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07374

Distr.
LIMITED

ID/WG.233/20
8 February 1977

ORIGINAL: ENGLISH

United Nations Industrial Development Organization

Meeting of Selected Heads of
Research Institutes

Vianna, Austria, 18 - 22 October 1976

THE ROLE OF NATIONAL INSTITUTE FOR TECHNOLOGY (INT) AND OF TECHNOLOGY SUPPORT FUND (FUNAT) IN THE BRAZILIAN POLICY FOR INDUSTRIAL TECHNOLOGY 1/

by

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id.77-785

I. INTRODUCTION

The National Institute for Technology (INT) was created in 1922 and is currently subordinated to the Secretariat for Industrial Technology (STI) of the Brazilian Ministry for Industry and Commerce. This Secretariat for Industrial Technology is the government office that establishes and executes, in a national scale, a general Policy for Industrial Technology. Within the framework of this policy, three main areas are considered:

- Industrial property (patents) and technology transfer policy, whose executive organ is the National Institute for Industrial Property (INPI);
- Metrology, standardization and industrial quality policy, whose executive organ is the National Institute for Weights and Measurements (INPM);
- Industrial technology development and financing policy, whose executive body is INT with its associated Technology Support Fund (FUNAT).

2. THE INDUSTRIAL TECHNOLOGY SITUATION IN BRASIL

A few words should be said about the dimensions of the industrial technology situation in Brasil. The country's population stands at about 110 million and is estimated to be growing at 2.7 per cent each year. The Gross National Product is equivalent to around 75 billion US$, of which one third comes from industry. Total imports have increased sharply to 12.5 billion US$, (mainly due to recent increases in the international crude oil prices) while total exports are slowly increasing to about 9.0 billion US$.

The principal items in the imports list are crude oil and capital goods, each one amounting to around US$3.5 billion. The presence of capital goods in such an outstanding position in the imports list indicates the efforts that are currently being devoted to the country's industrial expansion. On the other hand, it also gives a clue to the real dimensions of the country's technological demand that somehow is not being met by domestic offer.

Explicit technology payments, in the form of royalties for manufacturing licences and fees for technical services, amount to some US$500 million. To this bill one should add payments for implicit technology imports, generally in the form of built-in prices charged by capital goods suppliers. These built-in prices cannot be calculated accurately, but recent Brasilian studies, based on average sectorial indices valid for different industrialized countries, estimate that they should be equivalent to twice the imports of explicit technology. Thus, total technology imports, explicit and implicit, should amount to some US$1.5 billion. Technology, by itself, occupies an outstanding position in the Brasilian imports list.

The understanding of these facts led STI to the launching of an effective policy for industrial technology, aiming at identifying, quantifying and disciplining the technological flow, and, at the same time, striving to promote adaptation and assimilation of imported technologies. A sensible standardization and industrial quality programme is under way. Also under way are the programmes to foster the development of domestic technology, mainly in those areas where a diagnosis has been completed, a definite opportunity has been identified and teams of local experts have been formed.

In the context of such a policy, INT's objectives may be said

(a) To provide incentives for and co-ordinate the production and utilization of Brasilian technology, through the management of a Technology Support Fund - FUNAT;

(b) To create, develop, transfer, adapt and update national natural resources technology, in line with major objectives of the country.

(c) To supply technical assistance to other government agencies and industry at large in activities such as:

- Evaluation of technological alternatives and identification of domestic as well as foreign sources.
- Technical evaluation of equipment and products;
- Chemical analysis of products;
- Physical and metalographic tests;
- Industrial design of products;
- Product quality certification;
- Expert reports on technological matters.

3. FUNAT'S ACTIVITIES

The management of the Technology Support Fund places INT in a position to co-ordinate the execution of applied research and development projects geared towards national economic development.

Through the use of this instrument, INT is in constant contact with other research centers, as well as with industrial firms, fostering their capability for creating, adapting, absorbing, utilizing and developing technologies in the country's interest.

Within this framework INT closely collaborates with INPI, supplying it with the necessary technical assistance to regulate the foreign technology transfer process, as well as receiving from it a constant flow of information about Brasilian industry's actual technological demand.

From January to October 1976 the Fund has allocated the equivalent to approximately US$8 million to selected R+D projects, conducted by several research centres, and private firms. These projects cover various industrial sectors, as shown in Annex 1, Figure 1. Most of INT's own projects are also funded by FUNAT. Current projects are shown in Annex 2, Tables I, II and III. Next year's allocations are expected to amount to about US$25 million.

