines laid down by the National Science and Technology Programme (Programa Nacional de Ciencia y Tecnología - PNCT), this work is essentially geared to the evaluation of resources (fish, shrimps, clams and oysters), biological research on marine species, location of exploitation areas, and experimental and exploratory fishing with a view to the development of fishing techniques and, essentially, to establishing fishing villages and studying ecological problems relating to both inland waterways and maritime development and pollution.



#### Trinidad and Tobago

In the field of food technology, no specific research activities were detected in this country for inclusion in the present report.

It should be mentioned, however, that activities in this field are carried out through a subregional agency, the Caribbean Agricultural Research and Development Institute (CARDI).

As its name suggests, the activities of the Institute are basically oriented towards agricultural problems; those relating to the phases of processing and preservation of agricultural products, however, form part of its field of interest, and here it would be possible to establish co-operation links with Africa.

#### 2. Development of food technology in its strategic capacity

Some background data collected in the field with respect to the most important plans, which directly or indirectly affect the development of the sector, are presented below.

#### Brazil

There are several centres and institutes in Brazil which carry on a wide variety of activities in the field of food technology. Thus, a census taken in 1978, on the occasion of the formulation of the III Basic Plan for Scientific and Technological Development (PDBCT), 37 institutions with 400 specialists were enumerated, whose programming includes research in the field of food science and technology. In most cases the activities concerned consist in adaptations of technology and in support for agro-industrial production.

In order to co-ordinate action in this field, a national programme of agro-industrial research on food (PNTAA) was set up under the direction of EMBRAPA, to which reference has already been made, and the Centre for Agricultural and Food Technology (CTAA), with the active participation of ITAL, also mentioned above, the Agricultural Research Enterprise of the State of Rio de Janeiro (PESAGRO) and the Universidad Federal de Vicosa (UFV), in the State of Minas Gerais.

PNTAA, in accordance with the guidelines laid down in the III PBDCT, should direct its activities towards the following ends:

(i) increasing knowledge of the nutritive value of the foods currently consumed in Brazil;

(ii) developing technological processes for products of vegetable and animal origin with a view to expanding supplies of lower-cost and better-preserved foods of higher nutritive value;

(iii) developing industrial equipment and projects which will make it feasible to use locally-generated technology and reduce imports of foreign technologies;

(iv) promoting more satisfactory nutritional conditions, through practical experiments and utilization of foodstuffs of regional origin;

(v) carrying out studies on food economics and marketing; and

(vi) rationalizing the use of natural resources and agricultural and industrial residues as sources of food.

Colombia

(a) National Food and Nutrition Plan (Plan Nacional de Alimentación y Nutrición - PAN)

This is a strategy comprising activities at three levels: development of production and distribution of low-cost foods with a high nutritional content; expansion of health and environmental sanitation services; and education in the field of nutrition for eight million inhabitants in the lowest population strata. The Plan also contemplates activities on the part of the Technological Research Institute (Instituto de Investigaciones Tecnológicas - IIT) relating to research, development and transfer of technology in the areas of production, preservation, storage and transport of foodstuffs. IIT is also concerned with providing assistance in quality control and in general production problems.

These research and development activities comprise, inter alia, the study of minimum-cost diets, with due regard to the availability of foods of local origin and requirements in respect of food supplements; study of the ageing of enriched products, whereby their spans of life in different packaging and storage conditions can be determined; studies at the industrial level on methods of strengthening foods with vitamins and minerals; research to enable proteins obtained from cotton-seed and from fish by-products to be incorporated in human food; research on the development of industrial processing methods for products not yet directly used in human food, such as sorghum; identification of post-harvest losses of yuca and rice with the aim of finding ways and means of reducing them.

(b) Integrated Rural Development Programme (Programa de Desarrollo Rural Integrado - DRI)

This is a government strategy addressed to peasant owners of dwarf holdings (minifundistas), in particular, who are lagging behind in technology. It is a group of activities in which the object is to improve peasant income and welfare, generate employment and create the bases for development of the poorer regions of Colombia. Viewed from another angle, DRI may also be defined as a programme designed to increase food production by means of a rapid rise in productivity, through the use of simple technologies. The programme is implemented by the official national structure (22 institutions, no new mechanisms having been created), with the participation of international agencies.

Technological extension services are maintained by the Colombian Agricultural Institute (Instituto Colombiano Agropecuario - ICA). The main activity of this type -already mentioned above- relates to yuca. CIAT, to which allusion has also been made, is actively engaged in developing processes for the treatment, drying and storage of this tuber.

Unlike PAN, whose beneficiaries are basically to be found in the subsistence farming sector, DRI directs its action primarily to peasants producing for the market, even if they are minifundistas (owners of dwarf holdings). Since the two strategies have many points of contact, consideration has been given to consolidating the progressive integration of the administrations of DRI and PAN.

### Mexico

The Mexican Food System (Sistema Alimentario Mexicano - SAM) is an integral food development strategy whose formulation started a little over a year ago (18 March 1980) in response to a presidential initiative. Too short a time has gone by for any practical results to have been obtained through SAM as yet; but it is of interest in connexion with a problem of sectoral development planning and strategy. What is new about it is that the approach adopted to the food question is not sectoral, since the problem is one of production, marketing, transfer of technology and industrial processing, and distribution and consumption. This is not a matter exclusively confined to the crops sector, but also has to do with livestock production, food technology, the fishing industry and silviculture, and with the manifold problems of the five phases indicated above, on which account a systemic approach is adopted. Another aspect is concerned with the production-income and consumption relation. It is not a mere matter of stepping up production. Two objectives are simultaneously pursued: improving income distribution and increasing the output of food.

Approximately 200 persons are working on the SAM project on a decentralized basis and in close connexion with the various institutes that have to do with the food problem.

The World Food Council (WFC) has facilitated contacts with other countries -Africa in particular- which have displayed interest in acquainting themselves with the propositions formulated in the SAM strategy.

SAM, in turn, is interested in collaborating with CEPAL and ECA in advocacy of the concept of the systemic approach in planning methodology in the two regions.

### Board of the Cartagena Agreement

In the second half of 1978 the Andean Technological Development Programme (Programa Andino de Desarrollo Tecnológico - PADT) in the area of food was adopted under Decision 126. Consisting in a group of activities aimed at helping to resolve the problem of the subregion's food and nutritional situation, it is in reality an example of veritable macrosectoral planning reached by way of technological programming.

PADT comprises five projects, the object of all of which is to increase consumption of proteins and calories, especially in the low-income sectors, by means of proper utilization of technology. The following are the five projects in question:

(a) Project 1: Generation of intermediate food products on the basis of the subregion's own available raw materials. It consists, in its turn, of five subprojects:

(i) Incorporation of derivatives of dry pulses in low-cost food formulas and in quick-cooking foods;

(ii) Technology for the production of edible flour from cotton by a modified pressing process, and training of production engineers in cotton-processing enterprises with a view to the manufacture of edible flour from cottonseed;

(iii) New technologies for the production of edible flour, concentrates and isolates from cotton;

(iv) Development of intermediate food formulas based on cereals, fish solids and potato solids;

(v) Proteinic intermediate food products based on fish.

(b) Project 2: Experimental production and launching on the market of new low-cost consumer foods intended for population groups at risk from malnutrition. It comprises three subprojects:

(i) Food supplements and substitutes intended for young children, and for pregnant and nursing mothers;

(ii) Prepared rations for institutional child feeding. Development of non-traditional manufactured foods susceptible of preservation for up to ten days without cold storage;

(iii) Farinaceous foods modified by the use of wheat substitutes, and development of new farinaceous foods based on conventional technology.

(c) Project 3: Technology, production and marketing of infant food formulas. Perfecting of channels through which these foods can reach the poorer sectors.

(d) Project 4: Case studies of technical innovation opportunities with the aim of promoting to the category of innovation certain technological developments already in existence and relating to new processes and/or new products.

(e) Project 5: Reinforcement of scientific and technological information structures with a view to improving the capacity of existing information systems to respond to requests for information and documentation on the part of the food industry sector, and creating appropriate conditions for the possible operation of industrial information services for the sector in question.

As regards the financing of the projects, the local component is provided by the countries of the Andean Group, while the European Economic Community contributes the major proportion of external financing, followed by IDB and the Board of the Cartagena Agreement. Three years are allowed for the execution of the projects and their cost amounts to 6.5 million dollars, of which a little under half is represented by contributions from the Andean countries.

Experiments in producing biscuits on the basis of soya bean and rations for children have already been made, but up to now the stage of production on an industrial scale has not been reached.

#### B. FORESTS AND FOREST PRODUCTS: WOOD TECHNOLOGY

It is now almost a truism that Latin America's natural and artificial forests have potential capacity to supply, not only the volumes of raw materials necessary to satisfy the predictable increases in regional demand, but also substantial surpluses of specific products to serve extra-regional markets that are short of them. Notwithstanding the magnitude of the resources available and the notable progress made by its forest industries, there are still some gaps in the region's knowledge and certain technological lacunae which need to be filled if complete and more efficient utilization of this resource is to be achieved, both at the forestry stage and in the subsequent phase of

industrial processing. True, the situation differs greatly from one country to another and technological effort is expended on widely varying fronts, according to the scale of resources, the development of industry and local needs.

