767

UNIVERSITY OF STIRLING

CARLOS F. AGUILAR

Thesis entitled:

CODESA: STRATEGY FORMULATION FOR THE NATIONAL INDUSTRIAL DEVELOPMENT CORPORATION IN COSTA RICA

Submitted for the degree of Ph.D.

30 September, 1986.

5/87

767

UNIVERSITY OF STIRLING

CARLOS F. AGUILAR

Thesis entitled:

CODESA: STRATEGY FORMULATION FOR THE NATIONAL INDUSTRIAL DEVELOPMENT CORPORATION IN COSTA RICA

Submitted for the degree of Ph.D.

30 September, 1986.

5/87

UNIVERSITY OF STIRLING

CARLOS F. AGUILAR

Abstract of thesis entitled:

CODESA: STRATEGY FORMULATION FOR THE NATIONAL INDUSTRIAL DEVELOPMENT CORPORATION IN COSTA RICA

Submitted for the degree of Ph.D.

30 September, 1986.

Codesa: Strategy Formulation for the National Industrial Development Corporation in Costa Rica

A B S T R A C T

The present thesis embarks on the study of three distinct aspects of the Costa Rican Development Corporation's operations.

The first section presents the Ethos under which the organization was created in 1972, and follows the enterprise's development until the present day in order to analyze how well it has adhered to its fundamental precepts, as well as how significant its contribution has been to the national economy.

The following chapters cover in detail the present state of the four major areas of investment: cement factories, sugar cane based sugar and ethanol production, aluminium semi-processing, and fertilizers. Alternative strategies are discussed for each of the sectors involved, in an attempt to determine their potential to continue as independent on-going concerns.

In the analysis of the Costa Rican Cement industry, national consumption/installed capacity forecasts until the end of the century are included. Also, the comparative competitive position of the Codesa plants (quality, quantity, price, distribution) both nationally and internationally, is discussed. Finally, the impact of new massive construction programs on demand (dams, public housing, etc.), as well as the potential such programs could provide to enhance the export possibilities by the sale of similar package deals (design, construction, materials (cement), skilled labour, etc.) abroad is presented.

The use of alcohol as combustion fuel, both as a complement to petrol (gaschol), and as an independent combustible, represents the main theme of the sugar cane chapter. A dynamic impact study of the implementation of different oil substitution programs in Costa Rica (land use, alternative energy crops, cost competitiveness with respect to fluctuations in the price of oil, etc.). New technological developments in the production of alcohol from biomass are also presented.

In the Aluminium section, an analysis of the World aluminium industry scene is made, in an attempt to determine the subsidiary company's stategic outlook (currently the company has important limitations in the acquisition of raw materials). The potential for intagration: Establishment of backward linkages to secure the flow of raw materials into the process (from national bauxite deposits), as well as forward linkages to establish the production and marketing of end products (and recycling) to improve value-added position are discussed.

In relation to the fertilizers plant, the effort has been focused on two main areas: raw materials and the study of energy usage (including steps for an energy audit, and the establishment of an energy management system). Finally the review of chronic working capital problems of the past and the development of more adequate performance evaluation criteria and pricing policies are suggested.

The final section is devoted to organizational structure. Different organizational set-ups for the company, provided by management throughout the years, are reviewed and a revised structure, more adequate to fulfill the company's *raison d'etre* is proposed.

Codesa

Strategy Formulation for the National Industrial Corporation In Costa Rica

General Outline:

1. Introduction

1. INTRODUCTION

1.1 National Development Planning:

1.1.1 Laissez-faire (free-market) approach
1.1.2 Central Planning
1.1.3 Indicative Planning
1.1.4 Administrative Guidance
1.1.5 The Swedish System
1.1.6 Nationalistic Approach

1.2 Ethos of the Costa Rican Development Corporation:

1.2.1 Political Developments and Problem Areas
1.2.2 Evolution of the Codesa Proposal
1.2.3 Basic Organizational Problems
1.2.4 Comparison with Other Public Enterprises in Latin America
1.2.4.a Jurisprudence
1.2.4.b Fields of Action
1.2.4.c Example of the Influence of Central Government

1.3 Description of Codesa's Activities

1.1 National Development Planning:

There are various distinct approaches to economic development planning. The factors which determine what path a country is to choose in order to attain its economic and social goals, include the following: political system, general endowment situation (raw materials, availability of capital, availability of labour) *(1)*, size, reliance on foreign trade, etc.

A classification of some of the most important alternative paths of development is presented below:

1.1.1 Laissez-faire *(Free Market) approach:*

(Market Forces/Private Ownwership)

Focuses on the elimination of trade barriers and restrictions, i.e., "the operation of market forces and free trade"*(2)* represents its aim. The role of government should be restricted to discriminate intervention in areas where market forces are hindered from being effective.

The main exponents of this doctrine at present are the United States (Reaganomics - D. Stockman) and Great Britain (Thatcherism) in the developed world, and Hong Kong in the less developed countries *(2)*.

The goals of this doctrine may be summarized as follows:

a.- Reduction of the size of the State (reduction of the PSBR, services, taxes, etc.)

b.- Elimination of trade barriers, to allow free world trade (though regional treaties which promote protectionism against outsiders, such as the EEC, may prove too large an obstacle for this to be achieved on a world wide scale as aimed by the General Agreement on Tariffs and Trade (GATT) of 1947, a spin off from the Bretton Woods conference (1944)) *(3,2,1)*.

c.- Privatization of public companies, including utilities, public transport, etc.

d.- Enhancement of the allocative efficiency (4) of market forces for all (or most) activities within the economy, including wages (Weitzman), as has been the case in the U.S. automobile and airline industries, the Venezuelan public sector, etc.

In summary, development should not be a direct responsibility of government, apart from its intervention to promote the effectiveness of market forces.

1.1.2 Central Planning:

(Public Planning/Public Ownership)

The opposite of the latter approach, this method concentrates the development planning effort in Central Government, for example the *Gosplan* (State Planning Committee) and the *Gossnab* (State Supply Committee) in the U.S.S.R. *(5)*. In the Soviet case, the *Gosplan* receives information from Ministries and Industry (*zayavki* - applications for inputs) by which the planners estimate the additional "capital stock required for the future provision of goods and services" *(5)*. After this process, the two institutions mentioned above, employ the method of "material balances" (production, supply and distribution) throughout the economy, in order to ensure the effectiveness of each plan. (Plans are divided into current (one year, monitored on a *khozraschet* basis, profit and loss accounting), medium term (five years) and perspective (15 years or more).

Here, the government functions as the hub of the development process. All activities in the economic system are monitored or directly operated by the State. For example in agriculture, *Kolkhozy* (cooperatives) and *Sovkhozy* (State farms) must produce on a quota basis, with fixed prices for their produce.

The primary claims of this system are that it: (6)

a.- Avoids cyclical crises (expansion and contraction) present in the capitalist system.

b.- Adapts production to the rising material and cultural needs of the population

c.- Maintains full employment

d.- distributes wealth evenly

Even though the general role of government (throughout COMECON) with respect to the planning process has been maintained, important reforms have been introduced in various member countries.

The most widely noted case of these experiments is that of Hungary's "New Economic Mechanism" (7), which stresses the importance of decentralized planning. The most relevant features of this approach are outlined below (7):

" 1. The central administrative specification of enterprise production and sales programmes was abandoned, and enterprises were permitted to determine their production patterns on the basis of contracts with customers.

2. Central administrative allocation of material inputs was also ended, aside from a few minor exceptions.

3. One-year operational plans, disaggregated to enterprise level were discontinued and the five-year plans were to become the chief orientation for economic

development and the 'steering' of the economy.

4. The practice of fixing wage scales centrally came to an end, but average wage levels of enterprises were severely restrained by a new tax on wage increases.

5. The predominantly central allocation of resources for investment was changed to a system in which self-financing from profit had a more important role to play, although central supervision of investment activity was to remain strong.

6. The chief objective of enterprise activity was to be the pursuit of profit, and incentives for managers and workers were linked to profit, since this was to be basis for enterprise fund formation.

7. Separate foreign-trade multipliers for the COMECON and Western-world market trading areas were introduced to link domestic production and overseas markets. (Please refer to "Questions by GATT, and answers by the Hungarian government" Gatt document No. 3426, 1969, for not so convincing explanations for this dichotomy) (7).

8. A comprehensive price reform adjusted relative producer prices and introduced greater flexibility into price formation." (7)

Due to worries of stagnation, inefficiency, lack of incentives, etc., recent reforms have been introduced even in the Soviet Union (27th. Congress of the Central Committee of the Communist Party of the USSR) and China (12th.

Central Committee of the Communist Party of the People's Republic of China), the two most important exponents of central planning. What has resulted from these self-criticism exercises has been called by the Chinese "Socialist Market Economy"*(6)*, which introduces the following characteristics:

a.- Central goal setting and ownership is maintained. (Except where private or collective ownership existed before).

b.- More independence to companies which after fulfilling the central quotas can exchange their production freely (for example in the kolkhozy in the USSR and industrial companies in the Sichuan Province of China).

c.- Emphasis on better quality/ more variety of goods, i.e., the introduction of consumer choice.

d.- Market to be used as a monitoring tool under central control.

e.- Attract foreign technology (China)

1.1.3 Indicative Planning:

(Public Planning/ Mixed Ownership)

This form of economic development is best represented by the French *(8)* post-war experience. In this case, four distinct stages are involved in the planning process: analysis, dialogue, formulation, and implementation.

The first step is that of analysis. During this period, information is gathered (through interministerial study groups) in relation to perceived long term problems in specific areas: the labour market, industrial policy, the public sector, etc. *(9)*.

As a result, a large econometric model is formulated (*FIFI,* i.e., Financiere et Fisique, financial and physical), forecasting the state of the economy "x" years into the future, considering no specific action is taken to change the course of events (i.e., if a *laissez-faire* approach were pursued). An interesting feature of this initial stage is the evaluation of two separate economic sectors: one "protected" constituted by non-tradeables (essential foods, some raw materials, etc.) where strict controls are enforced, and an "exposed" sector in which prices reflect international values.

If the expected projection resulting from the FIFI exercise reveals worrying tendencies, new scenarios (simulating the effect of different policies) are computed in an attempt to devise an optimum approach which would counter the original disadvantageous outlook.

Having completed this preparatory phase, a period of deliberation follows. For this purpose, a number of sectorial commissions (and committees) including representatives from the government, the private sector, unions, etc., are formed to analyze separate aspects of the economy. After a concensus is reached of what the best strategy for the period (usually five years) is to be, the plan is formally formulated (stage 3).

Finally, in the implementation phase (stage 4), programmes of incentives are instituted. This is necessary due to the lack of a central source of decision making, such as is the case in Centralized economies *(7, p. 25)*, to persuade companies, both private and public, to abide by the guidelines of the plan, and as a result achieve the pre-set goals.

1.1.4 Administrative Guidances:

(Public Planning/Private Ownership)

This approach is exemplified most dramatically by Japan (other countries are Singapore under the guidance of Lee Kwan Yew, Taiwan under Chiang Kai Chek, and South Korea under several regimes). Robert S. Ozaki, professor of Economics at California State University (Hayward) *(10)* has described it as: " a case of programming for dynamic growth of a competitive economy; planning is thus an instrument of pragmatism devoid of socialist ideological content".

The aim of this approach is to foster unrestrained industrial growth, with the government as the central planning source. In Japan the Ministry of International Trade and Industry is such an institution. Chalmers Johnson, professor of political science at the University of California at Berkeley "views the MITI as the activist hub of the developmental state" *(10)*.

The government targets promising areas of development (with the help of deliberative councils where experts of a wide spectrum of knowledge are invited to contribute) and subsequently persuades (carrots and sticks practices *(10)*) private enterprise to develop them, either independently or collectively (groups of industries) disregarding the consequences of monopoly situations arising from these collaborations, i.e., anti-monopoly laws are not a main concern.

Other characteristics of this approach are:

- the emphasis on production R+D over basic science
- the direct monitoring of performance with respect to world competition by the government
- no special emphasis on social development if it is not directly related to overall economic performance.
- protectionism against foreign competition in the local market

1.1.5 The Swedish System:

(Mixed Planning/Mixed Ownwership)

In Sweden development planning is carried out by the Labour Market Board. This is a council formed by two members of government (Director General (chairman), and Deputy D.R.), three members from the Confederation of Employers, three from the Confederation of Trade Unions, two Salaried Employees, two from the Professional Staff Association, one Female Worker and one representative from the Agriculture sector *(11)*.

Apart from the LMB, there is a state owned Corporation, the Statsforetag, but its size is relatively small, though it is active in key areas such as mining, steelworks, tourism, forest products, etc., (29 industries, managed by thirty six officials, including the managing director, and a labour force of 35,000) *(11)*.

Every company in the country may keep 40% of its pre-tax profits for capital investment (46% of these monies must be deposited interest free at the Central Bank of Sweden). When the firm is ready to invest, it must present its plans to the LMB and this authority will decide if it may or may not use the investment funds it had previously set aside. If the investment is deemed to be beneficial to the country, nevertheless, the LMB may even provide assistance in the form of grants or low interest loans, (again a carrots and sticks approach). In this manner, the LMB monitors the way in which the nation's development programmes are executed emphasizing those aspects which it considers to be of more urgent importance.

1.1.6 Nationalistic Approach:

(Mixed Planning/Mixed Ownership)

This is the most typical path of development chosen by many Third World countries. The essence of the ideology behind it is best exemplified by Gandhi's principle of *Swaraj and Swadeshi (13)* (Self-rule and self-reliance, patriotism). His view that "unadulterated Home Rule, however inferior in quality it may be (should be prefered to any form of Foreign Rule)" *(14)*, may be extended to the management of firms. It is the responsibility of the State to strive towards the achievement of *sarvodaya* , or "uplift, welfare for all" society, (for which it may intervene directly in the management of enterprises, to ensure full employment, develop key industries, regulate foreign trade, etc.) *(13), (14)*.

For many years now, there has been an ongoing debate as to the benefits of foreign aid and foreign investment in recipient societies. Hollis Chenery in "Objectives and Criteria of Foreign Assistance" *(14)*, stated that *"The main objective of aid is to produce the kind of political and economic environment in the world in which the U.S. can best pursue its own goals"* in relation to U.S. aid programmes. Foreign aid and Direct Foreign Investment (DFI) are viewed with scepticism by many LDC leaders. The legacy of colonialism, and turn of the century, indiscriminate and usually unregulated, natural resource exploitation (in Latin America for example) are responsible for this perception.

It is apparent that this choice of development policy is based both on rational and irrational elements. I shall concentrate on those aspects which can be quantified in some way.

The evaluation of the benefits or drawbacks of DFI in LDC's (mainly the result of Transnational Corporation (TNC) involvement) is not an easy matter. For many LDC's, the attraction of TNC investment and production facilities represents the more feasible means of acquiring technology from the developed world. Nevertheless, the conditions in which this Transfer of Technology (TOT) occurs depends on the general characteristics of the host economy: size of the domestic market, competition, etc.. What this means is that what may be a reasonable option for a TNC with respect to a country such as Brazil (where the "associate development" policy (combined investment by government, TNC, and the local private sector) has been the more effective form of development) may not be when it considers investing in a small country like Costa Rica. In general, Vernon contends that TNC investment in LDC's depends on what he calls the "product cycle hypothesis" *(4)* (Please note that his research was based on US corporations).

Product Cycle Hypothesis on TNC DFI in LDC's:

Stage No. 1: New Products:

Production in the United States due to:

- availability of scientists and engineers with requisite skills
- low price elasticity of demand for the product, reducing the importance of cost differentials at alternative locations

Stage No. 2:

Production abroad to serve better overseas markets (Europe for example):

- Technology becomes more standardized
- Competitors appear and costs of production become more important

Stage No. 3:

Production transferred to LDC's

- production becomes standardized
- price competition intensifies

In conclusion, whatever technology is

eventually transferred to LDC's will not be "leading edge" and most probably will in effect be obsolete. Communication strategies in world markets *(15)*, also provides the possibility of differentiating between end user markets, selling new products to more competitive environments, and supplying less advanced products to other markets, thus establishing different objectives in different locations. Examples of the export of outdated technology to serve specific markets (usually due to the aim of the host economy to acquire foreign technological and managerial knowhow) are very common, (FIAT in Spain (SEAT), the USSR (LADA), Poland (Polski-FSO), Yugoslavia (YUGO); RENAULT in Romania (DACIA), Volkswagen in Brazil, etc.).

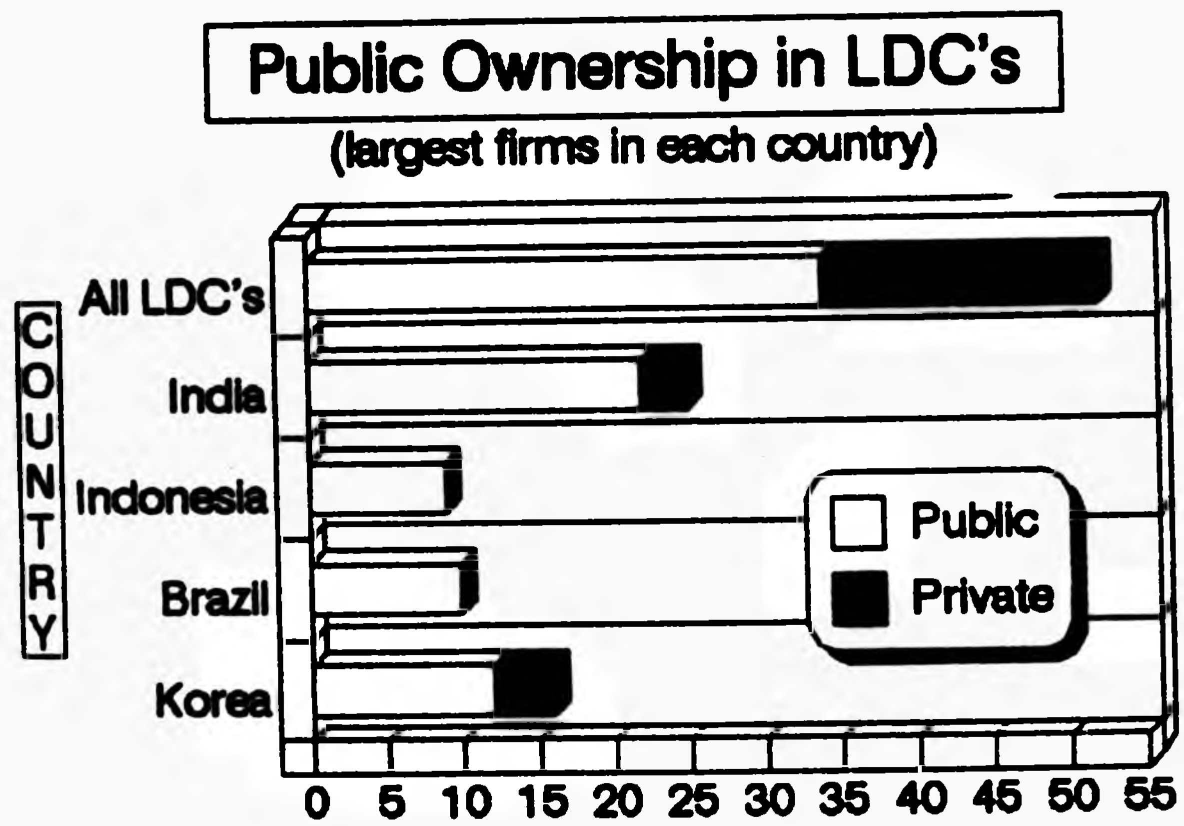
As an alternative to accepting the unrestricted participation of TNC's in their economies, many LDC governments have opted for the direct management of what they consider to be key industries (commanding heights *(17)*). This is how many of the largest enterprises in LDC's are publicly owned. An overview of how important this intervention has been follows:

Public Ownership in LDC's: (4)

(largest enterprises in each country)

Country	Of Largest No.	Public	Private
Korea	16	12	4
Brazil	10	10	
Indonesia	9	9	
India	25	22	3
ALL LDC's	52	34	18

(Fortune 500, 1979. (4)



Following the general principle of nationalism (commanding heights), though in a more moderate guise, the Costa Rican Development Corporation, CODESA, was created. The following sections are devoted to the presentation of this institution.

1.2 Ethos of the Costa Rican Development Corporation:

State development institutions in LDC's are created to achieve a number of objectives. Such a set of guidelines, extracted from Peter Nunnenkamp's article "State Enterprises in Developing Countries" is presented next: *(16)*

a.- Government control of key industries ("commanding heights") via public enterprises is intended to reduce the influence of foreign companies and to prevent private monopolies. Furthermore, governments wish to foster industrialization and influence the path and direction of development (this would apply to the Codesa subsidiaries Cementos del Pacifico, and Fertilizantes de Centroamerica, c.f. section 1.3).

b.- Non-competitive private companies faced with bankruptcy are nationalized in order to maintain the jobs, (or strategic activities afloat), (this applies to Fertica, Cementos del Valle, and other subsidiaries, c.f. section 1.3).

c.- It is expected that public enterprises will improve the supply of goods falling into the basic needs category at socially acceptable prices (In Codesa's case this would apply to the transport sector subsidiaries)

d.- Public enterprises should help the upgrading of unskilled labour and contribute to a better supply of managerial skills, thereby reducing the widespread lack of human capital e.- In the field of foreign trade, public enterprises should increase national self-sufficiency by import substitution and promote the expansion and diversification of national exports (Alunasa and Fertica could qualify here, c.f. section 1.3).

Below a description of the evolution of the Codesa proposal is presented.

1.2.1 Political Developments and Problem Areas:

Two traditional political movements have dominated the Costa Rican scene since the 1940's: The Partido Liberacion Nacional (National Liberation Party) of Democratic Socialist Ideology, and the Conservative sector of society, represented throughout these decades by different parties, all following a liberal economic line. These parties have been: Partido Republicano Nacional, Union Nacional, Unificacion Nacional, Unidad, and finally its current day exponent Partido Unidad Social-Cristiana (Christian Social Unity Party).

Needless to say, Liberacion Nacional has been the promoter of government expansion, geared towards the creation and operation of infrastructure organizations which attend, primarily, the basic needs of the population. It is through this approach that institutions such as the Caja

Costarricense de Seguro Social (CCSS) in health care, the Instituto Costarricense de Electricidad (ICE) in electricity generation, telephone, and telecommunications services, the Instituto Nacional de Vivienda y Urbanismo (INVU) in council home construction, the Instituto Costarricense de Acueductos y Alcantarillados (ICAA) in water purification and distribution, etc., have been established as monopolies. Other monopolies cover financial activities; for example, the Instituto Nacional de Seguros (INS) conducts all insurance dealings in Costa Rica, and the Sistema Bancario Nacional (SBN), formed by all national banks, excluding some small privately owned companies providing financial services, which nonetheless are regulated by this government body. The system also controls all bank deposits, and regulates the extension of credit (with the aim of democratizing this function).

1.2.2 Evolution of the Codesa proposals

Following the same general ideology, in the early 1960's, because of various worrying factors such as a very high population growth rate, an inexperienced private sector, and development concentration in and around the capital city with little or no attention devoted to other areas of the country, the then Ministro de Hacienda (Secretary of the Treasury), Lic. Raul Hess, fostered the idea of extending the scope of government investment into productive activities. For this aim he suggested the creation of a development corporation "for the promotion of development in the country" *(18)*. This institution was to devote all of its efforts towards the following: (author's perspective)

- The creation of new productive enterprises to absorb the growing demand in the labour market
- The decentralization of the industrial and agroindustrial activities from the Meseta Central (capital city and surrounding areas) to other regions of the country, in order to increase employment opprtunities in these parts and therefore slow down the migration of people from the countryside to the metropolis
- The creation of an industrial base for further private enterprise growth
- To contribute to the balance of payments by both increasing the country's export output, as well as reducing imports through economic integration and other import substitution practices.

During the following decade, various projects were put forth discussing the scope and legal framework such an organization should have. In 1965, Lic. Bernal Jimenez Monge, Ministro de Hacienda, proposed the creation of an Investment Corporation as a new branch of the National Banking System (SBN), supporting his reasoning on the following considerations: *(19)*

- The need for an expeditious

transformation of the country's productive structures

- The stagnation the country showed in dealing with important macroeconomic variables: Balance of Payments, Per capita Income, Level of Employment, etc., aggravated by an important increase in the population's growth rate

- The historic relationship which states that "the lower the level of development a country has , the lower the availability of managerial expertise it will have".

- The need to produce more goods than the private sector alone was capable of

- The need to establish a broader product base in the country

- The opportunity the state had to invest in projects "of national importance" which either because of the large outlays necessary during the early stages of development, the high risks and or the low initial return involved, the private sector was unable or unwilling to undertake. It must be noted that after these initial periods, ownership of the resulting enterprises was to be transferred to the private sector.

In 1969, another bill (which never became law) was presented by a conservative government *(20)*, by the board of the Central Bank, proposing the creation of a Corporation for Investment and Economic Development (CIDE) with the following general powers:

- To invest directly in national

companies, limiting its participation to 40% of common share issues

- To promote Money Market activities, aimed towards the establishment of the Costa Rican Stock Market
- To participate in, or promote the creation of national or Central American companies as: an associate, shareholder, provider of financial endorsement, etc.
- To extend credit to investors (short, medium, or long term)
- To regulate the exploitation of natural resources in the country, issuing leases, establishing procedures and ground rules for the distribution of the benefits resulting from these operations, etc.
- To participate temporarily in managing national private enterprises, when so required
- To study new sources of industrial development, as well as the improvement of present day installations in order to increase efficiency
- To promote the export of Costa Rican products.

Finally, in 1972, the Asamblea Legislativa (Senate) passed a law (No. 5122, which incorporated ideas from the three documents presented above), by which the Corporacion Costarricense de Desarrollo, Sociedad Anonima (CODESA) was created, (a complete translation of this document is included in Appendix 1).

1.2.3 Basic Organizational Problems:

During the final debate of the Codesa law, in the years 1971 - 1972, the most important opposition towards the approval of the bill, was centered not on the essence of the activities it was to carry out, but instead, on the legal organization this public entity was to have. Up and until that time, all large state owned enterprises had been structured as "autonomous institutions", following the Uruguayan guidelines on public administration management practices.

Because the *Instituciones Autonomas* were regulated under the Ley de Administracion Financiera (Law for financial administration of public funds)), which was thought to be (by the proponents of the bill, Lic. Daniel Oduber, later President of the Republic, 1974 - 1978, and Lic. Jenaro Valverde) a very lethargic regime, that would have impeded the corporation's effectiveness due to excessive bureaucratic procedures *(21)*, a private enterprise structure, Sociedad Anonima, (PLC in Britain), was preferred. This stirred severe criticism primarily from the Communist Party representative *(diputado)*, Lic. Manuel Mora Valverde, who was worried about the "workability" of such an arrangement within the government environment. Nevertheless, the bill was passed as proposed on 16th., November, 1972.

As was stated before, the Partido Liberacion Nacional (PLN), has been the main supporter of the

Codesa idea. With the benefit of hindsight, it can be observed that unlike the other state institutions, the corporation is regarded (and has been since its inception) as a "party" concern, rather than a national enterprise. For this reason, those who favour its existence, or repudiate its creation, focus their arguments around that central dilemma, without looking any further. The 1982 - 1986 PLN Codesa board attributed all of the enterprise's flaws on poor management during the last Unidad administration (1978 - 1982) *(22)*. On the other hand, those who oppose public enterprise, most firm supporters of the "free enterprise" doctrine, view privatization as the panacea for the solution of all the corporation's problems *(23)*. It is the author's belief that neither stance contributes positively towards the achievement of better results for this sector of the economy. Instead, a concerted effort (or working agreement at least) , as in the case of the autonomous institutions, is required to set the political stage for objective and effective technical / managerial solutions. It is important to note at this point that (through personal experience) because of the Sociedad Anonima set up (due to the lack of formal controls), the subsidiary companies as well as the corporate unit, can be easily misdirected or politicized by the party in power, mainly aimed at the achievement of short term goals, a situation which leaves very little scope for strategic (as opposed to tactical) decison making. Due to this loophole in the current legislation, along with the economic and technological changes required, the legal organizational framework must be revised, stressing the need of continued strategic planning practices *(24)*.

1.2.4 Comparison with other Public Enterprises in Latin America:

The Costa Rican venture into the establishment of a state controlled productive sector, was not a new occurence in Latin America. Since the 1940's countries like Chile and Mexico had already organized equivalent institutions *(25)*. At present, public enterprises concentrate important stakes in the economies of Peru, Mexico, Brazil, Mexico, and Venezuela, *(4)*.

1.2.4.a Jurisprudence:

With respect to the legal framework under which these companies operate, it must be said that it varies significantly between countries, as well as between different activities within one single nation. This is very clear from the case of Mexico *(26)*.

The single most important aspect of this framework is the relationship between Central Government and each of the firms in question. Next, I present a graph from Horacio Boneo's Saber Ver las Empresas Publicas, which should help clarify this point *(26)*.

DIMENSION	NON-COMMERCIAL	COMMERCIAL
EXTRA-ECON.OBJECTIVES	MANY	NONE
POWER	HIGH	LITTLE OR NONE
EXTERNALITIES	IMPORTANT	INSIGNIFICANT
FIN.SELF-RELIANCE	LOW	VERY HIGH
RELATION W.GOVERNMENT	CENTRALIZED	DECENTRALIZED

In the analysis of public enterprises, the setting of ground rules for the operation of these companies should be on a case by case basis, in order to reflect as closely as possible, the needs of each particular field of action (in relation to the graph above).

Overall, in the case of productive competitive enterprises (see "commercial" above), objective evaluation of results should be possible. Nevertheless, in the particular case of Costa Rica, Codesa's companies are caught between normative directives from Central Government (centralized company characteristic), and stiff business-like comparison with the private sector (decentralized company characteristic), which is relatively free from government regulation. What results from this situation, under the Sociedad Anonima (PLC) scheme used is a combination which does not fit into Boneo's classification.

1.2.4.b Fields of Action: (based on Boneo)

The span of activities which public enterprises cover in Latin America is very extensive. The range starts with infrastructure, public services, or more broadly put, those activities in which the private sector is not willing to participate.

A second group is directed towards the establishment of backward and forward industrial linkages with the private sector, such as in the case of steel mills or intermediate process operations (a good example of this type of industry is Alunasa, as will be discussed later).

A third classification is constituted by those institutions created for the development of specific regions within a country, which up to that point in time had been excluded from national development programmes (an example of this type of enterprise is JAPDEVA, which is in charge of the development of the Atlantic coastal area in Costa Rica).

The fourth, and last group, which closes this brief introduction into the fields in which Public Companies operate in Latin America, is that of the commercial enterprise, i.e., organizations solely directed towards creating a new source of national wealth, exports, and as a result, employment, industrial development, etc.. This category has not been clearly identified in the past in the country, most probably because it represents a very controversial issue. These are companies (with profit-making goals) where government intervention would be restricted to strategic level decision making. As a result, they could be more easily evaluated and monitored by all interested parties, if for no other reasons, because of the numeric simplicity of the results drawn from their operation, disregarding infrastructural, social welfare or other connotations.

The great variety of objectives presented above, gives an idea of the difficulty of uniform evaluation. Normative direction and extensive central government intervention should yield favourable results in groups one and three above. Number two, would fall in an intermediate category, to be evaluated in a case by case basis. Finally, it is not a wise proposition, as was discussed above, to extend normative-interventionist central government policy to the fourth category, as this represents a field where the importance of competition, market forces, contingency plans and the like, are of the highest priority (independence). In summary, a company's future in this group is determined by its ability to react to changes in its environment, and not by the attainment of rigorous pre-set goals, which at the time they are reached may be outdated. In these cases, the participation of central government (contrary to what has happened in the past at Codesa), should not be significant, and should be limited to management by objectives (by CODESA head quarters) and/or exception management, *(24)*.

1.2.4.c Example of the Influence of Central Government:

The creation of Cementos del Pacifico, the corporation's first major own project, is a clear example of interventionism from the President of the Republic himself, in the affairs of the corporation, decidedly affecting the outcome of a project.

Below I present a summary of a report approved by the corporation's board of directors session No. 27, of the 2nd. October, 1973. *(27)* on the desirability of the investment in question:

Document

I. Presentation:

A. Frame of reference:

- source of raw materials
- Possibility of marketing product

B. Method of Study:

- Stage 1:
  - Determine quantity and quality of raw materials
  - Study the possibility of selling the proposed production volume locally, abroad, or a combination of the two.
- Stage 2:
  - Feasibility studies:
    - technical
    - economic and social
    - financial
- Stage 3:
  - Negotiate financial terms, structure bid cartels, etc.

C. Possible economic gains:

- Regional development
- Generation of employment

- Increase GNP
- Balance of Payments

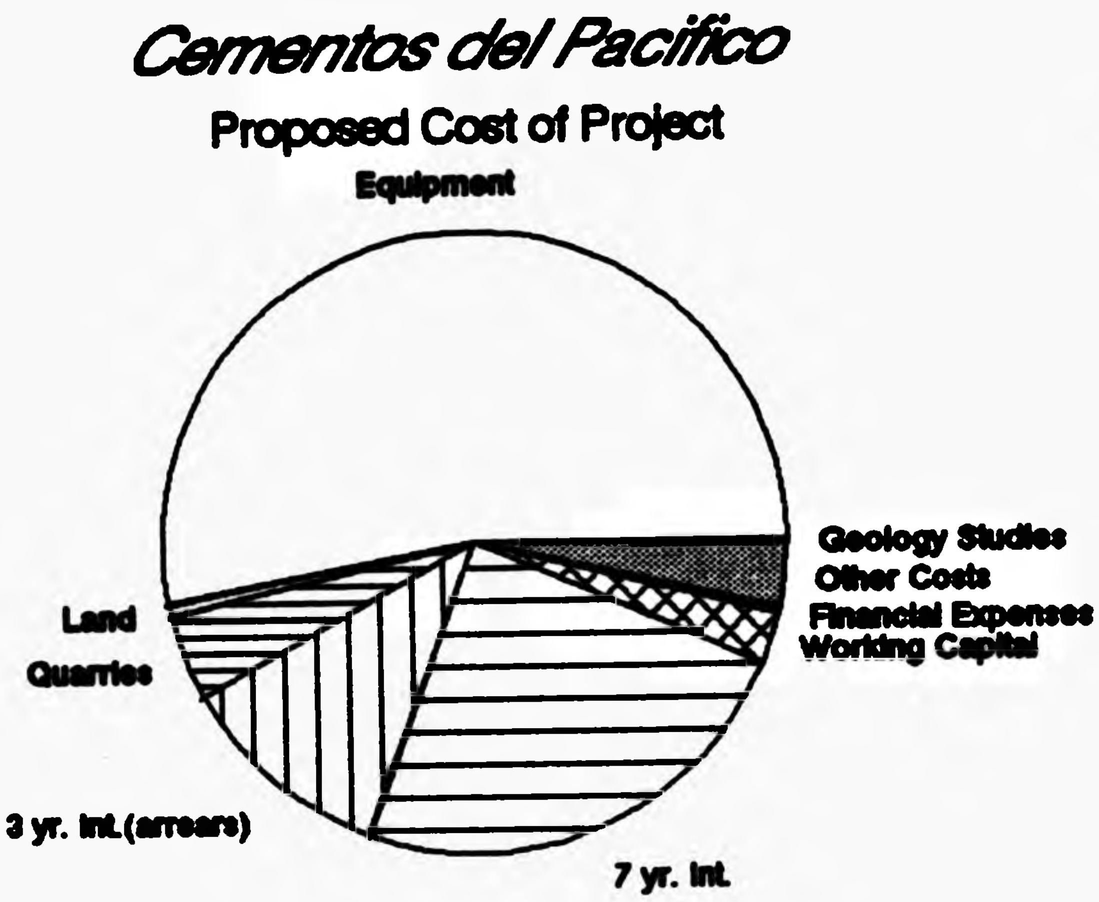
(Important factor: measure % national value added on final product)

D. Description of the project:

- The proposed plant would be able to produce 1,250,000 MT/yr., of a combination of cement, for regional consumption, and clinker for export to plants in other countries, especially the US (Atlantic Coast, and the factory would be located in the Costa Rican Pacific coast)
- Infrastructure required: conveyor belts to transport clinker to dedicated port facilities, which also have to be built.

E. Cost:

- Equipment	US $ 53,437,931
- Land	574,691
- Quarries	4,511,278
- 3yr Int (arrears)	11,292,691
- Int. 7 follow yrs.	24,395,353
- Working Capital	2,631,578
- Financial Expenses	323,653
- Other Costs	3,383,458
- Geological Studies	75,188
TOTAL	US$ 100,727,821



II. Result of Studies:

A. Raw Material Deposits:

- Quantity: Preliminary surveys have reported extensive deposits of required materials in the region.

- Quality: Had not been determined for the present report.

B. Market Possibilities:

- United States: total clinker cement imports: 4.4 million MT/yr. (Source: US Bureau of the Census: US Imports for Consumption, calendar year 1972). CEMPASA's capacity would amount to approximately one fourth of total needs.

- Competition: Mexico, Canada, Bahamas. All next door neighbors to the US. The most important cost in the cement exporting business is transportation.

- Central America: Total needs for regional cement: imports 1972: 54,000 MT., virtually self-sufficient market.

- Other possible markets:

- the reconstruction of Managua (destroyed by an earthquake on 23rd. December 1972.)

- ICE projects Arenal and Boruca (Hydro-electric schemes).

C. Technology:

- new process called "sinterization" (not offered in current deal) can produce 2 x to 2.5 x more cement than the proposed plant with a reduction of between 5% and 10% reduction on expected values. (Source: Revista Progreso Oct/Dec 1972)

D. Financial Analysis:

- drastic changes have been presented by the proponents of the deal (mainly regarding feasibility studies)

- Price Waterhouse + Co. in charge of the audit did not back the financial statements cash flow projections, etc., presented by the proponents.

- Repayment period is to short for a project of this magnitude: 10 yrs.

- Interest is too high (offered by a British consortium): 1.5% EIBR, estimated at the time at 11 3/8%.

III. Conclusion:

Due to the adverse market conditions, the financial uncertainty, and other considerations such as the obligation to purchase the equipment from ATEINSA of Spain, the Board rejects the proposal for financial assistence to the Cementos del Pacifico project.

End Document

Note: After heated debates, most of the directors resigned, or were ousted, and the plant (with an initial capacity of 450,000 MT/yr.) was constructed by ATEINSA of Spain. Current exports 0 MT, Current utilization of plant ~ 43% (1986). (Overcapacity situations are common in State sponsored investment: please see Nunnenkamp *(17)*.

1.3 Description of Codesa's activities:

As was stated earlier, the Costa Rican Development Corporation (Corporacion Costarricense de Desarrollo S.A.) was founded by law No. 5122, of 16 November, 1972.

The corporation's investment program has concentrated in four main fields.

The first of these is direct investment in industry: extractive, chemical, intermediate, and agroindustrial. In extraction, the organization has focused its efforts in the area of cement production (Cementos del Valle, CEMVASA, and Cementos del Pacifico, CEMPASA). In the chemical field, fertilizers are produced (Fertilizantes de Centroamerica S.A., FERTICA). In the category of industrial linkage, an aluminium semi-processing (from ingot form) facility supplies various manufacturing companies both in Costa Rica and the Central American region with inputs for their processes (Aluminios Nacionales S.A., ALUNASA). Finally, the other field of major involvement is the industrialization of sugar cane with three main outputs: sugar, molasses and alcohol (Central Azucarera del Tempisque S.A., CATSA). All of the above enterprises are subsidiaries where Codesa holds more than a fifty percent stake (in actual fact this figure is normally above ninety percent).