It should be mentioned that FUNAT's industrial technology financing programme is a part of Brasilian Government's Science and Technology Development Basic Programme, whose estimated outlays will have amounted to the equivalent of US$2,5 billion in the period 1975-1977. Some important R+D programmes related to industrial technology development, namely those pertaining to transportation, aeronautics, oil and conventional energy sources, nuclear energy, as well as communications, are funded and conducted by specific ministries other than the Ministry for Industry and Commerce.

4. MAIN R+D PROGRAMMES CONDUCTED BY INT

INT's main efforts are concentrated on the effective industrial utilization of Brasilian renewable natural resources. Along this line, INT is currently engaged in the execution of the Ethanol Technological Program, the Industrial Effluents Treatment Technologies Program, Starch-rich Raw Materials Program, as well as others that can be inferred from the examination of Tables I, II and III.

4.1 Ethanol Technological Program

Introduction

Given the substantial and frequent increases in crude oil prices and the launching by the Brasilian Government of the National Ethanol Program, aiming at partial or total substitution of oil derived liquid fuels, INT decided to intensify several research projects in the following areas:

- engine and fuel technology
- ethanol production technology
- agricultural technology
- other related technologies

As far as raw materials are concerned, research was first set upon potentially interesting agricultural products. Sugar cane and manioc were then, identified as the main resources that would provide a national solution, that is, those which could be obtained in almost every part of the country. Other interesting raw materials are babassu, sweet potato, sorghum, etc.

Manioc presented certain advantages, since the production of ethanol from sugar cane has traditionally been based on blackstrap molasses processing. Thus, sugar is the main product, and ethanol is obtained as a by-product, via fermentation of residual molasses. In this way, the production of adequate volumes of ethanol would be tied up to the production of large quantities of sugar, beyond world market requirements.

The direct production of ethanol from sugar cane showed the following yield: from 14.3 to 15.4 kg of sugar cane/litre of ethanol.

The results for manioc ranged from 5.0 to 5.6 kg manioc/litre of ethanol. Comparing these values and taking into consideration the necessary economic data, manioc is clearly a better option, particularly if its agricultural yield can be improved. As a matter of fact, some partial results of a specific INT project indicate the possibility of more than doubling the national average yield in a very short time (3-4 years).

Furthermore it is firmly integrated in the Brasilian agriculture and allows - due to its easy growth in poor soils - the inclusion in the national development programme of large marginal areas, not suitable for other agricultural and/or industrial investment.

Therefore, a series of research projects aiming to demonstrate the interest and feasibility of using manioc as the raw material for ethanol production was launched. Economical and technical analyses of ethanol production followed.

During 1975, these studies showed that production costs of ethanol from manioc were competitive with the gasoline price structure in Brasil. The continuous increase in price of the latter has turned ethanol from manioc into an extremely important and interesting alternative fuel. The key point on the adoption of ethanol is strongly connected to the feasibility to manage manioc production in such a way that it can be used as an adequate raw material.

Past experiences, such as those held during the Second World War, were performed on a small scale and employed processes of little interest nowadays, for modern purified enzymes were not either well-known or used for starch hydrolisis then.

Therefore, the establishment of research and development projects was a necessary step in order to update and improve the technology concerned, whose technical and economical feasibility had to be demonstrated through the building and operation of an industrial scale plant.

Furthermore, it was necessary also to prove, by implementing an extensive plantation using modern agricultural techniques, that the raw material manioc was appropriate for ethanol production and would allow the incorporation of anew and large unused areas, not suitable for other agricultural ventures.

Engines and fuel technology

All R+D projects developed in this area aimed to demonstrate the feasibility of using ethanol pure or mixed to other fuels, as a sbustitute for crude oil derived fuels. The following Table summarizes the results achieved to date.