It should be pointed out, however, that a major effort has been concentrated, in the region in general, on the study of forest resource management, while in the tropical and subtropical zones work has been done on identifying and gaining fuller knowledge of the specific properties and characteristics of these forests, which in general are little known, given, inter alia, their differences from the forest resources of countries whose woodworking industry has a longer tradition behind it.

As regards specific activities relating to wood technology, the observations on the activities of centres and/or institutes made in the preceding sections are equally valid in this case. That is, action is essentially directed towards obtaining information on the state of the art at the world level, work in the field of adaptation of technology and the provision of technical assistance to sawmills and users of timber in general, especially in the construction sector.

The following are the various institutes or centres through which information was gathered and which are engaged in this activity:

Argentina

National Institute of Industrial Technology (Instituto Nacional de Tecnología Industrial - INTI)

National Forestry Institute (Instituto Forestal Nacional - IFONA) in Castelar, a province of Buenos Aires.

Brazil

Wood Centre of the Technological Research Institute (IPT), São Paulo.

Mexico

National Institute for Forest Research (Instituto Nacional de Investigaciones Forestales - INIF)

National Institute for Research on Basic Resources (Instituto Nacional de Investigación en Recursos Básicos - INIRB)

Institute for Wood, Pulp and Paper, University of Guadalajara.

Peru

Ministry of Food and Agriculture, Forestry and Fauna Department Pucallpa Forestry Centre.

Cartagena Agreement

Andean Wood-Engineering Laboratory (Laboratorio Andino de Ingeniería de la Madera - LADIMA).

The activities carried out by the national institutions mentioned above and by LADIMA, either partly or in toto, may be classified in the following major groups:

1. Anatomy studies and identification of the various species, comprising inventories and technical evaluations of their physical and mechanical properties.
2. Development of various technologies for the preservation of timber:
  - (a) Preservation of soft and hard woods for use in housing. The treatment applied is against fire, fungi and insects and the method adopted is impregnation with chemicals or application of surface coatings;

- (b) Impregnation of wood for sleepers, posts and construction in general, in accordance with procedures developed in pilot plants;
- (c) Typification by quality and durability of species of wood and board employed in facings for housing units, with the types of paint and varnish in common use on the market.

3. Studies of the utilization of wood for construction and housing. For these purposes several institutes have engaged in the study of various techniques for the construction of prefabricated housing units, manufacture of furniture, etc. Specific research is also being conducted in relation to the different techniques for drying and for board based on wood agglomerates (or particle board); LADIMA, for example, is carrying out research on a material in the form of boards on the basis of wood and cement. In addition, this laboratory is one of the few in the region in which research is undertaken on tropical woods and their use as building material.

4. In the area of pulp and paper, IPT's activities in São Paulo, Brazil, serve to illustrate the type of work that is or can be done by institutes or centres in the region specializing in this field.

Thus, IPT has established a laboratory with a view to giving support to the Brazilian industry, both in the sphere of research and in that of training of human resources. To this end, IPT comprises the following sections: pulp paper, byproducts, standardization, documentation and information, and training activities, as well as a pilot plant. The IPT centre for Pulp and Paper Technology is well qualified to give advisory assistance to domestic industry in the development of pulp and paper technology, its main objects being to adapt certain international technologies, develop others with minor innovations, and train human resources for the industry.

Specifically, it should be noted that IPT has built up a stock of experience in the new high-yield thermo-mechanical processes for the treatment of wood for pulp. The experiments were carried out initially with pine wood, eucalyptus wood having been added later. A further point deserving special mention is that studies have been carried out in relation to the utilization of blends of tropical woods for pulp. Another development worthy of comment is a mathematical model for estimating the properties of different mixtures of pastes.

In the private sector, attention may be drawn to the development and command of high-yield processes, as in the case of a chemical-thermomechanical process for the treatment of eucalyptus wood. This consists basically in supplementing the thermo-mechanical process by prior treatment of the wood with chemical products.

#### C. CONSTRUCTION MATERIALS TECHNOLOGY <sup>1/</sup>

The main activity here is concerned with testing materials, in many instances with permanent control of the physical and particularly the mechanical properties of some of them. On the basis of the research

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<sup>1/</sup> In view of the relation between the two topics, see also the foregoing section B: Forests and forest products: timber technology.

concerned with these questions, technical standardization and advisory assistance to the construction sector are undertaken.

Some of the centres or institutes involved collaborate with others of a similar nature in the field of architectural design, a fact which has enabled them to undertake interesting studies in relation to habitat and to simple and standardized methods of self-help construction and low-cost housing in general, although this may not necessarily imply contributions originating in construction materials proper.

The following are the institutes on which observation was centred:

Argentina

National Institute of Industrial Technology (Instituto Nacional de Tecnología Industrial - INTI).

Brazil

Technological Research Institute (IPT) of São Paulo.

Colombia

Centro Las Gaviotas

Centre for Research on Bamboo and Vegetable Fibres, Universidad Nacional de Colombia.

National Apprenticeship Service (Servicio Nacional de Aprendizaje - SENA).

National Construction Centre (Centro Nacional de la Construcción - CENAC).

Mexico

Institute of Engineering and

Centre for Research on Materials (Centro de Investigaciones de Materiales - CIM), both pertaining to the Universidad Nacional Autónoma de México (UNAM).

UNAM, Azcapotzalco Unit, Department of Materials.

National Polytechnic Institute (Instituto Politécnico Nacional - IPN).

Ministry of Human Settlements and Public Works.

The principal activities carried out by all these institutions can be grouped as follows:

1. Manufacture of cement

Different experiments have been carried out in the use of granulated slag for cement manufacture; and also in the manufacture of cement on the basis of rice husks in suitable proportions, given their property of containing a high percentage of silex.

2. Additives for the manufacture of concrete

As in the preceding case, research is focused on the use of agroindustrial waste as additives for the manufacture of concrete. Among the various existing experiments in this field mention may be made of the use of bagasse, byproducts of the coconut, rice husks, wood waste, sulphur and other materials.

3. Experiments on the basis of soil-cement

The most traditional activities in this field are the various existing experiments using soil-cement in different proportions according

to the characteristics of the soil; among these undertakings mention may be made of the construction of roads, blocks, underground pipes, etc. In the first case success has been met within experiments in mixing soil with cement and bituminous materials.

4. Construction of blocks

As regards blocks, experience is varied, and ranges from the traditional adobe with the same mixtures as those mentioned above to more sophisticated ceramic bricks, and including soil-cement blocks.

Machines that are easy to use have been designed for the manufacture of blocks, and others for cleaning artisan-made ceramic bricks.

5. Others

Other activities carried out comprise such miscellaneous aspects as the construction of boards or panels using traditional materials with certain simple additives which make it possible to improve thermal, acoustic or physical properties in general. Among the specific activities worthy of mention is that relating to bamboo, on the one hand its rescue for utilization as a construction material, through the development of new techniques, and, on the other hand, the study of its silvicultural and botanical characteristics, since on account of its misuse it has been in increasing danger of extinction during the last few decades.



D. ENERGY: NEW SOURCES OF ENERGY FROM AGRICULTURAL  
WASTE AND PRODUCTS

In the development and use of new and renewable sources of energy, the countries of the region have worked actively in the elaboration of common formulas and positions in the framework of various world and regional forums. During the Regional Preparatory Meeting for the United Nations Conference on New and Renewable Sources of Energy (Mexico, 16-20 March 1981), a Regional Plan of Action was approved which proposes a series of national efforts and co-operative activities at the subregional, regional and world level, based on integral programmes which incorporate knowledge of the source, final use and adequate technology, bearing in mind the dynamic nature of the potential new sources of energy.

In respect of the object of specific concern here, this Plan contemplates various integral regional programmes, namely: Programme for vegetable residues and energy efficiency for agro-industry, biogas programme, Liquid fuel production programme (ethyl alcohol and vegetable oils) and Firewood and charcoal programmes. All of these pursue, inter alia, the determination and development of the energy potential offered by various vegetable, forest and agro-industrial products and residues available in the countries as well as the transfer of technologies between the countries involved.

As for specific activities in the region, the most important is related to the programmes for producing alcohol from biomass, in Brazil. Apart from this, the fundamental effort on the part of the great majority of institutes and centres is directed towards the production of methane gas from organic waste. In this field there are innumerable experiments with biodigestors of various types which, in the great majority of cases, are minor or substantial adaptations of the traditional biodigestors widely used in China and other Asiatic countries. In the case of Colombia, the interest lies in the modifications in design and accessories of these biodigestors, while in Mexico and Peru the effort appears to be mainly directed towards an attempt to facilitate the energy self-sufficiency of isolated rural areas, with family and community-based designs.