In second place, Codesa has financed new third party projects from the private sector, of small macroeconomic impact, (affiliate companies, where the corporation holds less than fifty percent of the stock),as well as specific ventures within established firms for renewing plant, etc., either by investing directly into the companies, or by granting guarantees on foreign loans. As a result of this policy, Codesa has suffered substantial losses and has had, as an ultimate measure, to operate some failed companies.

Thirdly, the corporation has served as a financial intermediary (broker) between foreign sources of capital and local concerns.

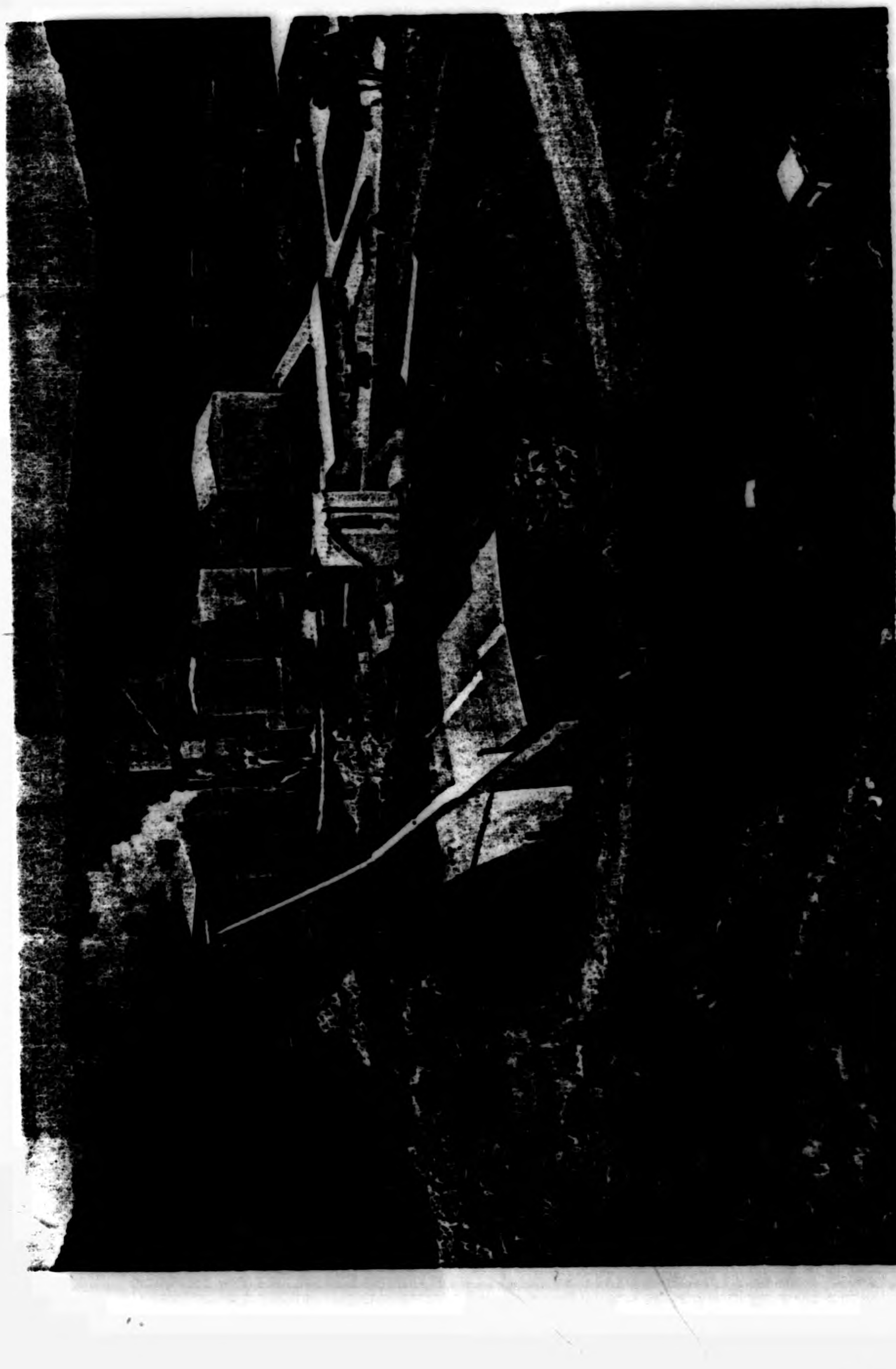
Lastly, due to pressures from different sectors of society, the corporation has been forced, directed by central government policy on an ad hoc basis, into the management of infrastructure institutions. Here, the emphasis has been focused on the transport sector (TRANSMESA in urban mass transport and FECOSA, the national railway system).

This thesis will concentrate on the analysis both of the corporate unit as a whole, as well as on the four largest investment areas amounting in 1984 to approximately 80% of the corporations financial exposure. *(28,29)*

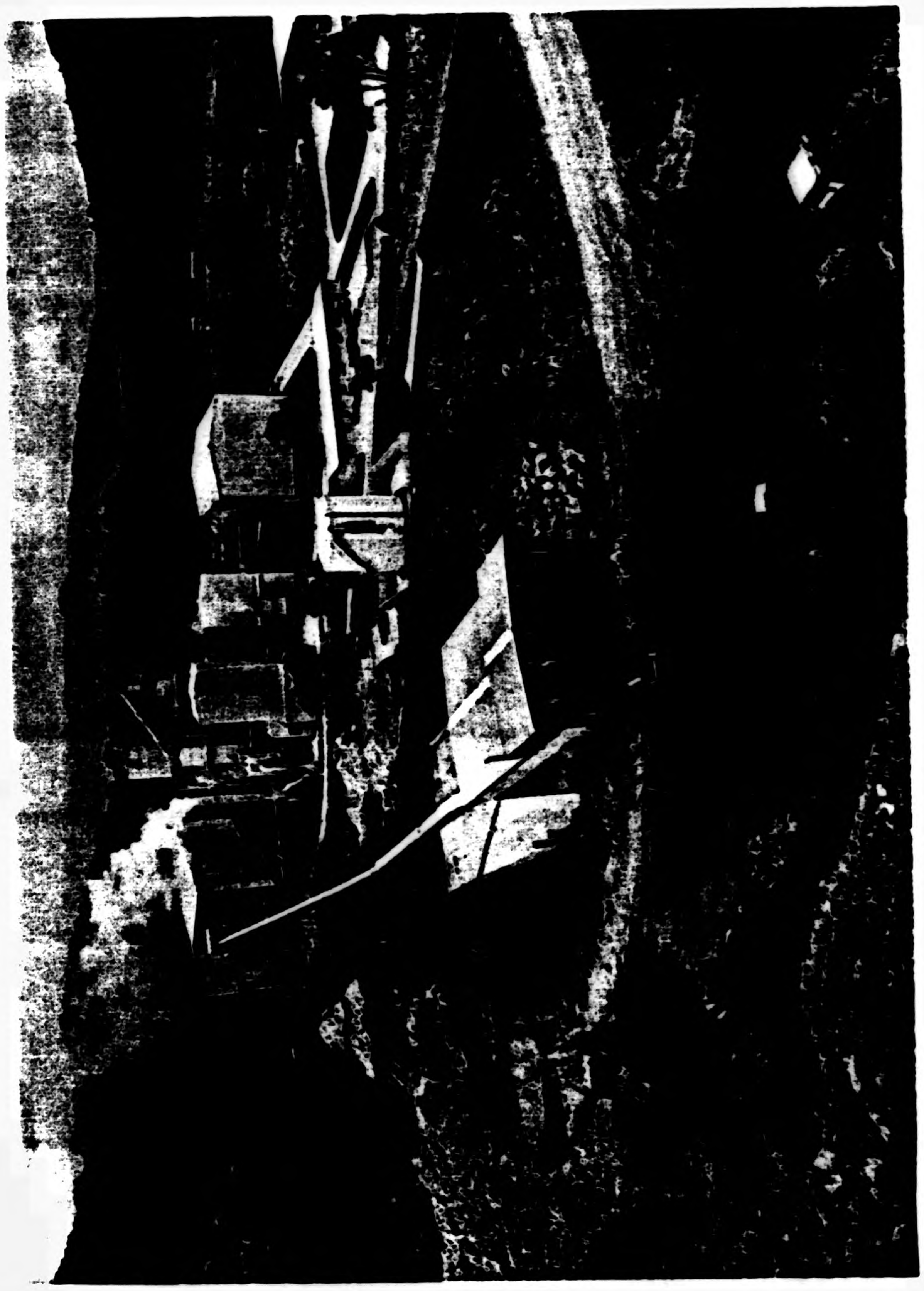
The concerns to be evaluated are: Cementos del Valle (140,000 MT/yr. nominal clinker production capacity), and Cementos del Pacifico (450,000 MT/yr. nominal clinker production capacity), in the extractive industries; Fertica, a fertilizers plant producing nitrogen (nitric acid: 450 MT/day, Ammonium Nitrate: 350 MT/day), sulfate (Ammonium Sulfate: 200 MT/day) and physical mixture complexes (400 MT/day); Catsa, a ~ 5,500 MT/day (sugar cane input) sugar mill and 240,000 L/day agroindustrial set up; and Alunasa, a 32,000 MT/yr. finished product aluminium semi's production facility.

Below I present some photographs of these installations:

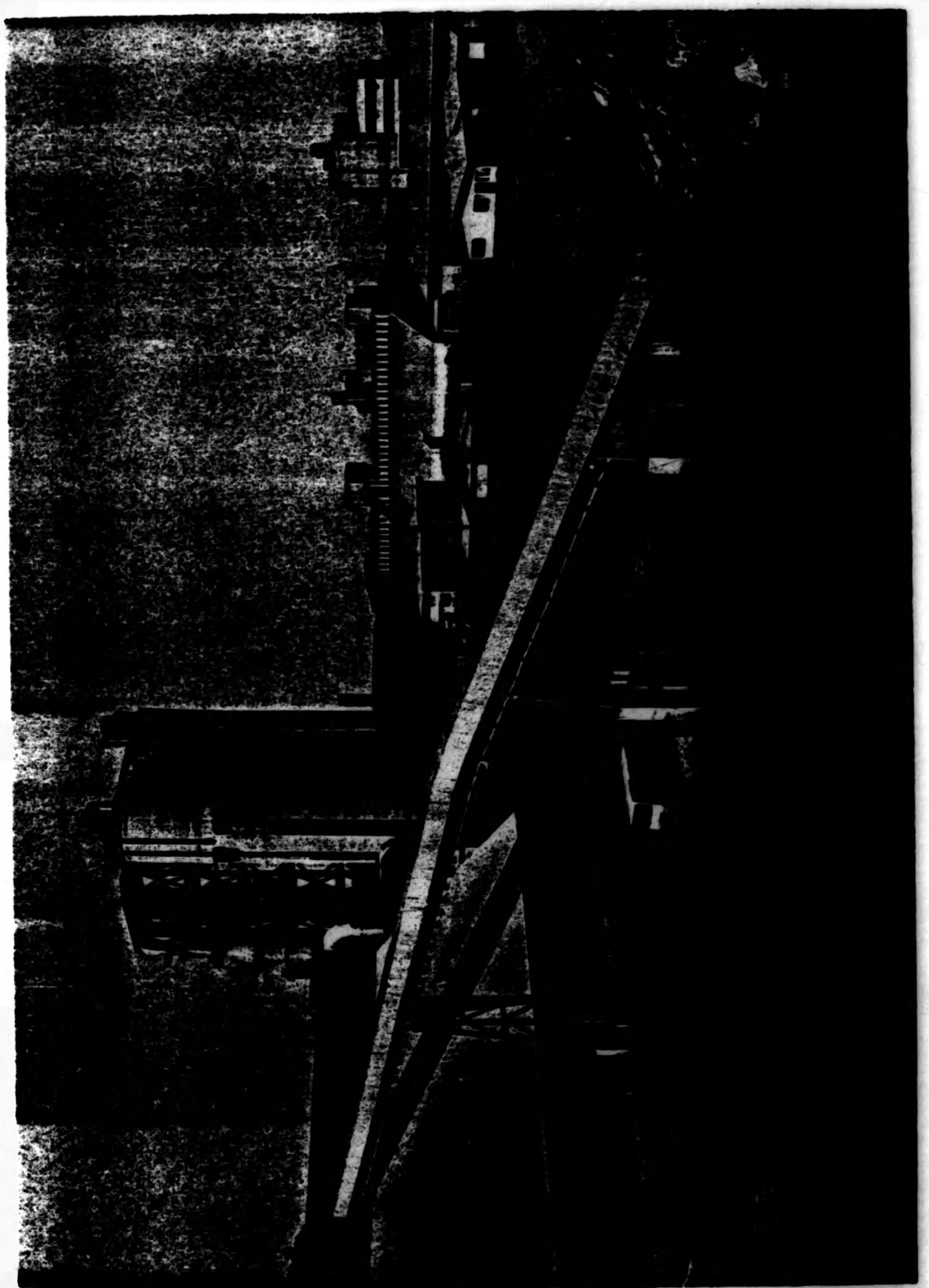
CEMENTOS DEL VALLE SOCIEDAD ANONIMA:



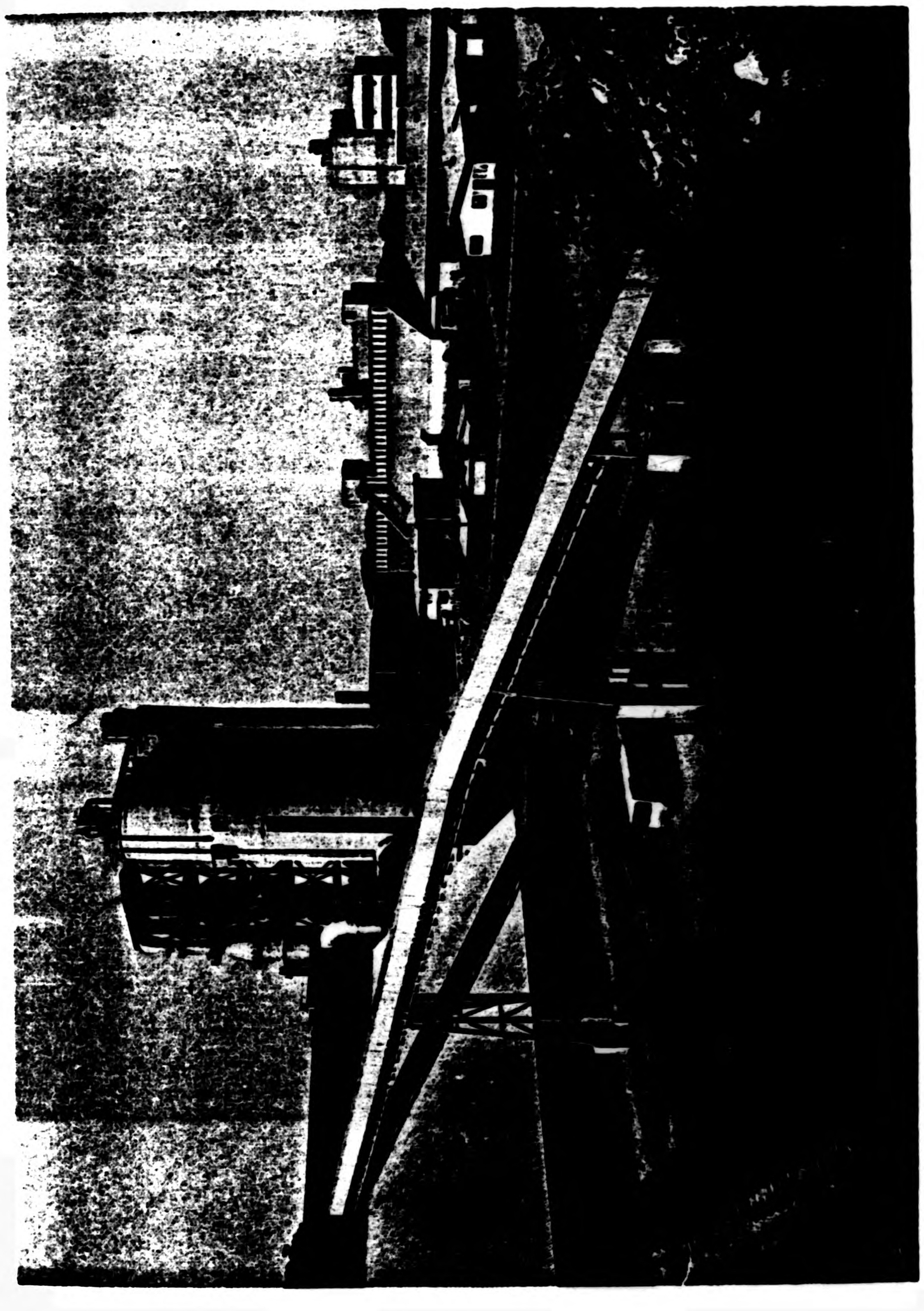
CEMENTOS DEL VALLE SOCIEDAD ANONIMA:



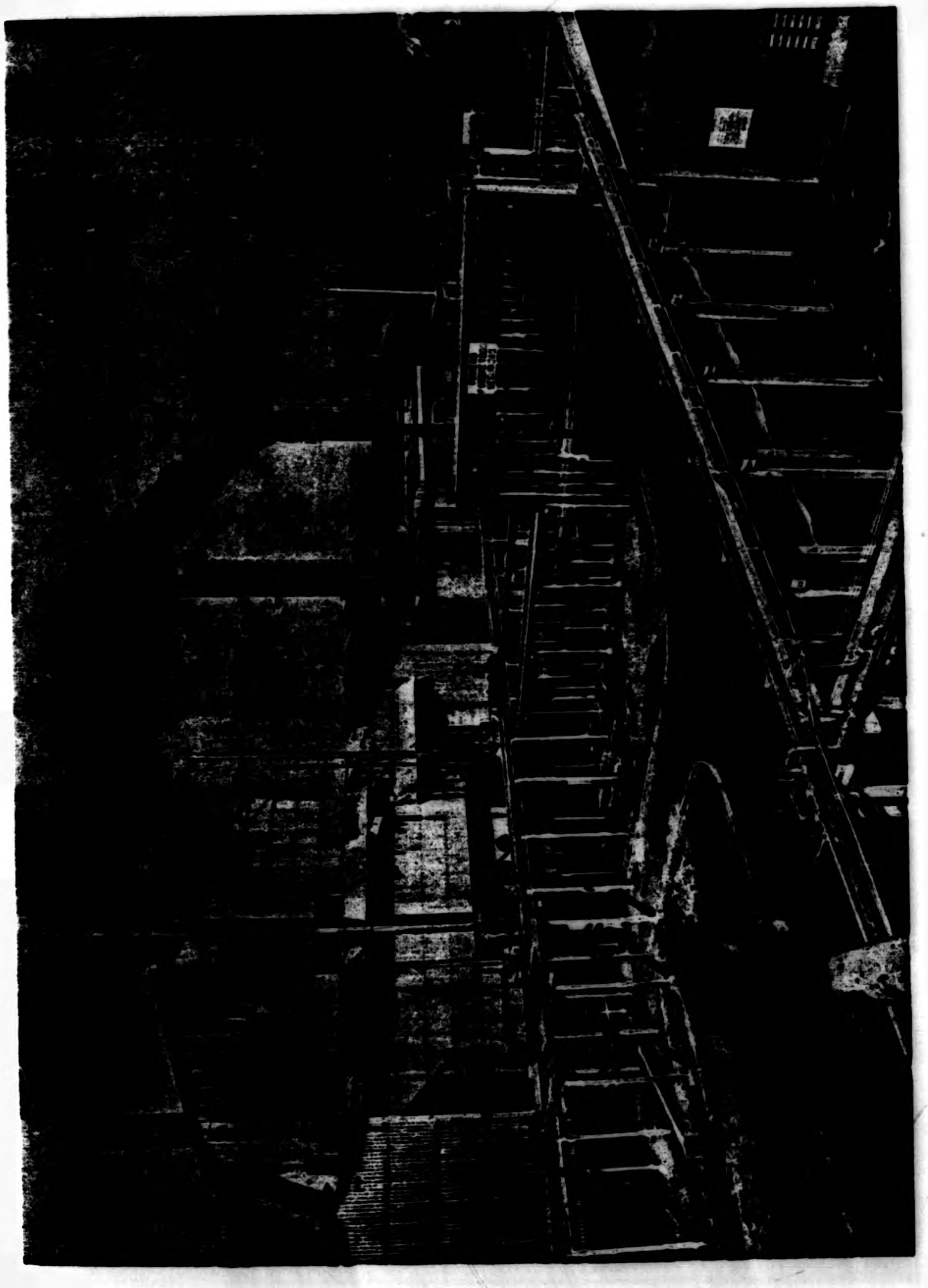
CEMENTOS DEL PACIFICO SOCIEDAD ANONIMA:



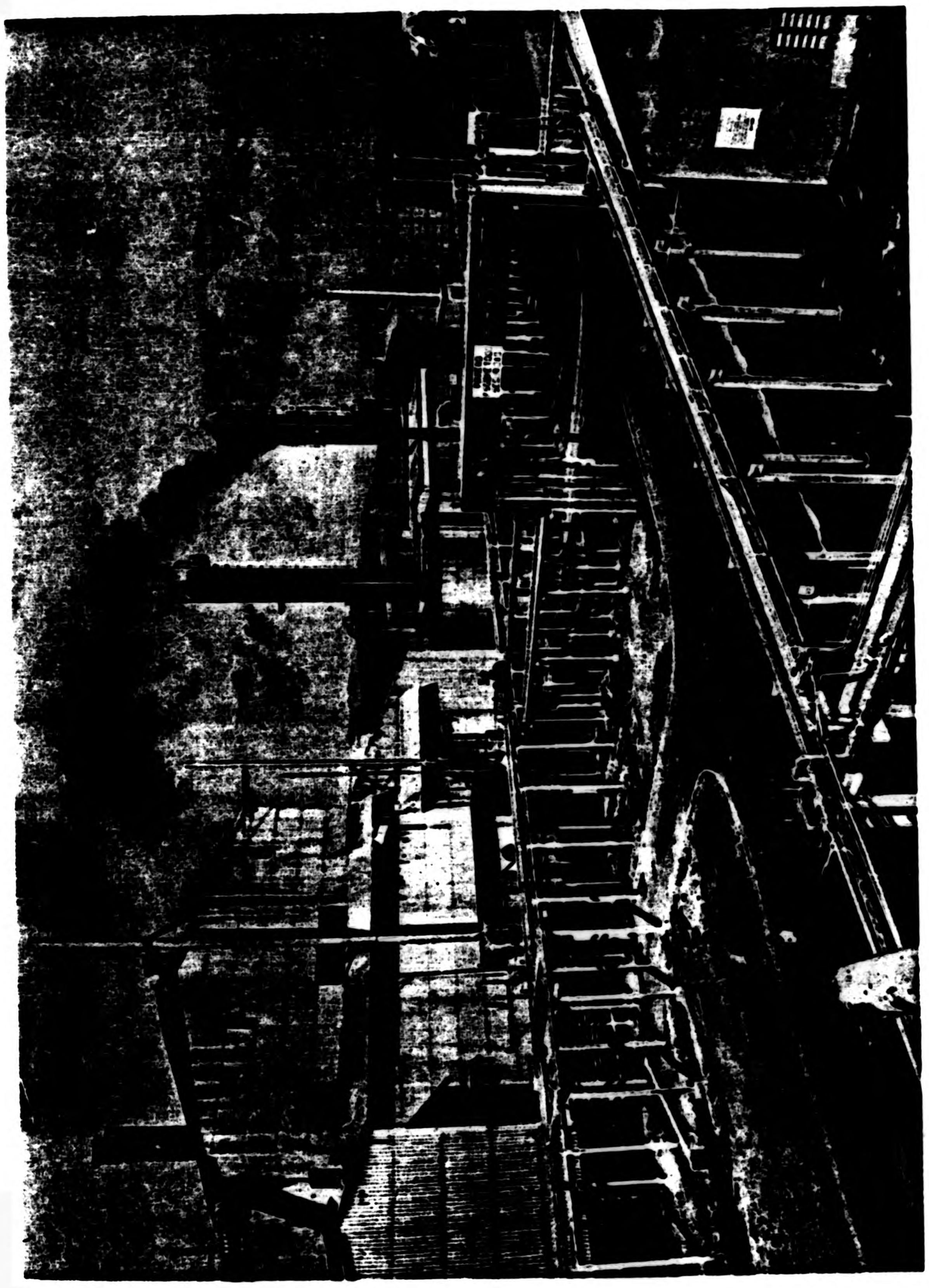
CEMENTOS DEL PACIFICO SOCIEDAD ANONIMA:



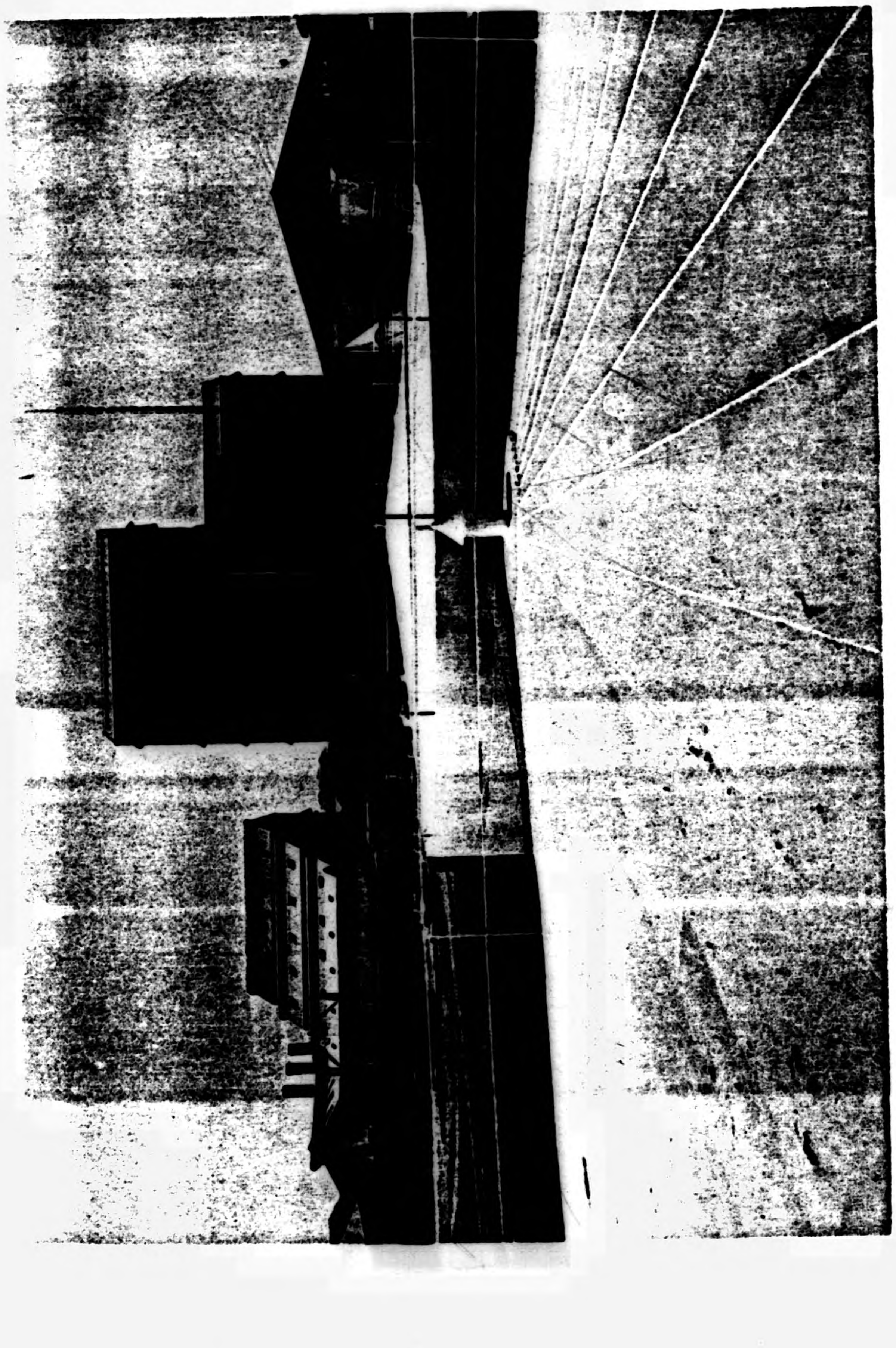
FERTILIZANTES DE CENTROAMERICA SOCIEDAD ANONIMA:



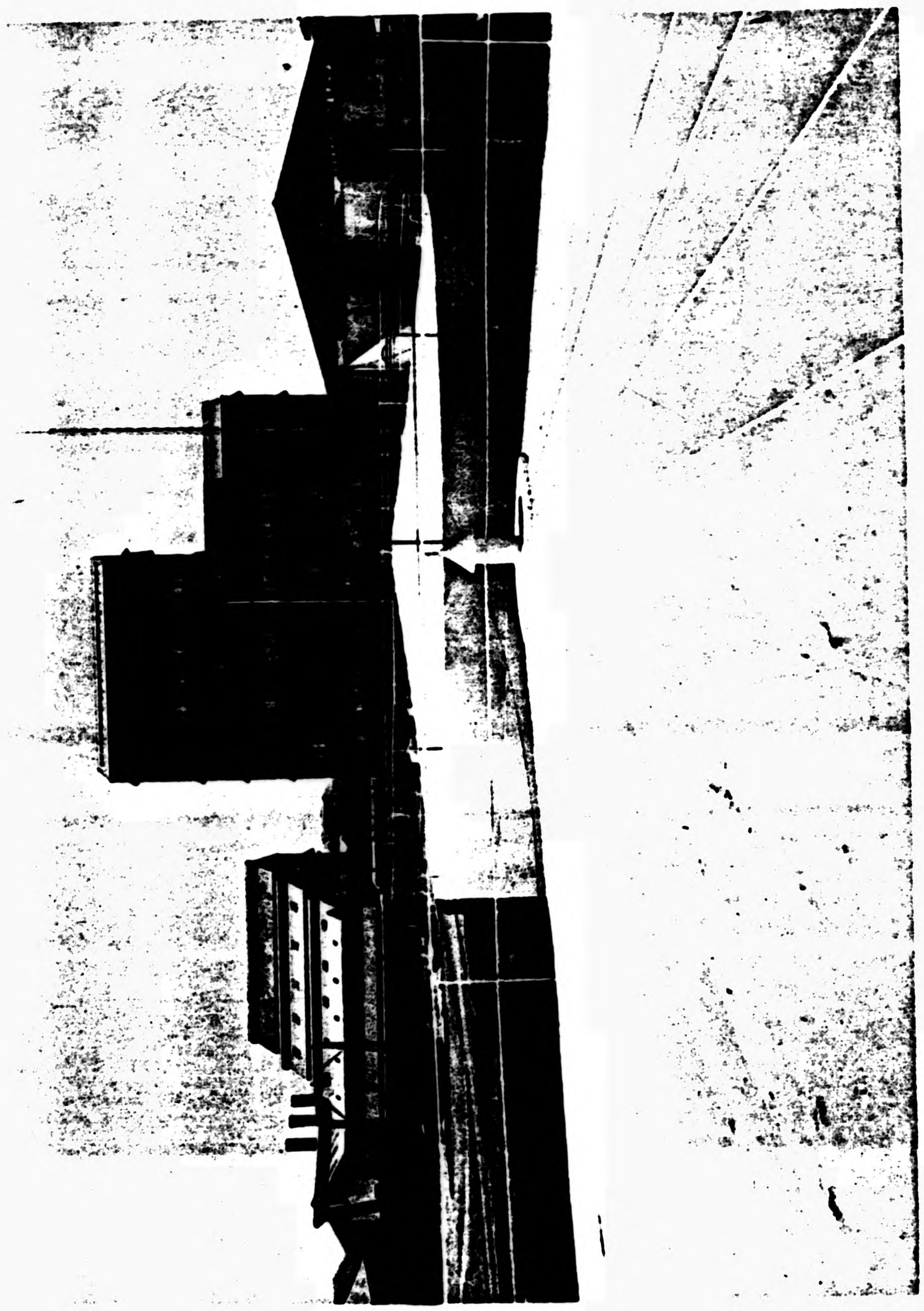
FERTILIZANTES DE CENTROAMERICA SOCIEDAD ANONIMA:



CENTRAL AZUCARERA DEL TEMPISQUE SOCIEDAD ANONIMA:

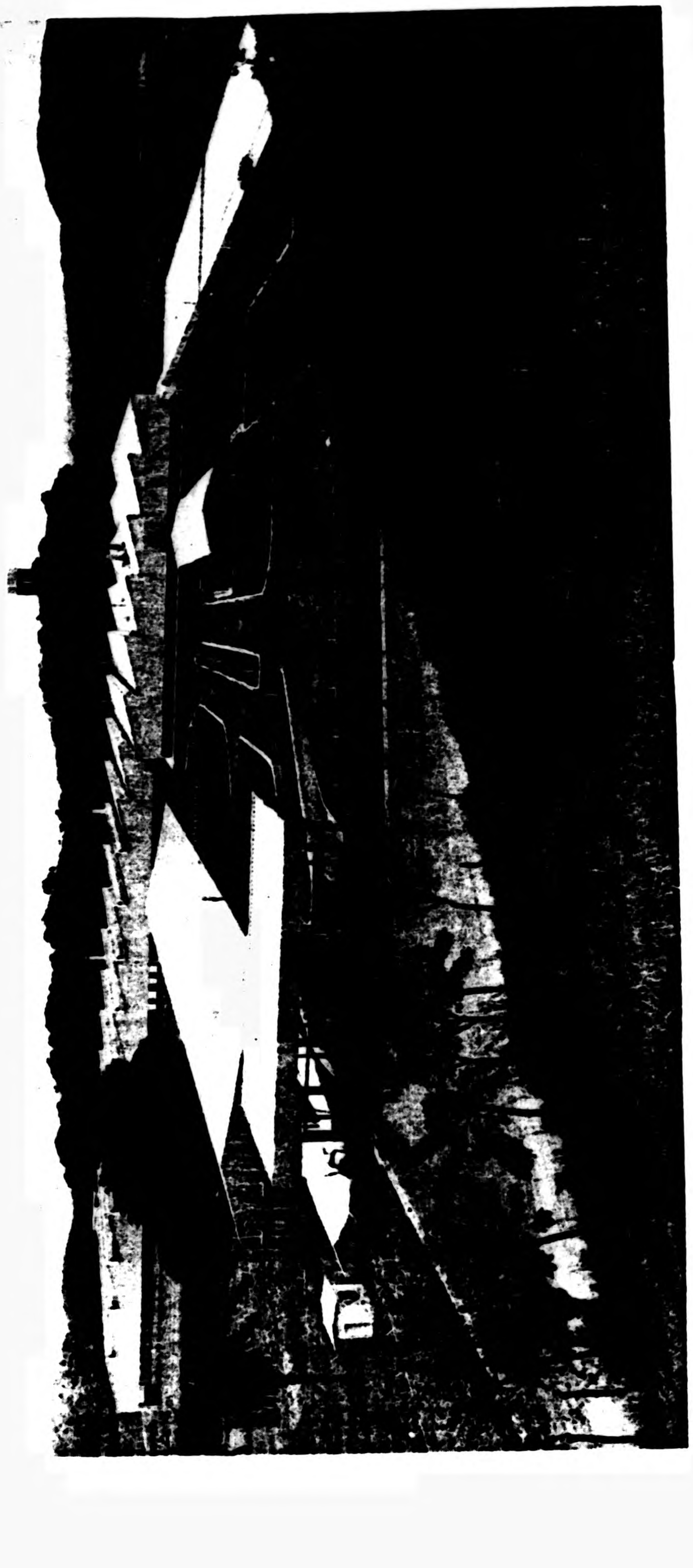


CENTRAL AZUCARERA DEL TEMPISQUE SOCIEDAD ANONIMA:



ALUMINIOS NACIONALES SOCIEDAD ANONIMA:

ALUMINIOS NACIONALES SOCIEDAD ANONIMA:



Finally, I shall present a chart of CODESA's debt situation with the Central Bank of Costa Rica (BCCR), as at 30 September, 1984 *(30)*. As will become apparent in later chapters, the current financial position of the corporation is not good. The total debt with the BCCR amounted at the end of fiscal year 1984 to ~ US$ 250 million.

Some aspects worthy of comment from the figures below are the following: Most debts have been consolidated at the corporate level. The financing of the investment programmes has come in the past, essentially from BCCR bond issues. The brokerage activity has become CODESA's main source of income, due to the fact that the enterprise has been cut off of new capital from the BCCR, as a result of the government's negotiations with the IMF.

Please note the importance of raw materials purchases for two of the subsidiaries to be covered in the present study: FERTICA and ALUNASA, as this is a major strategic problem which shall be dealt with in the following chapters. (Average exchange rate is 44.5 Costa Rican Colones (CR C) per US dollar.)

CODESA: Debt situation with the Central Bank of Costa Rica as at 30 September, 1984

CATEGORY	INTEREST %	TERM YEARS	BALANCE
BROKERAGE ACTIVITIES:			
FODEIN	18.70	6.00	25,304,000.00
AID	0.00	0.00	681,651,000.00
RECOPE	B.RATE +.5	5.00	931,759,000.00
TRANSMESA	7.50	8.00	315,550,000.00
FERTICA	4.00	2.00	281,806,000.00
ICE	8.50	8.50	147,169,000.00
SUBTOTAL BROKERAGE			2.383.239.000.00
CREDIT LINES:			
CATSA	8.50	8.00	29,761,000.00
SUBPRODUCTOS DE CAFE	8.00	8.00	3,706,000.00
ALUNASA (raw mats.)	10.00	0.50	85,615,000.00
FERTICA (Purchase)	10.00	8.00	715,337,000.00
SUBTOT. CREDIT LINES			834.419.000.00
SUBSIDIARY DEFAULTS:			
CATSA			15,874,000.00
FERTICA (raw mats.)			335,657,000.00
FERTICA (Purchase)			472,018,000.00
SUBTOTAL DEFAULTS:			823.549.000.00
BOND ISSUES:			
CODESA Series			4,091,899,000.00
INTEREST OUTSTANDING			1,956,094,000.00
RECOPE Series	BASE RATE		47,260,000.00
SUBTOTAL BONDS:			6.095.253.000.00
FOREIGN DEBT:			
PRIVATE			552,187,000.00
PUBLIC -NOT RESCHED.			447,610,000.00
SUBTOTAL FOREIGN DEBT			969.797.000.00
TOTAL DEBT WITH CENTRAL BANK			11.114.988.000.00

References Introduction:

1. SALVATORE, D.: International Economics, McGraw-Hill Book Co., New York, 1975.

2. YOUNGSON A.J.: Honk Kong: Economic Growth and Policy, Oxford University Press, Hong Kong, 1982.

3. WORLD BANK: World Development Report 1985, Oxford University Press, New York, 1985.

4. KIRKPATRICK, LEE, NIXSON: Industrial Structure and Policy in LDC's, George Allen & Unwin, London, 1984.

5. NOVE A.: The Soviet Economic System, George Allen & Unwin, London, 1980.

6. CHINESE COMMUNIST PARTY: Decision del Partido Comunista de China sobre la Reforma de la Estructura Economica, Ediciones Lenguas Extranjeras, Beijing, 1984.