Form of ethanol utilization		Performance	Engine alterations	Observations
In Otto cicle engines mixed to gasoline (0 to 25 % ethanol)		Good. In some ranges, fuel consumption lower than with pure gasoline	No engine alterations required. Carburation tuning necessary.	Beyond 25% ethanol, engine alterations must be made. Alterations are similar to those required for the use of pure ethanol.
In Diesel engines, parallel to oil (up to 80 % ethanol)		Good. Fuel consumption similar to pure diesel oil utilization	No substantion alterations required in diesel parts. Additional injection system for ethanol required	Performance is best in the range 50% ethanol and 50% diesel oil.
Pure ethanol in conventional gasoline engines	Anhydrous	Good. Good driveability. Consumption slightly above pure gasoline level.	Increased compression ratio, preheating of ethanol-air mixture and carburation tuning required. New spark distribution setting. Some plastic components have to be replaced.	Most rational immediate use of pure ethanol. Engines can be adapted for lowest consumption or for maximum power.
	Hydrated 95° G.L.	Good. Better efficiency as compared to anhydrous, due to possibility of further increasing of compression ratio. Good driveability.		
Pure ethanol in specially designed engines		Very good. Better efficiency as compared to conventional engines. Lower consumption and increased power possible.	Turbo compressor addition programmed.	Project started in Aug. 1976. Will be in progress until 1979. Extensive tests programmed 1978-1980.
Other forms of use	Turbines (gas)	Good (preliminary results) To be further investigated	Combustion chamber and admission system altered	Project started in May 1976. Will be in progress until 1978.
	Mixed to pulverized coal	To be investigated	To be investigated	Project programmed to start in 1977. Possible substitute for fuel oil

Ethanol production technology

Considering the agricultural set-up and the utilization of industrial residues as separate research programmes, the following phases of the industrial process were developed:

(a) Raw material preliminary treatment
(b) Cooking
(c) Hydrolisis or saccharification
(d) Fermentation
(e) Distillation

Studies were based on real data, using industrial enzymes, commercial yeast and semi-industrial scale Brasilian equipment, aiming to allow industrial scale-up. The results achieved have proved the technical and economical feasibility of producing ethanol from manioc.

Meeting a specific client demand, INT has developed a complete engineering design package for a pioneer industrial plant which is due to start operation in October 1977, producing 60 m^3 of ethanol/day.

Nevertheless, optimization studies concerning this technology continue at INT, in bench and pilot-plant scale - besides those in industrial scale, held at the pioneer plant. Within this context, technical and economical data will constantly flow between INT's pilot plant, laboratories and the ethanol industrial plant. INT is currently building its pilot plant, with a processing capacity of 5,000 litres/day.

Totally designed by INT's professinnals this pilot plant will allow studies such as: improvement of the national ethyl alcohol technology, alternative renewable raw materials for ethanol production· improvement of the national ethyl alcohol technology, alternative renewable raw materials for ethanol production; improvement and optimization of the original manioc enzymatic hydrolosis process and other starch containing materials; basic parameters for plant engineering design and operation; review of production equipment aiming to improve performance and reduce heat consumption; development of alternative processes such as continuous cooking, continuous saccharification and fermentation; treatment of stillage and utilization or its by-products etc.

ANNEX 3, TABLE I, shows the estimated plant investments to produce 90 or 120 m^3 per day of ethanol from manioc. The informations supplied here are specifically pertinent to Brasilian conditions. Their significance to other countries depends upon the existing crude oil proce structure and importance attached to the need of having safe and continuous fuel supplies.

Treatment of residues

Ethanol production generates stillage, which is a highly pollutant effluent. It can be treated by several methods, such as aerobic treatment; anaerobic digestion; concentration by evaporation; evaporation and incineration; mold production treatment; irrigation, as fertilizer.

The main methods currently being considered for stillage treatment are:

- Conventional water treatment using activated sludge;
- Anaerobic digestion, to produce a methane enriched fuel (to be used in boilers), as well as fertilizing sludge;
- Evaporation, to produce animal feedstuff syrup;
- Evaporation and incineration for ash recovery to produce refined potassium salts to be used as fertilizer;
- Torula or mold production.

An international workshop on industrial alcohol stillage processing was promoted by INT in August 1976, aimed at recovering useful products and obtaining the best utilization stillage. Its direct use on land, as irrigation, was then devised as best short-term alternative for the Brasilian sugar cane culture. Studies concerning cassava stillage treatment are currently in the final stages of experimentation at INT. Anyway, choice of treatment method and resulting by-product of specific interest will substantially depend upon the location of each specific plant (the existing type of land and water courses, being taken in due consideration).

Within this context, special importance is attributed to INT's pilot plant for industrial effluents treatment currently being built in an area of 5,000 m^2, next to its ethanol pilot plant.

Agricultural technology

Agricultural research projects have been developed by INT in co-operation with agriculture research institutions, dealing with the selection of manioc varieties for industrial use; production and commercialization of manioc by-products and the use of manioc roots and leaves for animal feedstuff.