Apart from the Brazilian institutes and centres described below, it may also be pointed out that in Colombia the activities of the Centro Las Gaviotas are directed towards the study of solar and wind energy, but are not based on biomass. The production of energy on the basis of biomass is located in the private sector and in projects in connexion with COLCIENCIAS. In Mexico, the most important activities in the area of biomass energy are being carried out by the Biomass Department of the Electrical Research Institute (IIE) and, in Peru, by the Institute for Technological Research and Technical Standards (ITINTEC) and the University of Cajamarca.

1. The case of Brazil: energy production from biomass

The technical problem of producing alcohol is not the focal point of concern of the programmes, since these are old and well-known technologies, although modifications have certainly been made in them which have contributed to improving their yield. The focal point is

the set of wide-range activities being carried out in Brazil in this area which may be of special interest for possible co-operative action. For this reason we have expanded the description of the programmes being carried out in Brazil in this field.

The marked dependency on imported oil (around 80%) was the key factor which led Brazilian authorities to use alcohol as a means of alleviating the pressure on the trade balance caused by the enormous imports of oil. For this reason, in 1975, the Technological Ethanol Programme (PTE) of the Industrial Technology Secretariat of the Ministry of Industry and Commerce, was established to develop the technological structure needed to promote alternatives to imported liquid fuel, primarily ethanol.

This same year, and complementing the work of PTE, the National Alcohol Programme (PROALCOOL) was established as a large-scale programme for the technological development of biomass energy, with an emphasis on fuel alcohols. The main objective was to develop and transfer to the private sector all the necessary technology for setting up the production and distribution structure.

Then the Industrial Technology Foundation (FTI) was established as the executive body of the Industrial Technology Secretariat, which was given the main responsibility for executing the above-mentioned PROALCOOL programme within the context of PTE.

As the highest body for the programme, the National Alcohol Commission was established, made up of representatives of the Ministries of Housing, Agriculture, Industry and Commerce, Mines and Energy, the Interior and the Planning Secretariat of the Presidency of the Republic and chaired by the Secretary-General of the Ministry of Industry and Commerce.

This programme developed very rapidly between 1975 and 1979, since production increased from 640 to 3 000 million litres. Estimated production in 1980 is about 4 000 million litres, a figure which, in spite of vigorous effort, did not reach the desired goal of 6 000 million litres for that year. By 1985 production is expected to reach 11 000 million litres, thus indicating that ethanol could substitute for almost 45% of gasoline consumption.

When the Programme was initiated in 1975, it was proposed to channel towards it by 1985, in the form of subsidies to the production and consumption of alcohol, an estimated 5 000 million dollars.<sup>1/</sup> Government incentives consist in financing, under concessionary terms, in order to aid or modernize and expand the existing distilleries, build new units and develop agricultural projects to supply them.

At first the percentage of alcohol to be mixed with gasoline was set at 20%, thus obtaining so-called "gasohol". Early in 1971 this proportion was reduced to 12%. This official decision, along with the raising of the price of ethanol from 54% to 63% of the price of gasoline, would tend to reduce the subsidy received by this product.

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<sup>1/</sup> More recently, the cost of PROALCOOL has been estimated, between 1981 and 1985, at 7 500 million dollars. The IBRD recently loaned 250 million dollars to PROALCOOL, this being the first credit for an alcohol production programme.

The rapid initial advances in the production of ethanol from sugar cane and the resulting -although partial- replacement of gasoline, encouraged, on the one hand, the substitution of other petroleum derivatives such as diesel oil and fuel oil and, on the other hand, the intensification of research on other alternative forms of energy: methanol, vegetable oils, methane and charcoal, all derived from renewable sources. As a result, PTE evolved into a more widespread programme, mainly consisting of energy alternatives from biomass.

It is possible, in the near future, that PROALCOOL will become a national programme for energy alternatives from biomass. In this respect, the study of plant biomass potential for energy purposes conducted by IPT for the Energy Commission of the State of Sao Paulo (CESP), which is to be extended to the national level, should be pointed out. Senegal has shown interest in receiving co-operation for a similar study, and IPT is preparing to provide it.

The principal technological development in the field of energy from agriculture resources and waste are the following:

(a) Alcohol from sugar cane

The processes used are well known, since there is copious literature and abundant experience on them.

The public institutions which have accumulated the most experience in this activity are the National Institute of Technology/Industrial Technology Foundation (INT/FTI), both in the area of the Industrial Technology Secretariat and the Technological Research Institute of the State of Sao Paulo (IPT).

In relation to the activities of the latter, the programme of alcohol microdistilleries may be mentioned, an integral part of the more extensive Integrated Sugar and Alcohol Project.

In the search for solutions so that small rural communities or productive units may reach energy self-sufficiency, IPT carried out studies on the production of alcohol from sugar cane in micro-distilleries with capacities of 50 000 to 100 000 litres per seven-month harvest (between 300 and 900 litres daily). These are low-cost units operated by semiskilled or unskilled workers, using simple and economical construction materials such as reinforced concrete for the tanks, wood for the distillation column with bamboo rings as filling, masonry fermentation tanks, etc.

In order to accelerate the adoption of these microdistilleries, five demonstration plants were set up in various parts of the country; the first of these have already been installed in Brasilia, at the headquarters of EMBRAPA, and in Piracicaba, State of Sao Paulo.

The alcohol produced may be used as a substitute for gasoline and diesel oil in the engines of automobiles, trucks, tractors and stationary machinery, etc., after proper adaptation of the engines.

IPT has also directed its research towards improving the production system in its various stages through, inter alia, the process of continual fermentation and biodigestion of the residue of distillation, called dregs, which is produced at a ratio of 12:1 with alcohol and which is highly polluting. Methane gas results from this process and may be used as a fuel, replacing sugar cane husks.

(b) Alcohol from manioc

This possibility has become a subject of concern for INT/FTI and IPT as well as the private sector, there being already some productive units in operation on the industrial scale, besides a demonstration plant of 60 000 litres per day in Curvelo, Minas Gerais, operated by PETROBRAS, which uses a process originated by INT/FTI in its biomass programme.

This body has developed and made technologies available for productive units of 2 000, 10 000, 30 000 and 60 000 litres per day. A 10 000 litres per day unit requires 18 months to build and an investment of 2 million dollars, while the smaller 2 000 litres per day plants require an investment of about half a million dollars. One of these plants is being constructed, also to be used as a demonstration unit. In general terms, the production of alcohol from manioc does not present serious problems, since its technology is known and is the same as that used in the production of alcohol from starches, cereals in general, sorghum, potatoes, babassu, etc. The most important advances in recent years have been the improvement in the energy balance of the processes for producing alcohol and the inclusion of more advanced techniques which have been developed for producing the other types of alcohols.

The characteristic features of manioc as a raw material for producing alcohol, which give it a special position in PROALCOOL, are the following:

- (i) possibility of operation of the industrial complex throughout the year;
- (ii) greater potential for reducing the consumption of energy in the industrial process due to higher content of fermentable sugars;
- (iii) production of its own processing fuel, represented by the more woody lower parts of the part of the plant above ground;
- (iv) high potential for production of ethanol per surface unit;
- (v) total utilization of the underground and above-ground parts, that is, great availability of biomass per surface unit;
- (vi) utilization of poorer soils, unusable for other more demanding crops;
- (vii) incorporation of these soils into the productive system, presently completed or partially fallow and, more importantly, incorporation of large contingents of labour, also idle, into a stable occupation;
- (viii) low consumption of energy and fertilizer on the crop-farming side;
- (ix) the projected plant for manioc is in a position to process any other agricultural raw material whose principal component is starch.

There are still doubts, however, about the purely agricultural aspects of manioc, since there is very limited experience in its large-scale management; concerns have been mainly centred on disease and the action of bacteria and insects. This is one of the reasons that greater attention should be paid to agricultural costs, considered as determining factors of the success of the operation.

As for the problem of the dregs, INT/FTI has done studies on various possibilities for its treatment as an effluent and its utilization: lakes of aerobic stabilization; concentration through its evaporation to be used as either fertilizer or animal food; its direct use through aspersion as fertilizers, etc. The possibility of using biodigestors for the production of methane gas has also been given special attention, as in the case of the dregs from the distillation of sugar.

Finally, the private sector has also studied the case of manioc pellets dried in the sun, made from the residues of manioc from the distilleries. This study is a part of an integral study of a distillery with a capacity of 150 000 litres of manioc alcohol daily.

## 2. Other sources of energy

### (a) Utilization of babassu <sup>1/</sup>

A joint study has been done by IPT and INT/FTI on the integral use of the babassu nut, after breaking or cracking it mechanically. The epicarp may be used as charcoal, since it has been shown that the endocarp, a subproduct of the industry which extracts the oil from the seed (edible, similar to that of copra) is usable in two different forms, as gas and as charcoal. Alcohol may be obtained from the mesocarp.