7. HARE P., RADICE H., SWAIN N.: HUNGARY: A Decade of Economic Reform, George Allen & Unwin, London, 1981.

8. HOUGH, J.R.: The French Economy, Croom Helm, London, 1982.

9. CAVE M., HARE P.: Alternative Approaches to Economic Planning, Macmillan, London, 1981.

10. TUCKER, J.B.: *"Managing the Industrial Miracle"*, High Technology, August 1985 issue, pp.22 - 30.

11. JONES H.G.: Planning and Productivity in Sweden, Croom Helm, London, 1976.

12. IYER R.N.: The Moral and Political Thought of Mahatma Gandhi, Oxford University Press, New York, 1973, Chapter 12.

13. RATTAN R.: Gandhi's Concept of Political Obligation, The Minerva Associates, Calcutta, 1972.

14. SWAMY S.: Indian Economic Planning. An Alternative Approach, Vikas Publications, New Delhi, 1971.

15. MAJARO S.: International Marketing. A Strategic Approach, George Allen & Unwin, London, 1983.

16. CHOSKI A.: State Intervention in the Industrialization of Developing Countries, WBSWP No. 341, Washington D.C., 1979, quoted in NUNNENKAMP P: *"State Enterprises in Developing Countries"*, Intereconomics, July/August 1986 issue, Hamburg, pp. 186 - 193.

17. NUNNENKAMP P.: "State Enterprises in Developing Countries", Intereconomics, July/August 1986 issue, Hamburg, pp. 186 - 193.

18. Original letter sent to Asamblea Legislativa, file No. 5122, Asamblea Legislativa, San Jose, Costa Rica.

19. Original document , file No. 5122, Asamblea Legislativa, San Jose, Costa Rica.

20. Letter sent by Board of Banco Central to Asamblea Legislativa, original document, file No. 5122, Asamblea Legislativa, San Jose.

21. ODUBER D.: Documentos de Codesa, Codesa, San Jose 1983

22. BONILLA-AYUB J. (Exec. Pres.-CODESA), Notas de Prensa Nos. 1,2,3,4, Codesa, San Jose, 1985

23. WOODBRIDGE J.: *"El Estado Empresario"* , La Nacion, San Jose, 14 Sept., 1984.

24. Please refer to GLUECK, JAUSCH: Strategic Management and Business Policy, McGraw-Hill Book Company, New York, 1984.

25. SOJO A: Empresa Estatal y Desarrollo en America Latina, IICE, Documento de trabajo No. 38, Universidad de Costa Rica, San Jose, 1982.

26. BONEO H.: Saber Ver las Empresas Publicas, EDUCA, San Jose, 1980.

27. Taken from Original document Board of Directors Session No. 27, 2 Oct., 1973.

28. Codesa: Memoria Anual 1981.

29. World Bank: SAL Appraisal for Costa Rica, CODESA component, Washington D.C., 1984.

30. Codesa: Obligaciones Directas e Indirectas con el Banco Central de Costa Rica al 30-9-84.

2. Cement

2. CEMENT PRODUCTION

2.1 Introduction:

2.1.1 Incsa

2.1.2 Codesa
- 2.1.2.a Cemvasa
- 2.1.2.b Cempasa

2.1.3 Comparison with Central America

2.2 Demand Analysis:

2.2.1 Introduction
- 2.2.1.a Cartel Agreements
- 2.2.1.b Financial Position

2.2.2 National Market Historical Behaviour

2.2.3 Growth Projections
- 2.2.3.a Formal Forecasting
- 2.2.3.b Multiple Simulations
- 2.2.3.c Analysis of Results

2.2.4 Large Consumption Projects (Impact Studies)
- 2.2.4.a Low Cost Housing
- 2.2.4.b Hydro-electrical Schemes
- 2.2.4.c Road Building

2.2.5 Exports
- 2.2.5.a Historical Behaviour
- 2.2.5.b Future Prospects

2.3 Policy Instruments to Improve Performance

2.3.1 Energy Monitoring, Conservation & Substitution

2.3.2 Package Deal Capacity Development

2.1 Introduction:

2.1.1 INCSA:

Cement production activity has existed in Costa Rica for over twenty years. The first plant built for this purpose, was that of the Industria Nacional de Cemento, S.A., (INCSA), an affiliate company of the Swiss conglomerate Holderbank Financiere Glaris, A.G. (Haupstrasse 44, CH-8750, Glarus, Switzerland) *(1)*.

For over a decade, this private sector operator enjoyed a monopoly situation, supplying the country with most of its needs (cement and concrete products) in the construction sector. Through the years, a number of linkage (sister and affiliate) companies, covering areas such as pre-cast cement structures, quarries, concrete mixing, fibre-cement products, etc., grew alongside INCSA. Nowadays, the whole network constitutes, without doubt, one of the most established and experienced vertically integrated activities present in the country's economic life.

The INCSA plant is located some 30 kilometres away from the capital city of San Jose, within what has been designated the highest cement consuming area in the country, i.e., the Meseta Central, where approximately 74% *(2)* of the product is sold.

The process itself is conformed by a two kiln layout. The first one, originally a "wet" process (slurry), transformed in the early seventies to operate under the more energy efficient "dry" conditions, has a nominal capacity of between 400 and 450 metric tonnes/day of clinker throughput (estimates varied from source to source). The other production line, a more up to date design installed during 1974 (dry process), has a nominal capacity of between 600 and 800 metric tonnes/day (again, the values varied depending on who was providing the information).

According to company officials, it is unlikely that the first of these processes (currently stopped) will ever operate again due to its outdated technology, i.e., it would be recommissioned only as a result of a sudden dramatic rise in demand. The preferred route to nominal capacity expansion has been identified as the updating of the newer production facility, by the introduction of energy saving (and monitoring) equipment and practices, and pre-calcination systems. Based on the current investment projects being carried out at the plant, these improvements could yield up to a 50% increase in capacity, i.e., to approximately 1,200 - 1,450 metric tonnes/day *(3)*. For the purposes of this study, the figure of 1,200 metric tonnes/day will be used when projecting the company's contribution to total available capacity in Costa Rica for the period 1985 - 2000.

2.1.2 CODESA:

2.1.2.a Cementos del Valle, S.A.:

The other two cement plants, Cementos del Valle (CEMVASA) and Cementos del Pacifico (CEMPASA) belong to CODESA.

The first was absorbed by the corporation from the private sector, after the original company, Calhidra S.A. (which started the construction of the plant in 1972) filed for bankruptcy, before finishing the project. After a period of reassessment, CODESA concluded the plant having estimated that additional was required, due to the prospect of a relative shortage of national supply, as a result of the rapid growth experienced in the construction sector in the middle and late seventies (i.e., consumption growing faster than installed capacity). Finally, the company started producing cement in 1978.

The plant's characteristics and location are quite dissimilar to that of its other two competitors. Its capacity is approximately one third of either INCSA or CEMPASA: around 400 metric tonnes/day. The production installations are located very close to the main centre of consumption, roughly 15 kilometres away from the capital city.

In September 1983, due to the

dramatic drop in consumption experienced in the country, the government decided to shut the plant down, remaining so until the present day.

2.1.2.b Cementos del Pacifico:

The second CODESA company, Cementos del Pacifico S.A. (CEMPASA) has the most up to date plant in the country. The industrial site was built by ATEINSA of Spain, in conjunction with Allis-Chalmers of the USA which supplied most of the equipment. Asland, Spain's largest cement producer was in charge of the start-up phase, as well as the training of key personnel. (Both Ateinsa and Asland are subsidiary companies of the INI, the Spanish equivalent of CODESA).

The production capacity of the CODESA plant is of ~1,250 metric tonnes/day or approximately 450,000 metric tonnes/year, and its raw material deposits are recognized by most people interviewed, as the richest in the country and probably in Central America. In fact, at a nominal capacity rate of exploitation, the estimated supply potential (availability of raw materials) would be of up to two hundred years *(4)*, compared to approximately forty years in the case of INCSA's quarries *(3)*. (An important drawback of CEMPASA's rock deposits is their high concentrations of alkali, which could prevent the company from exporting into the American market).

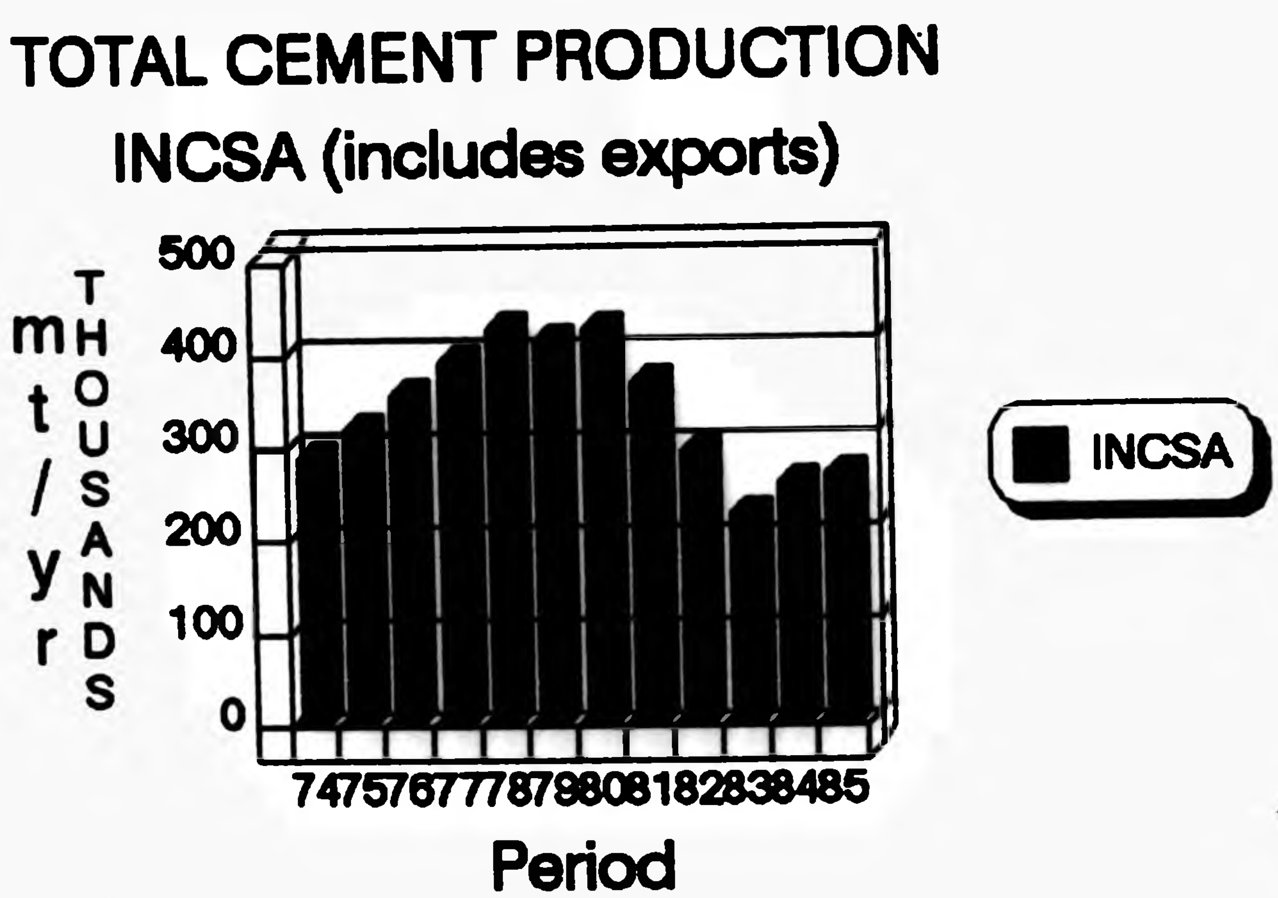
The greatest problem faced by

the company, if it is to compete in the national market, lies in the fact that its production site is located far away, some 250 kilometres, from the main centre of consumption, through mountainous terrain (CEMPASA's installations are located at sea level, while the capital city is at ~4,000 feet above sea level). It has been estimated that the cost of transportation to the Meseta Central is between 20% and 30% of the total production value, a figure which places this firm in a poor strategic position with respect to the other two producers.

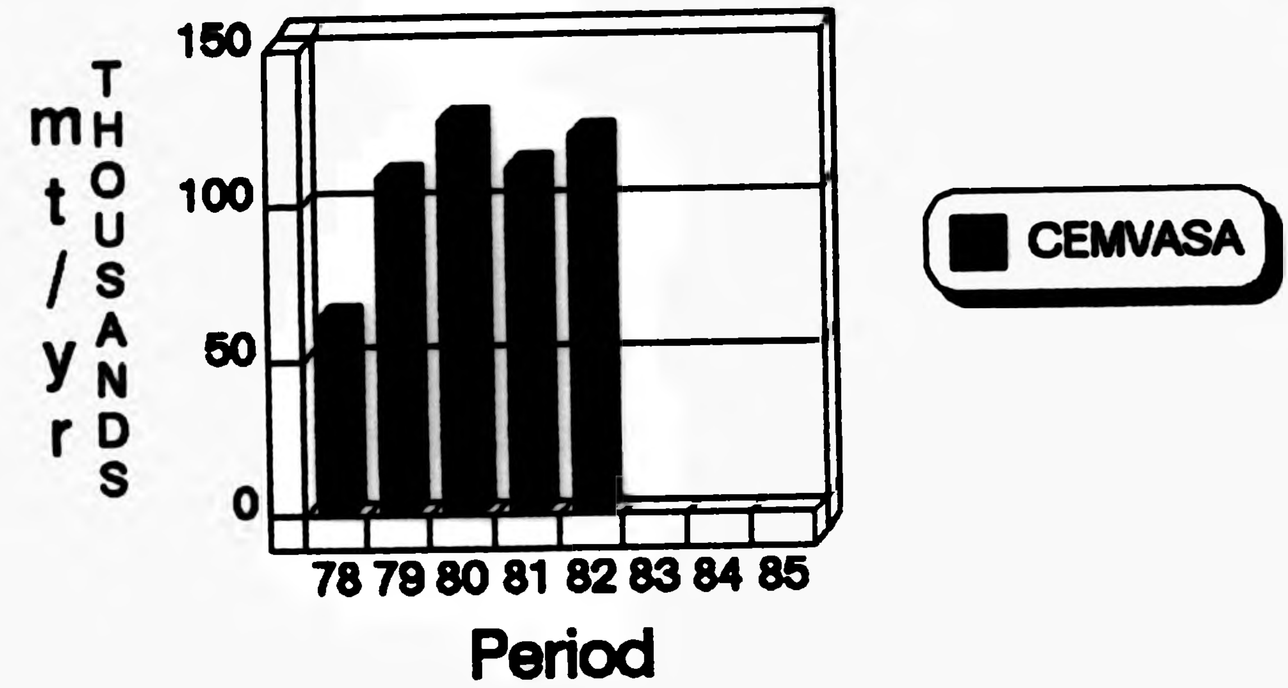
In relation to comparative competitiveness (apart from that mentioned above) of the public and private sector businesses in the industry, it must be stressed that INCSA is much better situated. The reasons are as follows: deeper knowledge of the sector due to its greater experience in the national market, the existence of sister and affiliated companies absorbing dedicated production, serving as a more stable base for future planning, and finally the technological links with the international group from which great expertise is drawn (for example, currently, the financial records operation is being computerized, following a system developed at Cementos Apasco, a Mexican sister company).

The following charts present the relation of sales to nominal capacity for the three plants, for the past ten years. As can be seen, while INCSA and CEMVASA operated side by side, no crowding out effect was evident. In fact, Cementos del Valle came to fulfill a need in times of high growth in consumption (late 70' and early 80's).

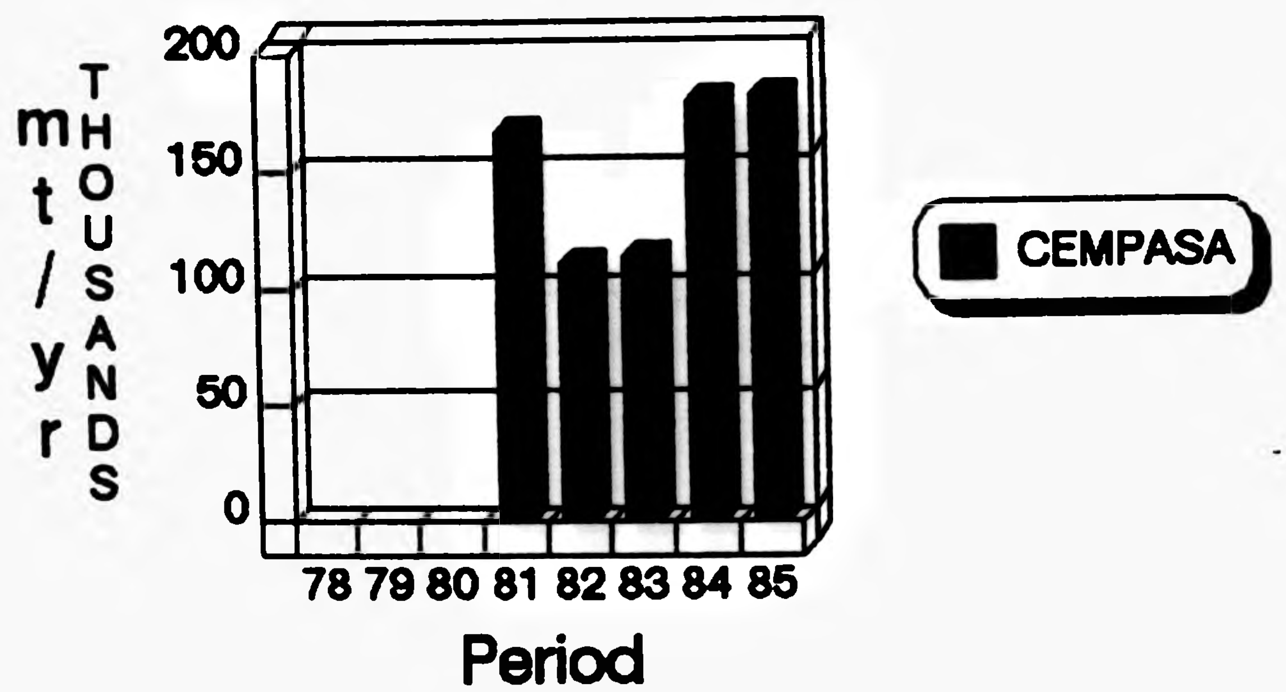
Nevertheless, when Cementos del Pacifico started its operations, and the effect of the 1981 economic crisis struck, the conditions rapidly changed. This fact can be clearly observed in the "Total Production" graph No. 4. Moreover, for 1983 through 1985, either of the larger two companies could have, on their own, fulfilled the total national demand.



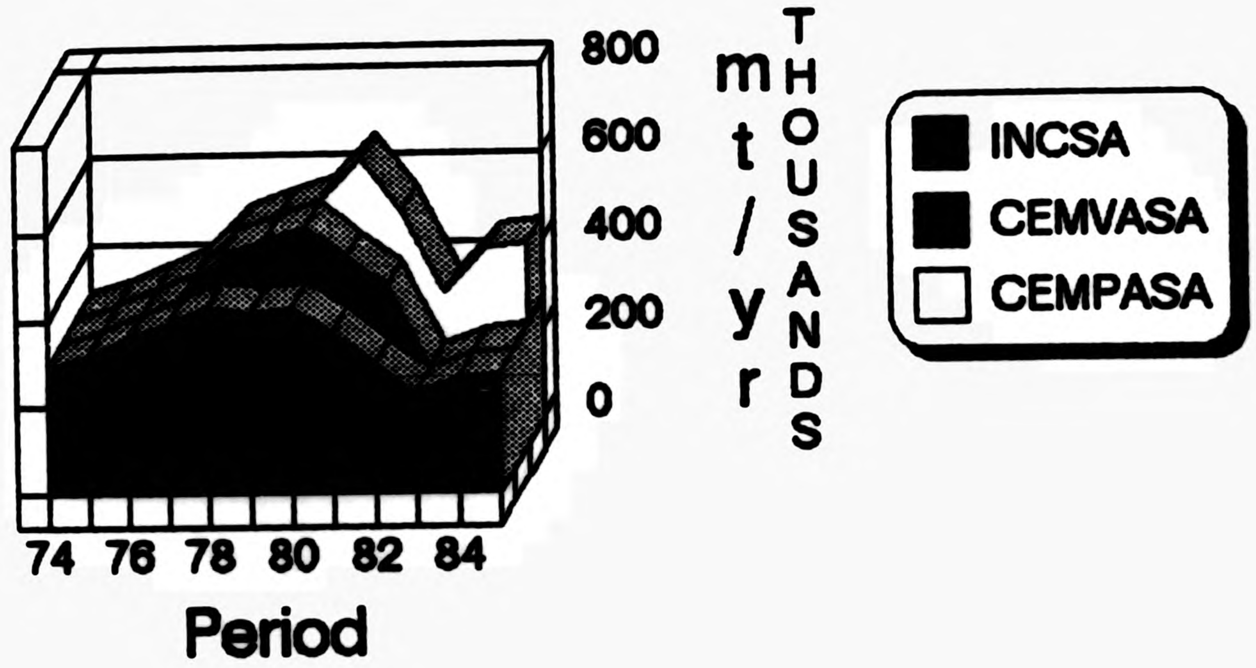
TOTAL CEMENT PRODUCTION
CEMVASA (includes exports)



TOTAL CEMENT PRODUCTION
CEMPASA (includes exports)



TOTAL CEMENT PRODUCTION
COSTA RICA (inc. exports)



2.1.3 Comparison with Central America:

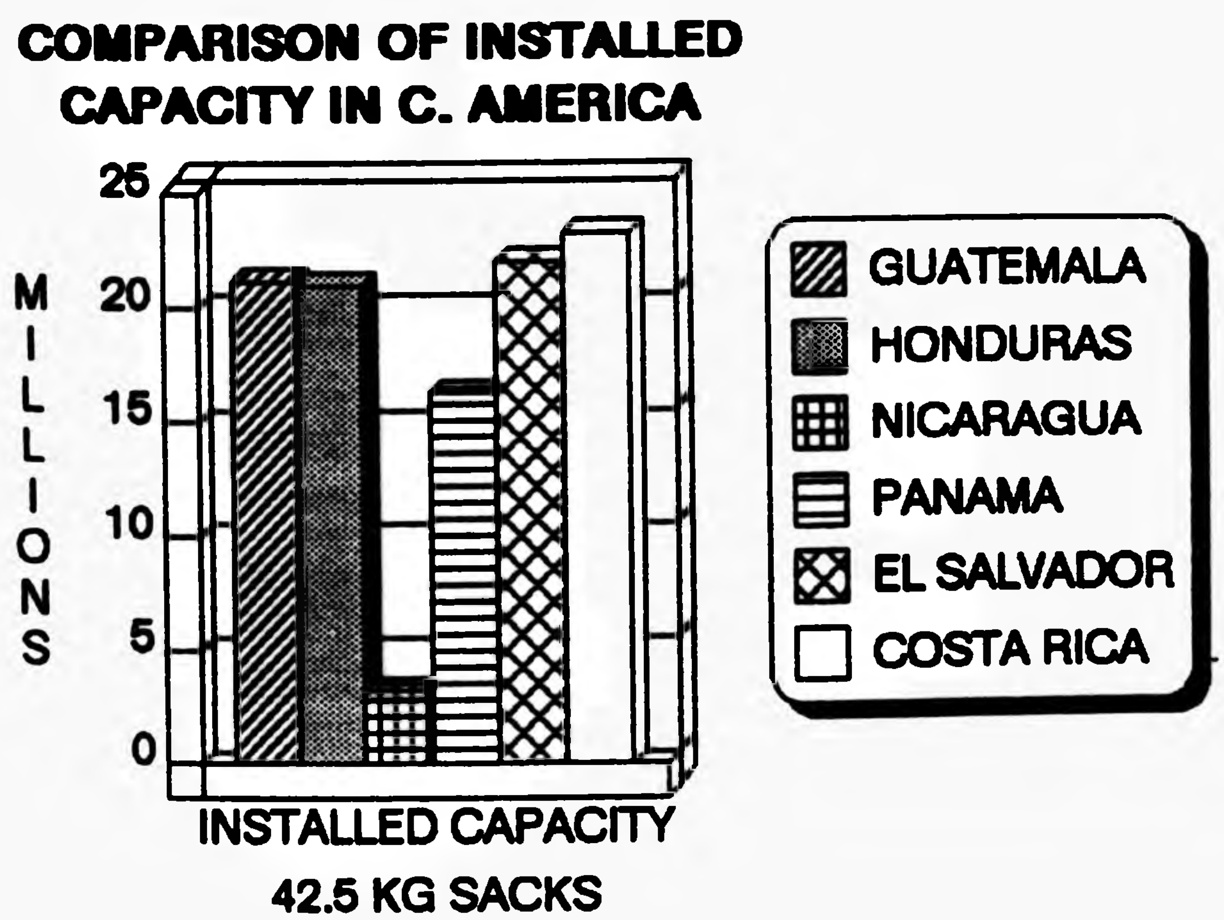
Having presented a brief description of each of the Costa Rican cement producing facilities, I shall now dedicate some paragraphs to the comparison of the installed capacity situation in the Central American countries.

I have chosen to base the study both on overall values, as well as per capita relationships. In terms of overall capacity, Costa Rica ranks first in the area, even though four of the other five nations in the region have larger populations (three of them substantially larger). While Costa Rica has 21.72% of the installed capacity in Central America, the country's population accounts to only 10.86% of the total for the Isthmus.

Analyzing the per capita values closer, we have that the country's potential production capacity is twice the average for the area (8.86 bags (@ 42.5 kgs.)/yr vs. 4.43 bags/yr). The following chart depicts this situation in greater detail: (Sources: *(4) and World Almanac 1985.*)

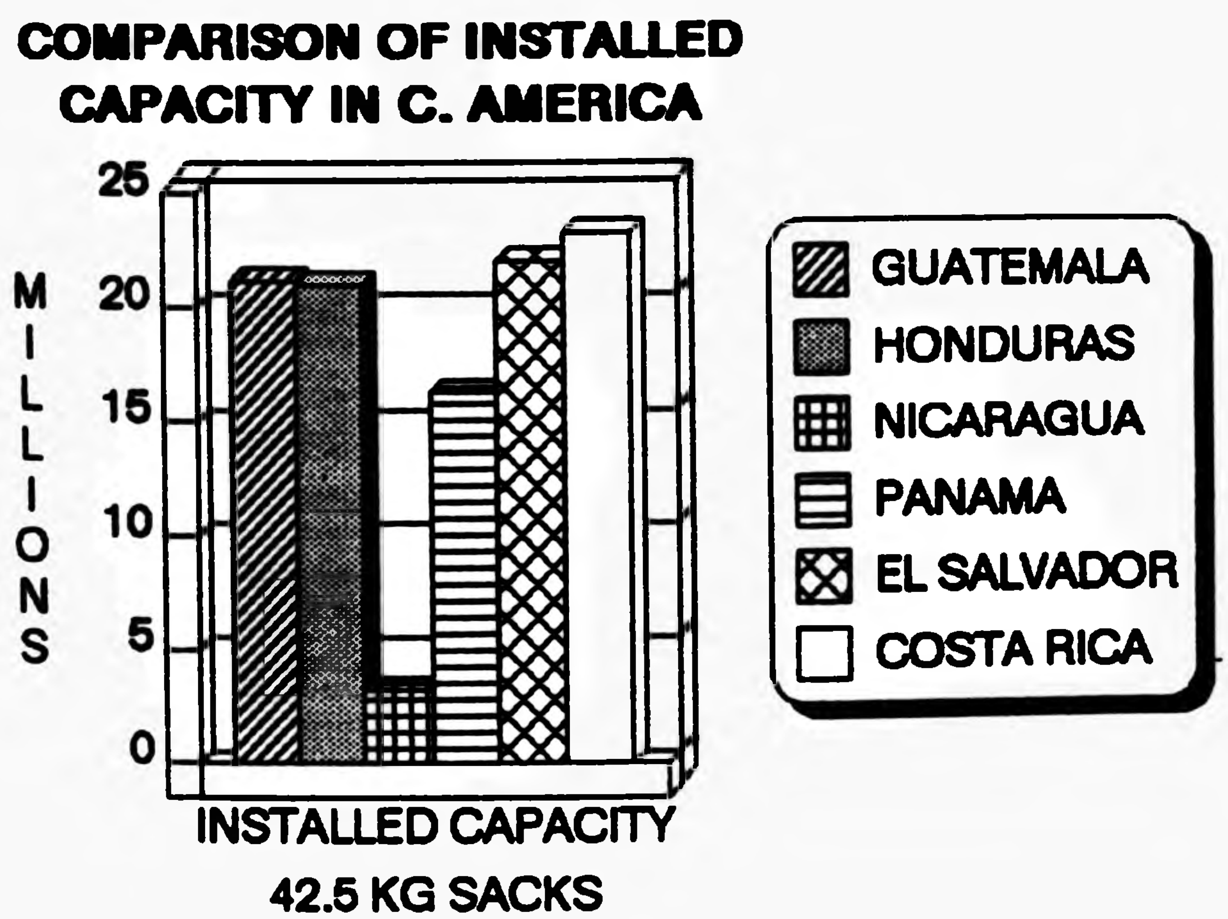
INSTALLED CEMENT CAPACITY IN CENTRAL AMERICA

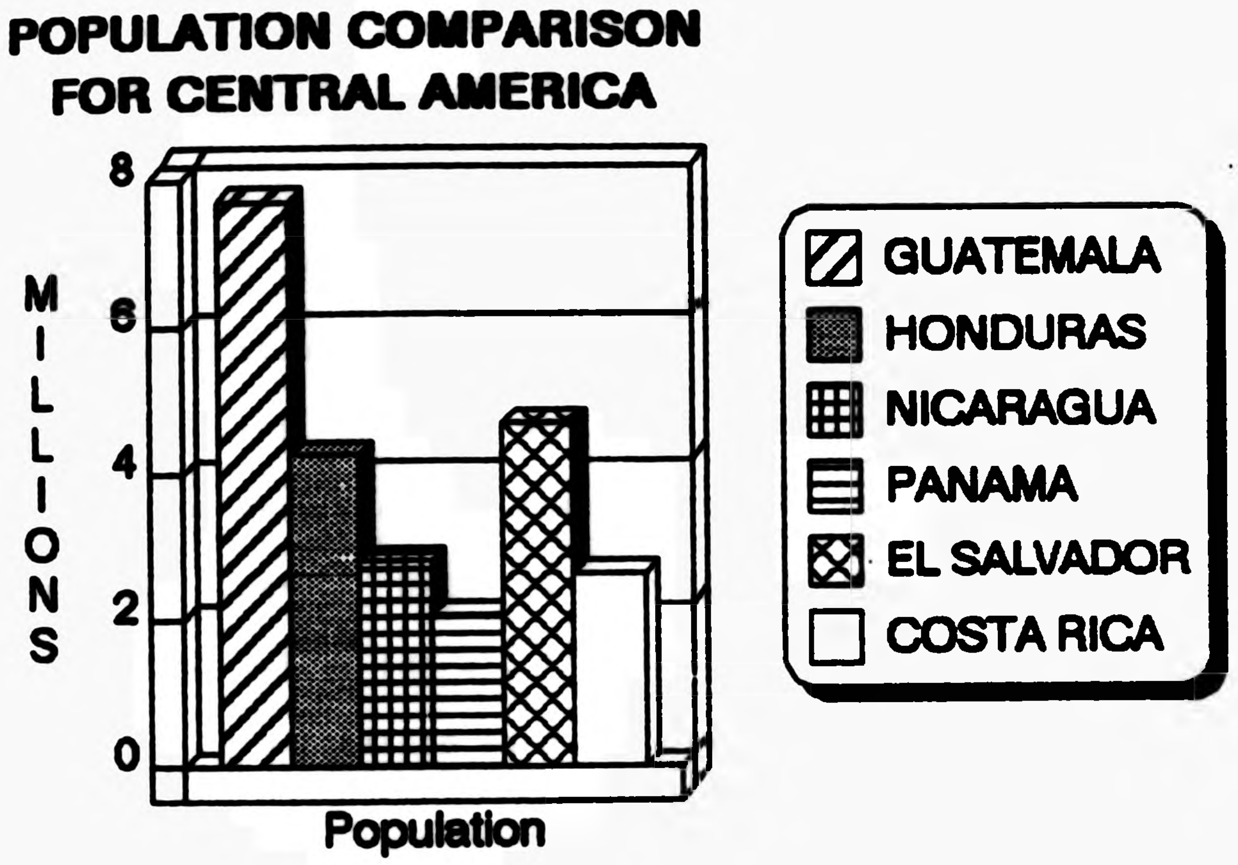
Country:	Installed Capacity (42 kgs bags/yr)	Population	Per Capita (bags/yr)
Guatemala	21,197,647	7,714,000	2.75
El Salvador	22,012,941	4,685,000	4.70
Honduras	20,953,059	4,276,000	4.90
Nicaragua	3,261,176	2,812,000	1.16
Costa Rica	23,235,883	2,624,000	8.86
Panama	16,305,882	2,058,000	7.92
TOTALS:	106,966,589	24,169,000	
AVERAGES:	17,827,765	4,028,167	4.43

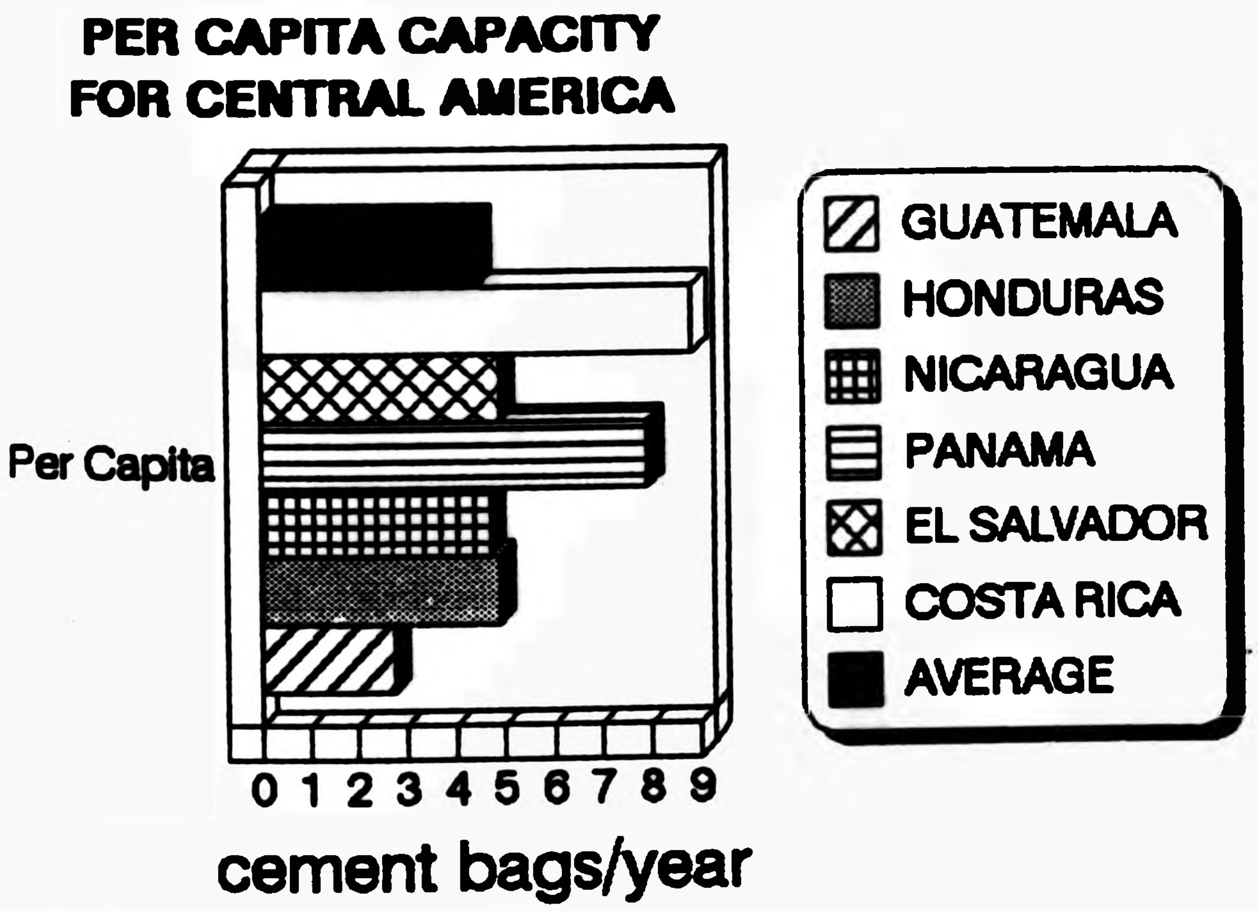


INSTALLED CEMENT CAPACITY IN CENTRAL AMERICA

Country:	Installed Capacity (42 kgs bags/yr)	Population	Per Capita (bags/yr)
Guatemala	21,197,647	7,714,000	2.75
El Salvador	22,012,941	4,685,000	4.70
Honduras	20,953,059	4,276,000	4.90
Nicaragua	3,261,176	2,812,000	1.16
Costa Rica	23,235,883	2,624,000	8.86
Panama	16,305,882	2,058,000	7.92
TOTALS:	106,966,589	24,169,000	
AVERAGES:	17,827,765	4,028,167	4.43




POPULATION COMPARISON
FOR CENTRAL AMERICA
MILLIONS
8
6
4
2
0
Population
GUATEMALA
HONDURAS
NICARAGUA
PANAMA
EL SALVADOR
COSTA RICA


PER CAPITA CAPACITY
FOR CENTRAL AMERICA
Per Capita
0 1 2 3 4 5 6 7 8 9
cement bags/year
GUATEMALA
HONDURAS
NICARAGUA
PANAMA
EL SALVADOR
COSTA RICA
AVERAGE

Furthermore, the per capita figure quoted for Costa Rica, 8.86 bags per capita, or:

8.86 bags x 42.5 kgs./bag = 376.55 kgs. per capita

would be enough to satisfy an equivalent demand to that of the United States of America for 1980 (5) . Clearly, considering the great separation in the stage of development for these two societies, the country will experience a severe spare capacity problem for many years to come, if sales are restricted to the national scene. Below I present a chart which shows the consumption values for all the American countries, so that this situation is understood more fully.

Furthermore, the per capita figure quoted for Costa Rica, 8.86 bags per capita, or:

8.86 bags x 42.5 kgs./bag = 376.55 kgs. per capita

would be enough to satisfy an equivalent demand to that of the United States of America for 1980 (5) . Clearly, considering the great separation in the stage of development for these two societies, the country will experience a severe spare capacity problem for many years to come, if sales are restricted to the national scene. Below I present a chart which shows the consumption values for all the American countries, so that this situation is understood more fully.