Within this framework, and due to its relevance to the feasibility of the whole ethanol programme, INT has established an agricultural project to develop a 500 hectares plantation of manioc during 1975/1976. It aimed to produce the necessary number of seedlings to establish 4,400 hectares of manioc during 1976/1977.

So far, this project has been extremely successful, and modern agricultural techniques employed have increased the productivity to around 40 tons/hectare of manioc (compared to 14 tons/hectare as representative of the national average).

Other technologies involved

Ethanol industrial utilization scope is very broad indeed. When the Ministry for Industry and Commerce promoted ethanol's rebirth as a fuel, the possibility of its utilization in the alcohol chemistry area was not overlooked. Nevertheless, the necessary adaptation studies were phased to start after the 'ethanol as fuel" programme is implemented.

Before 1950, a substantial part of the worldwide ethylene production derived from ethanol, economic and production factors, though, progressively displaced the use of ethanol, favouring the use of naphta, derived from crude oil.

Nowadays the whole situation has changed and ethanol is again looked upon as a serious substitute for naphta.

Ethanol's potential for ethylene production can be summarized in the following table:

RAW MATERIAL	GRAMS OF ETHYLENE/ LITRES OF RAW MATERIAL	A/B
A - ETHANOL	425	2.07
B - NAPHTA	205	

Therefore, ethanol produces twice more ethylene than naphta. Nevertheless, naphta's several derivates represent a noticeable advantage for its use.

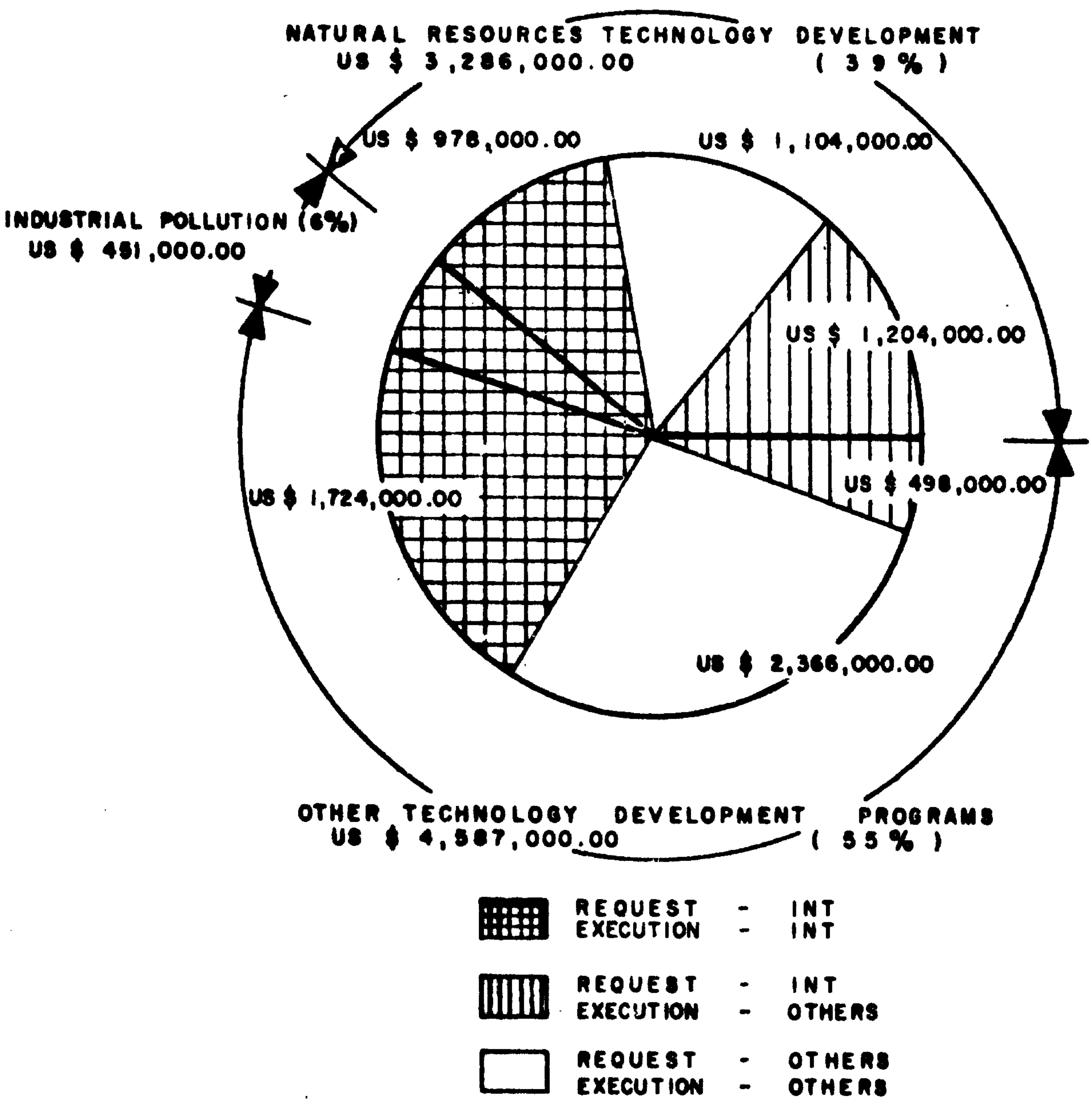
The economically competitive aspects are not very clear yet. The substitution of ethanol for naphta will depend, amongst other things, on naphta's prices in the near future. Political and strategic factors are also to play an important role in this decision.