IPT has developed a continuous carbonization process from the endocarp of babassu, for which it installed a pilot plant with a capacity to produce up to 300 kg of raw material per hour and to obtain tar and charcoal, making it into briquets and converting it into a product similar to coke.

Another project based on babassu has been to set up a plant for the carbonization and compacting of the babassu endocarp on a barge capable of processing 10 000 tons annually. It will operate on the deposits of babassu nut supply along a stretch of the river Parnaiba in the State of Piauí.

### (b) Biogas

Besides the utilization of the dregs from sugar cane alcohol and manioc, there have been some technological developments in this area.

The Brazilian Corporation for Agricultural Research (EMBRAPA) has been developing a National Research Programme on Energy since the end of 1979, basically oriented towards capturing solar energy in the form of biomass and transforming it into solid, liquid and gaseous fuels.

Research is also being carried out on microdistilleries and biodigestors aimed at the production of alcohol, with the residue (including the dregs) being sent to the biodigestors. The system also provides for the production of electricity with generators run by alcohol or gas. The raw materials used are sweet sorghum or sugar cane.

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<sup>1/</sup> Variety of native, perennial palm (Orbina Martiana Oleifera) with a rapid reproduction cycle, occupying an estimated area of 15 million hectares in northern Brazil.

There is a microdistillery, with a capacity of 100 litres per hour of alcohol, in operation in the National Centre for Investigation on Maize and Sorghum.

On other level, there is the IPT project for the aerobic digestion of urban waste enriched by the sludge from sewers to produce methane gas. The study involves a semi-industrial scale unit for treating between 0.5 and 10 tons per day of waste and 0.25 to 17 m<sup>3</sup> per day of sludge, producing around 19 m<sup>3</sup> per day of gas.

(c) Wood

The Energy Commission of the State of Sao Paulo (CESP) centralized a large project for the utilization of wood as an energy source, in which national and foreign private corporations and research institutes are participating.

At the request of CESP, IPT planned a pilot plant for generating electrical energy from the gasification of wood, with a 500 kw. capacity. The results of this project led to another similar one for a 1 000 kw. unit.

Another IPT programme has to do with the various ways of using eucalyptus as an energy source, among which is the obtaining of methanol through gasification.

Gas synthesized from wood or other lignocellulosic materials may be obtained in two basic ways:

- (i) direct gasification of wood in a single plant;
- (ii) gasification of the charcoal produced in carbonization units.

The attempts made up to now seem to indicate the feasibility of the project. The first stages involved classifying the eucalyptus raw material to be gasified, a process which will be studied under varied conditions. The choosing of the most appropriate technology for the synthesis of methanol, the second stage of the process, will be based on the production capacity of the characteristics of the synthetic gas generated by gasification and the particular conditions of the region where the plant will be installed.

INT/FTI have considerable experience in obtaining ethanol through acid hydrolysis of wood, since they have been working on this subject for four or five years. They operate a pilot plant in Lorena (Sao Paulo), the only one of its kind in South America.

A state enterprise -COALBRA- has been established for the installation of a network of wood alcohol plants, which INT/FTI will supply with technological support.

There is, however, the belief that the production of ethanol from wood has clear disadvantages compared with sugar cane basically stemming from the greater cost of investment in equipment. However, a fact in favour of wood is that, generally speaking, trees may be planted on land which is in a condition very inferior to that required by sugar cane.

Research is also progressing in the enzymatic hydrolysis of wood, a subject that has become applicable much sooner than expected.

(d) Vegetable oils

IPT undertook a preliminary study of oil-producing crops, with a view to determining which would be the most appropriate to be used as fuels, followed by another investigation on microplants for vegetable oils from soya, cotton, sunflower, mamona and colza.

The objectives of these studies are to make possible the use of these oils in the diesel engines of tractors and other rural vehicles, which would result in a proposal for specification of vegetable oils or their mixtures and recommendations for possible modifications of these engines.

III. ELEMENTS FOR CO-OPERATION IN THE INSTITUTIONAL SPHERE:  
THE FORMULATION OF POLICIES, THE PLANNING OF SCIENCE  
AND TECHNOLOGY AND THE SYSTEMS AND INFRA-STRUCTURE  
TO REGULATE ITS TRANSFER

In the past decade, there has been a marked acceleration of the rate of technological growth for the region as a whole. At the same time there has also been a notable improvement in the institutional structures and machinery which have been developed in connexion with the management of the technological variable. We must also recognize the considerable qualitative advance in the formulation of plans and programmes and in the achievement of an increasing integration between the latter and the objectives and goals of economic and social development, thus tending to make more explicit the role and the presence of technology in the process of decision-making and planning.

There are obviously appreciable differences among the countries according to their level of development and other circumstances. In the same way, not all the countries -especially the smaller ones- have the institutional infrastructure to give adequate consideration to scientific and technological matters. However, the region has shown progress in this direction in recent years, and a growing number of countries, whether individually or collectively, have been establishing or improving their institutional base and the corresponding machinery for the management of science and technology in the context of their development goals and objectives.

All of this is true, along with the progress made by the region in its economic and social development process. However, Latin America shows a high degree of dependency in the area of technology, and the import of technology from developed countries continues to be the region's main form of access to technological innovation. Conscious of this, and of the important role played by scientific and technological capacity in the acceleration of economic growth, the Latin American countries, in recently approving the "Regional Programme of Action for Latin America in the 1980s",<sup>1/</sup> have agreed to adopt a whole series of actions aimed at strengthening scientific and technological capacity and thus attenuating the relationship of dependency of Latin American countries in this area. In this way, the region as a whole and the countries in particular are seeking the adaptation of their scientific and technological systems to the economic and social goals and objectives they have proposed to reach in the present decade.

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<sup>1/</sup> See "Regional Programme of Action for the Implementation of the International Development Strategy for the Third United Nations Development Decade", CEPAL, nineteenth session, Montevideo, Uruguay, 4 to 15 May 1981.

Co-operation, both on the regional level and with developing areas and developed countries, plays a relevant role in this effort.

The diversity of situations and experiences in scientific and technological matters offered by the region is surely a propitious field for the exchange of and search for opportunities for co-operation between Latin America and Africa.

Following is the situation with respect to the countries specifically concerned with the project:

Argentina

The highest body is the Subsecretariat for Science and Technology of the Ministry of Education and Culture. Its mission is defined in the new law of ministries (March 1981), as "to be charged with the execution of the national policies connected with scientific and technological development". Among its specific functions are the following: (a) to intervene in the elaboration of technological and scientific policy; (b) to deal with the determination of scientific and technological tasks of public and private bodies, avoiding duplications; (c) to intervene in the determination of fields and priorities in which there is a possibility of developing the country's own technology, and concerning scholarships and loans in the scientific and technological field; (d) to participate in co-operative scientific and technological international relations.

The present Subsecretariat is the result of successive changes: its earliest precedent is the National Council for Science and Technology (CONACYT) established in 1968 as the highest body for scientific and technological policy under the jurisdiction of the Presidency. This was a council at the ministerial level presided over by the President of the Republic and which had as an operative organ a secretariat, whose top position was at the ministerial level and which operated for very brief time.

After successive modifications, the abovementioned law of ministries was passed, which changed the institutional structure, establishing -as mentioned before- that what has now become the Subsecretariat for Science and Technology would "intervene" in scientific and technological policy-making activities.

Presently, the centre of this Subsecretariat's activities is the co-ordination of programmes in various areas declared to have priority, that is: food, non-conventional energy, petrochemicals, endemic illnesses, electronics, natural resources and housing.

The National Council for Scientific and Technical Research (CONICET), which depends on the Subsecretariat for Science and Technology, was established in 1968 to promote, co-ordinate and orient research in the field of pure and applied sciences. Their action was direct almost exclusively to the support of basic sciences and the training of researchers, with preference given to the fields of medical and exact sciences.



It presently functions as an autarchic entity dependent on the Ministry of Education through the Subsecretariat for Science and Technology.

The scientific community is represented by 12 members of the Board of CONICET, and the rest represent the Subsecretariat and the Ministry of Defence.

Possibly one of the most significant results of CONICET activities has been the setting up of the research career in 1960, which has been one of the most effective supports for the development of the Argentine scientific capacity. This mechanism was created with the objective of encouraging the exclusive dedication of researchers to their specific function.

The origin of the systems and infrastructure for regulating technology transfer transactions go back to the establishment in Argentina of the National Registry of Licence Contracts and Technology Transfer (RNCLTT) in 1971, under INTI. The authority for implementing this was the Secretariat for Industrial Development, advised by a commission made up of INTI, the Secretariat of State, the National Development Bank and the Central Bank.

In October 1974, in accordance with the changes which took place in the legislation on foreign investments, a new law was passed, No. 20 797, regulating the transfer of technology from abroad, which was, generally speaking, slightly more restrictive than the previous one.