CEMENT PER CAPITA CONSUMPTION IN AMERICAN COUNTRIES (1980):

(Kilogrammes / inhabitant / year)

Canada	389.0
United States	364.7
Mexico	206.0
Guatemala	104.0
El Salvador	107.0
Nicaragua	80.0
Costa Rica	220.0
Panama	147.6
Cuba	285.0
Venezuela	389.5
Colombia	136.0
Ecuador	200.0
Peru	102.0
Bolivia	69.0
Chile	111.9
Argentina	244.6
Paraguay	100.0
Uruguay	184.0
Brazil	200.0

Source: (5)

2.2 Demand Analysis:

2.2.1 Introduction:

2.2.1.a Cartel Agreements:

At present a series of cartel agreements *(6)* exist between CODESA, CEMPASA and INCSA. The workings of these are as follows:

a1.- CEMVASA does not operate. In return, it receives CR C 2.00 (~2.5 p.) for each bag sold by either of the other two producers. With this income, the company is able to maintain a small staff, and carry out necessary maintenance work on its equipment, (this agreement dates from March, 1984).

a2.- Cementos del Pacifico and INCSA each hold a fifty per cent quota of the national market. Nevertheless, a contingency clause establishes that INCSA may produce up to 64% of the national demand, in so far as it compensates Cementos del Pacifico with CR C 42.00 (~52.5 p.) per bag sold in excess of the predetermined quota (50%). More recently, the actual sales figures have been stabilized at 57% INCSA and 43% CEMPASA. This "equilibrium" level was reached as a result of the evaluation of CEMPASA's cost of transportation to the Meseta Central vs. the compensation provided by INCSA.

2.2.1.b Financial Position:

A summary of the actual operative results for the two public sector companies follows:

b1.- CEMVASA: As was stated before, CEMVASA stopped its plant in September 1983. Due to this, its income is restricted to the compensation fee paid by the Industria Nacional de Cemento and Cementos del Pacifico, for each bag of cement they sell locally.

Because of the particular status of the company at present (it is effectively "mothballed"), any financial report would not be representative of CEMVASA's potential performance under normal competitive conditions.

Keeping this in mind I shall now present some figures. The historical value of the company's fixed assets amounts to CR C 124 million (~ £ 1.55 million). Its "current" assets would be constituted by its inventory value, CR C 51 million (~£ 637,500) and its accounts receivables of CR C 6 million (~ £ 75,000), a total figure of CR C 57 million (~£ 712,000), though the plant being shut down, the realizable value of these is difficult to assess.

Moving on to the debt situation, (CR C 112 million long term documents payable, and CR C 54 million long term accounts payable) a total of CR C 166 million or ~ £ 2.07 million are owed.

Apart from these figures, a further worrying aspect of CEMPASA's position relates to a court case being heard in the State of New York, relative to a conflict arising from a frustrated effort to export cement to Mexico. The company is being sued by the shipping firm which transported the shipment concerned to and from Mexico (in fact the Mexican importer went bankrupt in the meantime), for US$ 1.5 million (~ £ 1 million). According to the legal advisors to the Comision Nacional Para la Reestructuracion de CODESA, the prospects of avoiding this penalty are not very promising.

In summary, even though it is difficult to assess the financial position of a company which is not currently operating, it is clear that the debt situation, even more so if the court case is lost, is important, considering the small size of the firm:

Estimated Total Debt:

Long term debt + *Court case costs:*

£ 2.075 million + £ 2.0 million

= ~ £ 4 million

VERSUS

Estimated Total Yearly Revenue:

140,000 metric tonnes x 1,000 kgs/42.5 kgs/bag = 3,294,000 bags/yr
@ CR C 140/bag (average for 1985):
= CR C 461,160,000 or ~ £ 5,764,500/yr.

b2.- CEMPASA: Moving on to Cementos del Pacifico S.A., a relative balance has been struck, resulting from the cartel agreement with INCSA, with respect to the operating results, yielding a marginally positive result for 1985 of some CR C 16 million or ~ £ 200,000 (ignoring debt charges).

Nevertheless, when we take into account the debt situation, we see that the company's ability to cover it is greatly in doubt. CODESA Headquarters is the main creditor, having absorbed losses for CR C 174 million (~£ 2.175 million), and still holding loans for CR C 368 million (~£ 4.6 million), under highly subsidized conditions: CR C 266 million at 8% interest, 3 years grace, and 9 years payback period; and CR C 102 million at 0% interest with 3 years to pay. Finally, the total long term debt amounts to CR C 395 million (~£ 5 million) or 64% of the total assset historical value of CR C 616 million or ~£ 7,700,000. (Please note that a 600% devaluation occurred in Costa Rica between 1981 and 1983).

In summary, even though the company is not returning an operating deficit at present, its prospects of functioning as an independent company in a competitive environment are very poor, due to its very low return on investment (even based on historical values, the operating profit/assets = 2.5%).

2.2.2 National Market Historical Behaviours

As a first step in the study of the local cement demand, it is prudent to examine the sector's behaviour over the last twenty years, the period since when cement has been produced in the country.

In relation to the comparison of results from year to year, per capita consumption values have been chosen, since these reflect a clearer picture of the state of the industry at any given point in time. As a result, for our purposes, an important variable would be that of the rate of population growth.

In per capita terms, demand grew on average, during this period, at a rate of 4.15%/year, having reached levels of 19% both in 1969 and 1972. The average per capita consumption was of 147 kgs./yr. with a maximum value of 243 kgs./yr. in 1980, when the highest consumption level in the country's history was achieved, i.e., 552,220 metric tonnes/year.

Searching deeper into the analysis of the chosen parameters, we observe that up to 1980, before the crisis, the average per capita growth rate amounted to 8.45%/yr, (with important fluctuations), with a nearly constant population growth rate of ~ 2.75%/yr. Unfortunately, with the drop of the country's overall economic activity in the early 1980's, when negative growth rates in the construction sector were common, the twenty year average (1965 - 1985) fell to the 4.15%/yr mentioned earlier.

In fact, three well established trends are evident for the study period: the first one of erratic but important expansion (1965 - 1972); the second of consistent but less significant growth (1973 - 1980); and finally a last stage of profound crisis and very weak recovery from 1981 to the present day, (in fact 0% growth is forecast for 1986 *(3)*).

Below two tables are offered, describing in detail the relationships between population growth, consumption, installed capacity, operating capacity, as well as per capita values (for consumption, installed capacity, and operating capacity) for the period between 1965 and 1985. Explanatory notes for each set of figures are also included:

Table 2.2.2.a: Cement Demand in Costa Rica: General Relations

Year	Population	Installed Capacity	Operating Capacity	National Consump.	P.Cap Inst	P.Cap Oper	P.Cap Cons
1965	1515292	140,000	140,000	111,714			74
1966	1567230	"	"	108,075			69
1967	1615480	"	"	114,809			71
1968	1664581	"	"	129,527			78
1969	1710083	"	"	158.858			93
1970	1766120	"	"	187,361			106
1971	1811290	"	"	210,952			116
1972	1867045	"	"	258,658			139
1973	1878409	"	"	278,196			148
1974	1938000	450,000	450,000	301,974	232	232	156
1975	1993784	"	"	326,780	226	226	164
1976	2031520	"	"	361,876	222	222	178
1977	2098531	"	"	408,703	214	214	195
1978	2131870	594,000	594,000	462,715	279	279	217
1979	2219815	"	"	524,268	268	268	236
1980	2276676	"	"	552,220	261	261	243
1981	2339829	1,044,000	1,044,000	484,277	446	446	207
1982	2403781	"	882,000	419,684	434	367	175
1983	2467339	"	738,000	342,020	423	299	139
1984	2536424	"	"	415,321	412	291	164
1985	2624000	"	"	438,373	398	281	167

Sources: (3), (7), (9), and CODESA Annual Reports

Comments Table 2.2.2.a:

Information for columns 1 and 4 was provided by INCSA (3) and (7). Other values from the other sources mentioned, appart from the last three columns which were calculated by the author. Column 2 presents the installed capacity for the country during every period quoted. Column 3 describes the capacity under operation: until 1977, this includes the two INCSA processes; between 1978 and 1980 that of both INCSA kilns and CEMVASA; for 1981 all three plants; during 1982 the value represents INCSA's two processes and CEMPASA conbined; finally, from 1983 to the present it is restricted to INCSA's newer production line and CEMPASA.

Table 2.2.2.b: Cement Demand in Costa Rica: Parameters:

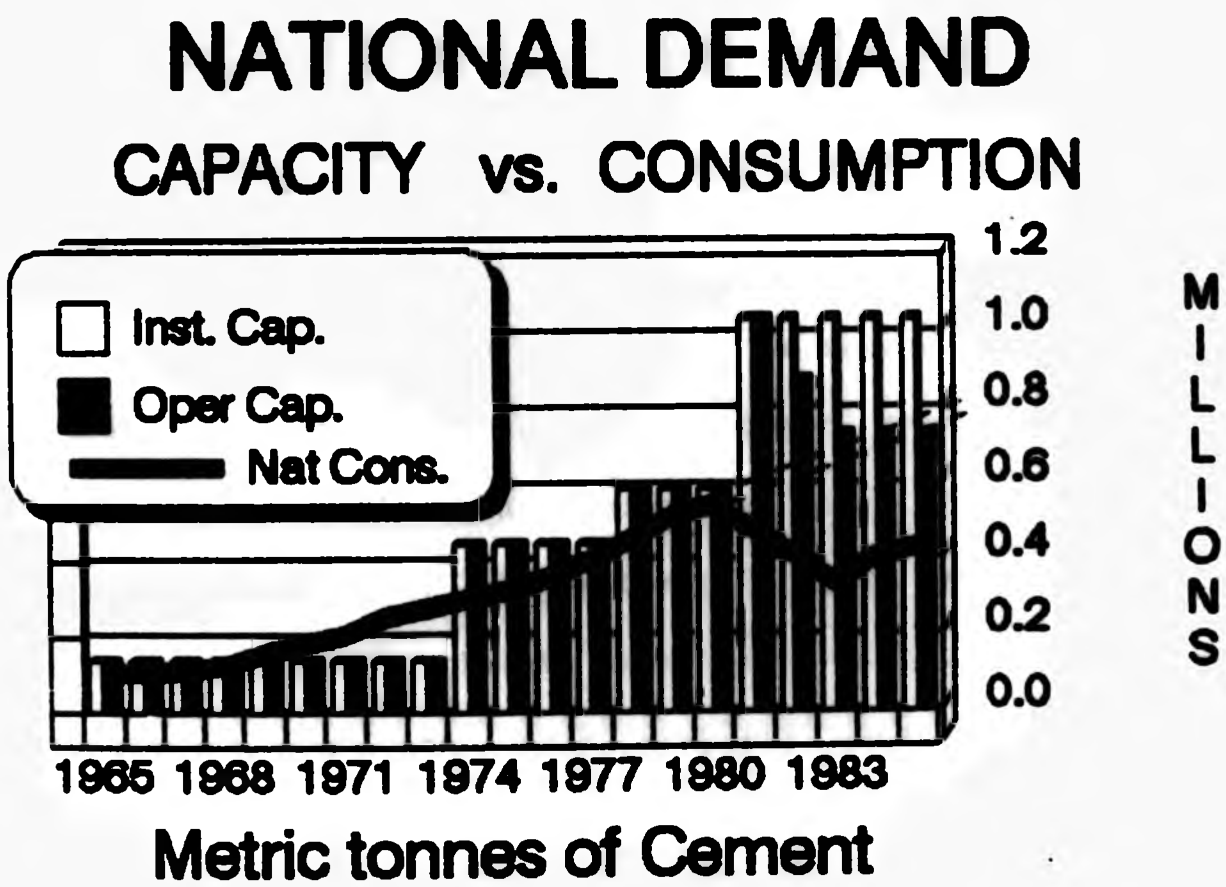
Year	Per capita Consumption	Population Growth (%)	Variation in PC Cons
1965	73.72		
1966	68.96	3.43	-6.46
1967	71.07	3.08	3.06
1968	77.81	3.04	9.49
1969	92.89	2.73	19.38
1970	106.09	3.28	14.20
1971	116.47	2.56	9.78
1972	138.54	3.08	18.95
1973	148.10	0.61	6.90
1974	155.82	3.17	5.21
1975	163.9	2.88	5.19
1976	178.13	1.89	8.68
1977	194.76	3.30	9.33
1978	217.05	1.59	11.44
1979	236.18	4.13	8.81
1980	242.56	2.56	2.70
1981	206.97	2.77	-14.67
1982	174.59	2.73	-15.64
1983	138.57	2.64	-20.60
1984	163.70	2.80	18.10
1985	167.06	3.45	2.10
1986		estimate --->	~0.00

Source: *Based on data from Table 2.2.2.a*

Comments Table 2.2.2.b

The second table shows the behaviour of the selected parameters for the study from period to period. Please note the great variation in per capita consumption growth. Also, from the data provided it is apparent that population values have not been collected at 12 month intervals, leading to misrepresentation in some cases of per capita figures.

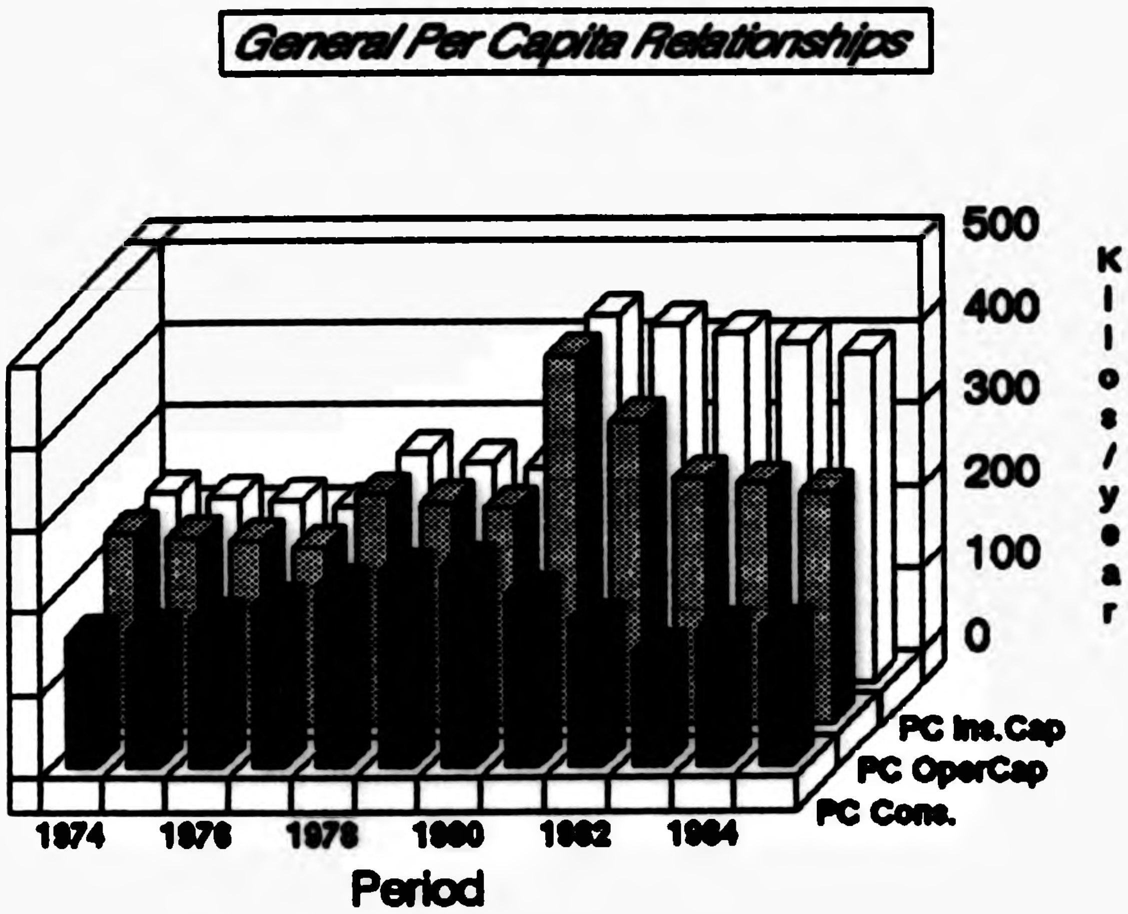
The following graph presents the relationship between installed capacity, capacity in operation, and national consumption. It is important to note first of all, that in 1980 the total installed capacity in the country was absorbed by local consumption, for which reason the proposal of a new plant was not out of place.



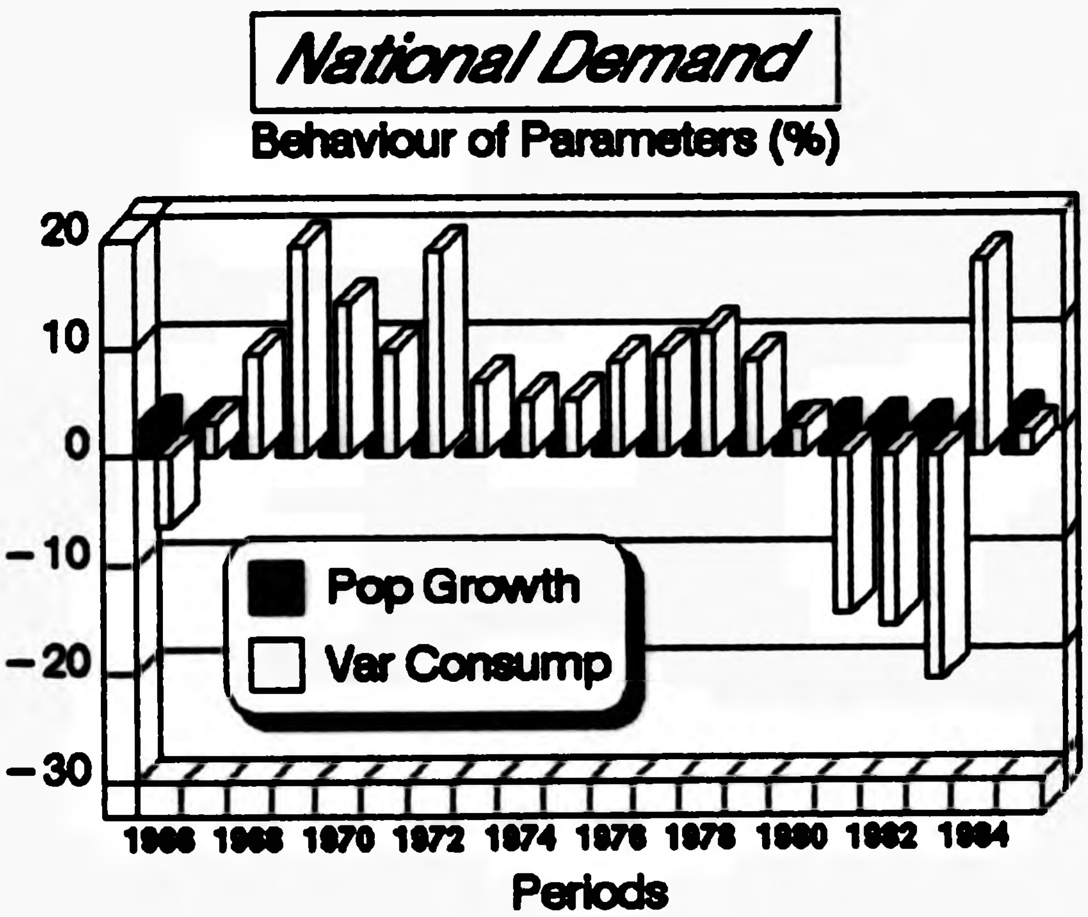
Nevertheless, due to the size of the new facility, it was evident that even continuing with a steady growth in consumption (dotted line), an important amount of spare capacity would be available for many years to come (more than five as can be seen from the graph). Estimating the amount of this spare capacity five years on (1985), under normal conditions, we have that this would have amounted to approximately 240,000 metric tonnes/year or the equivalent of all of CEMVASA's production plus one fourth of CEMPASA's capacity (assuming a 100% utilization rate for INCSA).

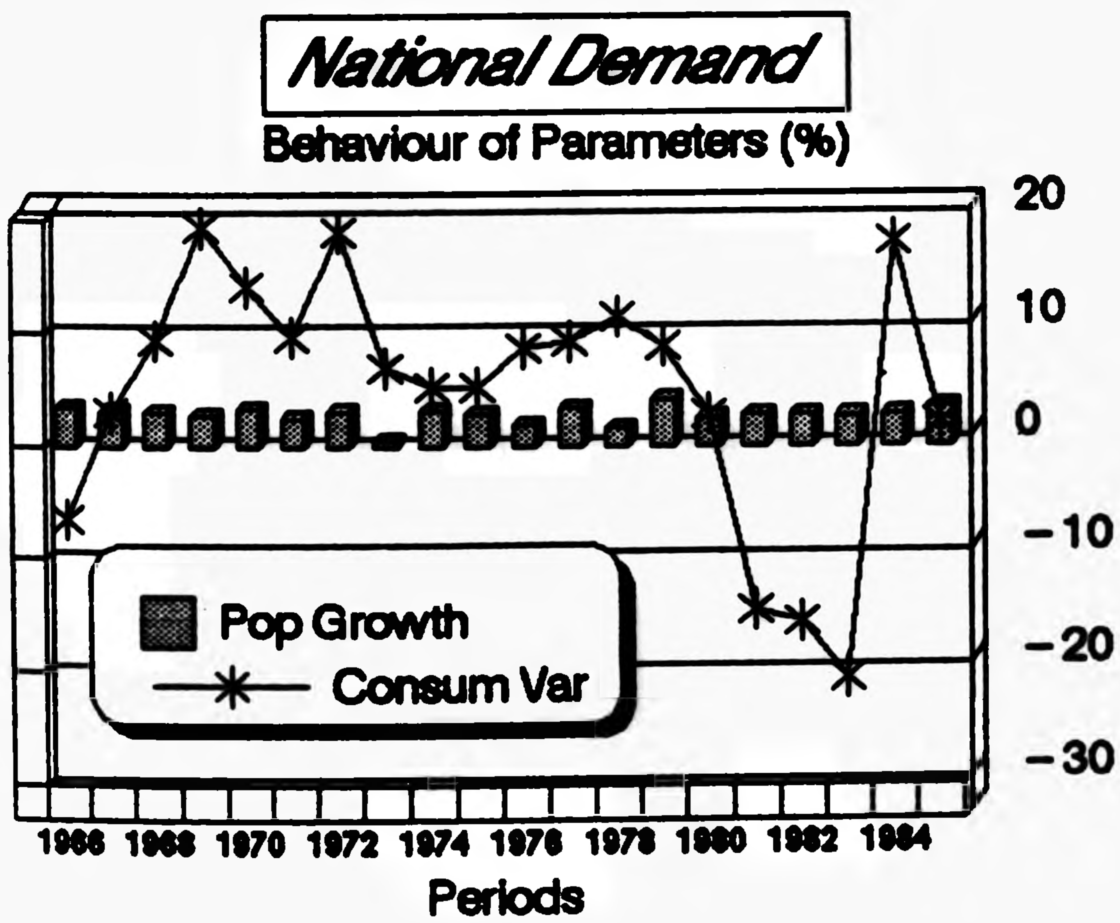
A second aspect that can be drawn from the graph, is the acute drop in consumption resulting from the 1981 crisis.

Moving on to per capita values for installed capacity, operating capacity and consumption, we get a clearer view of the state of the industry at any point in time. From the data from table 2.2.2.b, it is possible to observe the dramatic effect that general economic conditions have on the sector as a whole. The impact of the 1981 crisis (first devaluation occured in September 1980), dropped consumption figures to per capita levels experienced in the early seventies, effectively, a ten year backward shift in the country's construction activity. In fact, the per capita consumption levels for 1983 - 1985 fell below the 1974 value. Another consequence of the crisis can be seen when we analyze growth trends. Since 1983, per capita consumption growth appears to have a much less significant slope, than that experienced in the past decade. Below I present a graph which depicts these aspects more clearly.



Finally, below two graphs are offered, which study the behaviour of the resulting parameters from this section i.e., population growth rate, and per capita cement consumption variation from period to period. Please note the relative stability in the population growth values. Also, observe the three stages described before in relation to the behaviour of per capita consumption for the period 1965 - 1985.


National Demand
Behaviour of Parameters (%)
20
10
0
-10
-20
-30
Pop Growth
Var Consump
1966 1968 1970 1972 1974 1976 1978 1980 1982 1984
Periods


National Demand
Behaviour of Parameters (%)
20
10
0
-10
-20
-30
Pop Growth
Consum Var
1966 1968 1970 1972 1974 1976 1978 1980 1982 1984
Periods

2.2.3 Growth Projections:

2.2.3.a Formal Forecasting:

This section is dedicated to the study of the potential growth of national cement consumption between 1985 and the end of this century.

It is clear, because of various factors, such as past historical behaviour, very competitive international scene, etc., that this industry depends, and will depend in the future, very heavily on the local market for its survival.

Having established in the preceeding paragraphs that there exists a vast spare capacity in the country, it is the purpose of this exercise to establish up to what point new sources of sales must be pursued to take the industry as a whole to a more favourable position, i.e., how much cement must be sold outside the normal local demand scene (through exports, targeted large consumption schemes, and the like) to achieve this end.

Formal forecasting of the growth path of consumption for the next fifteen years, based on the record of the past twenty, is an alternative which is not likely

2.2.3 Growth Projections:

2.2.3.a Formal Forecasting:

This section is dedicated to the study of the potential growth of national cement consumption between 1985 and the end of this century.

It is clear, because of various factors, such as past historical behaviour, very competitive international scene, etc., that this industry depends, and will depend in the future, very heavily on the local market for its survival.

Having established in the preceeding paragraphs that there exists a vast spare capacity in the country, it is the purpose of this exercise to establish up to what point new sources of sales must be pursued to take the industry as a whole to a more favourable position, i.e., how much cement must be sold outside the normal local demand scene (through exports, targeted large consumption schemes, and the like) to achieve this end.

Formal forecasting of the growth path of consumption for the next fifteen years, based on the record of the past twenty, is an alternative which is not likely to yield reasonable results, because of the erratic behaviour, explained in the last section. Apart from anything else, the present economic climate in which the country is immersed will hinder any large expansive trend in the construction sector to take place for many years to come.

Not taking account of these facts, CODESA has forecast *(8)* strong continued growth for the industry (1985 - 2000), based on the rapid expansion of the 1960's and early 1970's. In fact, they have proposed a formula for per capita consumption growth, of the form: $y = a + b * \ln x$, as their unique estimate (no contingency scenarios), which would lead to unbound growth into the future, i.e., it would approximate a vertical asymptote (infinite growth vs. a horizontal asymptote "limit to growth" approach, with an inflection point where PC consumption growth is bound to slow down and gradually level off). Below I present a chart which shows the results from the CODESA forecast.

Table 2.2.3.a: Per Capita Cement Consumption in Costa Rica

CODESA Forecast 1984 - 2000

Year	Consumption (MT)	Population	PC Consumption
1984	429904	2452103	175
1985	657674	2590503	254
1986	698492	2666000	262
1987	740772	2733476	271
1988	787208	2801452	281
1989	832140	2869447	290
1990	881095	2936983	300
1991	928281	3004147	309
1992	976661	3071260	318
1993	1029326	3138188	328
1994	1080018	3204801	337
1995	1131754	3270965	346
1996	1187818	3336568	356
1997	1241620	3401698	365
1998	1296480	3466525	374
1999	1355988	3531218	384
2000	1413207	3595947	393

Source: (8)

As can be observed, CODESA is working on the basis of a 53% increase in sales between 1984 and 1985 (the report was written in October 1984, and revised in 1986). The official figures according to INCSA (3), state an increase in local consumption of only 5.5% (based on calculations from figures from the cartel agreement). The actual figures are as follows:

a1.- CODESA Estimate:

1984	1985
429,904 mt.	657,674 mt.

a2.- Actual Results (INCSA):

1984	1985
415,321 mt.	438,373 mt.

The gap between 1986 estimates is similar in magnitude. CODESA overshooting the more recent INCSA figure by ~260,120 metric tonnes. In contrast, INCSA is not forecasting any growth for the construction (private) sector at all, a view shared by various sources in the industry:

a3.- Estimate for 1986 (Normal Consumption):

CODESA	INCSA
~698,490 mt.	~440,000 mt.

2.2.3.b Multiple Simulations:

In order to avoid falling into the same errors experienced in the CODESA exercise presented above, I have decided to follow an alternative route. The projections provided below involve the combination of a series of growth patterns for both population and per capita consumption, which shall yield expected overall consumption levels.

The ranges for the chosen parameters are as follows: population growth between 2.6% and 3.0% a year (the average for the past twenty years has been ~2.8%/yr.). With respect to the rates of growth in per capita consumption, a range including a pessimistic estimate of 1%/yr below the average for the period 1965 - 1985, and an optimistic value of 0.5% above the 1965 - 1980 average has been selected. A "most likely" path has been also chosen at around 7%/yr. per capita growth rate and 2.6%/yr. population increase, based on a moderate to strong recovery of the national economy, i.e., GNP growth rates of ~3%/yr. (per capita cement consumption has been observed in the past to grow at between 3% and 4% above GNP (9)), and a gradual drop in population growth, respectively (population increases are bound to drop due to combined efforts by the national health board and other organizations, towards this end.)

2.2.3.c Analysis of Results:

Reviewing the iterations resulting from the multiplication of the chosen parameters we get the following general results:

c1.- The level of overall consumption for 1980, the highest in the country's history, would be reached most probably around 1988, with an optimistic figure of 1987, and a pessimistic one of ~1989 (level = 550,000 mt/yr.).

c2.- The combined installed capacity of Incsa (1,200 mt/day or ~432,000 mt/yr.) and Cempasa (1,250 mt/day or ~450,000 mt/yr.) would become insufficient approximately in 1993, the optimistic value being 1992, and the pessimistic estimate, 1998.

c3.- With respect to the per capita consumption rates, which reflect the state of the industry more objectively than overall consumption figures, the results suggest that the highest level experienced in the past (resulting from the boom in coffee prices in world markets towards the end of the 1970's), i.e., 243 kgrs. PC/yr. for 1980, would be reached again by ~ 1991 (1990 = optimistic estimate, 1998 = pessimistic).

c4.- Finally, in reference to the exhaustion of the total national installed capacity, i.e., CEMVASA + CEMPASA + INCSA, this would occur around 1995, with optimistic and pessimistic values falling around 1993, and 2000, respectively. Below the whole set of results is provided for further inspection.

The first two tables (2.2.3.b and c) present the suggested paths of growth for the two chosen parameters, i.e., population and per capita consumption. The next sequence, (d, e f and g) shows the results of the iterations carried out between the two sets of parameters, from which the choice of "most likely", optimistic and pessimistic forecasts are selected. Finally, a series of graphs are presented at the end showing the relation (% occupation for each period) between these three forecasts and both installed and operating capacity (which amounts to ~84.5% of the total).

Table 2.2.3.b: Population Growth Projections

For the Period 1985 - 2000

Year	Growth @ 2.6%/yr	Growth @ 2.8%/yr	Growth @ 3.0%/yr
1965	1,515,292	1,515,292	1,515,292
1966	1,567,230	1,567,230	1,567,230
1967	1,615,480	1,615,480	1,615,480
1968	1,664,581	1,664,581	1,664,581
1969	1,710,083	1,710,083	1,710,083
1970	1,766,120	1,766,120	1,766,120
1971	1,811,290	1,811,290	1,811,290
1972	1,867,045	1,867,045	1,867,045
1973	1,878,409	1,878,409	1,878,409
1974	1,938,000	1,938,000	1,938,000
1975	1,993,784	1,993,784	1,993,784
1976	2,031,520	2,031,520	2,031,520
1977	2,098,531	2,098,531	2,098,531
1978	2,131,870	2,131,870	2,131,870
1979	2,219,815	2,219,815	2,219,815
1980	2,276,676	2,276,676	2,276,676
1981	2,339,829	2,339,829	2,339,829
1982	2,403,781	2,403,781	2,403,781
1983	2,467,339	2,467,339	2,467,339
1984	2,536,424	2,536,424	2,536,424
1985	2,624,000	2,624,000	2,624,000
1986	2,692,224	2,697,472	2,702,720
1987	2,762,222	2,773,001	2,783,802
1988	2,834,040	2,850,645	2,867,316
1989	2,907,725	2,930,463	2,953,335
1990	2,983,325	3,012,516	3,041,935
1991	3,060,892	3,096,867	3,133,193
1992	3,140,475	3,183,579	3,227,189
1993	3,222,127	3,272,719	3,324,005
1994	3,305,903	3,364,355	3,423,725
1995	3,391,856	3,458,557	3,526,437
1996	3,480,045	3,555,397	3,632,230
1997	3,570,526	3,654,948	3,741,197
1998	3,663,359	3,757,287	3,853,432
1999	3,758,607	3,862,491	3,969,035
2000	3,856,330	3,970,640	4,088,107

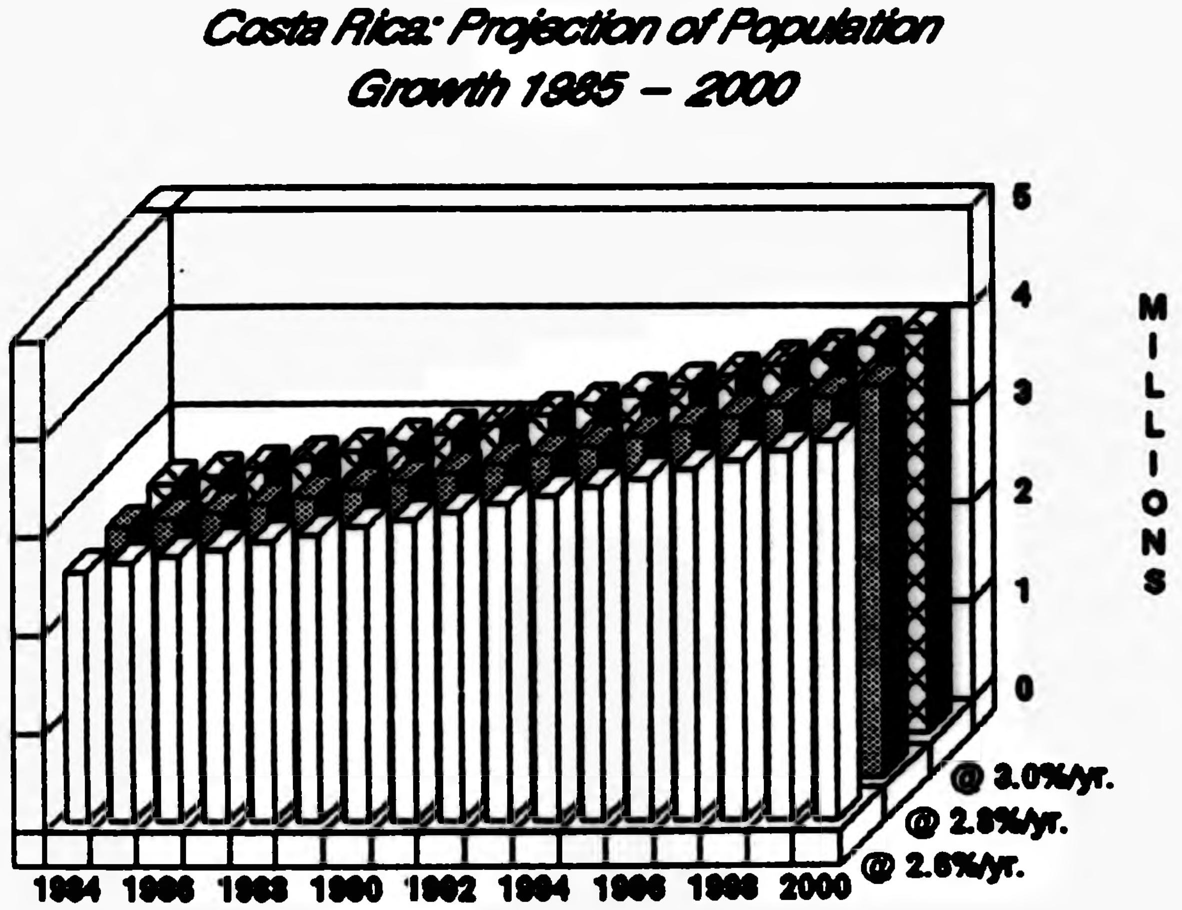


Table 2.2.3.c: Per Capita Consumption Growth Projections

For the Period 1985 - 2000

Per capita Consumption

Year	Growth @ 7%	Growth @ 8%	Growth @ 9%	Growth @ 3%
1,985	167	167	167	167
1,986	179	180	182	172
1,987	191	195	198	177
1,988	205	210	216	182
1,989	219	227	236	188
1,990	234	245	257	194
1,991	251	265	280	199
1,992	268	286	305	205
1,993	287	309	333	212
1,994	307	334	363	218
1,995	329	361		224
1,996	352			231
1,997				238
1,998				245
1,999				253
2,000				260