ANNEX I - FIGURE 1

INVESTED RESOURCES BY
THE TECHNOLOGICAL FOMENT FUND

FUNAT

JANUARY TO OCTOBER 1976: US $ 8,324,000.00



ANNEX 2 - TABLE I

TECHNOLOGICAL FUND: R & D PROJECTS FINANCED

AREA: NATURAL RESOURCES TECHNOLOGICAL DEVELOPMENT

YEAR. 1976

(as of 1 October)

T I T L E	EXECUTION BY
NEW TECHNIQUES FOR CELLULOSE PULP PRODUCTION	INT (R)*
AVELOZ (EUPHORBIA S.p.) - TECHNOLOGICAL DEVELOPMENT	INT (R)
IBITIARITA - PROPERTIES, INDUSTRIALIZATION PROCESSES AND PRODUCTS UTILIZING ITS PROPERTIES OF ABSORBING OIL AND REJECTING WATER.	INT (R)
TUNGSTEN AND TANTALUM CARBIDE PRODUCTION FROM BRAZILIAN ORES	CERVIN (I) *
"HOT MELT" ADHESIVE PRODUCTION TECHNOLOGY	[illegible]CCA (I)
UTILIZATION OF TIN AND OTHER NOBLE ELEMENTS CONTAINED IN LOW - GRADE ORES AND INDUSTRIAL RESIDUES	MANORE (I)
CHEMICAL - PHARMACEUTICAL TREE - UPDATING TECHNICAL AND ECONOMIC DATA	CEPED (R)
THE BRAZILIAN PETROCHEMICAL INDUSTRY - UPDATING TECHNICAL AND ECONOMIC DATA.	IBP (R)
RAW MATERIALS SURVEY AND TECHNOLOGICAL ANALYSIS FOR MAGNESIUM PRODUCTION IN BRAZIL	CTA (R)
TEXTURIZED PROTEIN PROCESSING - KNOW-HOW DEVELOPMENT	UNICAMP (R)
QUARTZ INDUSTRIALIZATION STUDIES	INTEC (I)
MANIVA PRODUCTION: MANIOC PLANTATION, CULTURAL TECHNIQUES DEVELOPMENT, FOLLOW-UP	INT/INDI/ AGRIFLORA (R/I)

* (R) - Research Centre
(I) - Private Industry/Engineering F[illegible]

ANNEX 2 - TABLE I (CONTINUED)

TECHNOLOGICAL FOMENT FUND: R & D PROJECTS FINANCED

AREA: NATURAL RESOURCES TECHNOLOGICAL DEVELOPMENT

YEAR: 1976
(as of 1 October)

T I T L E	EXECUTION BY
PLANT ENGINEERING DESIGN FOR PRODUCTION OF ETHANOL FROM MANIOC	INT (R/I)
SURVEY ON THE STATE OF ART ON ETHANOL PRODUCTION FROM STARCH RICH RAW MATERIALS	INT/CTP (R/I)
SATURATED STEAM GENERATION FROM SOLAR ENERGY	INT/CTP (R/I)
ENGINE AND FUEL DEVELOPMENT	CTA (R)
PILOT PLANT FOR ETHANOL TECHNOLOGY DEVELOPMENT	INT (R)
ADAPTATION OF BRAZILIAN ENGINES AND VEHICLES TO AN UNIVERSAL FUEL INJECTION SYSTEM WITH AUTOMATIC COMMAND	UNICAMP (R)
DEVELOPMENT OF ETHANOL FROM BARASSU TECHNOLOGY - ECONOMIC AND INDUSTRIAL ASPECTS	INT (R/I)
HECOGENINE AND TIGOGENINE PRODUCTION FROM SISAL JUICE	INT (R)
NORTHEASTERN SUGAR CANE BAGASSE TECHNOLOGY	INT (R)
CHEMICALLY MODIFIED STARCHES	INT (R)
INDUSTRIAL PRE-GELATINIZED PRODUCTS	INT (R/I)