The modification of the economic policy in 1976 brought with it a change in the legislation on technology transfer, passed in 1977 (Law 21 617), by virtue of which RNCLTT was maintained, but both the Advisory Commission and the Consultative Commission were terminated. In general, the changes tended to liberalize the system of control, while maintaining its basic outlines. Ceilings were maintained for royalties on net sales and, in general, the restrictive clauses were listed which might cause the contract to be rejected: obsolete technology, in the public domain, prohibition of exports, royalties higher than the ceilings indicated, refusal of permission to the licensee to develop improved technologies, obligation to acquire raw materials or inputs from the transferer, obligation to employ staff of the transferer, limitation of the use or development of the permit holder's own technology, etc.

The new law, passed in early 1981, introduces radical changes into the system of control, in accordance with the guidelines of the prevailing economic scheme or model. The traditional a posteriori approach has been changed into anticipatory action, where the focus is not on the analysis of contracts already signed but on support for the bargaining power of the purchaser, providing him with the information he needs.

On the basis of this philosophy, the obligatory nature of previous approvals of licence and transfer agreements for the use of technology and trademarks made between independent corporations has been eliminated, while maintaining it for related corporations, in order to prevent the latter from obtaining a tax benefit without an actual technological transfer. For these latter, if they do not obtain

approval for the contracts,<sup>1/</sup> the royalty payments are considered as profits, for tax purposes. Also maintained for these enterprises is the 5% ceiling on net sales, as a compensation for the technology provided, and the prohibition of compensation for the use of trademarks.

RNCLTT was dissolved, and INTI was designated as the authority for implementing the new system. For its activities in the field of technology transfer, the guidelines related to the supply of the latter established the need for INTI to develop and maintain permanent contact with UNIDO, foreign industrial associations, foreign public offices and agencies working in technological development, whether to support their respective local industries or to transfer technology to the exterior. Other necessary contacts are mentioned, such as specialized publications, industrial events (fairs and exhibitions), existing data banks (without the need to develop their own system), individual enterprises and technological intermediates.

On the demand side, the main task of INTI is to advise the enterprises desiring to incorporate new imported technologies into their productive processes. Also mentioned are the tasks of analysis of the different sectors of the industry in order to detect the degree of technological backwardness of each one of them, enabling it to establish priorities in the search for technologies and, in general, in relation to its activities in this field.

Other areas in which INTI activities are mentioned are quality control and the standarization of products.

In brief, the new approach consists in only partially retaining the control apparatus, for cases in which it is considered indispensable, putting the emphasis instead on co-operation with the private industrial sector in order to assist in the appropriate selection of technology.

#### Brazil

The first Scientific and Technological Development Plan, covering the period 1973-1975, had the advantage of focusing the country's attention on the importance of science and technology and of establishing the National Fund for Scientific and Technological Development (FNDCT). The second Plan, for the period 1975-1979, sought to expand the supply of science and technology and to create the conditions for setting up the National System for Scientific and Technological Development (SNDCT). The current Plan -1980-1985- primarily pursues the goals of scientific and technological training and self-determination in this field.

In this last area, the change in the dependency situation in relationship to the developed countries, the Plan centres its attention on priority sectors such as energy, agriculture and social development. In these it seeks to achieve more scientific training and a reduction in the degree of technological dependency through policies directed towards lessening the country's need to import energy inputs,

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<sup>1/</sup> The law defines as juridical acts subject to approval those acts which are performed between a local enterprise with foreign capital and the enterprise which directly or indirectly controls it or another subsidiary of the latter.

reinforcing their capacity for selecting appropriate technologies, promoting an effective absorption and generation of its own solutions to respond to the regional diversities of the Brazilian reality.

The principal bodies or governmental institutions charged with the formulation of policies, control and financing in the technological area are the following: the National Council for Scientific and Technological Development (CNPq), connected with the Planning Secretariat of the Presidency of the Republic (SEPLAN), which is responsible for outlining general policies; the National Institute for Industrial Property (INPI), under the Ministry of Industry and Commerce, which is the controlling body for the acquisition of technology, and the Financing of Studies and Projects (FINEP), also connected with SEPLAN, which is concerned with the financing of technological development.

As already mentioned, the most important body from the point of view of policy making is the CNPq, which depends on the Science and Technology Council (CCT) as a higher leading body.

The composition of CCT reflects the current interest in facilitating co-ordination of scientific and technological activities. Thus, all the bodies and institutions which in one way or another have to do with this activity are represented on the Council, which is composed of 32 members, 17 of which are members in their own right and 15 of which are appointed by the President of the Republic.

In co-ordinating science and technology activities and in implementing some aspects of training and research, CNPq acts jointly with other institutions which depend directly on it, such as: the National Institute for Amazon Research (INPA) located in Manaus; the National Institute for Special Research (INPE) located in Sao Paulo; the Pure and Applied Mathematics Institute (IMPA) located in Rio de Janeiro; the Brazilian Centre for Physics Research (CBPF), in Rio de Janeiro; National Observatory (ON) located in Rio de Janeiro; the Brazilian Institute for Information on Science and Technology (IBICT) located in Brasilia and the Laboratory for Scientific Computation (LCC).

For 1981 it is estimated that the expenditures of CNPq will be approximately 100 million dollars. Between CNPq and the previously mentioned institutes, 3 000 persons will be employed directly and indirectly.

The Financing of Studies and Projects (FINEP) connected with SEPLAN and established in 1967 has the purpose of supporting studies, projects and programmes of interest to the economic, social, scientific and technological development of the host country in accordance with the sectoral goals and priorities in the plans of the Federal Government. It works on the valuation of recoverable and lost funds, following the priorities established in the National Plan and the Basic Plan for Scientific and Technological Development. Thus, its activities include three basic functions: (a) as a public enterprise, financing and developing studies, projects and research, in the technical and financial training of the national and consulting office and in the technological development of the national enterprise; (b) as Executive Secretariat of the National Fund for Scientific and Technological Development (FNDCT), as technical and administrative agency in the

generation of this fund, guaranteeing its use in specific programmes of science and technology; (c) as Executive Secretariat of the Co-ordinating Committee of Centres of Articulation with Industry (CCNAI) to promote, through these centres, the substitution of imports of capital goods and engineering services required by State enterprises.

Both public institutes and private enterprises may apply to FINEP.

Brazil was the first Latin American country to establish juridical machinery to control foreign investment, through a foreign investment law in 1962. Later, in 1970, the National Institute for Industrial Property, (INPI) was established, which was assigned a determining role in the field of technology transfer.

INPI has the following functions in relation to the authorization of technology transfer contracts: reception of the application, advisory services to the parties, evaluation, authorization and finally recording of the respective contracts. The tasks of official control and follow-up are the responsibility of the Central Bank of Brazil. In addition, INPI is also responsible for the tasks of granting patents, trademarks and other industrial property titles.

Given the powers granted by the law, and because it possesses, in a centralized form, a vast amount of information on the contractual machinery used by the providers of technology to penetrate the Brazilian market, INPI is a body with wide bargaining powers in connexion with the entrance of imported technology.

Through various legal instruments, restrictions have been established on the payment of royalties between affiliate and head office by licencing patents and trademarks. In other contractual categories, on the other hand, payments are admissible, in principle, as compensation for such items as provision of industrial technology, technical and industrial co-operation and specialized technical services.

An other area relevant to the system of regulation of the acts of approval of technology transfer contracts is the detailed specification established by Normative Act 015 for the classification of contracts. These are classified by categories, and within them, by the type of goods to whose production the technology transferred is applied. These categories are:

- (a) permit for use of patent;
- (b) permit for use of trademark;
- (c) provision of industrial technology;
- (d) technical and industrial co-operation, and
- (e) specialized technical services.

Apart from its activities in technology transfer, INPI is developing other control and regulation functions in the field of industrial property, and specifically in connexion with the registry and approval of trademarks and patents. For these purposes it co-operates with other national institutes -such as IPT in Sao Paulo- with which it has established specific agreements to obtain the technical reports necessary for the assessment of patents.

In INPI's administrative structure, there are around 850 persons working in four major divisions: patents, with 140-150 engineers; trademarks, with 3-4 technicians; Centre for Technological Documentation and Information (CEDIN), with 5 engineers working directly with patents; and technology transfer, where 25 economists participate. Apart from these divisions there is a legal section where some 20 lawyers are working.

#### Colombia

The efforts to plan scientific and technological development formally began in this country around 1968, although before this date some technological institutes were already in operation, such as the Institute for Technological Research (IIT) established in 1958 and the Colombian Agricultural Institute (ICA) in operation since 1962.

In 1968, the National Council for Science and Technology (CONACYT) and the Colombian Fund for Scientific Research and Special Projects (COLCIENCIAS) were established simultaneously. Of the two institutions, it was COLCIENCIAS, initially conceived as an executive secretariat for the abovementioned council, which acquired a noteworthy dynamism, becoming the main Colombian body dealing with scientific and technological policy in Colombia, concentrating its efforts on financial support for scientific research and technological activity in general, as well as on co-ordinating the various national efforts in this area.