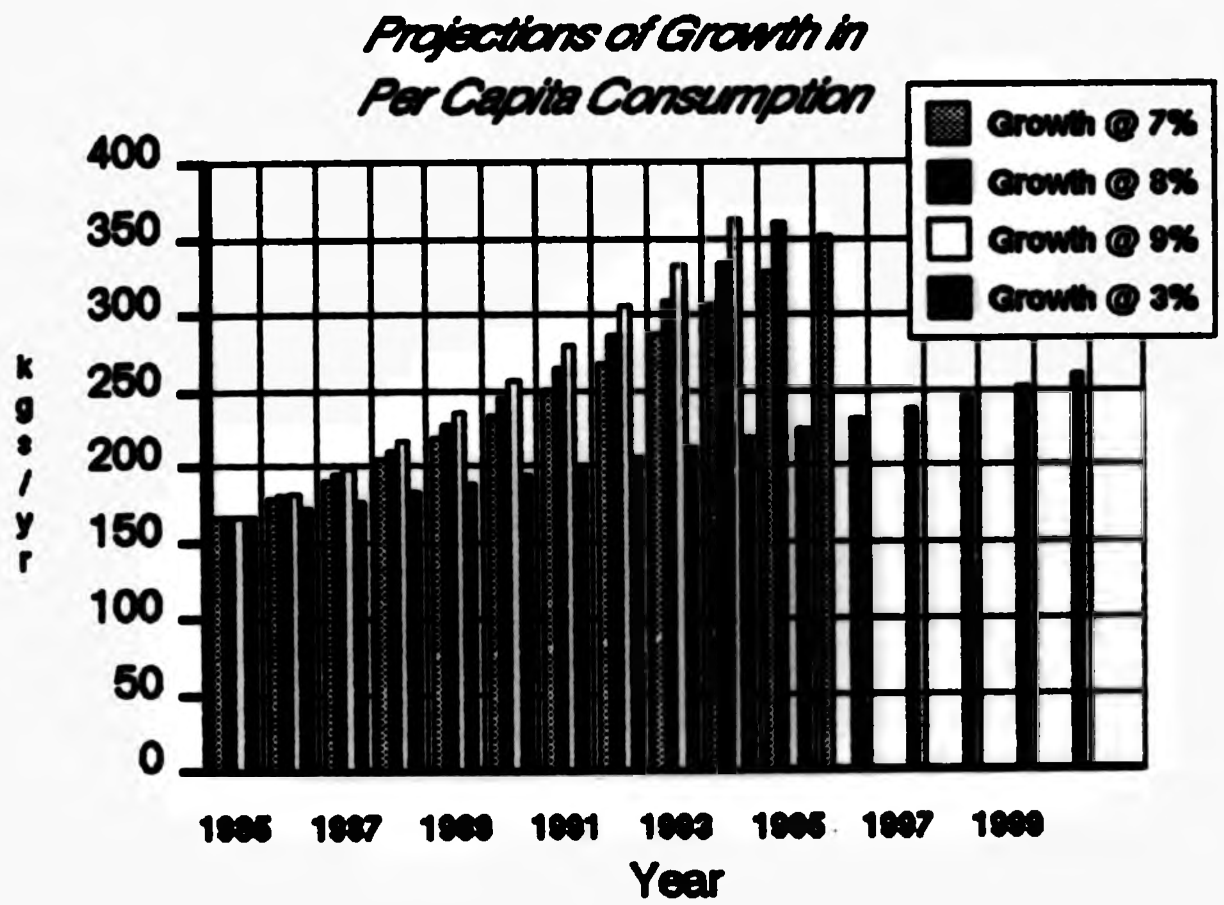
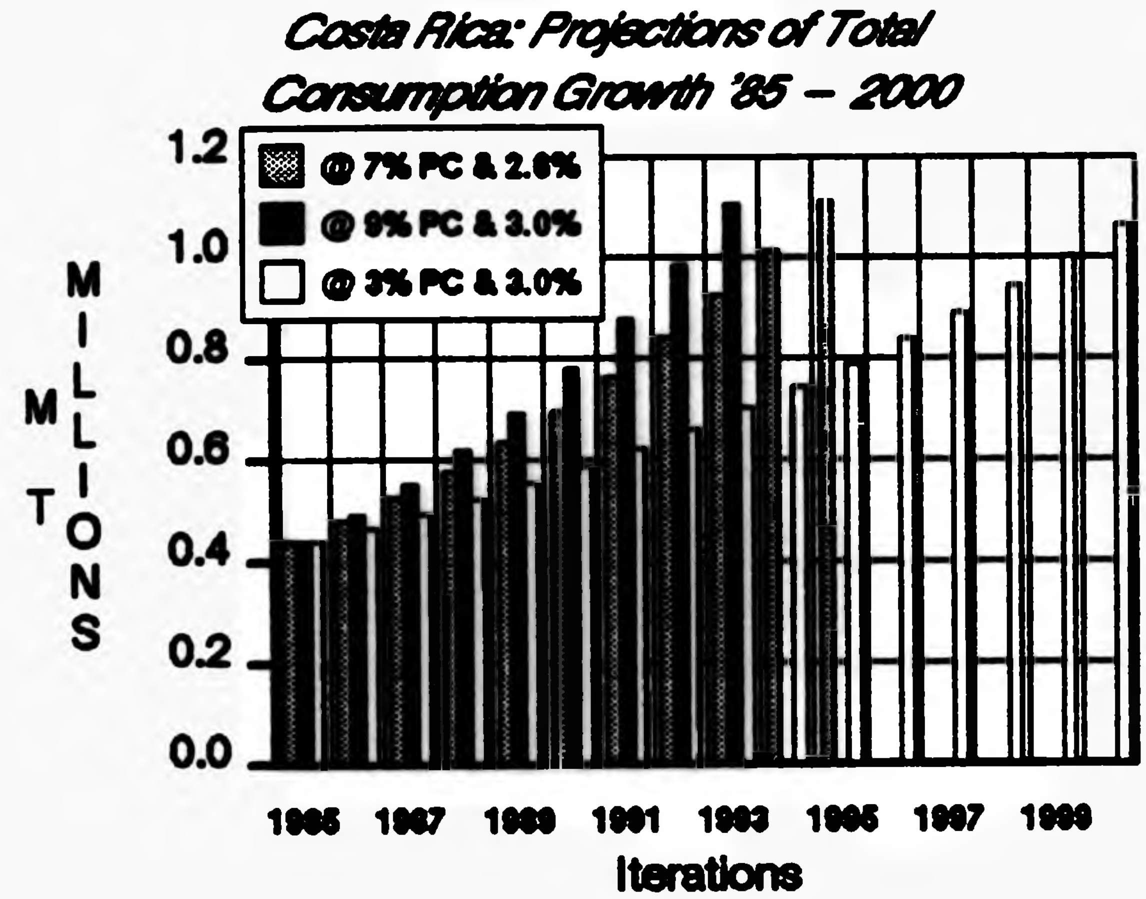


Table 2.2.3.d: Cement:Total Cement Consumption Projections

Metric Tonnes/year

Year	"Most Likely" @ 7% PC & 2.6%	Optimistic @ 9% PC & 3.0%	Pessimistic @ 3% PC & 3.0%
1985	438,208	438,208	438,208
1986	481,074	491,976	464,895
1987	528,132	552,342	493,207
1988	579,794	620,114	523,243
1989	636,509	696,202	555,109
1990	698,773	781,626	588,915
1991	767,127	877,531	624,780
1992	842,167	985,204	662,829
1993	924,548	1,106,089	703,195
1994	1,014,987		746,020
1995	1,114,273		791,452
1996			839,652
1997			890,787
1998			945,036
1999			1,002,588
2000			1,063,646



The iterations on which the above summary of choices has been drawn are presented below (tables e,f,g):

Table 2.2.3.e: Cement: Projections of Total Consumption Growth @ 7% Per Capita Increases and Various Population Rates

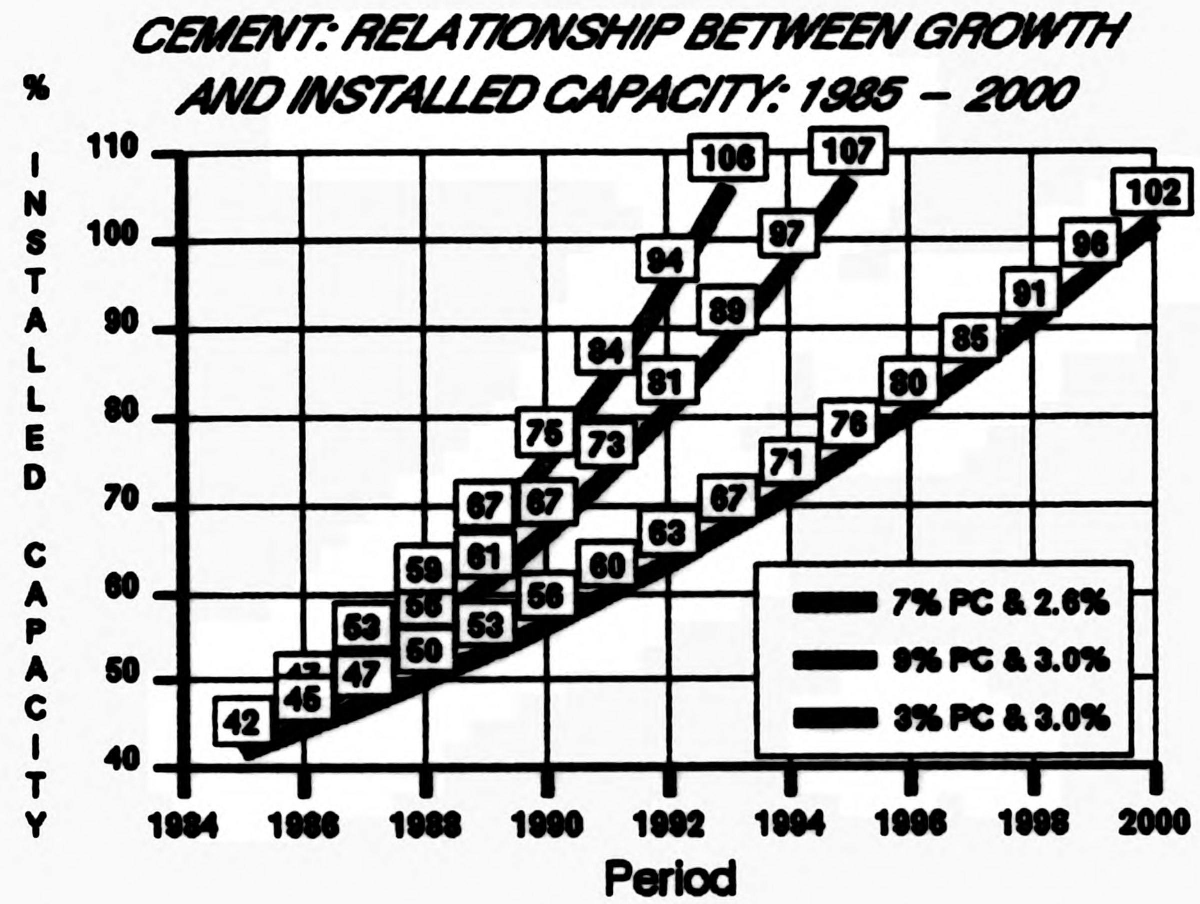
Year	Iteration No.1 @ 7% PC & 2.6%	Iteration No.2 @ 7% PC & 2.8%	Iteration No.3 @ 7% PC & 3.0%
1985	438,208	438,208	438,208
1986	481,074	482,011	482,949
1987	528,132	530,193	532,258
1988	579,794	583,191	586,602
1989	636,509	641,487	646,494
1990	698,773	705,610	712,501
1991	767,127	776,143	785,247
1992	842,167	853,726	865,421
1993	924,548	939,065	953,780
1994	1,014,987	1,032,933	1,051,161
1995	1,114,273		

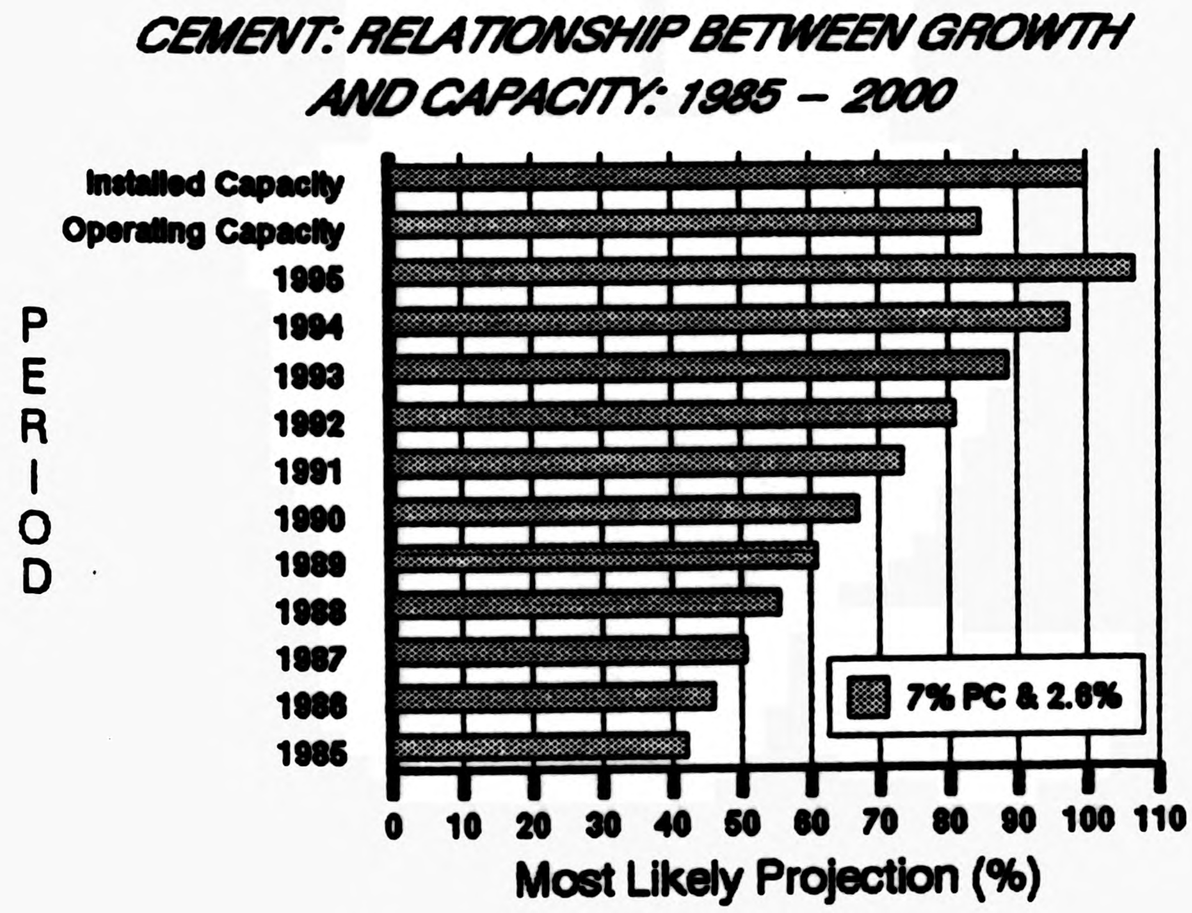
Table 2.2.3.f: Cement: Projections of Total Consumption Growth @ 8% PC Increases and Various Population Rates

Year	Iteration No.4 @ 8% PC & 2.6%	Iteration No.5 @ 8% PC & 2.8%	Iteration No.6 @ 8% PC & 3.0%
1985	438,208	438,208	438,208
1986	485,570	486,516	487,463
1987	538,050	540,150	542,253
1988	596,202	599,696	603,203
1989	660,640	665,806	671,003
1990	732,042	739,205	746,423
1991	811,161	820,694	830,321
1992	898,831	911,168	923,649
1993	995,977	1,011,615	1,027,468
1994	1,103,622	1,123,135	1,142,955

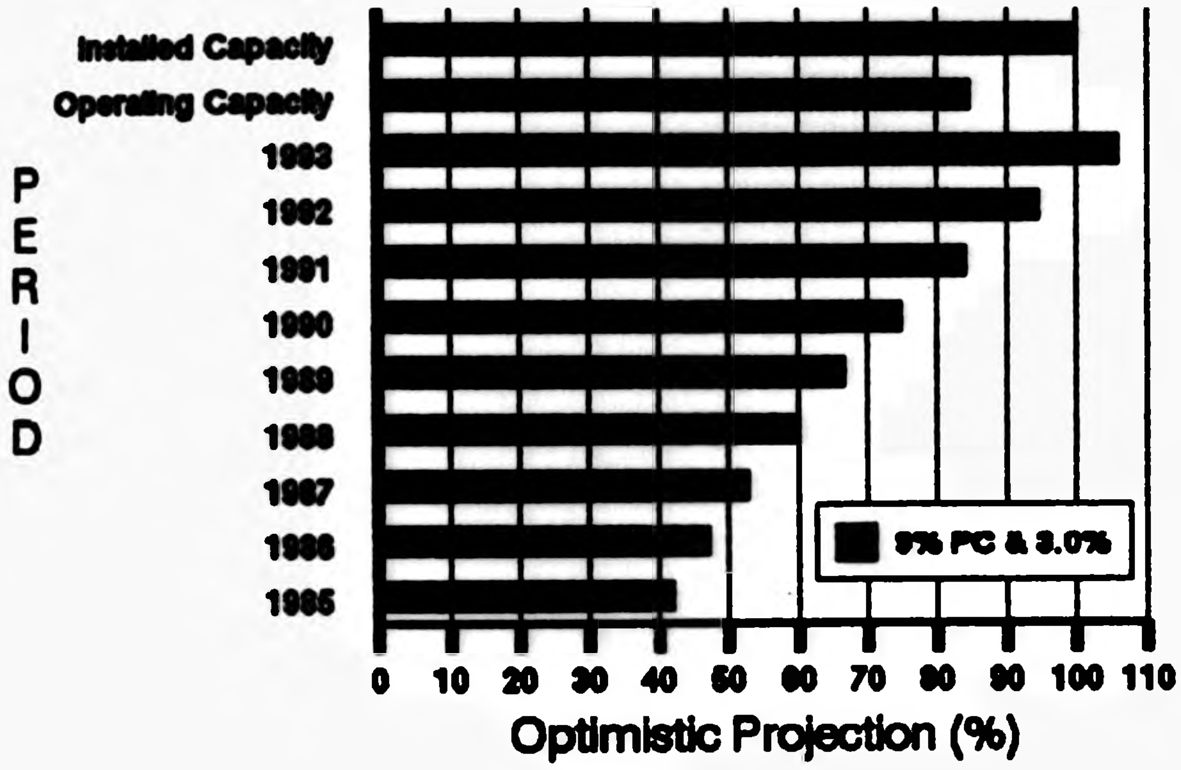
Table 2.2.3.g: Cement: Projections of Total Consumption Growth @ 9% PC Increases and Various Population Rates & Pessimistic Est.

Year	Iteration No.7 @ 9% PC & 2.6%	Iteration No.8 @ 9% PC & 2.8%	Iteration No.9 @ 9% PC & 3.0%	Pessimistic @ 3% PC & 3.0%
1985	438,208	438,208	438,208	438,208
1986	490,066	491,021	491,976	464,895
1987	548,060	550,199	552,342	493,207
1988	612,917	616,509	620,114	523,243
1989	685,450	690,810	696,202	555,109
1990	766,566	774,067	781,626	588,915
1991	857,282	867,357	877,531	624,780
1992	958,732	971,891	985,204	662,829
1993	1,072,189	1,089,023	1,106,089	703,195
1994				746,020
1995				791,452
1996				839,652
1997				890,787
1998				945,036
1999				1,002,588
2000				1,063,646

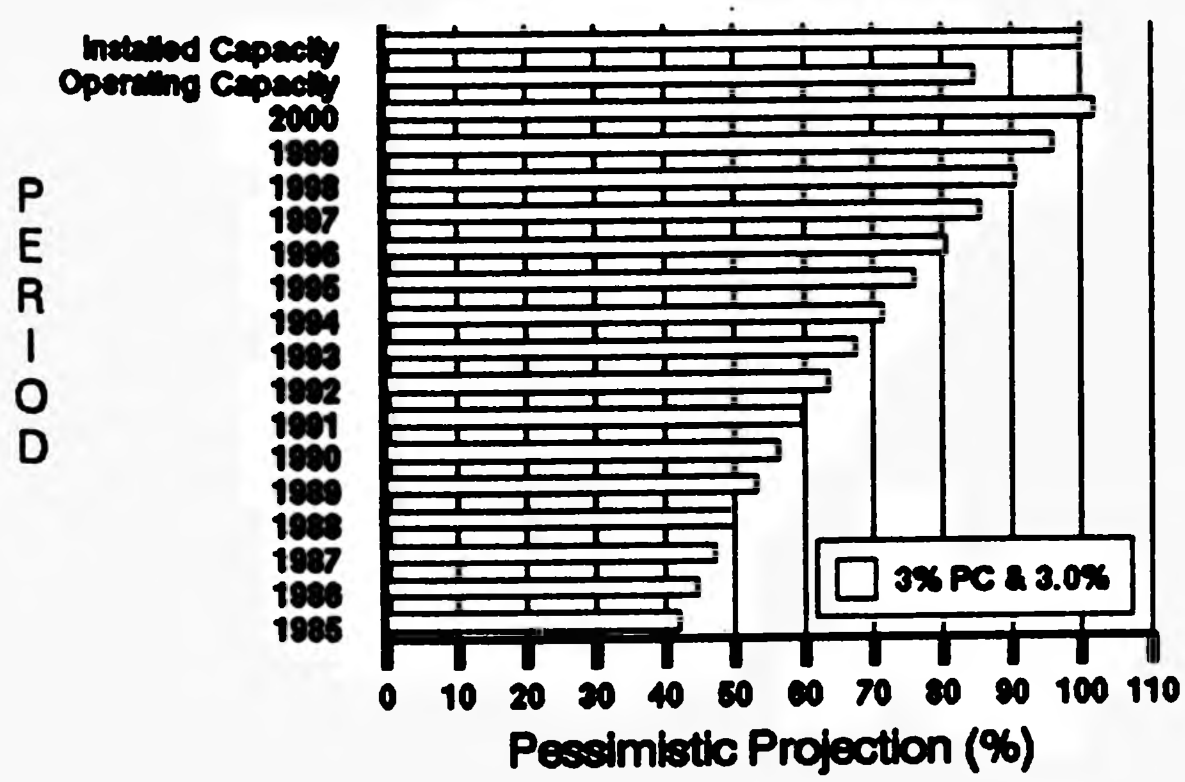

CEMENT: RELATIONSHIP BETWEEN GROWTH AND INSTALLED CAPACITY: 1985 - 2000
% INSTALLED CAPACITY
Period
7% PC & 2.6%
9% PC & 3.0%
3% PC & 3.0%


CEMENT: RELATIONSHIP BETWEEN GROWTH AND CAPACITY: 1985 - 2000
Installed Capacity
Operating Capacity
PERIOD
Most Likely Projection (%)
7% PC & 2.6%

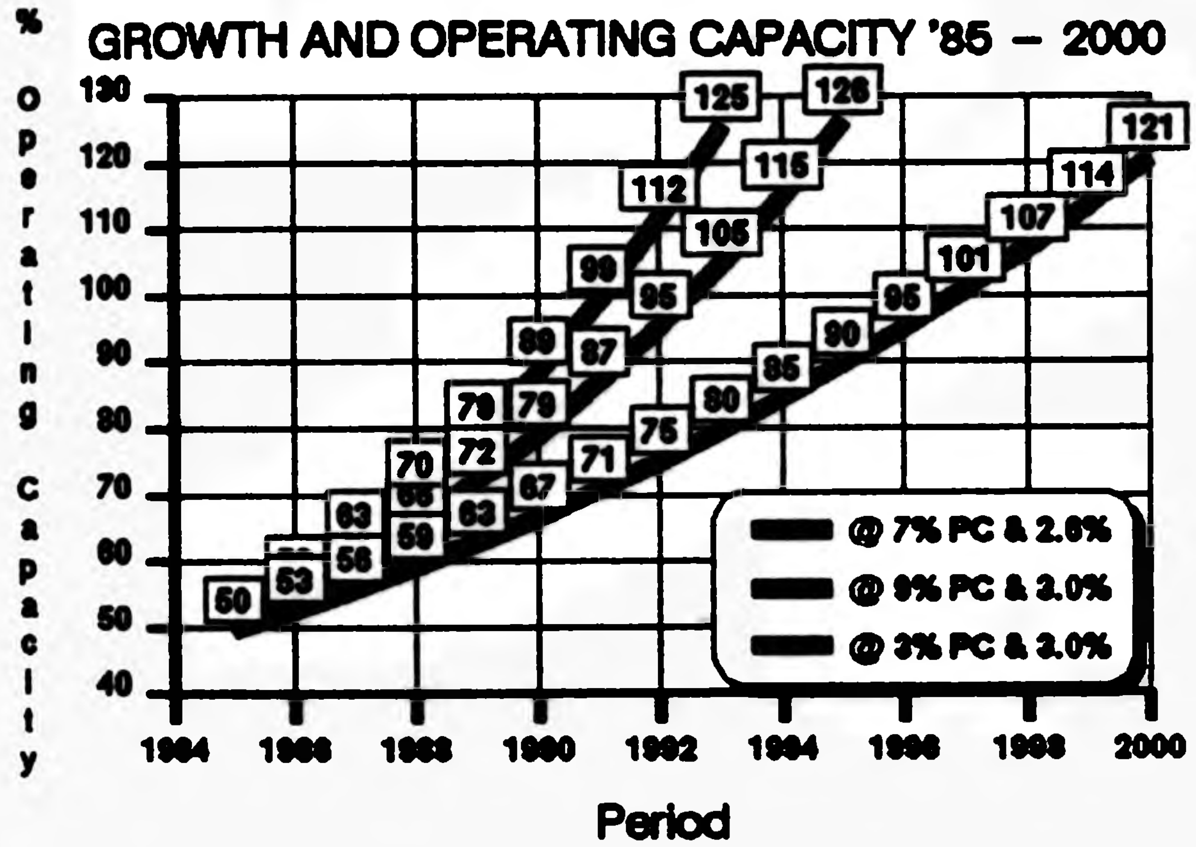
CEMENT: RELATIONSHIP BETWEEN GROWTH AND CAPACITY: 1985 – 2000



CEMENT: RELATIONSHIP BETWEEN GROWTH AND CAPACITY: 1985 – 2000



CEMENT: RELATIONSHIP BETWEEN CONSUMPTION GROWTH AND OPERATING CAPACITY '85 – 2000



Note: Please consult the results presented above when reviewing the following section. In this manner, the assessment of the impact of large consumption schemes on overall demand will become clearer.

2.2.4 Large Consumption Projects:

According to INCSA's Executive President, Mr. Edmond Woodbridge, as well as other company officials (3), large consumption projects, which could significantly increase consumption above the levels discussed in the last section (derived from normal activities), could only come, as a result of public sector investment. The main target areas for such programmes would be low cost housing, hydro-electric generating plants, and road works.

2.2.4.a Low Cost Housing:

Specific proposals have been mentioned by the present (newly elected) President of the Republic, to reduce the national housing deficit of some 120,000 homes, through the implementation of massive construction projects. Keeping this in mind, I have calculated the impact such a programme would have on the national installed cement production capacity.

In the following pages, cement use estimates are given for three different periods of duration (4, 5, or 6 years), based on two different types of house (60 mts. sq., the most popular privately built house size, and 48 mts. sq., the standard dwelling size built by the IMAS, the public institution in charge of poverty level housing programmes).

Unfortunately, the impact this scheme would have on the current installed capacity is not very great: between 4.7%/yr, if 20,000 houses measuring 48 mts. sq. were to be built in a period of six years, and 8.8%/yr if an "optimistic" plan got underway, i.e., 30,000, 60 mts. sq. homes built in four years.

In summary, a massive housing scheme would not on its own solve the underlying spare capacity problem, though it would contribute positively towards reducing the present gap.

The full set of calculations follows:

Option A: "Optimistic Estimate"

1. House size: 60 mts. sq.
2. Cement Use:
   - 1,000 blocks
   - 50 additional bags (@ 42.5 kgs.)

3. Ratio of blocks to Cement bag:

(Source: Bloquera "El Progreso")

- 45 blocks/bag.

or 1,000 blocks / 45 blocks/bag = <u>22.22 bags</u>

4. Total bags per house:

50 bags for concrete + 22.22 bags in blocks =

<u>72.22 bags/house</u>

or 72.22 bags/house/23.529 bags/mt =

<u>3.07 MT/house</u>

5. Estimated total consumption of project:

3.07 MT/house x 120,000 houses/project =

~<u>368.400 MT/project</u>

6. Yearly Usage:

- 6 years: 61,400 MT/yr.
- 5 years: 73,770 MT/yr.
- 4 years: 92,100 MT/yr.

Option B: IMAS Type House:

1. House size: 48 mts. sq.
2. Cement used:
   - 800 blocks
   - 40 additional cement bags
3. Total Cement use / house:

   2.46 MT/house

4. Total Consumption for the Project:

   ~ **294,700 MT/project**

5. Yearly usage:
   - 6 years: 49,120 MT/yr.
   - 5 years: 58,940 MT/yr.
   - 4 years: 73,675 MT/yr.

Impact Assessment on Capacity:

1. Number of houses built per day:

a. Operating Capacity (INCSA + CEMPASA)

OPTION A: 2,450 MT/day / 3.07 MT/house =

- 20,000 houses in ~ 25 days
- 24,000 houses in ~ 30 days
- 30,000 houses in ~ 38 days

OPTION B: 2,450 MT/day / 2.46 MT/house =

- 20,000 houses in ~ 20 days
- 24,000 houses in ~ 24 days
- 30,000 houses in ~ 30 days

b. Total Installed Capacity (INCSA + CEMVASA + CEMPASA)

OPTION A:

- 20,000 houses in ~ 22 days
- 24,000 houses in ~ 26 days
- 30,000 houses in ~ 33 days

OPTION B:

- 20,000 houses in ~ 18 days
- 24,000 houses in ~ 21 days
- 30,000 houses in ~ 26 days

2. Impact in Percentage Terms:

(Installed Capacity = 1,044,000 MT/yr, Operating Capacity = 882,000 MT/yr.)

OPTION A:

6 years:

6.96% of Operating Capacity

5.88% of Installed Capacity

5 years:

8.36% of Operating Capacity

7.06% of Installed Capacity

4 years:

10.44% of Operating Capacity

8.82% of Installed Capacity

OPTION B:

6 years:

5.57% of Operating Capacity

4.70% of Installed Capacity

5 years:

6.68% of Operating Capacity

5.65% of Installed Capacity

4 years:

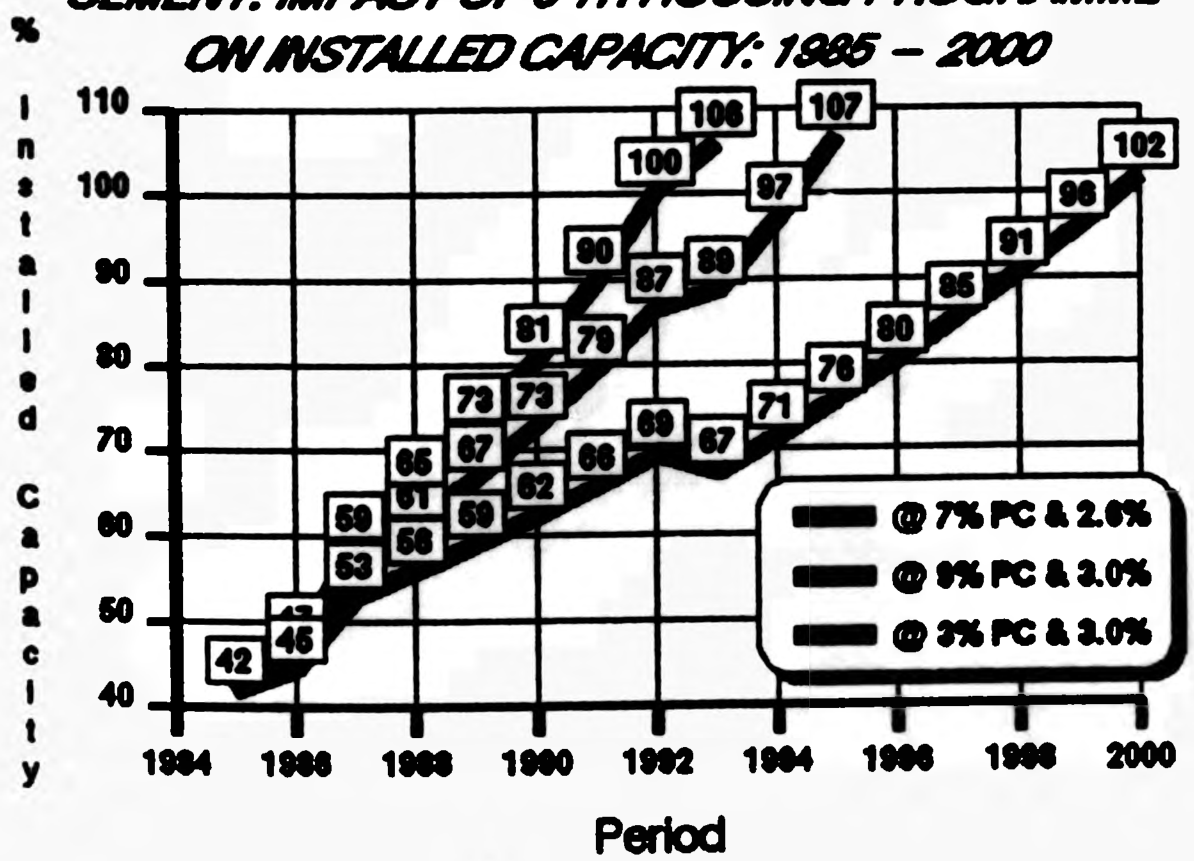
8.35% of Operating Capacity

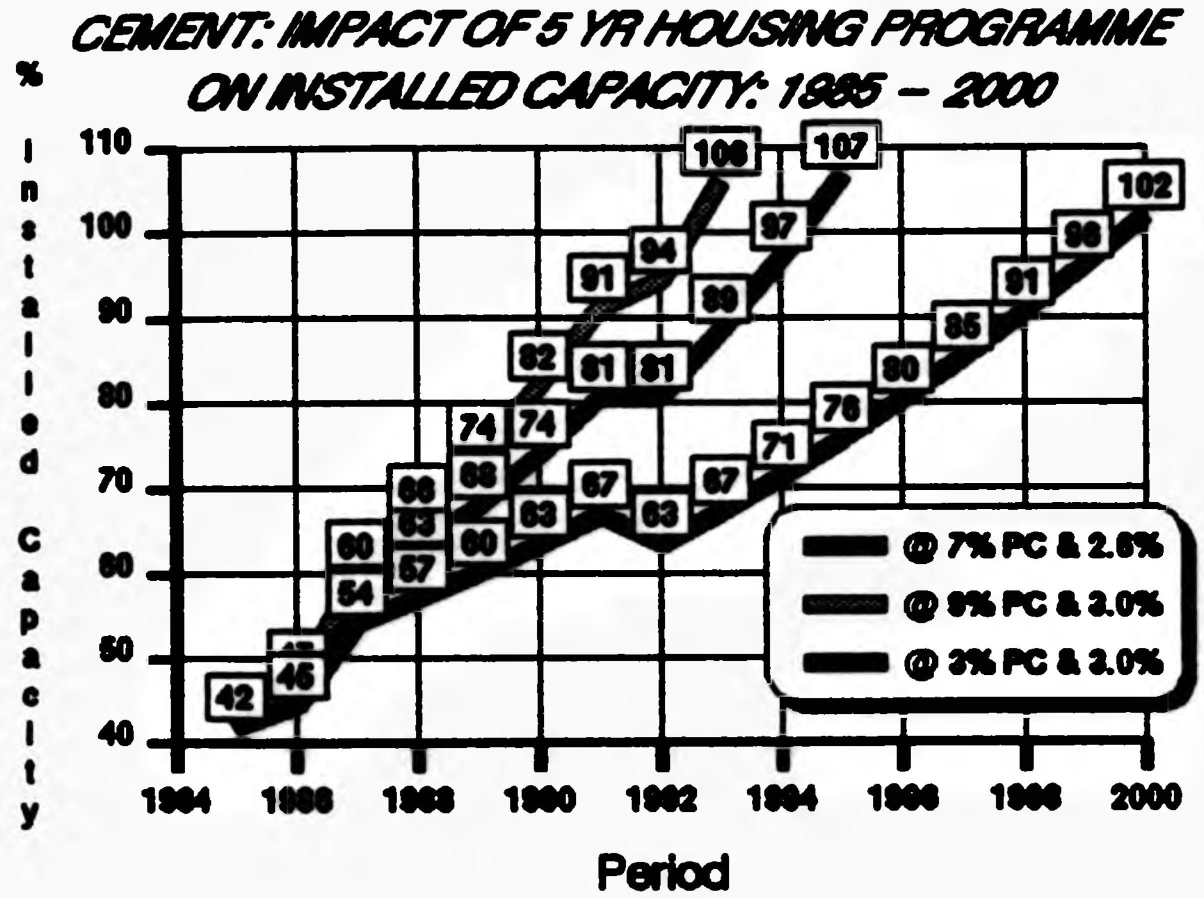
7.06% of Installed Capacity

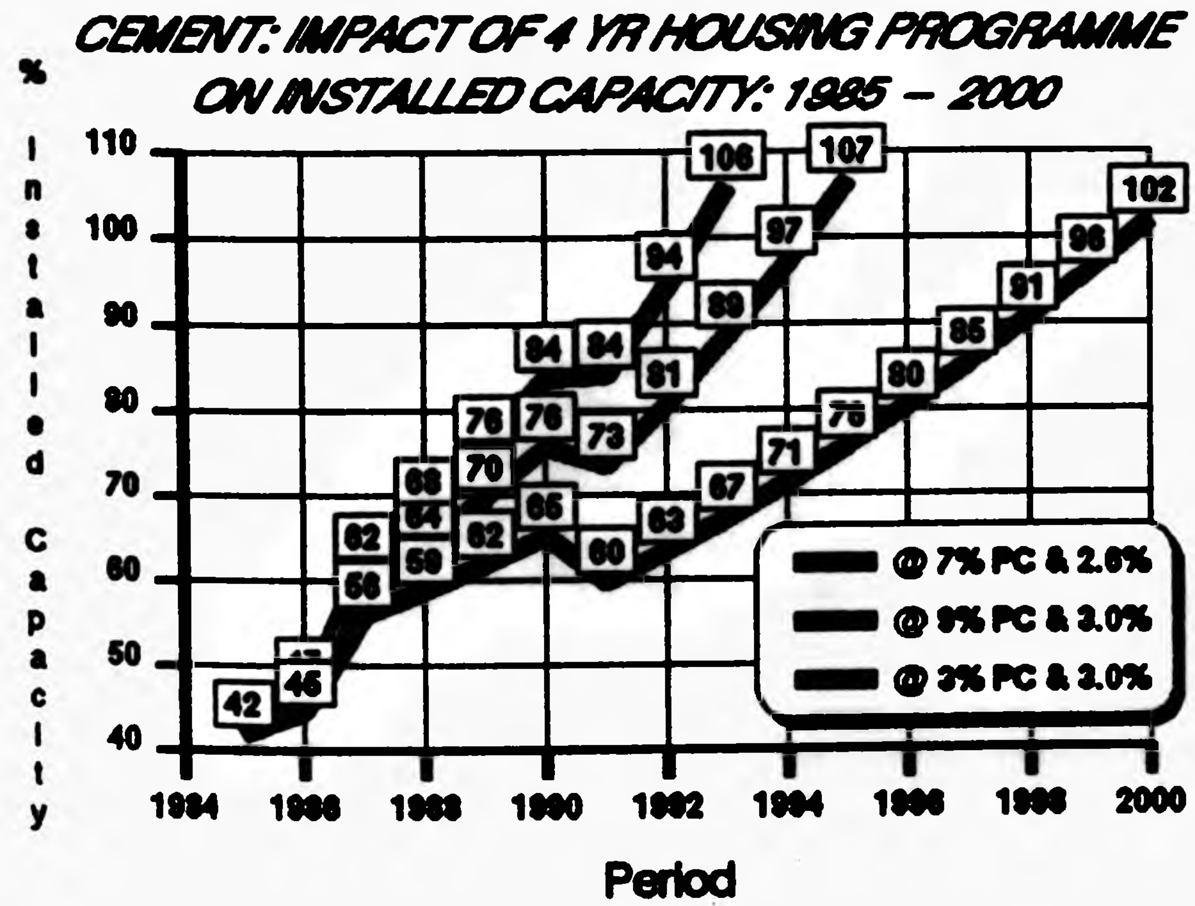
Note: Cementos del Valle, on its own could cope with the demand resulting from the housing project.