ANNEX 2 - TABLE II

TECHNOLOGICAL FOMENT FUND: R & D PROJECTS FINANCED

[illegible]: INDUSTRIAL EFFLUENTS TREATMENT

YEAR 1976
(as of 1 October)

T I T L E	EXECUTION BY
STILLAGE TREATMENT PILOT PLANT VIA SINGLE CELL PROTEIN PRODUCTION	INT (R/I)
INDUSTRIAL POLLUTION PREVENTION AND CONTROL STUDIES	INT(R/I)
MICROBIOLOGICAL RECOVERY OF INDUSTRIAL EFFLUENTS	INT (R)
PROCESSES FOR UTILIZATION OF SISAL INDUSTRY RESIDUES	INT (R)
EXPERIMENTAL PLANT FOR INDUSTRIAL EFFLUENT TREATMENT	INT (R)

ANNEX 2 - TABLE III

TECHNOLOGICAL FOMENT FUND: R & D PROJECTS FINANCED

AREA: OTHER TECHNOLOGICAL DEVELOPMENT PROGRAMS

YEAR: 1976 (as of 1 October 1976)

T I T L E	EXECUTION BY
HYDRAULIC ENGINES PROTOTYPE DEVELOPMENT	IPT (R)
HIGH TENSION ELETRIC TESTS LABORATORY	SOMA (I)
IMPLEMENTATION OF THE TECHNOLOGY DEVELOPMENT COMPANY S.A. PHASE II	UNICAMP/CODETEC (I)
STUDIES ON PHYSICAL, ECONOMICAL AND OPERATION CHARACTERISTICS OF BRAZILIAN CARGO SHIPS FOR THE RIO GRANDE DO SUL RIVER NETWORK	IPT/GEIPOT (R/I)
CREATION OF METALLURGICAL TECHNOLOGY LABORATORIES	INT (R)
TECNOTEXT - TEXTILE FIBERS TREATMENT PROCESSES	INT/UNICAMP (R/I)
SACCHARIMETER PROTOTYPE DEVELOPMENT FOR THE SUGAR INDUSTRY	UNICAMP (R/I)
AUTOMATIC HYDRAULIC PRESS FOR CERAMIC PAVEMENT MATERIALS	CONVENTOS (I)
THERMOELECTRIC EQUIPMENT FOR VITRIFIED CERAMIC PRODUCTS	CONVENTOS (I)
AUTOMATIC HYDRAULIC PRESS FOR REFRACTORY MATERIALS	CONVENTOS (I)
AGRICULTURAL TRACTOR PROTOTYPE "R 2220"	ROGOWSKI (I)
TELEPHONE MULTIPLEX SYSTEM - PCM	E.E. (I)
STUDIES AND PRIORITIES SURVEY IN NORMALIZATION AND QUALITY CERTIFICATION FOR INDUSTRIAL PRODUCTS IN THE CHEMICAL, AGRO-INDUSTRIAL AND CIVIL CONSTRUCTION SECTORS	INT (R)
TEXTILE INDUSTRY PATTERN DESIGN - DIFFUSION OF RESULTS	UFSM (R/I)

ANNEX 3 - TABLE I

ETHANOL PRODUCTION FROM MANIOC

INDUSTRIAL PLANT INVESTMENTS
(in US$1,000,000)

ITEM	Plant Capacity	
	90 m^3/day	120 m^3/day
1. Equipment and assembly		
Process equipment	3,200	3,800
Auxiliary equipment	1,700	2,000
Assembly	320	380
Subtotal	5,220	6,180
2. Civil works		
Land	6	9
Earth moving	5.5	8.1
Buildings	140	165
Subtotal	151.5	182.1
3. Plant engineering design, technical assistance	605	605
TOTAL	5,976	6,967

Note: Working capital and stillage treatment facilities not included

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