The National Integration Plan (PIN) defines the outlines of national policy in the area of science and technology. It expresses the general objective of the scientific and technological development policy which is, on the one hand, the application of science and technology to strengthening the productive sector and, on the other, its connexion with the development programmes of the Government.

The strategy presented tends to seek a concerted effort by the public and private sector both in defining and in financing and implementing the main programmes for scientific and technological development, assigning to the Government a role as a catalyst and promoter of these concerted actions.

As an institutional mechanism to ensure adequate co-ordination among the various bodies participating in the Plan and also for the follow-up, revision and evaluation of its development, CONACYT was assigned to this function and COLCIENCIAS was confirmed as the Technical Secretariat for this body.

COLCIENCIAS is a decentralized institute under the Ministry of Education which almost from its beginning has been the axis of Colombian scientific and technological activities, assuming the functions of formulating national policy in science and technology, promoting and financially supporting research and preparing studies. For this it receives a budgetary allocation of 5 to 6 million dollars and employs about 40 professionals.

The approach followed by COLCIENCIAS in the area of scientific and technological planning has been to start at the sectoral level, primarily improving the knowledge of the situation of each sector, and later to deal with the compatibilization and aggregation of all the sectors.

It is possible that the emphasis on COLCIENCIAS's activities is changing in the direction of "the technological" per se, placing the emphasis on the search for technological innovations more than on basic research, nevertheless continuing with its traditional function of granting subsidies for research. However, another body, the Colombian Institute for Higher Education, will deal with support for teaching and academic development in general.

In controlling entrance of technologies from abroad, the Colombian experience has been especially significant. This function is fulfilled by the so called Royalties Committee and the Exchange Office of the Bank of the Republic, which initiated this control in 1967 with the passing of a series of decrees and laws, and also in later years.

The machinery for regulating the importation of technologies has very special characteristics. The licensing contracts are approved by the Royalties Committee, under the Ministry of Development; the occasional technical assistance and engineering contracts by the Exchange Office of the Bank of the Republic; technology incorporated into complete or semi-complete plants by the Division of Global Licenses of the Foreign Trade Institute; technology linked to direct foreign investment by the Division of Private Investments of the National Planning Department.

The initial raison d'etre of this complex machinery was none other than the control of the outflow of foreign currency; considerations of the policies of acquisition and adaptation of technology were either absent or played only an accessory role. Later, as a result of Decision 24 of the Andean Pact, concerns also centered upon the purge of contracts, tending to eliminate clauses from them which were considered restrictive or damaging to the interested parties.

It has been felt that this institutional basis is not the most appropriate for reaching more advanced stages, characterized by decreased dependency, assimilation of imported technology and its diffusion within the country to other enterprises; actually, the operation of four channels of entrance to deal with technology import creates some co-ordination problems, and the grouping of these into one single institution managing both foreign investment and technology imports could contribute to solving these problems.

Even with the centralization of functions, it is indispensable to have an efficient system of information on technology import and investment in order to make available to the applicant the various alternatives to help him make a proper decision. In the case of Colombia, this would probably be the responsibility of the Andean Technological Information System, established by Decision 154 of the Andean Group.

#### Mexico

There are two instruments by which the policy and machinery for national scientific and technological development are established: the first is the Indicative National Plan for Science and Technology and the second, the National Programme for Science and Technology.

The Plan establishes a conceptual framework for the relations between the activities of technological and scientific research and the cultural, economic and education systems, designs a strategy for future efforts in science and technology, establishes the main objectives of a medium and long-term policy in the field, proposes goals of financial support and training of human resources for research and defines the sectoral outlines of the same, in accordance with the social and political needs of the countries.

The Plan served as a basis for the National Programme for Science and Technology, in the development of which the scientific community, the public sector and the main users of the technology also participated.

Both the Indicative Plans for Science and Technology and the National Programme for Science and Technology (1978-1982) serve the purpose of beginning to solve the problems and obstacles facing the scientific and technological development of Mexico, through the concerted action of the government, the scientific community and the productive sector.

The application of the Plan and the Programme for Science and Technology were possible only to the extent that there were instruments and adequate machinery to carry them forward; for this reason, during the 1970s efforts were made to centralize and instrumentalize legally a series of areas necessary for the technological development of Mexico. Thus, the National Council for Science and Technology (CONACYT) was established by Presidential Decree in 1970; the law on the registry of technology transfer and use of patents and trademarks in 1973, the law on inventions and trademarks in 1976, the Advisory Service to Data Banks (SECOBI), the Technical Information Trust for Industry (INFOTEC) established in 1975, the law promoting Mexican investment and regulating foreign investment in 1973, etc.

Among the powers granted to it by law, the most important are those of planning, programming, developing and co-ordinating scientific and technological activities; channelling resources from both the State and other sources, for the implementation of specific projects and programmes; achieving the broadest possible participation by the scientific community in the formulation of research programmes related to the objectives of economic and social development; obtaining the best possible co-ordination and communication between research institutions and higher education, the State and users of research; promoting the establishment of general support services to research and formulating and implementing a controlled programme of scholarships.

There are also various mechanisms and institutions which, directly or indirectly, are connected with the technological development of the country, among which are the following: the Inventions and Trademarks law (1976), which regulates the granting of patents for inventions and improvements, invention certificates, registry of industrial models and drawings, registry of trademarks, names of origin and advertisements and trade names; the Advisory Service to Data Banks (SECOB), established by CONACYT as a part of a programme seeking to establish a national system of information and documentation which would serve as a working instrument for Mexican researchers, providing them with adequate and timely information on the alternative technologies and

knowledge necessary for the development of processes more adapted to the needs of the country; the Technical Information Trust for Industry (INFOTEC) established in 1975 for the purpose of identifying and responding to the needs for technical information for small and medium-sized industry, also providing services to public bodies, universities, technological institutes, researchers and staff of CONACYT. It covers the areas of innovation and technological information and constitutes, in brief, a technical assistance and technological extension service.

Also noteworthy is a project to establish an organization which would group together the institutes which are working on appropriate technologies, which would aptly be called Appropriate Technology Institutes (ITAS) for the purpose of promoting the development and marketing of these technologies.

Mexico, along with other Latin American countries, established the National Technology Transfer Registry (RNTT) in late 1972. The main reason for this decision was based on the excessive payments which had to be paid for imported technology, which in many cases were hidden remittances of profits to the exterior. Another of the main concerns was the frequent existence, in the transfer contracts, of clauses which restricted the operation of the enterprises buying the technology.

The operation of the Registry is based on the law on Technology Transfer and the Use and Exploitation of Patents and Trademarks of 30 December 1972, which regulates the transfer of technology from abroad. By virtue of this provision, which makes it obligatory to sign transfer contracts, since their omission invalidates them before national tribunals, restrictive clauses in the contracts have been eliminated which were obstacles to industrial growth, and considerable savings have been made in foreign currency under the heading of royalty payments abroad, technical assistance and engineering services.

Among the purposes of establishing the above-mentioned RNTT were those of strengthening the bargaining position of national enterprises, creating a consciousness in the business world of the importance of technology and its international transfer for the development of the country, and establishing a mechanism for determining the conditions of the contracts and the problems inherent in technology transfer, as a contribution to the task of national planning of the country's technological development.

For a contract to be able to be signed, it must not contain restrictive clauses and entailments considered harmful, such as: (a) very high price; (b) excessive terms of applicability and (c) imposition of restrictions on exports, production, research and, in general, on the operation of the buyer enterprise.

The most common (57%) form of payment is that of royalties on sales, since the unwritten rule is that their proportion should not rise above 4% on the gross sales.

#### Peru

The National Research Council (CONI), established in 1968, is the first Peruvian institution in the area of formulation and proposal of scientific and technological development policy and co-ordination of scientific research in the country.



CONI was composed of a Higher Council, including the highest bodies of scientific research and members of the scientific community, to decide the support policy in the fields of national science and technology and of a General Technical Administration as the executive body and co-ordinator with specialized agencies for the promotion, support, co-ordination and evaluation of scientific research projects. Among CONI's achievements were the national inventories of human resources, the evaluation of technical requirements for industry and the setting up of a National Centre for Scientific and Technological Information and Documentation. It also created various institutes such as that of Advanced Technologies, Intermediate Technologies, Physics, Mathematical Research, etc.

At present it is working on a major revision of legal normativeness in science and technology.

The salient features of this new order are the following: (i) to modify the present bent towards the scientific to include the technological; (ii) to confirm the National Council for Science and Technology (CONACYT), the successor to CONI, as exclusively responsible for formulating scientific and technological development policy and co-ordinating it with the economic and social development policy; (iii) also to confirm CONACYT as responsible for promoting and supporting all areas of scientific and technological research; (iv) to assign to CONACYT all the functions related to international co-operation, designating it as the responsible body in this field. It should, however, co-ordinate its activities with the Ministry of Foreign Relations and the National Planning Institute; (v) the establishment of the National Fund for Scientific and Technological Development to act in the fields of obtention, management, administration and allocation of national and foreign resources for these purposes.