As a final note I have decided to show graphically the impact the best of these two plans (option A) would have on the country's operating and installed capacity depending on the three base patterns of behaviour described in section 2.2.3 (i.e., "most likely", optimistic, and pessimistic projections of national consumption). In this respect, it is assumed that the housing programme, being directed at the very poor (who otherwise would not build a house on their own), operates as a complement, (not a supplement) of normal consumption:

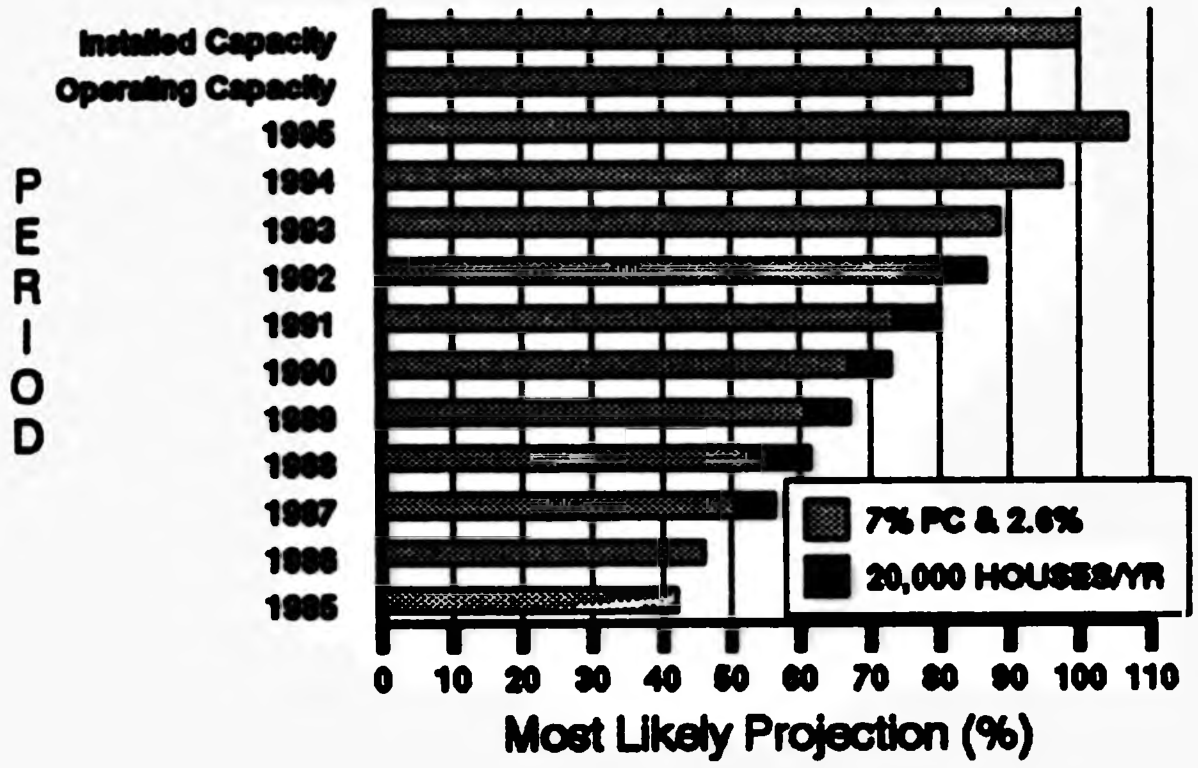
CEMENT: IMPACT OF 6 YR HOUSING PROGRAMME ON INSTALLED CAPACITY: 1985 – 2000



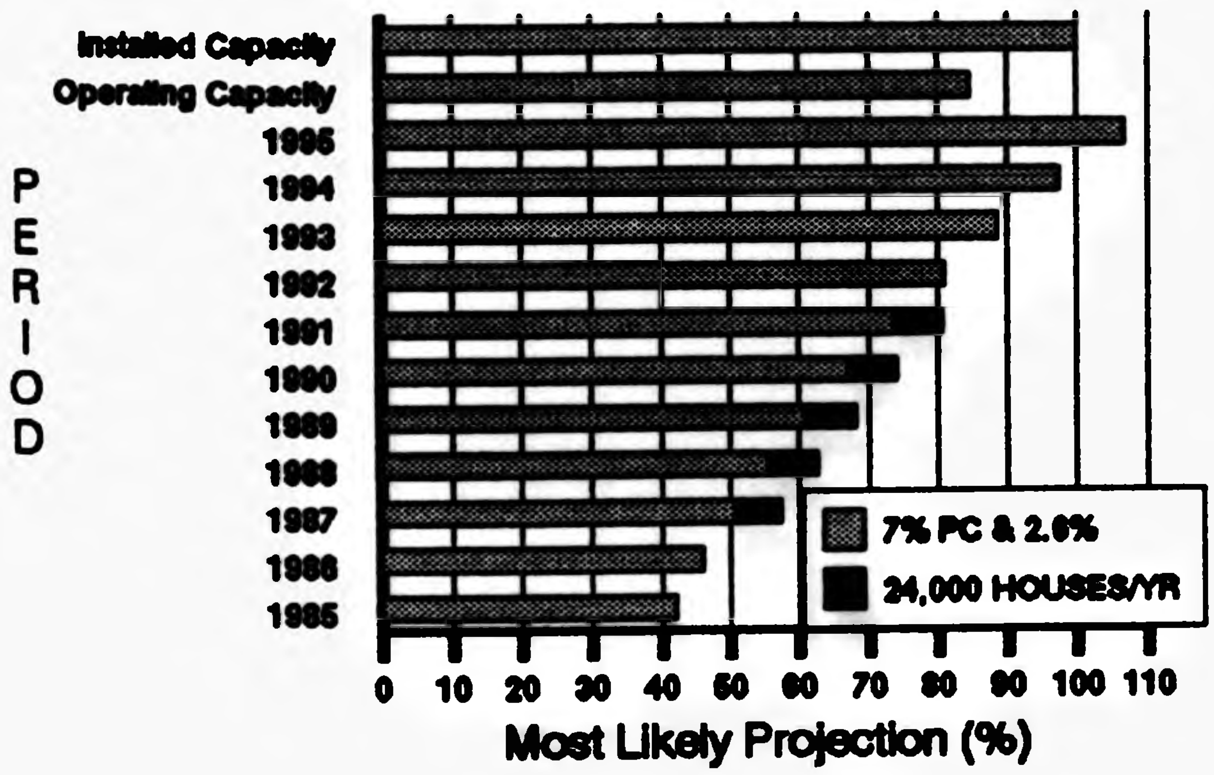

CEMENT: IMPACT OF 5 YR HOUSING PROGRAMME
ON INSTALLED CAPACITY: 1985 – 2000
% Installed Capacity
110
100
90
80
70
60
50
40
106
107
102
97
98
94
91
89
91
82
81
81
85
80
74
74
76
68
68
71
67
67
66
63
63
60
60
63
57
54
42
45
1984
1986
1988
1990
1992
1994
1996
1998
2000
Period
@ 7% PC & 2.6%
@ 9% PC & 3.0%
@ 3% PC & 3.0%


CEMENT: IMPACT OF 4 YR HOUSING PROGRAMME
ON INSTALLED CAPACITY: 1985 – 2000
% Installed Capacity
110
100
90
80
70
60
50
40
106
107
102
97
98
94
91
89
84
84
81
85
80
76
76
73
76
71
68
70
64
62
65
67
63
62
59
60
56
42
45
1984
1986
1988
1990
1992
1994
1996
1998
2000
Period
@ 7% PC & 2.6%
@ 9% PC & 3.0%
@ 3% PC & 3.0%

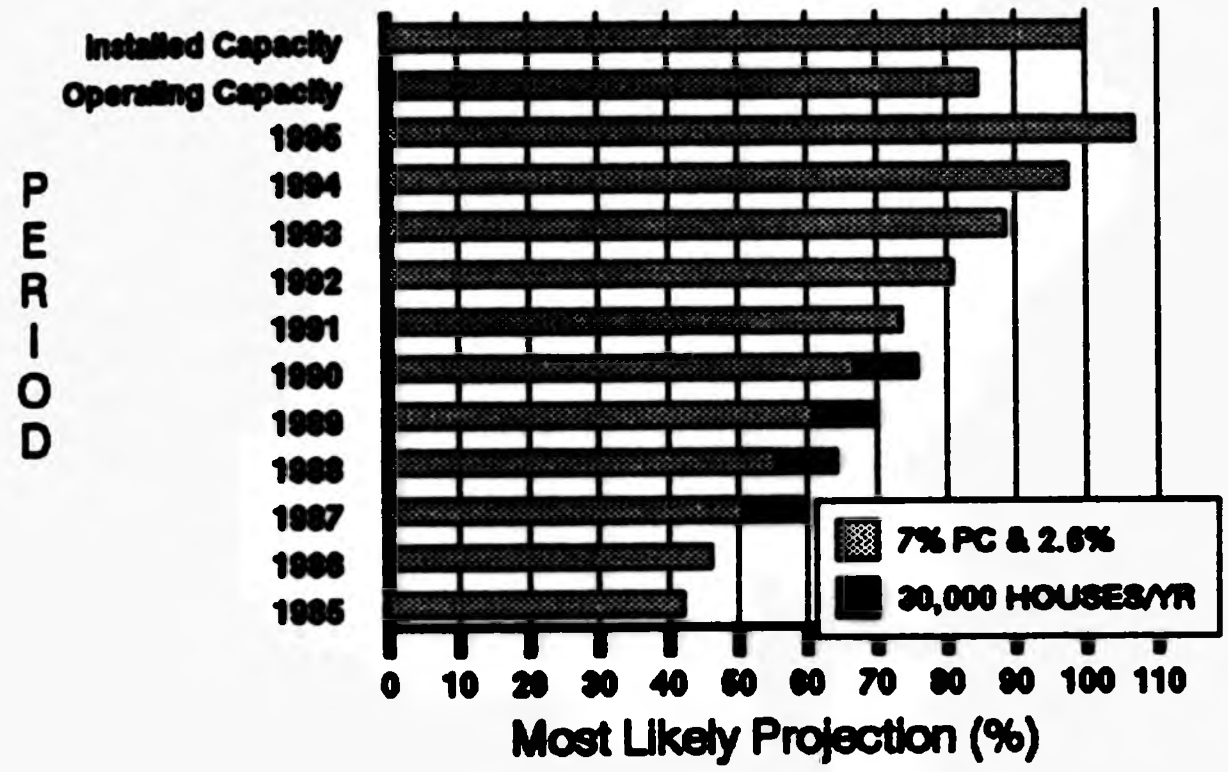
CEMENT: IMPACT OF 6 YR HOUSING PROGRAMME ON CAPACITY: 1985 – 2000



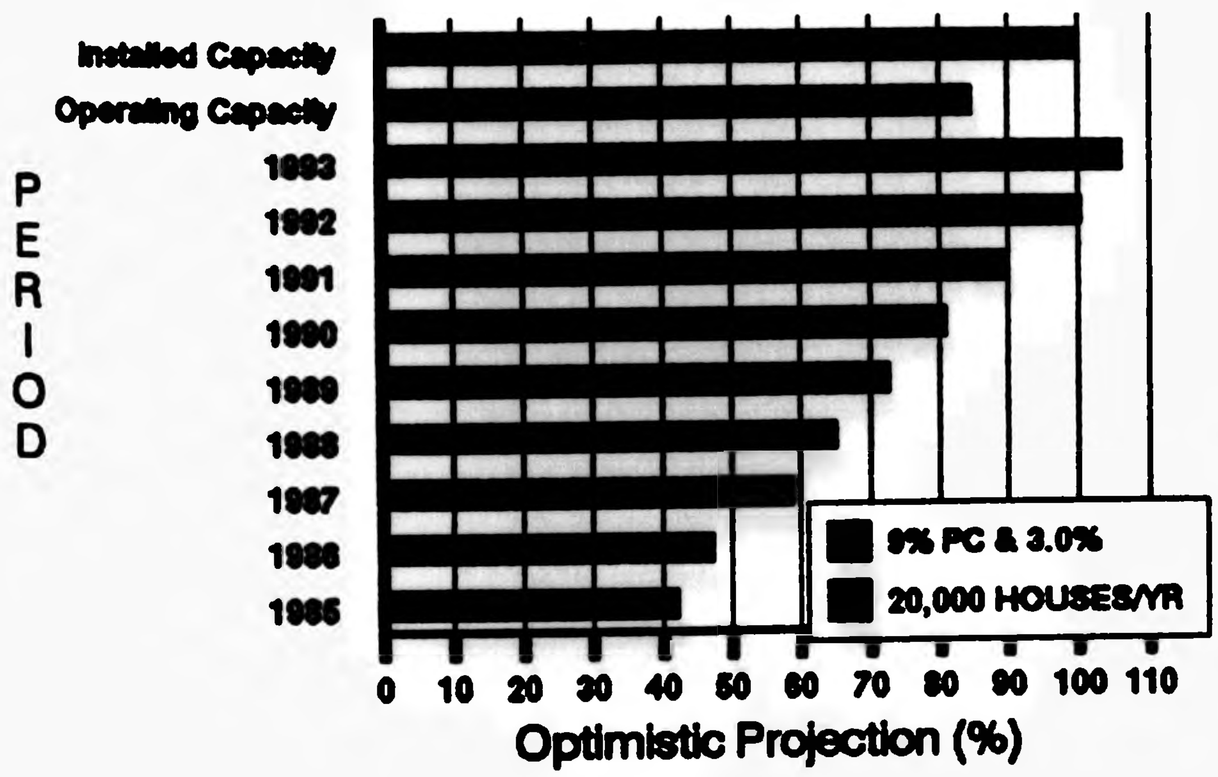
CEMENT: IMPACT OF 5 YR HOUSING PROGRAMME ON CAPACITY: 1985 – 2000



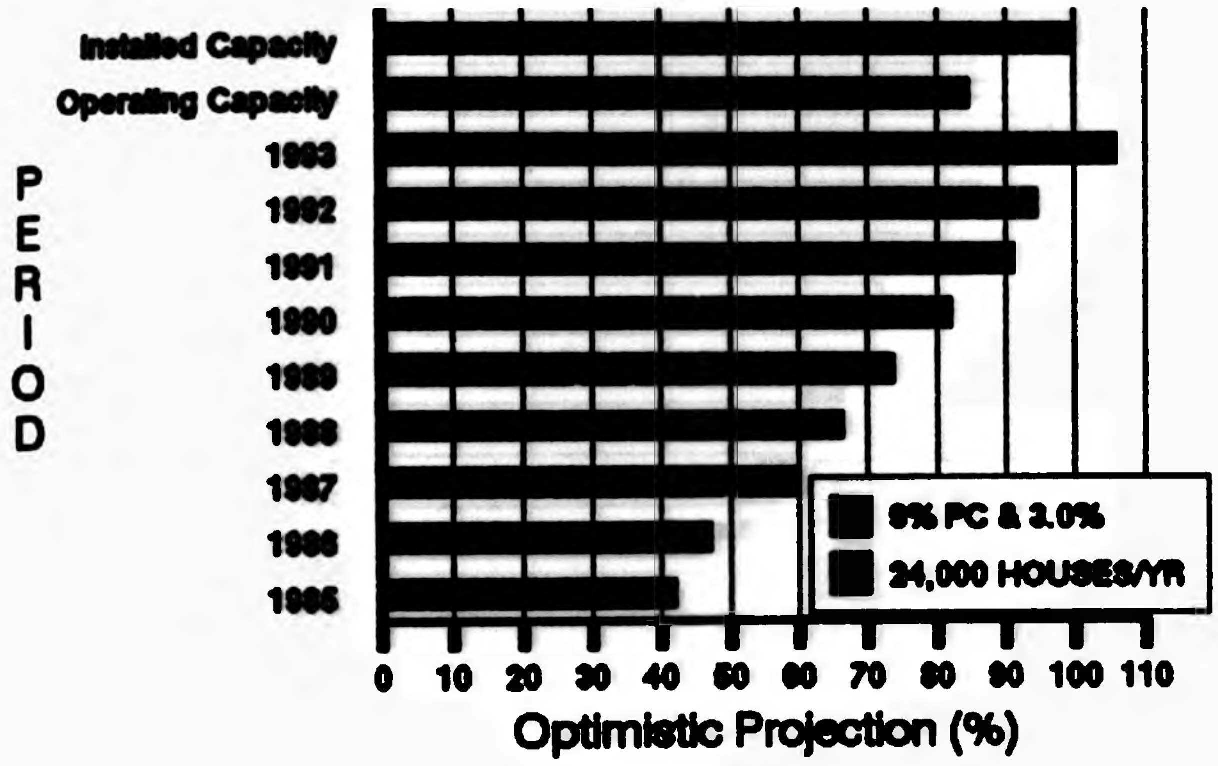
CEMENT: IMPACT OF 4 YR HOUSING PROGRAMME ON CAPACITY: 1985 – 2000



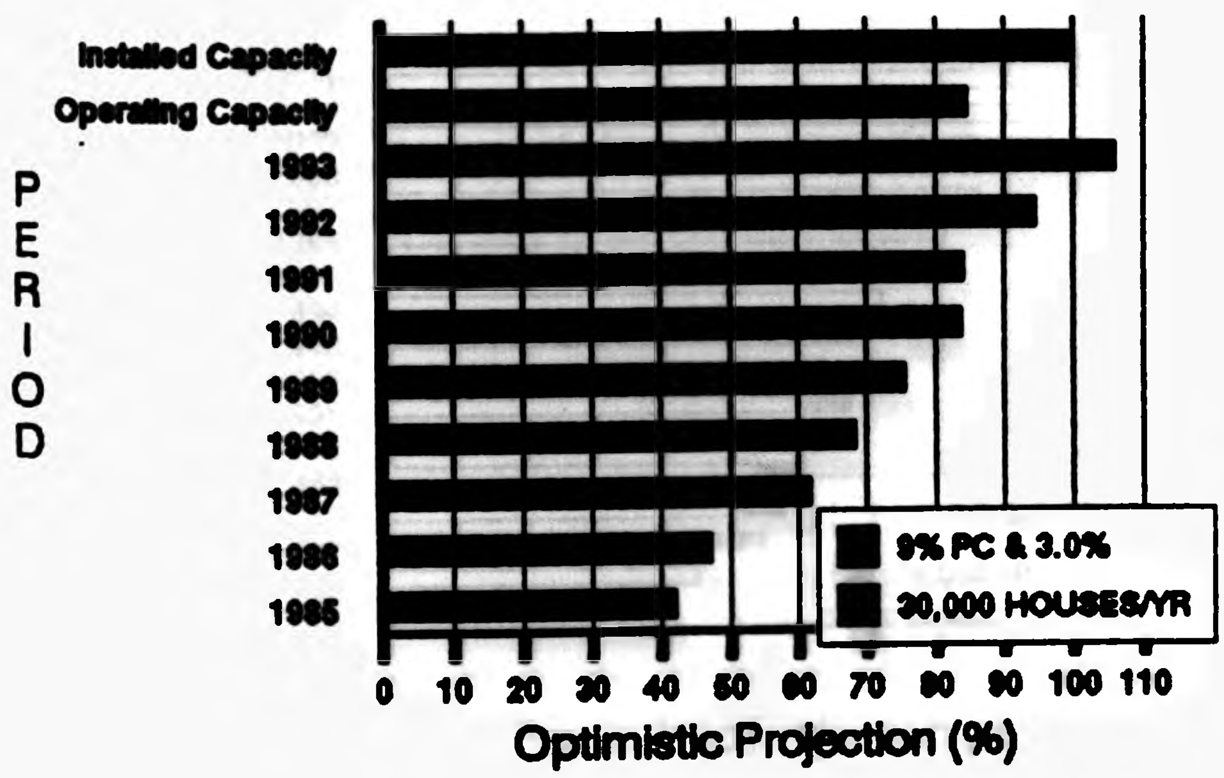
CEMENT: IMPACT OF 6 YR HOUSING PROGRAMME ON CAPACITY: 1985 – 2000



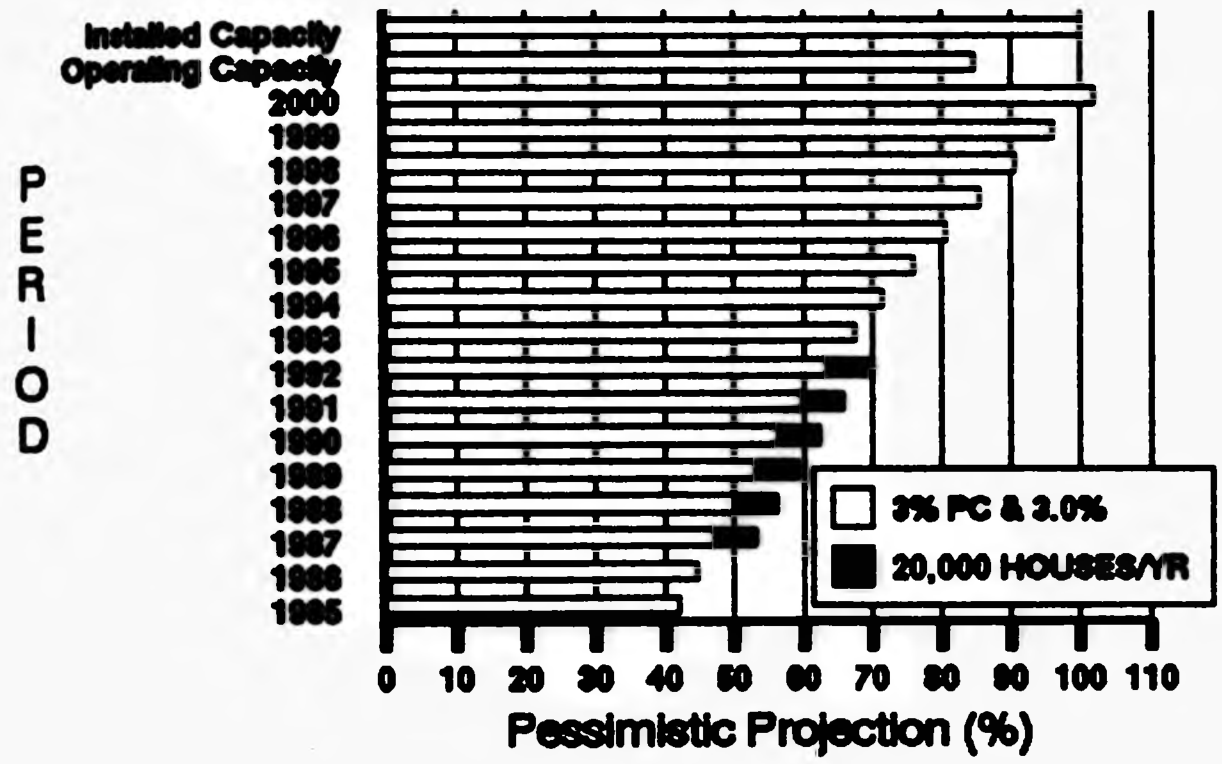
CEMENT: IMPACT OF 5 YR HOUSING PROGRAMME ON CAPACITY: 1985 – 2000



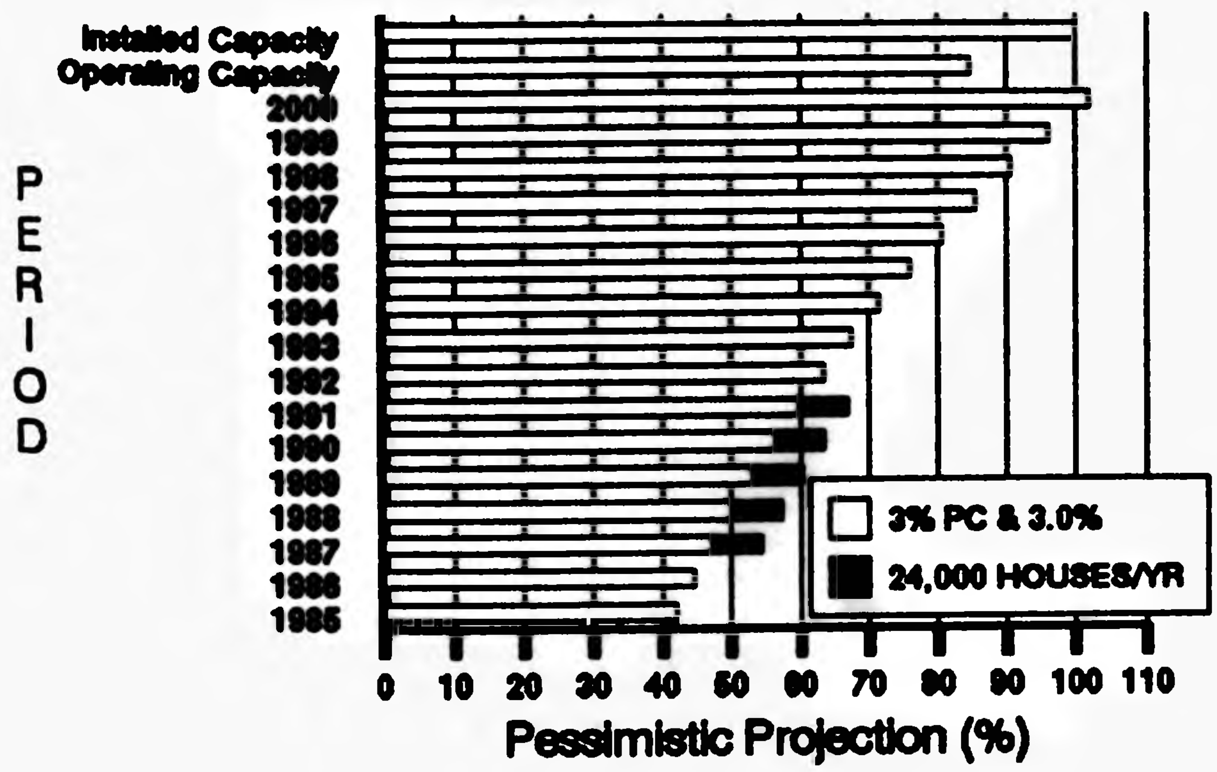
CEMENT: IMPACT OF 4 YR HOUSING PROGRAMME ON CAPACITY: 1985 – 2000



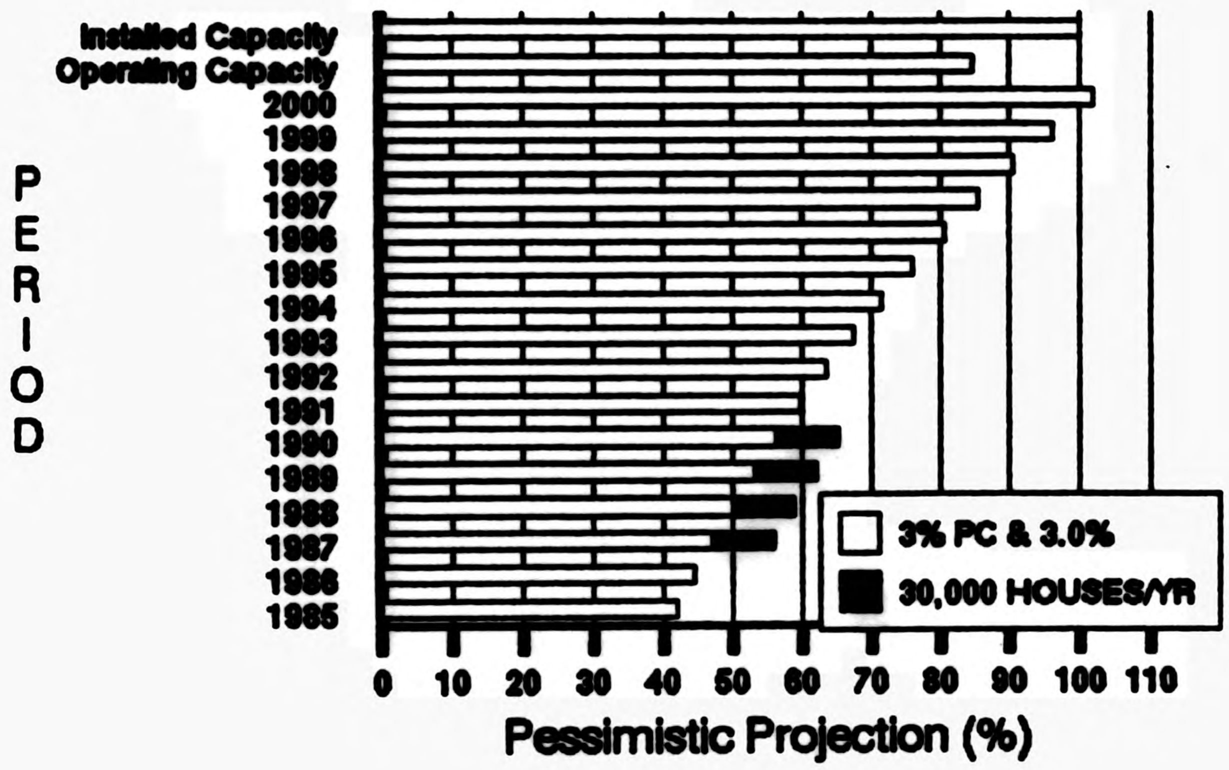
CEMENT: IMPACT OF 6 YR HOUSING PROGRAMME ON CAPACITY: 1985 – 2000



CEMENT: IMPACT OF 5 YR HOUSING PROGRAMME ON CAPACITY: 1985 – 2000



CEMENT: IMPACT OF 4 YR HOUSING PROGRAMME ON CAPACITY: 1985 – 2000



b. Hydro-electrical Schemes:

The expected increase in consumption (overall) for 1986 over 1985 (4.9%) (3), is associated solely with the construction of ICE's (Utility company) Ventanas-Garita hydro-electric project (~ 21,600 MT or ~ 2% of the national installed capacity). Unfortunately, no other large schemes would be required in the medium term (apart from the option posed by the Boruca plant discussed in the Aluminium chapter of this thesis). In conclusion, no further significant contribution is expected from this sector for some years to come.

c. Road Building:

The traditional method for building roads in the country is by the use of tarmac surfaces. Concrete, because of the higher initial capital investment involved, and the poor climatic conditions (rainy season lasts for 9 months/yr.) are rarely used. With the drop in the price of oil, it is unlikely that policies in this field will change very much in the near future. As a result, the prospect of expecting increased cement use, based on new road building programmes does not appear to be a realistic one.

2.2.5 Exports:

Below, the complete record of Costa Rican cement exports is presented:

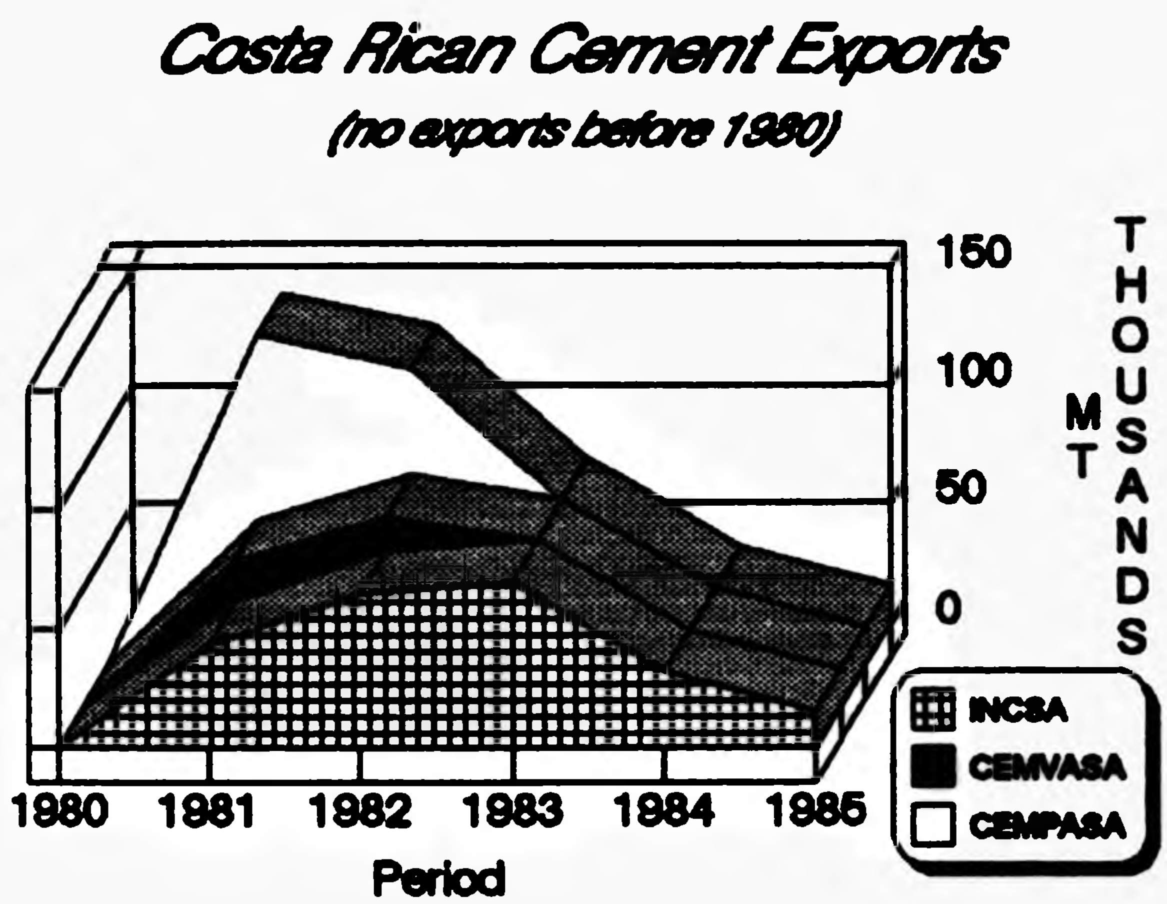
Table 2.2.5.a Costa Rican Cement Exports: (metric tonnes)

(no exports before 1980)

Period:	Incsa	Cemvasa	Cempasa	TOTALS
1980	0	0	0	0
1981	43,533	17,059	78,000	138,592
1982	64,644	14,523*	45,423	124,590
1983	69,318			69,318
1984	32,267			32,267
1985	15,209			15,209
Totals	224,971	31,582	123,423	379,976

* Includes cement involved in legal case, refer to Cemvasa section above.

(Sources: *Incsa (3), Codesa, Memorias Anuales*)



Exports began in 1981, favoured by the drop in the value of our currency (as well as the introduction of new production capacity, CEMPASA). Nevertheless, as can be seen from the figures, as soon as the costs returned to their normal levels, the depletion of national exports has been very substantial. In fact, for 1985, only Incsa exported and solely by means of small shipments (1,000 MT to 1,500 MT) to some Caribbean islands.

The chances of penetrating new markets, according to both Cempasa *(4)* and Incsa *(3)* are very slim, either because of the entry of new exporting nations from the region, which have much lower energy costs than Costa Rica:

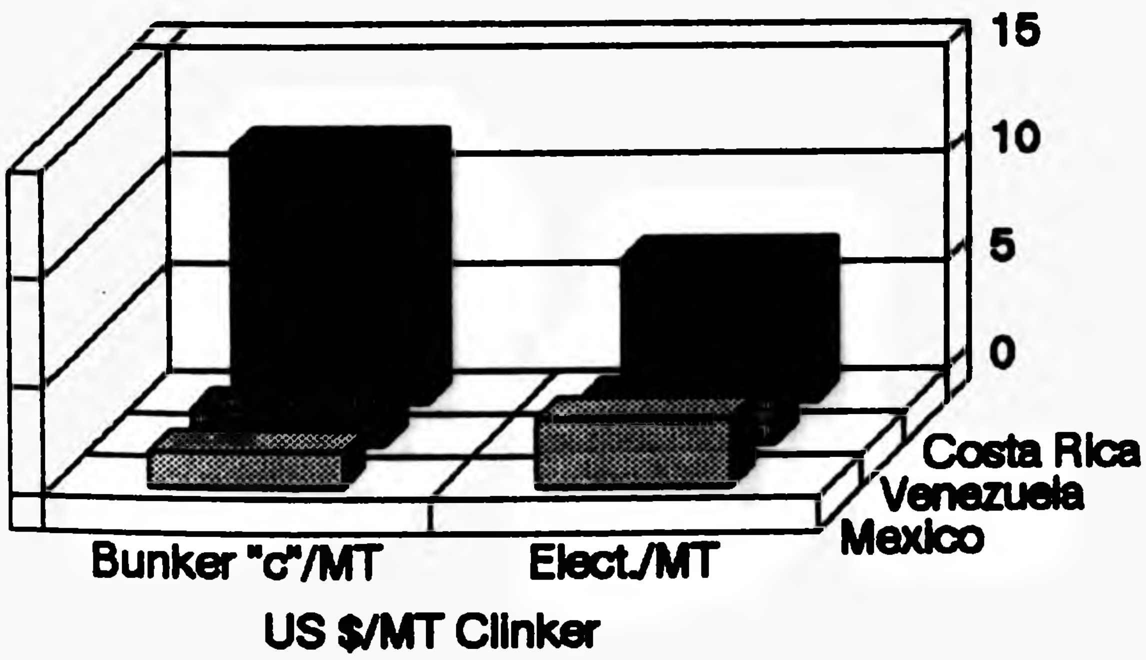
Table 2.2.5.b: Energy Cost Comparison

	Cost Bunker "C"/MT	Cost Elect./MT
Mexico	US $1.66/MT clinker	$3.16/MT clinker
Venezuela	$1.66/MT clinker	$2.13/MT clinker
Costa Rica	$11.76/MT clinker	$6.63/MT clinker

(Note: these figures were supplied in April 1985. With the recent drop in the World price of oil the gap should now be smaller.)

or because of the subsidized export sales in Latin America by traditional exporters *(3)*, (Spain in particular), which could sell cement in Costa Rica cheaper (~$28/MT in 1985) than we can produce it.

ENERGY COST COMPARISON



A summary of the World cement scene is provided below (1981) *(10)*.

Table 2.2.5.c World Cement Data, 1981:

(million Metric Tonnes)

Region	Output	Imports	Exports	App Cnsp
Europe	283.2	8.4	39.4+	252.0
USSR	127.0	0.6	3.0	124.6
Africa	27.3	10.4	2.0	33.6
Mid-East	34.6	32.8	2.7	61.3
Americas	151.2	7.2	4.9	151.0
Asia	255.6	11.5	21.2*	246.5
Australasia	6.0	0.03	0.2	5.8
TOTAL	757.8	70.3	70.3	750.2

+ includes ~ 10 Million MT from Spain

* includes ~ 16 Million MT from Japan

2.3 Policy Instruments to Improve Performance:

2.3.1 Energy Monitoring, Conservation and Substitution

In an industry where ~50% of the total cost of production is directly associated with energy use, it is of the utmost importance to focus on its efficient management.

A summary of the World cement scene is provided below (1981) *(10)*.

Table 2.2.5.c World Cement Data, 1981:

(million Metric Tonnes)

Region	Output	Imports	Exports	App Cnsp
Europe	283.2	8.4	39.4+	252.0
USSR	127.0	0.6	3.0	124.6
Africa	27.3	10.4	2.0	33.6
Mid-East	34.6	32.8	2.7	61.3
Americas	151.2	7.2	4.9	151.0
Asia	255.6	11.5	21.2*	246.5
Australasia	6.0	0.03	0.2	5.8
TOTAL	757.8	70.3	70.3	750.2

+ includes ~ 10 Million MT from Spain

* includes ~ 16 Million MT from Japan

2.3 Policy Instruments to Improve Performance:

2.3.1 Energy Monitoring, Conservation and Substitution

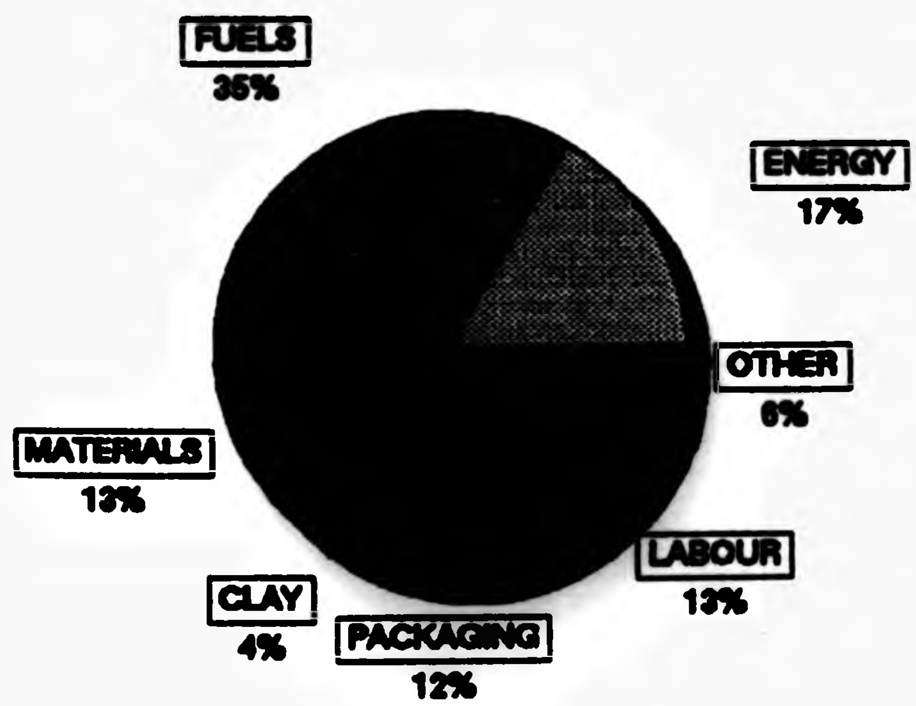
In an industry where ~50% of the total cost of production is directly associated with energy use, it is of the utmost importance to focus on its efficient management.

Table 2.3.1.a Direct Production Costs: (3)

(CR C/MT)

Energy	261.50	16.6%
Fuels	548.64	34.7%
Materials	209.06	13.2%
Clay	63.32	4.0%
Packaging	194.66	12.3%
Labour	212.05	13.4%
Other Costs	91.24	5.8%
TOTALS	1,580.49	100.0%

CEMENT: DIRECT PRODUCTION COSTS



As explained more fully in the fertilizers chapter, energy audits and subsequent monitoring should be some of the first priorities in this type of activity. Energy conservation and the study of the feasibility of oil substitution with indigenous fuels, such as coal, which has been recently located by Recope (in substantial quantities) in the Talamanca region of the country *(12)*, therefore constitute important areas of joint action by both government and the companies in the industry, (a detailed description of how energy audits should be carried out is presented in the fertilizers chapter).

2.3.2 Package Deal Capacity Development:

It may well be the case that the only substantial source for future continued growth of the industry lies in adopting a concerted campaign to promote exports of bundled construction packages including design, materials, construction, skilled manpower, etc., to less technologically advanced countries in the region (Nicaragua constitutes a prime target due to its small installed cement capacity, the proximity of Cementos del Pacifico to its main center of consumption: the Managua area, etc.). Costa Rica has a relative advantage with respect to many other Central American and Caribbean countries in terms of engineering design expertise. In fact, local consulting firms are constantly involved (independently) in projects outside the country. Many nations (most notably in South East Asia: Korea, Japan and Singapore, exporting to the Middle East *(11)*, for example), have gained, in the past, from similar relatively favourable competitive positions to achieve their own development targets. The purpose of reducing the relative importance of the cost of the cement with respect to the overall value of the projects involved, seems to be a reasonable option, since it is widely accepted, that on its own the export of cement is unlikely to occur on a significant scale.

Finally, large national construction schemes, such as the low cost housing programme planned by the present administration could provide the necessary training ground (if planned correctly) for future projects abroad. The development of a new product, i.e., the package deal, would then seem more realistic, as prospective client countries could see for themselves the results of previous experiences in Costa Rica.

Cement Production References:

1. Who Owns Who in Europe. 1985 Edition.

2. Codesa, Memorias Anuales 1976, 1977, 1978, 1980, 1981, 1983.

3. Written report to the author from Incsa company officials, December 1985.

4. Based on figures provided by Ing. Jorge Delgado, Technical Manager, Cempasa, April 1985.

5. Cemento Hormigon: Technical Magazine N-55, February, 1980, quoted in Codesa report to the Comision Nacional Para la Reestructuracion de Codesa, February, 1986.

6. Comision Nacional Para la Reestructuracion de Codesa: Preliminary Report to the President of the Republic, April, 1986.

7. Meeting with Incsa's Executive President, Mr. Edmond Woodbridge, and other company officials, September, 1985.

8. Codesa: *Estudio Sobre la Demanda de Cemento a Nivel Nacional*, October, 1984, revised for presentation to the Comision Nacional para la Reestructuracion de Codesa , 1986.

9. Cefsa: *La Industria del Cemento en Costa Rica: Situacion Actual y Perspectivas de Crecimiento*, October, 1984.

10. World Statistical Review, Feb., 1983 issue, Paris.

11. Japan Economic Journal: Issue 84.04.17, p. 18, Tokio, 1984.

12. Conicit: "*10 Millones de Toneladas de Carbon en el Pais*", Prociencia, Vol. IX, No. 49, San Jose, August 1984.

3. Fertilizers

3. Fertilizers

3. FERTILIZER PRODUCTION

3.1 Introduction:

3.1.1 Presentation:

As discussed in the early stages of this thesis, FERTICA was not originally promoted by CODESA. In fact, the company operated for twenty years outside the government of Costa Rica's control: starting under American management in 1960, and after a decade passing on to Mexican ownership (state owned company) until Feb, 1980.

The plant is located in Puntarenas, the main Pacific port, some 120 kms. away from the capital city of San Jose. Its installations include plants to produce nitrogen based (based on ammonia which is imported mainly from Mexico, ~70% of total production cost), sulphur, and phosphate (P-2 O-5) fertilizers, physical formulas, etc., as well as Nitramin - a nitrogen formula for the production of explosives. The installed capacity of the plant is ~192,000 MT/yr. of intermediate products (nitric acid and sulphuric acid), and ~427,000 MT/yr. of finished products (ammonia sulphate, ammonium nitrate, wet process Pec., dry process CI/Girdler mixed compound products, and physical mixtures. The total number of employees is of 650. *(1)*

Following an independent (multisector) commission's recommendation, CODESA's board approved the purchase of 90% of the fertilizer company's shares on the 29th. of February, 1980 *(2)*. (Recope, the nationalized oil refinery, had previously purchased the remaining 10%). The transaction was carried out through a government to government negotiation involving the Central Bank of Costa Rica and Mexico's National Bank for International Trade (Banco Nacional de Comercio Exterior, S.A., Mexico). The price was considered to be extremely low: US$ 22.5 million, but as will be discussed later, this may have been due to the obsolescence of the plant, during highly energy conscious times. In fact, the government of Mexico proposed the shutting down of the whole complex as the only other option open to them, apart from the transfer of ownership to Costa Rica *(3)*.

The decision to bring the fertilizer plant into public ownership, as expressed by the study commission's report *(3)*, had clear political rather than business-like overtones. The main arguments put forth at the time of the purchase included the following: strategic importance for the agricultural sector which would be assured of a reliable source of fertilizers *(4)*; the low asking price (please note that the expenditure the government had to make during the first fiscal year on the plant, including the purchase premium paid, credits etc., rose to the amount of CR C 1,020,972,000 *(3)*, or ~US $ 120 million, considerably more than the figure quoted earlier); and the appropriateness of expressing a gesture of good will on the part of the government of Costa Rica towards the Mexican government, which supplied the country with oil under preferential terms:

" the political price to pay in order to acquire Mexican oil at OPEC prices rather than at the spot market rate" *(3)*

FERTICA, from the start, was to play a political role which would prevent effective management decision making. This circumstance has carried grave financial consequences.

Having in mind what the original scenario of the subsidiary's initialization into public life was like, we shall now devote to the study of the main problem areas identified in the enterprise's present state. Concurrently, alternative lines of action will be proposed , which if implemented could contribute significantly to better overall performance.

3.1.2 Financial Information: *(7)*

The activity of the company appears to be dependent very heavily on the efficient management of its stocks (raw material, in process and finished product). This is due to the high value of this category in its asset structure: 66% of all current assets and 40.8% of total assets (based of historical fixed asset valuation).

The company's current ratio is of 2.52

(C1,210,000,000 = current assets, and C479,000,000 = current liabilities). Nevertheless, the rotation of the stock appears to be very slow (or the asking prices for the products too low), since a current deficit is an identified problem area, as reflected in the fact that for the first ten months of 1985, the company had an operating loss of C76,000,000. (Recently, a grant for $8.25 million from the Interamerican Bank has been obtained for the purchase of raw materials).

In the long term Fertica's debt amounts to ~1,556,750,000, ~50% of which is with CODESA under interest terms. Note: most of these debts are low interest soft loans from aid institutions for the purchase of raw materials.

3.2 The Strategic Outlook:

In a similar fashion to its sister company, ALUNASA, FERTICA stands in a very poor strategic position. Not producing ammonia (nor any other plant in the country) as well as other raw materials of lesser importance (magnesium oxide, urea, borum, etc.), which are estimated by the plant's management *(5)* to account for approximately 70% to 80% of the end product value, it is totally dependent on foreign suppliers for its production activities. This has led in the past to repeated crises in the company's ability to procure its process inputs *(6)*. Although at present massive resources have been made available to Fertica for this purpose, greatly improving its working capital position *(7)*,

($8.25 million granted by the Interamerican Bank and the Ministry of Agriculture during 1983-1985), the standard method of purchase continues to be through credit lines (mainly ammonia from Mexico), paying substantially higher prices than those prevailing in world markets *(5)*.

On the output side again, the space for manoeuvre with the current product line is very restricted, due to politically led fertilizer price controls exercised by central government *(4,6)*. Such an approach is understandable, considering the impact fertilizer costs have on the economy of a primarily agricultural nation, but not one that brings any benefits to the company. (Please note that the subsidy to the consumer is not made directly, but instead it is exercised through undercharging by FERTICA). As a result, the company has chronically (as can be seen in the debt chart presented in Chapter 1), built up a large debt, derived from the purchase of raw materials (~$50,000/day are used *(5)*).

In summary, the company is situated in the middle of two opposing trends: paying high prices for its inputs, and asking low prices for its outputs.

3.2.1 The Scope for Action:

The general situation described above requires that various alternative contingent lines of action are identified and prepared for eventual execution. The criteria for choosing any strategy over another will depend on the availability of finance, the competitive position with respect to the handling of raw materials, the in process efficiency, and the allocation of the company's production nationally and internationally. Encompassing these elements, the political will to encourage better efficiency, while establishing more equitable (more widely spread) distribution of the financial responsibility throughout the agricultural activity, must be present.

It is important to distinguish between operating efficiency and financial performance at FERTICA. If it is the government's will to distribute fertilizers at prices below the cost of production, specific accountable subsidies (and not lump sum additions to working capital) should be introduced. This would facilitate the evaluation of performance by management, as problem areas could be pinpointed more easily).

Having reached such a consensus the following proposals could have a positive impact on the company's operation. It must be stressed, nevertheless, that such plans should be adopted only when specific sets of criteria are prevalent.

3.2.2 The Short/Medium Term:

For the time being, due to the restrictive conditions the country as a whole is facing, as well as the company's por financial record which precludes any major investments, the search for improvements within the current plant's operation is the only alternative.

Three areas have been identified as being crucial to accomplish this end: Energy Management, and Product/Service Mix and Marketing management.

3.2.2.a Energy Management:

As identified by the World Bank Report "The Potential for Energy Efficiency in the Fertilizer Industry" *(8)*, important savings can be achieved by better control, adaptation and use of the different plants in the energy intensive world of nitrogen and phophate based fertilizers production.

When visiting the company's installations in March 1985, various signs prompted me to believe that not enough was being done along these lines. For example, having two processes for the production of nitric acid, (currently only one is used due to the contraction of the demand as a result of the Central American conflict), the less efficient, more obsolete equipment was preferred. The reason for this decision is that the older plant is driven by an electric motor vs. a bunker fueled turbine in the case of the newer process. The problem has been identified by the technical team, the feasibility of interchanging both power plants has been determined (in fact such a course of action has been recommended by outside foreign consultants), but as yet no action has been forthcoming to resolve the situation.

Another aspect which strongly attracted my attention was the amount of monitoring equipment out of service. As can be inferred, before one is able to measure accurately the performance of the plant being studied, little can be done to assess its energy efficiency.

Following the report mentioned at the beginning of this section, a summary of specific energy management steps, which should improve consciousness among managers, as well as save money, is presented below.

Energy Conservation Plan

(from World Bank Technical Report No. 35)

Step No. 1. Energy Audit: The initial action to be taken would be to assess current performance through the following:

- Install energy accounting system.
- Establish position of energy coordinator.
- Retrain production manager on energy saving methods.
- Conduct unit by unit energy audits.

- Continue follow-up program based on audits, working towards known attainable consumption standards (researched from similar installations).

Goals:

1. To establish overall economics of the plant. After conservation procedures have been implemented to optimize energy use, a clearer picture of the competitive position will be available.

2. To record energy balances of inputs and outputs and locate major areas of loss and inefficiency.

3. Promote management involvement in the analysis of energy matters.

4. Be able to identify costs and benefits of probable actions to be taken.

Step No. 2. Areas of Action:

A. Good Housekeeping: (up to 10% - 20% improved values according to the report's findings).

This involves a day to day monitoring of all the activities within the plant, keeping close controls on material and energy balances, integrating the activities (opposing goals) of the production and maintenance departments, and recording closely the use of raw materials.

B. Operating Efficiency:

Here the focus is on ensuring better usage of the plant, achieving increased capacity utilization by integrating the planning, maintenance and operator training activities. This would be combined by an effort to reduce frequent plant breakdowns, establishing effective pollution controls which could lead to better output/energy usage ratios. (For example reduce NO emmissions from nitric acid plants by extended absorption, and of SO-2 emmissions by extra conversion and absorption. A plant in Florida was modified into a double conversion/ double absorption process improving output from 800 tons/day to 1850 tons/day). *(8)*

C. Steam Systems: (up to 10% potential reduction in energy use).

To accomplish this, the whole system should be checked for losses on a regular basis: insulation, flange tightness, steam traps, etc. Also, a close look should be taken at condensate recovery and utilization, using it where possible for low heat requirements. Finally, a review of steam availability and demands utilizing optimum pressure/temperature levels should be done.

D. Equipment Performance:

The next area to be covered is that of equipment performance which relates primarily with the establishment of preventive maintenance programs for drives, gearboxes, and monitoring equipment, measuring actual performance and comparing it to design values.

Step No. 3. Evaluation:

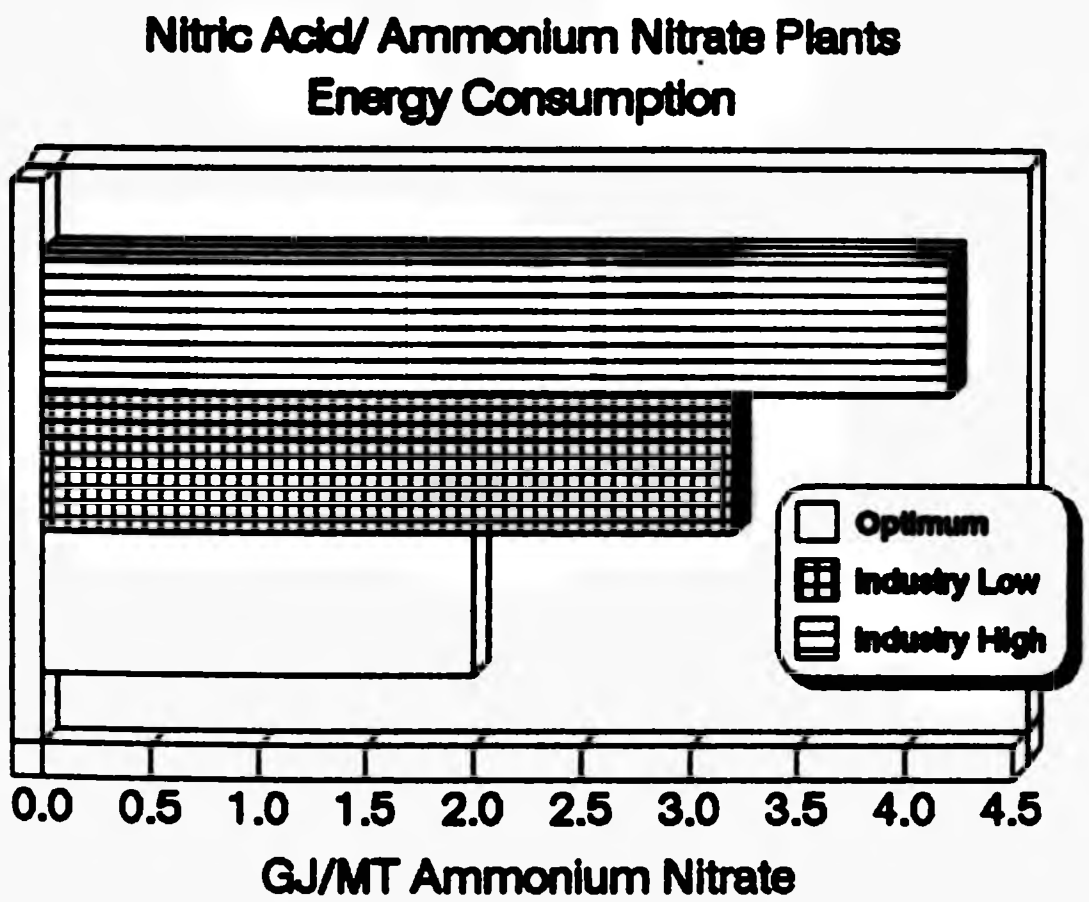
Below, energy consumptions of processes similar to those at FERTICA are presented. These should serve as basis for comparison of the company's competitiveness with respect to similar plants worldwide:

A. Nitric Acid/Ammonium Nitrate Plants

Optimum: 2.0 GJ/MT of ammonium nitrate

Industry Range: low - 3.2 GJ/MT

high - 4.2 GJ/MT



Step No. 3. Evaluation:

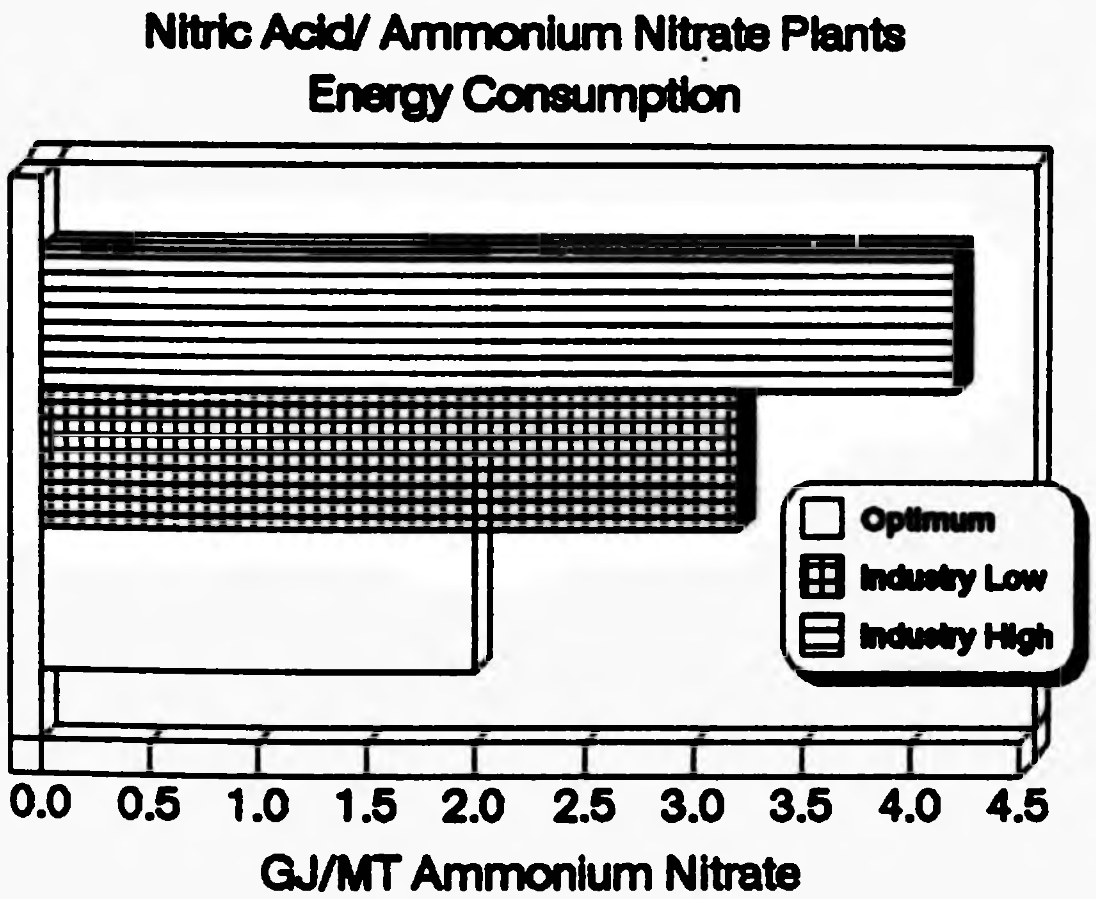
Below, energy consumptions of processes similar to those at FERTICA are presented. These should serve as basis for comparison of the company's competitiveness with respect to similar plants worldwide:

A. Nitric Acid/Ammonium Nitrate Plants

Optimum: 2.0 GJ/MT of ammonium nitrate

Industry Range: low - 3.2 GJ/MT

high - 4.2 GJ/MT



B. Sulfuric Acid Plants: (recovery)

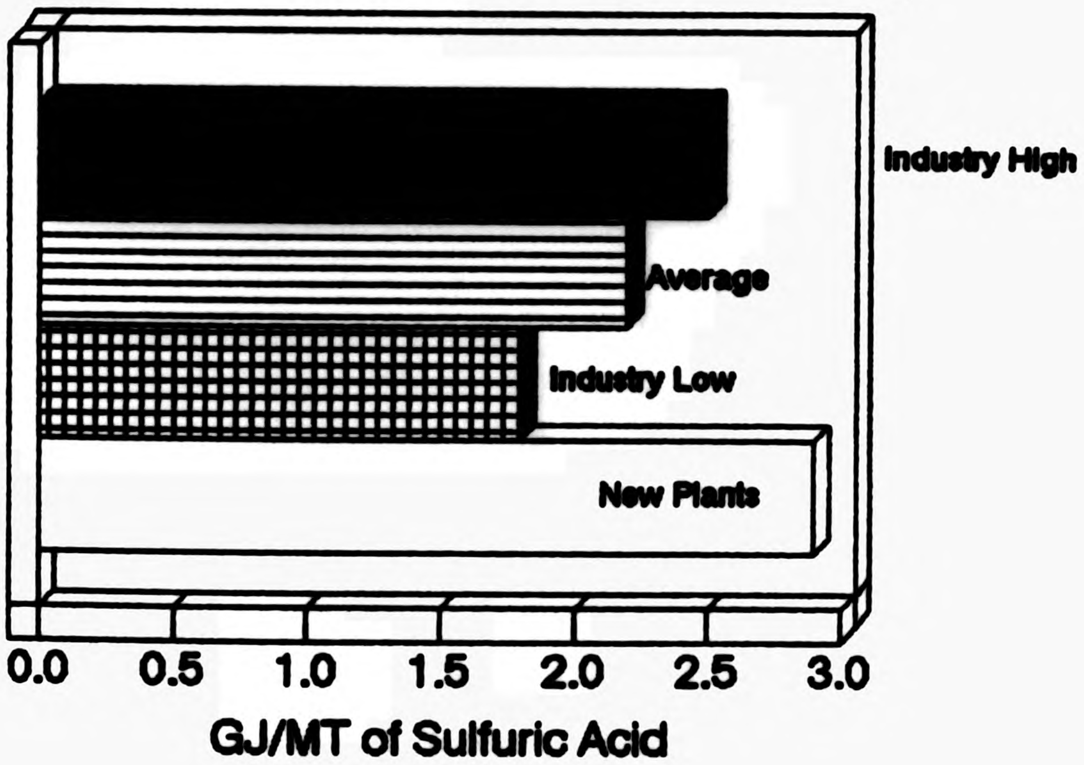
New plants: 2.9 GJ/MT of acid

Average: 2.2 GJ/MT

Range: low - 1.8 GJ/MT

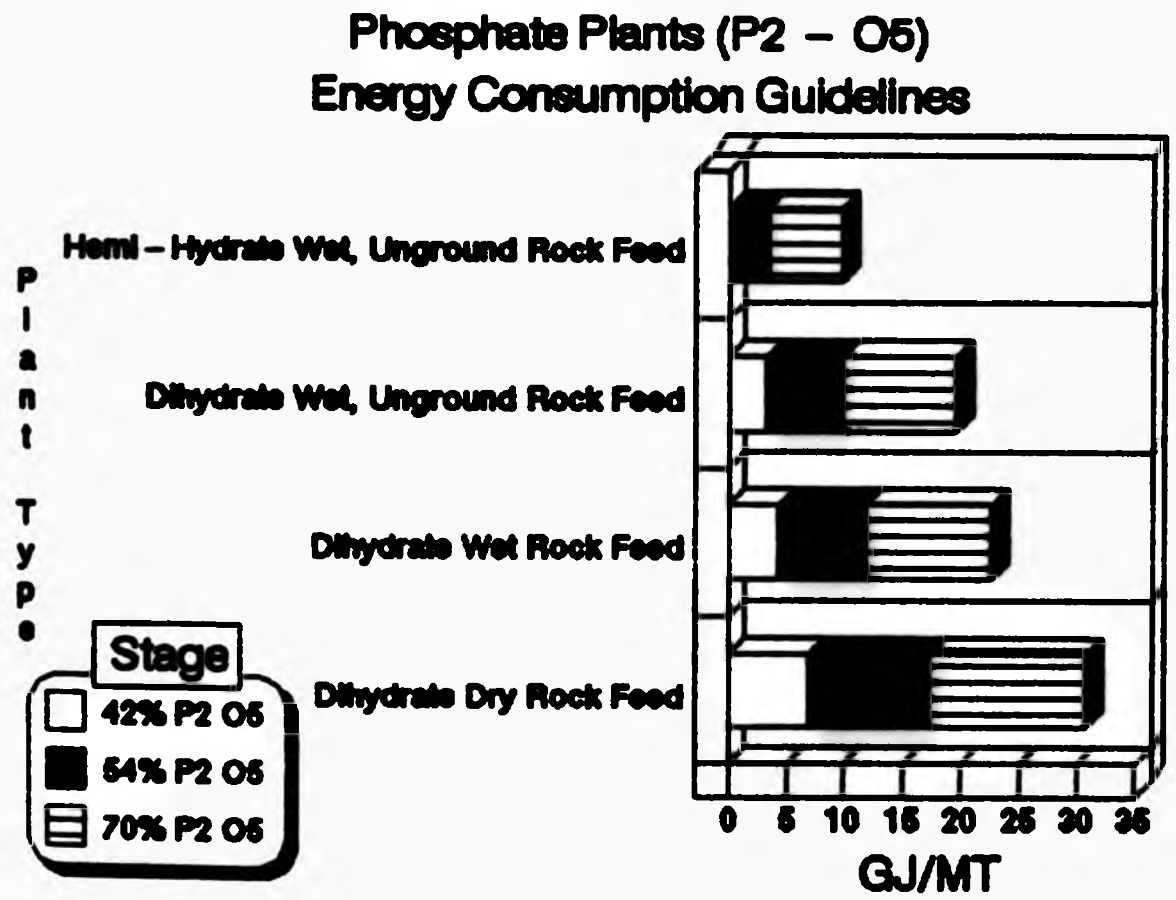
high - 2.5 GJ/MT

Sulfuric Acid Plants:
Energy Recovery (Exothermic Process)



C. Phosphate Fertilizer Plants (P-2 O-5)

% P-2 O-5 (all in GJ/MT)	42%	54%	70%
Dihydrate Dry Rock feed	6.97	10.32	13.46
Dihydrate Wet Rock feed	4.27	7.62	10.76
Dihydrate Wet, Unground Rock feed	3.27	6.62	9.76
Hemi-hydrate Wet, Unground Rock feed	0.00	3.35	6.49



3.2.2.b Stock Management:

The second activity to be reviewed in the short term should be that of stock control. From information provided by the National Commission for the Re-structuring of CODESA, (quoted in section 3.1.2) we see that the levels of stock held by FERTICA at any one time are of approximately C800,000,000 or ~£10,000,000, i.e., 2.89 times its billed short term sales and 1.44 times its total billings, a figure which by the way is lower than its documents due (owed). Such a condition suggests a chronic drain of funds, making re-stocking a major problem, as was acknowledged in the 1983 Annual Report. (Refer to the $8.25 million loan (or donation) by Mag/BID aimed at covering this gap, i.e., long term financing for short term operations).

Having identified the fragility of such an arrangement it is relevant to stress the importance of efficiency in stock procurement and use. Minimizing the cost of handling the stock, because of the volumes involved, inherently may mean important savings. Systems such as MRP by IBM, the establishment of a raw materials control position (process engineer), etc. should prove helpful. Also, as in the case of energy management, careful monitoring should be promoted throughout the organization.

3.2.2.c Product/Service Mix and Marketing:

As has been discussed before, the relation of stock to recoverable income must be improved. The previous section suggested an approach which if implemented should reduce the cost of maintaining stock, and as a consequence would probably reduce the volumes handled. The present proposal would be directed at the short/medium term goal of improving product turnaround, thereby increasing the volume of short term receivables. The combined effect of these two policies should lead to more independent financial performance.

Special efforts should be made to develop areas where price controls are not exercised such as explosives forming activities (technical nitrogen products, TNT --> Trinitro-toluene). The initial potential sales (South America) were estimated to be of 30,000 MT/yr. in 1981. *(8)*

It has to be taken into account that any coherent effort along these lines: either at introducing existing products to other markets or new products to present and new markets is of great relevance. Having lost Central America as its natural captive market, the company must expand its horizons if it is to survive due to the excess in installed capacity, in a high raw material cost, highly energy intensive industry.

These three strategies appear to cover the actions viable in the short/medium term. The scope for this time frame should be to seek the cumulative contribution of relatively small investment/quick payback policies.

Apart from these benefits, which appear to be readily quantifiable, an underlying purpose is intended: the development of technological awareness and capability. This is the concerted effort to involve technical and management personnel in task forces created to analyze and correct recognized problem areas, and to identify and study opportunities open to the company, and capitalize on them. Insofar as the enterprise succeeds in these areas, it should be gaining experience, valuable for the time when long term planning becomes a reasonable proposition.

Dahlman et al. describe the stages of technological capability (as will be developed more fully in later chapters) in LDC's as: *(9)*

1. Capability in managing existing enterprises.

2. Capability in improving performance of these enterprises.

3. Capability in the choice of alternative investment projects.

Such an approach is what I propose in the case of FERTICA.

3.2.3 The Long Term:

The actions open to the company in order to improve its competitive strategic position are three: equipment replacement, integration and diversification.

Equipment replacement would be relevant, first to phase out obsolete equipment (sulfuric acid plants, for example) to improve volume output for new markets or to approach the optimum energy values presented above.

With respect to integration, backward linkage is the attractive option. Many processes are available for the production of ammonia, nevertheless the preferred feedstock: natural gas is not available in Costa Rica. Other possibilities should be explored such as refinery gas or coal gasification through collaboration with RECOPE, and methanol/ammonia yielding processes using urban waste or alcohol process outflow as feedstocks (for example, the Purox method developed by Union Carbide). *(11)*

Nonetheless, whatever option is studied it should approximate the performance of new natural gas facilities i.e., ~33 GJ/MT, with minimum performance of around 41.6 GJ/MT of ammonia, this to stand in any favourable competitive position as can be seen from the following table.

Table 3.2.a: World Ammonia Capacity and Energy Consumption

(average Ammonia Price 1984: US$ 195/MT)

Period Capacity Came on-stream	Capacity Mil MT/yr	Consumption GJ/MT	Energy Value US$/MT
<1955	2.42	59.00	219.00
55-60	1.69	51.70	192.00
60-62	3.18	47.90	178.00
63-65	6.79	46.70	174.00
65-75	53.49	41.40	154.00
76-82	46.93	39.40	146.00
New 1985:	- -	33.00	122.30
Total: ------------>	114.50		
Weighted Average ---------------->		41.60	

Source: World Bank *(8)*

3.3 Conclusion:

Dealing with an aging facility is a difficult task. The first step to take is to optimize performance in order to be able to compare potential performance to that available at new plants.

Along with this consideration, the introduction of new activities: more profitable (and less affected by seasonality) product lines, the provision of consultancy services to farmers at home and abroad, and the like, may well be important courses of action to be studied in an effort to improve profitability.

If after an effort has been made to ensure efficient operation, the company's performance lags far behind the world average, there would be a strong case for closure or deep re-investment, whatever is deemed to be more favourable by national opinion (since we are dealing with a strategic industry). It must be clear though, that if it is determined, after all efforts are taken to improve efficiency, that potential performance will not be competitive, some action should be taken, if not the continuous drain of resources experienced in the past will be everpresent, and the enterprise will stand always at a net loss (note that 70% - 80% of value added is imported anyway).

Fertilizer Production References:

1. Servicios Tecnicos, FERTICA: Planta Carrizal, Manual Descriptivo de Planta, FERTICA, Puntarenas, 1982.

2. CODESA: 385-80 (Board Meeting Report), 29 Feb. 1980.

3. Vega, M.: La Politica de CODESA durante el Gobierno de Carazo, IICE, UCR, San Jose, 1984.

4. CODESA: Memoria Anual 1981.

5. Interview with Ing. Rafael Lee, Plant Engineer, FERTICA, April, 1985.

6. CODESA: Memoria Anual 1983.

7. Comision Nacional para la Reestructuracion de CODESA: Informe Preliminar para el Presidente de la Republica, April, 1986.

8. Mulckhuyse, Venkataram, Heath: The Potential for Energy Efficiency in the Fertilizer Industry, World Bank Technical Paper No. 35, Washington D.C., 1985.

9. CODESA: Memoria Anual 1984.

10. Dahlman, Ross-Larson, Westphal: Managing Technological Development, World Bank Staff Working Paper No. 717, Washington D.C., 1985.

11. Llorente, J.C.: "*Alcohol como Combustible Alternativo*", Proceedings: Energy and Food Industry International Symposium, Madrid, 1980.

4. Aluminium

4. ALUMINIUM PROCESSING:

4.1 Introduction:

4.1.1 Presentation

4.1.2 The Aluminium Business

4.2 Integration Potential:

4.2.1 Backward Linkage

4.2.1.a Cost of Infrastructure
4.2.1.b Technological Complexity
4.2.1.c Comparative Analysis of Deposits
4.2.1.d Summary

4.2.2 Forward Linkage

4.3 Conclusion:

4.1 Introduction:

4.1.1 Presentation:

CODESA's aluminium semi-processing plant, ALUNASA, is located some 100 kms. west of San Jose, near Puntarenas, the country's most important Pacific port. The range of products it manufactures is constituted mainly by intermediate goods which serve as inputs for other industries in Costa Rica (forward linkage), as well as in Central America (30% of production) and the U.S.A. (70%).*(1)* Its installed capacity is of ~36,000 MT/yr. of finished product (discs, sheet, foil, tubing, extrusion pellets, etc.).*(1)*

Because none of its raw materials are produced locally (Al ingot, genrex lubricants for the industrial process, alloy constituents, etc.), the company depends on foreign sources for its input requirements. Its production costs are divided into the following categories:*(2)*

Raw materials - 90-95%

Variable costs and labour - 2-4%

Interest Charges - 2-5%

As can be seen, the company's situation in this respect is similar to that of FERTICA (Chapter 3), suffering as the latter of a chronic shortage of working capital.

4.1 Introduction:

4.1.1 Presentation:

CODESA's aluminium semi-processing plant, ALUNASA, is located some 100 kms. west of San Jose, near Puntarenas, the country's most important Pacific port. The range of products it manufactures is constituted mainly by intermediate goods which serve as inputs for other industries in Costa Rica (forward linkage), as well as in Central America (30% of production) and the U.S.A. (70%).*(1)* Its installed capacity is of ~36,000 MT/yr. of finished product (discs, sheet, foil, tubing, extrusion pellets, etc.).*(1)*

Because none of its raw materials are produced locally (Al ingot, genrex lubricants for the industrial process, alloy constituents, etc.), the company depends on foreign sources for its input requirements. Its production costs are divided into the following categories:*(2)*

Raw materials - 90-95%

Variable costs and labour - 2-4%

Interest Charges - 2-5%

As can be seen, the company's situation in this respect is similar to that of FERTICA (Chapter 3), suffering as the latter of a chronic shortage of working capital.

Another worrying factor is that of its value added situation. According to the plant's management *(3)* the levels of value added at present (1985) are extremely low: purchasing Al ingots at around ~$1300/ton (up to $400 above the international market quotations); incurring in ~$200/ton of production costs; and selling at between $1,500/ton and $1,800/ton (sole supplier which is also sole purchaser); this means that in repeated occasions the company gains nothing from the transactions.