A revision of the legal order in science and technology also reached the Institute for Technological Industrial Research and Technical Standards (ITINTEC) established in 1970 to act specifically in the industrial field. It is intended that this entity should place greater emphasis on the activities of research and development which it carries out on its own, relatively decreasing the financing of subcontracting by other agents.

In the area of finance, ITINTEC receives its funds from a contribution of 2% of the net income (after taxes) of medium-sized and large industrial corporations. However, it is possible that the corporations may decide to use these funds for their own research programmes. In this case, and with previous approval of these programmes by ITINTEC, they are financed by the 2% contribution, which in this case -although they do so in the other cases- the corporations do not pay. ITINTEC is empowered to complement, with its own resources, the resources that the enterprises are using for their own research programmes.

In addition, ITINTEC activities related to Decision 24 of the Andean Group were transferred to the National Commission for Foreign Technologies and Investment (CONITE) along with everything related to the control of technology transfer.

As already pointed out, at the beginning of 1977 ITINTEC transferred to the National Commission for Foreign Technologies and Investment (CONITE) the responsibility of registry and authorization of technology transfer contracts from the exterior. This function was the result of the implementation of the Peruvian provisions incorporated in Decision 24 of the Andean Group in this country's legislation.

From 1975 to 1977, while ITINTEC was in charge of these functions, for which it had established the Technology Transfer Committee, the approaches used were mainly directed towards the search for an effective technology transfer, for which the payments in foreign currency to the exterior actually corresponded to the compensation received from abroad.

CONITE began its operations in July 1976 as a consultative body of the Ministry of the Economy and Finances and is made up of three representatives from the Economy and Finances sector, two from Industry and Tourism, one from Energy and Mines, one from the Commerce sector, one from the National Planning Institute and one from the National Integration Office.<sup>1/</sup>

The Technical Secretariat of the Commission functions as an advisory and technical support unit of CONITE at the Administration level. This body is responsible for receiving applications, advising contractors, evaluating the contracts from a legal and economic point of view and overseeing their implementation.

It is also the responsibility of CONITE to develop, propose and execute the foreign technologies and investment policy, and to evaluate the adaptation of these to the socioeconomic development of the country. Trinidad and Tobago

Although a system of science and technology with supporting institutions, plans and policy has not yet been developed, science and technology have been defined as an important area of external policy with the establishment of an interministerial group in this area. Its chairman is the permanent secretary of the Ministry of Foreign Relations, which is advised by a Ministry unit dealing with science, technology and international trade. Although there is no science and technology plan, some policies have been formulated to cover certain basic areas and sectors.

One of the central areas on which attention has been focused for the future is the concern to have adequate systems of technology and information for the Caribbean. For this reason, the CEPAL Caribbean Documentation Centre is playing a key role in facilitating the establishment of a system of science and technology.

There is no definite policy on technology transfer, nor is there machinery to regulate it. However, there is a registry for foreign licences in the Central Bank, but only for the purpose of controlling international exchange.

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<sup>1/</sup> The National Integration Office was changed into the Ministry of Integration in 1976. In late 1977 the previous ministries of Industry and Tourism and Commerce and Integration were combined into one single body.

IV. MEANS AND INSTRUMENTS TO FACILITATE THE FORMULATION  
AND SETTING UP OF THE RECOMMENDED TECHNICAL  
CO-OPERATION INITIATIVES

The previous sections of the document were basically devoted to a review of the experience and present situation of scientific and technological co-operation between both regions and an attempt to gather information and elements which, once confronted with the corresponding similarities of Africa, would make possible a fundamental identification of opportunities or areas in which co-operative efforts appeared to be most promising.

As determined by the draft document, this task of consolidating or "crossing" information gathered in both regions should lead to proposals or suggestions for interregional projects which might be undertaken by the secretariats of CEPAL and ECA to be submitted for their consideration at the meeting of governmental experts of the countries of Africa and Latin America.

Such proposals and suggestions would indicate not only the material or area in which it is proposed to carry out co-operative action but also, naturally, the means and instruments -institutional, organization and other types of arrangements- appropriate for putting them into practice.

It is also clear that the means of co-operation will depend to a great extent on the nature and characteristics of the subject matter of the co-operative action: for example, association to complete or continue a certain experimental development would obviously require different machinery from that required to use the experience of a public body in the control of technology transfer, without denying that some activities -such as the exchange of information- would tend to be a common component in almost all forms of co-operation.

It is possible, along these lines, to anticipate -on the level of agents of co-operation- that a very relevant role will be taken by the agricultural or industrial research institute, in everything referring to the co-operative efforts to open up into the chosen sectors related to agriculture, industry and energy. On the other hand, in the policy area, it is very probable that the co-operative actions may be entrusted to central administrative bodies of the countries responsible for the formulation of technological policies and plans as well as those in charge of activities such as the control and registry of the entrance of technologies from abroad. It may be recalled from the first chapter that there are possibilities for co-operation in relation to determined developments which, in the scientific and technological policy area, have taken place under the Cartagena Agreement.

Without detracting from the above, we should also point out that in the private Latin American sector there are potentials that should be taken into account in future co-operative arrangements and activities between both regions, since the very rich and varied experience accumulated makes this sector especially suitable to participate in training activities and, in general, technical assistance.

Besides the countries, which are natural agents of co-operation, the participation of regional or subregional bodies would also be possible. The Regional African Centre for Technology, in which almost all the countries of the Organization of African Unity participate, and the Cartagena Agreement are both regional examples of a rather extensive list of possible participants which includes ALADI, SELA-RITLA and also, of course, CEPAL and ECA.

It is interesting, on the subject of possible means or mechanisms for co-operation, to look at what was recently agreed upon at the High-Level Meeting on Economic Co-operation among Developing Countries, held under the auspices of the Group of 77 (Caracas, Venezuela, 13-19 May 1981). Attention was paid on this occasion, among other subjects, to technology and the promising possibilities offered by co-operation among developing countries in this area, and reiterating the critical importance of this co-operation in order to continue and strengthen efforts towards autonomous and sustained development.

In addition to the objectives pursued by the project and, specifically, in relation to the proposed purposes of the present chapter, a list is presented below of actions which might be considered in order to set up co-operation between the two regions and attain the hoped-for benefits.<sup>1/</sup>

It would appear that a fundamental action to be encouraged would be to establish or strengthen and keep up-to-date an inventory of the scientific and technological capacities and activities of the countries of each region and of their needs, with special emphasis on technological developments, experiences of pilot or demonstration plants and availability of technical knowledge. This inventory would also include a catalogue of institutions and machinery related to science and technology. This was precisely a part of the task which was to be carried out in selected areas to comply with the mandates of the present project.

This systematic compilation of basic information should be available for the concerned countries and institutions and also for international and regional organizations.

The carrying out of the above would considerably facilitate the establishment of the arrangements and machinery which may be considered appropriate to make co-operation effective in the two regions.

The range of these mechanisms is very wide, since it ranges from the simple exchange of information for a specific purpose to complex forms of association or collaboration such as might be the case of the

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<sup>1/</sup> Besides the Programme of Action adopted by the High-Level Meeting on Economic Co-operation among Developing Countries (Caracas, 13-19 May 1981), A/36/333, the suggestions submitted were also inspired by Co-ordinated technological research and development in developing countries: regional co-operation to strengthen indigenous capacities for innovation, study prepared at the request of the UNCTAD Secretariat, TD/B/C.6/63.

so-called "twinning agreements" between two or more institutions which are usually national centres for technological research and development. The machinery mentioned might even include the establishment of permanent or temporary institutions which would serve as an appropriate framework and structure for co-operative activities. Naturally, the existence of co-operative agreements in the field of science and technology, such as those which have been signed among various countries of the region -Argentina and Brazil, for example- and countries of Africa, are a very interesting element for future activities of co-operation, whose concrete actions might be included in the framework offered by the above-mentioned instruments.

Without claiming to be exhaustive, we offer below some forms which the operative arrangements mentioned above might take, with the express warning that such arrangements would probably include various forms, many of which, in turn, are normally combine.

It goes without saying that the concept of technical assistance, in the sense of transfer of accumulated experience and knowledge from one party to another, whether carried out in relation to a specific area or in general terms, is present in practically all of the forms and mechanisms listed below, constituting precisely the main object of the relationships proposed as an illustration.

1. Exchange of general or specific information and knowledge on specific topic or problem

This is undoubtedly a kind of primary component of all co-operative activity, since it is difficult to conceive of it without including this exchange. However, it may occur, especially in the initial stages, that the co-operation consists basically in an exchange of information and knowledge referring to a specific activity or area of work.

2. Establishment of information networks

These are mechanisms to strengthen and confer some permanence to exchanges of information, communication of ideas and results of regular experiences and consultations among participating countries. Obviously, this dissemination activity must be preceded by the collection, systematization, processing and analysis of the information.

Various such mechanisms exist; firstly, there are those of SELA-RITLA and the Andean Technological Information System, to which should be added those under UNIDO, UNCTAD, UNESCO, UNDP and WIPO, which offer extremely useful and helpful elements and experiences.

In relation to UNDP and its computerized information referral system (INRES) on the capacities and services which may be obtained in the developing countries for co-operation with other developing countries, it could be convenient to foresee a greater role for the competent bodies of the developing regions in the management of this instrument as a means of increasing its use and making it more effective.

3. Exchange of staff

This is a method used in the region, with one of the most frequent forms being the so-called pasantias, that is, more or less brief training courses of one or more researchers from one centre of research to another similar one in order to acquire or perfect certain knowledge. Naturally, visits of longer and more extensive periods, such as scholarships, are included here.

These longer and more extensive visits include moves of staff of the experimental research and development centres not only for original development or specific technology adaptation but also for the transfer of knowledge and experience accumulated by these centres, both in specific subjects and in general areas. This is also applicable to the private sector, whose equipment in this sense is very considerable, although its transfer will probably be made by other channels different from those utilized by the technological centres.

4. Joint training programmes

This is one of the means of co-operation which offers the best possibilities and in which three different types may be distinguished. First of all, there is the training of specialized staff to apply and master certain techniques. This is one of the most frequent situations in which training through transfer of knowledge and skills is done from the party which is most advanced or which has completed a specific activity of experimental research and development, or a partial area of it. Naturally, the training does not necessarily have to be connected with a specific project or activity, since it may touch on areas or subjects of a general nature. Secondly, the training may also have as an object the staff members whose function is the selection, acquisition, importation and adaptation of technology, generally from industrialized countries, dealing with both juridical and legal aspects -directed towards negotiation- such as technologies connected with the selection of appropriate technologies and the deglobalization of the so-called "technological package", given the existing relationship between deciding which technology should be acquired and the way to acquire it. This is a very appropriate sphere for co-operation among developing countries, given the common characteristics of their technological dependency on the industrialized countries.

The same considerations are applicable to areas dealing with industrial property (patterns and trademarks) and the formulation and application of technical standards and quality control.

Finally, the area of formulating science and technology policies is also suitable for training efforts, especially since there are few institutions which provide training in this area.

5. Joint experimental research and development programmes

Obviously this heading may include a wide range of possible co-operative initiatives, whether it is a question of undertaking a determined technological development or combining efforts to continue one already started. At the same time we should not lose sight of the fact that this is a rather complex method, since the sum of the efforts made towards a common objective, even if the participants are of a similar nature, is in no case exempt from the problems and difficulties inherent in this type of activity, particularly when the experience of the participants is neither rich nor prolonged.

The first possible line of action which comes to mind is the combination of efforts to face and solve specific technological problems, in order to facilitate the utilization of the obvious economies of scale characterizing many activities of this type.

In the region there are some experiences, among which are the Andean PADT already mentioned on various occasions. We could also point out, for example, the "twinning agreements or arrangements" of the Brazilian IPT with the Technological Laboratory of Uruguay (LATU) on the chemical and leather industries, and with the National Institute of Technology and Standards (INTN) of Paraguay in various technical fields, with the Mexican LANFI in the area of packaging and, finally, with the Caribbean IIT.

The establishment of action committees among concerned countries in both regions might be considered, to act as promoters and catalysts of technological development, encouraging contacts between the respective institutions and organizations and, in general, serving as points of reference in the sectors for which they are responsible.

The programmes for substituting alcohol for gasoline -particularly in the case of manioc- the use of bamboo as a construction material, especially in rural areas, the use of cassava and the development of composite or enriched flour, the use of the African palm and the study and use of tropical woods for housing are merely some illustrative cases of areas which might possibly be considered as the object of initiatives and co-operative arrangements such as those already proposed.

It goes without saying that such a list of possible arrangements in these sectors to be included in the project should arise from the joint study of the potential needs of both regions in the scientific and technological fields.

6. Co-operation to improve bargaining power with suppliers of technology

The previous paragraph pointed out the advantages emerging from the combining of efforts on the part of research institutes to reach, with an economy of cost and time, determined objectives related to the generation and adaptation of technologies.

It could also be pointed out -along these lines- that there are undeniable benefits to be obtained from the sum of national efforts directed, however, in this case, towards another type of proposal, related instead to the institutional sphere. The countries of the region have accumulated an experience which may well be called valuable in the transfer of technologies from the industrialized countries, especially in the control of their entrance (analysis of contracts, detailing of the technological package, etc.) and ensuring that the loans arising from them are suitably related to their usefulness.

It is evident that this accumulation of experience might undoubtedly be enriched by the contribution of similar stores of knowledge accumulated in other countries of other regions as in the case of the African countries. The search for the most appropriate technologies, their selection and the corresponding negotiation are all fields that require constant activity in order to improve the bargaining power and conditions in which these are incorporated in the productive apparatus of the developing countries. As a result, it is believed that these are a very suitable field for horizontal co-operation, as expressed earlier in discussing the possible joint training programmes. The concrete actions could consist of an exchange of information and experiences previously compiled on all the stages of

technology transfer, including aspects related to the elaboration of contract models, the problems of industrial property and, possibly, technical standards and quality; promotion of the use of commercial services from consulting firms from the countries of both regions for the evaluation, supervision and putting into practice of projects, which could also bring with it the provision of technologies developed or adapted in these countries; joint negotiation of various countries for the acquisition of determined technologies, for which there could be support, as in other already mentioned activities on technology transfer, from the Technological Information Exchange System <sup>1/</sup> sponsored by UNIDO; the organization of technical meetings of those in charge of these functions in the countries of both regions, for which they may have the sponsorship of international organization if they so request.

7. Schemes of preferential treatment for the development and transfer of technology among countries

This is a very broad and complex topic which will require further analyses and studies, since there is little or no experience on it. For the moment, it is enough to point out that the giving of this preferential treatment, which is done entirely in agreement with the national legislation, would normally, under the heading of exchange of technological development, be carried out in large part by the enterprises providing these services as their usual function. It would also be applicable, although probably to a lesser extent, to the remaining technological exchange activities, for example, those carried out by the technological centres.

8. Establishment of regional and interregional centres or mechanisms for development and transfer of technology

It is possible that the identification of opportunities for co-operation between both regions will lead to consideration of the need to reinforce or establish interregional mechanisms and, in some cases, also regional, in order to reach some type of permanent connexion between Africa and Latin America which would channel and serve as institutional support for co-operative activities.

Since 1979 the above-mentioned African Regional Centre for Technology has been functioning in Dakar, Senegal, with the participation of almost all the member countries of OAU (Organization for African Unity). Its functions are basically to stimulate and promote co-operation among these countries in the areas of development and technology transfer.

The similar Asiatic Regional Centre for the Transfer of Technology has been operating in Bangalore, India, since 1977, while the negotiations for the establishment of an Arab centre of this type are almost completed.

The need to establish these centres has been confirmed by various provisions of the Vienna Programme of Action on Science and Technology for Development, which states that "developing countries should use,

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<sup>1/</sup> Known by the acronym TIES (Technological Information Exchange System).



strengthen and, when necessary, set up subregional, regional and interregional centres for the transfer and development of technology".<sup>1/</sup>

The existence of a body of this type at the other geographical extreme of the possible flow of co-operation leads to the thought that it might be convenient to consider its establishment in Latin America, in line with what was established in the above-mentioned Vienna Programme of Action. This possibility, however, should be very carefully evaluated, in view of the existence of regional bodies which, if they receive the charge from their respective governments, might perhaps, if properly adapted, carry out these functions. Consider, for example, RITLA, among whose various functions is that of supporting the integration of the technological institutes of the region, it being agreed to begin with an exchange of information and experiences. The World Association of Industrial and Technological Research Organizations <sup>2/</sup> might also provide an adequate framework for the possible co-operative activity of the countries through its centres of industrial technology.

In brief, the existing regional machinery -or that which is acting in the region- would have to be reviewed for the purpose of determining its ability to carry out functions which the concerned governments might decide to assign to it for the specific purpose of intensifying scientific and technological co-operation between both regions.

It would also be possible to consider, <sup>3/</sup> in the area of inter-regional machinery, organizing a meeting in which selected organizations or institutes from both regions, regional organizations such as the regional commissions, development banks, subregional organizations, etc., would participate.

The purpose of the meeting -the first of a series- would be to set up the bases of a machinery to identify, formulate and promote specific co-operation projects.

The machinery of the network type to be established would adopt the approach of a club, in that only the concerned country or bodies would be involved; it would also be possible to set up sectoral committees or subcommittees.

The protagonists for this initiative would be, as indicated, the centres or organizations already mentioned, with the United Nations organizations taking the role of promoters, in addition to any others which the countries might decide to assign them.

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<sup>1/</sup> The Vienna Programme of Action on Science and Technology for Development, section I, paragraph B, 3, 6, 43, approved by General Assembly resolution 34/218.

<sup>2/</sup> Better known by its English acronym WAITRO.

<sup>3/</sup> According to an informal UNIDO proposal.