4.1.2 The Aluminium Business:

The aluminium industry worldwide is divided into four separate areas depending on the stage of production. These are:

1. Refining:

Mining of Bauxite --> Aluminium Ingot

2. Intermediate Processing:

Aluminium Ingot --> Semi-processed Aluminium Alloys

3. Manufacturing:

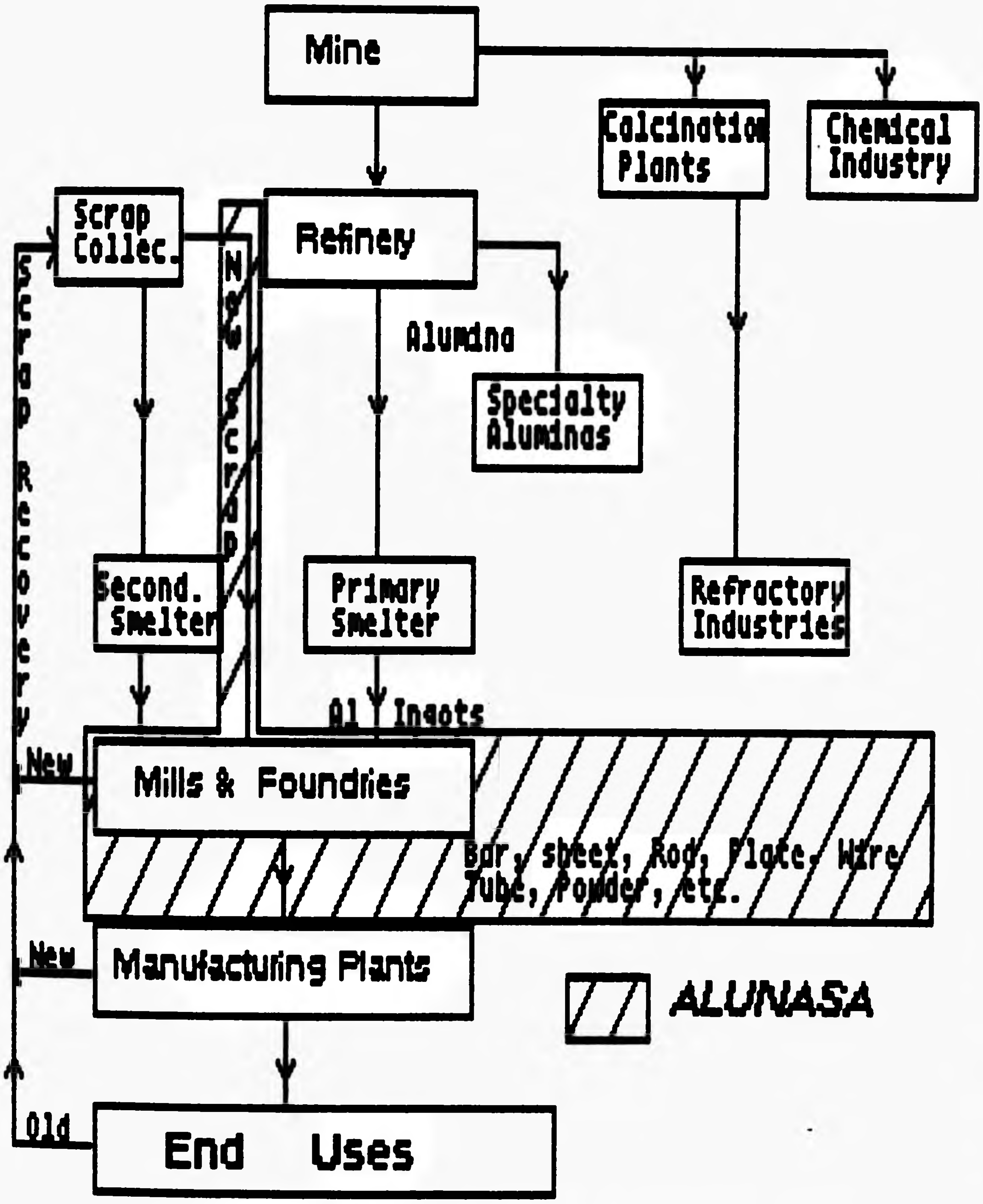
Semi-alloys --> Finished Products

4. Recovery:

Old and New Scrap --> Aluminium Ingot

Large companies in the past have chosen vertical integration of the steps presented above as the most viable way of operating in the industry. Through this policy, six companies control nowadays over sixty percent of the refining business and approximately fifty percent of the aluminium business as a whole. These companies are, three American: The Aluminum Company of America (ALCOA), Reynolds Metals, and The Kaiser Aluminum and Chemical Company; one Canadian: Alcan Aluminium Ltd. (parent company of British Aluminium); one French: Pechiney S.A. (a nationalized enterprise); and one Swiss: Schweizrische Aluminium A.G. (ALUSUISSE: this is the only one with a Costa Rican subsidiary: Swiss Aluminium Mining of Costa Rica S.A.).*(4,5)*

Below I present a diagram which describes the industry's activities in more detail. Also, I have included the scope of ALUNASA's operation within this frame of reference.*(4)*



PLANTS OF THE ALUMINIUM INDUSTRY [4]

As can be seen from the graph, the company to the present day has limited its field to the production of semi-processed alloys (that is discs, sheets, rolls, pellets, foil, etc., of various alloy denominations), with the exception of some simple final products: tubing, roofing (only plates, since the shaping is carried out at METALCO, the largest producer of metal roofing sheets in the country), and domestic paper foil (distributed by a number of private companies, with no mention of ALUNASA on the package). As a result of this, the company appears to be in a very delicate strategic position. It follows from such an argument, that integration of some sort would prove to be an important competitive improvement. The following paragraphs are devoted to the analysis of this possibility, within the national scene.

4.2 Integration Potential:

4.2.1 Backward Linkages:

The exploitation of bauxite deposits in the region of El General in the South Pacific region of Costa Rica has been discussed for many years. Since 1951, ALCOA secured an exploration and exploitation license.

In 1968, congress discussed and rejected a proposal put forward by this company for the construction of a

As can be seen from the graph, the company to the present day has limited its field to the production of semi-processed alloys (that is discs, sheets, rolls, pellets, foil, etc., of various alloy denominations), with the exception of some simple final products: tubing, roofing (only plates, since the shaping is carried out at METALCO, the largest producer of metal roofing sheets in the country), and domestic paper foil (distributed by a number of private companies, with no mention of ALUNASA on the package). As a result of this, the company appears to be in a very delicate strategic position. It follows from such an argument, that integration of some sort would prove to be an important competitive improvement. The following paragraphs are devoted to the analysis of this possibility, within the national scene.

4.2 Integration Potential:

4.2.1 Backward Linkage:

The exploitation of bauxite deposits in the region of El General in the South Pacific region of Costa Rica has been discussed for many years. Since 1951, ALCOA secured an exploration and exploitation license.

In 1968, congress discussed and rejected a proposal put forward by this company for the construction of a

As can be seen from the graph, the company to the present day has limited its field to the production of semi-processed alloys (that is discs, sheets, rolls, pellets, foil, etc., of various alloy denominations), with the exception of some simple final products: tubing, roofing (only plates, since the shaping is carried out at METALCO, the largest producer of metal roofing sheets in the country), and domestic paper foil (distributed by a number of private companies, with no mention of ALUNASA on the package). As a result of this, the company appears to be in a very delicate strategic position. It follows from such an argument, that integration of some sort would prove to be an important competitive improvement. The following paragraphs are devoted to the analysis of this possibility, within the national scene.

4.2 Integration Potential:

4.2.1 Backward Linkages

The exploitation of bauxite deposits in the region of El General in the South Pacific region of Costa Rica has been discussed for many years. Since 1951, ALCOA secured an exploration and exploitation license.

In 1968, congress discussed and rejected a proposal put forward by this company for the construction of a

forty thousand metric ton alumina plant.

Later, in 1973 a task force was formed by members of ICE (the national utility company), CODESA, and the Ministry of Economic Policy and Planning to study the case for a bauxite to aluminium ingot conversion process in the region. The limiting factor in that occasion, which prevented further advancement towards the project phase, was the cost of the energy infrastructure required. Being an energy intensive application, a new hydroelectric generating installation (code named BORUCA, approx. 850,000 kw capacity), had to be built at a cost estimated at around C2,000 million (approx. US$300 million) of 1972.*(6)*

Further developments involved the decision by ALCOA to withdraw from the country in 1976, after twenty five years of holding the rights to exploit the bauxite deposits. At this point the rights were transferred to CODESA which set out to study the feasibilty of an exploitaton program.

During 1977-78, technical assistance was provided by the government of Romania, through its representative METARON. After surveying the land in question, a series of reports were produced (as part of a comprehensive techno-economic study) which concluded that at the time, exploitation was economically viable.*(7)*

Concurrently, Techmo-Hunter Engineering, an Italian company proposed the construction of the present installations of ALUNASA, a stage 2 semi-processing plant. CODESA's management at the time decided to postpone the exploitation program, for the same infrastructural considerations as before.

At present, because of new developments in the world bauxite picture, backward linkage appears to be out of the question for three main reasons: cost of infrastructure, technological complexity, and quality of the ore. The following lines will cover all these subjects separately.

4.2.1.a Cost of Infrastructure:

As was stated earlier, the construction of an 850,000 kw hydroelectric power plant is a technically feasible proposition in the region of El General, using the waters of the Rio Grande de Terraba, and enclosing the largest available hydrographic basin in the country. In fact, since the sixties, the construction of such a facility has been discussed nationally.

Because of its large scale, by Costa Rican standards, such a plant would at present double the installed electric capability, resulting inevitably in excess potential. (At present the hydroelectric capacity stands at approximately 624,170 kw, with two medium sized plants Ventanas I and II coming on stream in the near future. Total capacity, including diesel powered and minor plants stands at around 780,000 kw. With the contributions of the two Ventanas plants as well as the Geothermal project at Miravalles Volcano the revised capacity would reach approximately 900,000 kw - as can be seen from the following chart. *(8)*

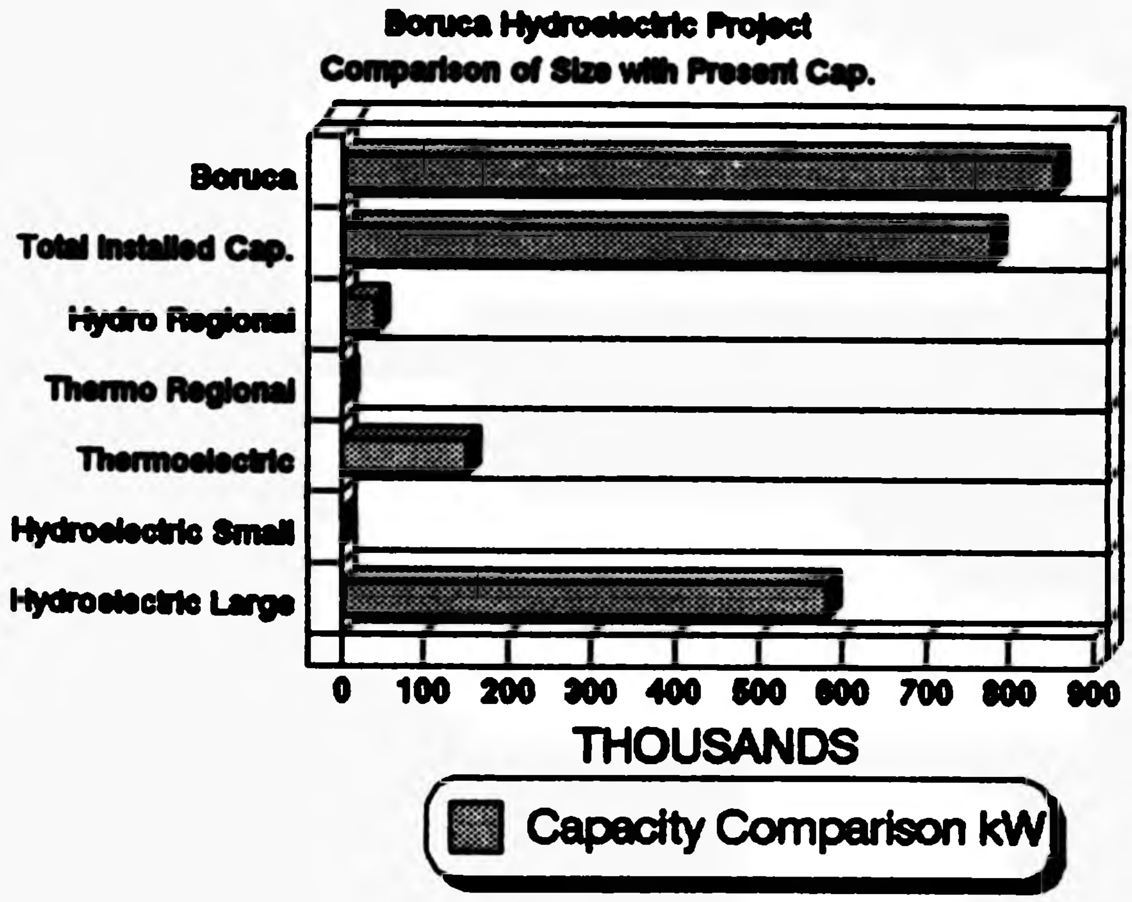


Table 4.2.1.a Costa Rica: Electricity Generating Capacity

Plant Type:	Inst.Cap kW
Hydroelectric Large	582200
Hydroelectric Small	1471
Thermoelectric	151552
Thermo Regional	3285
Hydro Regional	40500
Total Installed	799008
Boruca	850000

The construction of BORUCA would therefore yield a substantial overcapacity situation, which could be utilized for other economic purposes apart from supporting the national grid. Following this argument, we see that according to the World Bank report cited before *(4)*, up to 35,540 gigawatt hours/year could be devoted to the transformation of bauxite into aluminium, a quite extraordinary figure when we consider the country's land area. (Please refer to accompanying chart)*(4)*:

Table 4.2.1.b

Undeveloped Energy Resources (GW hrs/yr.)

Regions	Hydropower	Flared Gas	Coal
USA West			
USA East			
Canada West	131400		
Canada East			
Jamaica			
Mexico	15080	18200	
Costa Rica	35540		
Guyana	17400		
Suriname	4400		
Argent./Chile/Peru	267800		
Brazil	261640		
Venezuela	50576		
W. Europe			

E. Europe			
Asian USSR	48000		
New Guinea	145610		
Australia			16000000
ASEAN	120340	14700	
Korea/Taiwan			
China	17300		
Japan			
India	161540		
Rest Asia	42410		
Middle East		315600	
N. Africa		39500	
Ghana/W.Africa	153000	97400	
Guinea	56064		
Zaire	109000		
Rest E. Africa			
S. Africa			

Unfortunately, the same report offers a word of caution with respect to the effect massive infrastructural costs could have on the feasibility of extraction and refining projects in underdeveloped areas. It stresses that even if the quality and size of the bauxite deposits are satisfactory, a very close study into the extent of the infrastructural work required is in order. This element alone could prove the project uneconomical, especially in LDC's.

It may well be the case that this limitation is very relevant in this particular instance due to the country's poor standing with respect to our National External Debt and Balance of Payments situation (since most of the infrastructure would have to be imported), two conditions which have severely reduced the government's investment programs.

Due to the above, further investigation into the other two variables presented before: technological complexity of the process, as well as the comparative standing of the ore deposits, is important.

4.2.1.b Technological Complexity:

In the next few paragraphs a description of the conversion process: soil rich in bauxite content to aluminium ingot (stage 1) is presented. From this discussion, it can be observed that considerable expertise is required to manage such an enterprise. Costa Rica , as a new entrant into an environment controlled by transnational corporations with vast experience in the business, would encounter serious difficulties in establishing an extraction complex on its own. Most likely, extensive assistance from abroad, either by collaboration with the TNC's, or by direct government assistance from experienced producers would be required. In summary, without a joint venture of some kind, to ensure an adequate medium for technological transfer, the proposal is not likely to succeed.

Description of Stage 1: (4)

(Mining of bauxite, separation of soil and bauxite, yield of alumina (Al)2 (O)3, production of aluminium)

Step A: Mining for the ore is usually through open pit operations (strip mining) with the exception of France, Greece, Turkey, and Hungary, which have underground resources.

Step B: Separation of soil and bauxite by physical processes involving crushing, drying and beneficiation (wet process) to increase alumina content and reduce silica and iron presence (unwanted impurities). An added cost here involves the replacement of overburden to original sites, so that the land can subsequently be used for forestry or agriculture. (The richest soils are those closer to the surface). If indiscriminate mining took place severe ecological damage would be caused: infertile lands, erosion, etc.

Step C: Yield of alumina (Al)2 (O)3 from bauxite (refining). This process involves two plants working in series:

1. Hydrate facility: transforms bauxite into alumina hydrate in four stages:

a. Grinding and slurring: During this period, ore is crushed in ball or rod mills, adding later caustic soda, lime and hot water, in order to separate impurities (consumption of caustic soda depends on silica content).

b. Digestion: At this point, the slurry (bauxite and caustic soda) resulting from the previous stage, is dissolved through the Bayer process forming (NaAl)(O)2. Three variations of this process exist depending on the solubility of the ore used: the American Bayer process requires relatively low temperature levels of approx. 290'C, and is used for easily soluble gibbsite (tryhydrate) ores; the European Bayer process on the other hand, utilizes much higher temperature levels of ~490'C and is designed for more difficult ores such as boehmite (monohydrate); finally, somewhere in the middle of these two extreme conditions, lies the modified American Bayer process designed to handle mixed ores (mainly gibbsite with some boehmite).

c. Filtration: Next, a filtration and settling of insoluble impurities takes place, to separate these from the (NaAl)(O)2 (red mud).

d. Precipitation: After the sodium aluminate (NaAl)(O)2 has been concentrated, it is seeded with aluminium hydrate which causes the alumina to dissociate from the soda and precipitate as alumina hydrate crystals (Al)2(O)3 3(H)2O or (Al)2(O)3 (H)2O.

2. Calcination Plant:

Finally, tha alumina hydrate is transferred to the calcination unit where it is treated for the removal of moisture as well as the chemical OH bond by exposing the hydrate to high temperatures in the region of 1150'C - 1250'C using fluid bed calciners (which have replaced rotary kilns similar to the principle found in the production of klinker in cement factories). The final product of these two plants is alumina (Al)2(O)3, the input material to aluminium smelting plants.

Step D: Aluminium Smelting: The aluminium is obtained by the electrolysis of alumina (Al)2(O)3 to separate the oxygen from the metal. (This process is called the Hall-He'roult process).It is here where electricity is a major input. Concern over the levels of consumption of this energy source by the two currently used reduction methods: pre-baked anode plants and Soderberg anode plants, has led to the development of less electricity dependent methods such as the ALCOA smelting process. This process involves the chlorination of alumina and posterior electrolysis of the aluminium chloride, which has reduced electricity consumption by up to 20% (this process has not yet been applied commercially).

After the aluminium has been separated, it is cast into different molds, and the ingots resulting from this are sent of to semi-processing plants.

4.2.1.c Comparative Analysis of Deposits:

The final element to be scrutinized in relation to backward linkage of ALUNASA's current operation is that of the status of the ore available in Costa Rica. For this I have chosen to compare general characteristics of the country's deposits with those of other regions worldwide.

The important variables considered are: economic reserves, bauxite-alumina ratio, strip ratio (bauxite to soil), type of ore, and silica content.

The regions surveyed (included in the World Bank report) cover enough supply for over one hundred years of projected world consumption.

With respect to the size of the proven reserves established by METARON *(7)*, i.e., 78.5 million metric tonnes, the Costa Rican site ranks 30th among those chosen (larger only than the United States Arkansas reserves, some European locations (Turkey and France), one in Haiti, and one in Ghana). Furthermore, it must be noted that regional competition from Brazil, Guyana, Jamaica, and Suriname, with deposits five to forty times larger, would be overwhelming.

In relation to the alumina yield from the extracted bauxite, El General ranks 34th among 35. It must be said, though, that the spread of the yield values is not very great, with the best figure standing at 2:1 for Guyana, 3:1 for Costa Rica, and 3.4:1 for the Darling Ranges in Western Australia.

Table 4.2.1.c Comparison of Bauxite Deposits Worldwide (4)

Bauxite Site	Econ Reserves (Million MT)	Bauxite/Alumina Ratio	Strip Ratio % % Bauxite
Arkansas USA	40.00	2.20	25.00
Jamaica Site A	1,050.00	2.40	100.00
Jamaica Site B	542.00	2.70	100.00
Haiti/Dom.Rep.	50.00	2.70	100.00
COSTA RICA	78.50	3.00	
Guyana	700.00	2.00	33.30
Suriname A	390.00	2.10	50.00
Suriname B	100.00	2.50	100.00
Brazil	4,070.00	2.10	33.30
Venezuela	500.00	2.10	50.00
Greece	700.00	2.50	25.00
Yugoslavia	460.00	2.40	28.60
France	40.00	2.40	25.00
Hungary	300.00	2.50	25.00
USSR	300.00	2.50	25.00
Australia A	300.00	2.20	100.00
Australia B	3,100.00	2.20	100.00
W. Australia	1,200.00	3.40	100.00
India	600.00	2.40	100.00
Indonesia	700.00	2.20	100.00
China	200.00	2.50	100.00
Malaysia	100.00	2.40	50.00
Turkey	30.00	2.40	50.00
Ghana A	250.00	2.20	50.00
Ghana B	50.00	2.20	50.00
Ghana C	200.00	2.20	50.00
Guinea A	2,500.00	2.30	100.00
Guinea B	1,000.00	2.30	100.00
Guinea C	500.00	2.30	100.00
Guinea D	500.00	2.40	100.00
Guinea E	700.00	2.40	100.00
Guinea F	300.00	2.40	100.00
Sierra Leone A	150.00	2.20	100.00
Sierra Leone B	150.00	2.20	100.00
Cameroun	1,020.00	2.30	100.00

Table 4.2.1.d: Rank of Bauxite Deposits by Size:

RANK:	Economic Reserves:
Brazil	4,070.00
Australia B	3,100.00
Guinea A	2,500.00
W. Australia	1,200.00
Jamaica Site A	1,050.00
Cameroun	1,020.00
Guinea B	1,000.00
Indonesia	700.00
Guyana	700.00
Guinea E	700.00
Greece	700.00
India	600.00
Jamaica Site B	542.00
Guinea D	500.00
Venezuela	500.00
Guinea C	500.00
Yugoslavia	460.00
Suriname A	390.00
Guinea F	300.00
Hungary	300.00
USSR	300.00
Australia A	300.00
Ghana A	250.00
China	200.00
Ghana C	200.00
Sierra Leone A	150.00
Sierra Leone B	150.00
Malaysia	100.00
Suriname B	100.00
COSTA RICA	78.50
Haiti/Dom.Rep.	50.00
Ghana B	50.00
France	40.00
Arkansas USA	40.00
Turkey	30.00

Table 4.2.1.e: Rank of Bauxite Deposits by Quality

RANK	Bauxite/Alumina Ratio
Guyana	2.00
Brazil	2.10
Venezuela	2.10
Suriname A	2.10
Ghana B	2.20
Arkansas USA	2.20
Australia B	2.20
Indonesia	2.20
Ghana A	2.20
Sierra Leone B	2.20
Sierra Leone A	2.20
Australia A	2.20
Ghana C	2.20
Cameroun	2.30
Guinea C	2.30
Guinea A	2.30
Guinea B	2.30
Yugoslavia	2.40
India	2.40
Jamaica Site A	2.40
Guinea F	2.40
Guinea E	2.40
Malaysia	2.40
France	2.40
Guinea D	2.40
Turkey	2.40
Hungary	2.50
China	2.50
Greece	2.50
USSR	2.50
Suriname B	2.50
Haiti/Dom.Rep.	2.70
Jamaica Site B	2.70
COSTA RICA	3.00
W. Australia	3.40

Looking at the silica content, we find values ranging from negligible concentrations to a maximum of 15% at Arkansas. Costa Rica at 7.5% silica presence ranks above the average content, with values in the region of 2.5% to 4.5% being the more common occurences.

> "The consumption of caustic soda depends principally on the reactive silica content and mud washing losses, with an average of 1.4 kilogrammes of soda (as NaOH) per kilogramme of reactive silica" p. 12 *(4)*.

Note: No information is available on the type of ore present in the region (which would determine the Bayer process to be used). Nevertheless, being an American site, it will probably consist primarily of trihydrate gibbsite (soft - American Bayer process) material, similar to that found in Guyana, Suriname, Venezuela, Arkansas, Jamaica and Brazil. No information was available regarding strip ratios for Costa Rica.

4.2.1.d Summary:

As can be seen from the previous pages, backward linkage does not seem to be an attractive alternative for ALUNASA. Unfortunately for the foreseeable future, the company will have to rely on outside sources to secure the inputs to its process. It is clear that, as will be discussed later, the possibility of adding more value, (i.e., processing the aluminium further than the semi- stage, to final products) to its product lines could be a better approach in the progression towards a more stable strategic position. With respect to the supply of raw materials, some agreement with smelters in the area would be beneficial. Along these lines, little success has been attained, having the company to purchase its ingots from a single supplier: Aluminios El Caroni from Venezuela, an affiliate company of Reynolds Metals *(5)*. Another possibility would be the construction of a smelting plant for the process of foreign regional ore (from Jamaica, Haiti, and Dominican Republic for example) and thereby utilize the underdeveloped electricity potential, the only undeniable asset of the region: *(4)*

> "Primary aluminum production is energy intensive, approximately 13,500 kwh of electricity being required to produce one metric ton of aluminum"..."the availability of sufficient supplies of low cost energy is one of the critical factors determining the location of smelters. A large number of smelters built before the 1973 energy crisis are located in industrial countries"..."these trends point toward a shift in aluminum industry patterns: new smelters will be located in regions with untapped energy sources which have little or no alternative uses, as may be the case of hydropower, flared gas and low quality coal." p. 5 (4)

(Please note that available energy potential is much greater than that of Jamaica, Guyana, Suriname, etc.)

4.2.2 Forward Linkages

The following chart presents a percentage distribution of the consumption of aluminium end products by various sectors of the world's economy. This represents an important guideline in the analysis of which product lines might offer more potential in the future.

Consumption of Aluminium by end Uses, 1980 (4):

(Metallgesellschaft, "Metal Stats. 1971 - 1981)

	Western Europe	Japan	U.S.A.	World Average
	(%)			
Transport	27.9	26.1	19.3	22.8
Mechanical Engineering	6.8	4.8	5.4	5.6
Electrical Engineering	10.4	10.1	11.1	10.6
Building & Construction	18.3	32.9	21.4	22.9
Packing	9.7	6.0	27.8	18.3
Domestic & Office App.	8.5	5.5	6.3	6.6
Metal Ind. & Misc.	18,4	14.6	8.7	13.2

Of the most relevant categories (transport, electrical engineering, building and construction, and packaging), two offer interesting possibilities: electric cable, and packaging products, because of their relatively uncomplicated further processing, and readily available applications.

Aluminium, because of its low cost and low weight, has replaced copper in many general wiring applications. While copper has higher conductivity values per surface area, aluminium has better performance per weight and cost:

> "although aluminum's conductivity is only 60% of that of copper, due to its low density, an electric transmission line made of aluminum weighs only 48% of an equivalent copper line" p. 14 (4).

The second proposal, that of packaging, plays a two fold purpose. The first has already been discussed (contributing to value added performance). The company already produces "end product" domestic aluminium foil (though it does not distribute it, loosing therefore substantial profit potential: supermarket prices are at least 100% higher than ALUNASA's rate, this according to company officials interviewed in April 1985), which it could easily convert into a large range of packaging forms, "vaccuum sealed", for example. The second involves the possibility of developing to some extent, a stage four (recovery) operation, recycling used scrap to the ALUNASA mills for reprocessing, thereby reducing the dependence on imported raw materials. Such practice has had important effect in developed countries such as the U.S., Western Europe, and more importantly in Japan where more than one third of the consumption comes from scrap recovery, as can be seen from the accompanying chart:

Estimates of Aluminium Consumption - Low Case

(World Bureau of Metal Statistics (4))

('000s metric tonnes, 1985)

	Primary Consump.	Scrap Recovery	Total Consump.	Scrap/Total (%)
U.S.A.	6,022	1,968	8,000	24.6
W. Europe	4,240	1,542	5,782	26.7
Japan	1,891	934	2,825	33.10

4.3 Conclusion:

Having reviewed the strategic options open to ALUNASA, it is apparent that the main areas to be attacked are: increasing the contribution of value added into the company's operation, and procuring a better position with respect to its source of raw materials.

It may well be the case, that the element which has to be encouraged is that of technological capability, so that exploitable areas can be identified and their potential realized. Technological advantage is required to study the potential of the household "utensil" process present in the plant (currently stopped), to guide the introduction of new products, to penetrate new export markets, etc. Finally, technological and management knowhow are essential to capitalize on the opportunities available to the company (contrary to the case of aluminium foil, discussed earlier).

Aluminium References:

1. Paolo Boano: "*Alumasa: Situacion Actual y Perspectivas Futuras*", New Hunter Engineering (Manufacturers of plant), Milan, Italy, 1985.

2. Roberts CP: "*Estudio de Viabilidad Tecnologica, Economica y Financiera de Alumasa*", Cougar Metals International, San Jose, 28 June, 1983.

3. Interview with Mr. David Valderrama, Plant Administrative Director, April, 1985.

4. Brown, Dammert, Meerans, Stoutjesdijk: Worldwide Investment Analysis: The Case of Aluminum, World Bank Staff Working Paper No. 603, 1983.

5. Who Owns Who in N. America, Europe, UK, 1985 Edition.

6. Codesa: Sesion de Junta Directiva No. 9 (Summary), 1973.

7. Codesa: Codesa en la Actividad Minera, Serie Informes y Estudios No. 2, San Jose, 1984.

8. ICE: Plantas Electricas de Costa Rica (leaflet), 1985.

5. Alcohol

5. Alcohol Production

5.1 INTRODUCTION: Catsa's Present Position

5.1.1 Presentation:

The Central Azucarera del Tempisque S.A., CATSA, is CODESA's exponent in the agroindustrial field. The production site is located near the Tempisque River in Guardia, Province of Guanacaste, some 350 kilometres Northwest of the capital city of San Jose, and is capable of producing sugar, molasses and most important, alcohol, through a combined sugar cane mill/distillery layout. The plant's capacity is of ~5,800 MT/sugar cane input / day and 240,000 litres of ethanol output / day.

5.1.2 Financial Position: (1)

CATSA's position at present is by no means encouraging. Indeed, its standing is so poor, that if the company was to operate on its own (without the Government's backing), it would need to file for bankruptcy:

In the short term, the company faces a negative working capital of -CR C137 million ~ -£1.6 million (reduced by -CR C103 million in the past ten months of financial year 1985), caused by current losses of -CR C58 million ~ -£680,000, as well as a decrease in receivables.

In the long term, Catsa has a debt of CR C673 million (~ £7.9 million), the equivalent of 81.3 % of total assets historical value of CR C828 million (~ £9.75 million). Of these, CR C665 are owed to CODESA mainly for the purchase of plant, on either low, (8% for CR C523 million) or no (0% for the rest) interest terms. Finally, the firm has overdue debt payments for CR C161 with Headquarters (CR C86 from interest charges and CR C75 from amortization) and CR C4 million with other creditors.

It has to be said at this point that a number of strategic problems (most of them beyond the company'control) have contributed negatively to the current financial crisis. The first of these is related with the substantial drop in the price of sugar, the most readily available output from the plant. This fact can be corroborated by looking up the IMF's International Financial Statistics. *(2)*

Table 5.1.2.a: Sugar Prices End of Year 1965 - 1981, 1985:

Period	Price/lb. (US cents)
1965	5.82
1966	5.94
1967	5.63
1968	5.09
1969	5.09
1970	5.09
1971	5.31
1972	6.43
1973	6.47
1974	14.56
1975	23.71
1976	11.39
1977	13.16
1978	15.87
1979	19.65
1980	24.00
1981	18.47
1985	~3.0

Analyzing a rough costing estimate provided by the National Sugar Producers League (LAICA), in February 1985, *(3)* we see the following:

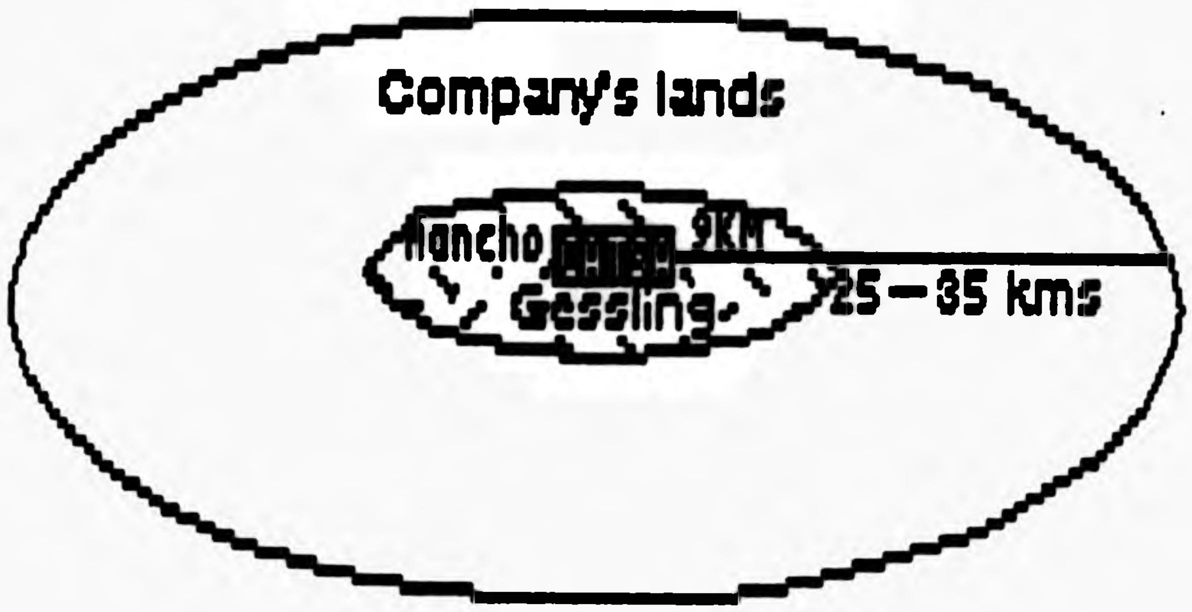
The average cost of production for a bag of 100 lbs. in Costa Rica is approximately US$10.50. This is contrasted by a world (non-quota) price which has fluctuated between ~US$0.03/lb and US$0.06/lb FOB (free on board) at Caribbean port during the last six months of 1985 *(4)*. The result of exporting sugar under the above conditions would mean a loss of between US$7.50 and US$4.50 per 100 lbs. bag shipped. Unfortunately, the scene is not likely to change for the better according to various recent reports, due to continued overproduction in many countries worldwide. *(5)*

The second problem observed is that of the legal complications which have delayed the expropriation of lands surrounding the industrial site which were to be planted with sugar cane for the process. At present, due to this debate, Catsa has to transport its raw materials from at least 9kms, according to the plant's management *(6)*, a figure which is very significant if we note that in the Brazilian example *(7)*, the feasible limit for vinhoto (outflow of the process) utilization as fertilizer using tanker trucks is restricted in the best of cases to between 25 and 34 kms (7, p.50), of which this 9 kms radius area would represent the most suitable ~10% of the land available.

contrasted by a world (non-quota) price which has fluctuated between ~US$0.03/lb and US$0.06/lb FOB (free on board) at Caribbean port during the last six months of 1985 *(4)*. The result of exporting sugar under the above conditions would mean a loss of between US$7.50 and US$4.50 per 100 lbs. bag shipped. Unfortunately, the scene is not likely to change for the better according to various recent reports, due to continued overproduction in many countries worldwide. *(5)*

The second problem observed is that of the legal complications which have delayed the expropriation of lands surrounding the industrial site which were to be planted with sugar cane for the process. At present, due to this debate, Catsa has to transport its raw materials from at least 9kms, according to the plant's management *(6)*, a figure which is very significant if we note that in the Brazilian example *(7)*, the feasible limit for vinhoto (outflow of the process) utilization as fertilizer using tanker trucks is restricted in the best of cases to between 25 and 34 kms (7, p.50), of which this 9 kms radius area would represent the most suitable ~10% of the land available.

Catsa: Land Situation



The third negative characteristic lies in the inability due to various internal and external conditions, to secure the establishment of higher value added applications for the second possible output, alcohol:

1. The failure of the gasohol program during the Carazo Administration 1978-1982, as well as the suspension of further action along those lines ever since.

2. The limitation of being unable to produce beverages (liquor) using the anhydrous ethanol 99.8% pure distillation process base, due mainly to the monopoly situation that exists in favour of the Fabrica Nacional de Licores.

3. The lack of downstream

activities using ethanol as their feedstock for the production of ethylene and its derived family of materials, for example.

Because of the above, the company has limited its operation to the export of anhydrous ethanol to the United States to be used there for exactly the same application as described in the last paragraph (No.3). The contribution received from this arrangement is marginally positive as can be seen from the preliminary values provided by both LAICA and Catsa's plant management during 1985 *(3,6,8)*:

1. Marginal Cost of production/38 litres (equiv. to 100 lbs/sugar)

   = US$12.00/38 litres or US$0.32/litre.

2. Sale Price by Catsa = CR C18.50/litre ~US$0.34/litre FOB at Puerto Punta Morales.

This represents a negligible margin which is not enough to offset the debt burden faced by the company, but under the current limited scenario, it is better than exporting sugar at surplus (non-quota) prices.

The following sections concentrate on the study of alternative approaches which could yield better prospects for Catsa.

5.2 Brief Description of the Process:

5.2.1 Sugar Mill:

This plant was purchased second-hand from Puerto Rico during the Oduber Administration (1974-1978), in an attempt to encourage the sugar cane activity in the region.

The milling capacity (according to plant management) is of 6,000 tons/day, producing as alternative outputs sugar and molasses, or "sugar cane wine" for the distillery. Apart from this, the crushed solid residue called bagasse is recycled to be used as fuel to fire the boilers which run the whole operation.

5.2.2 Distillery:

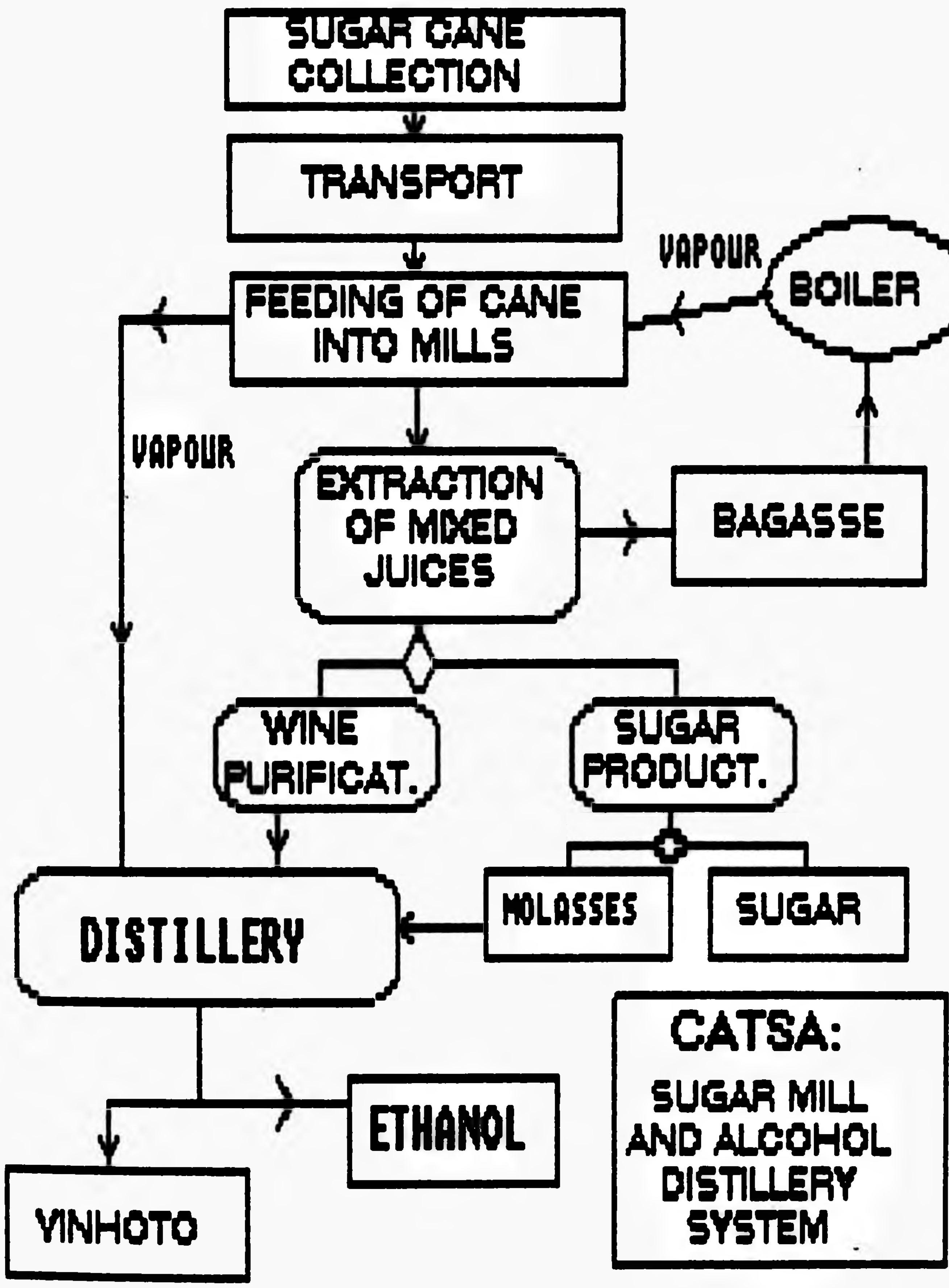
Further plans to develop an agroindustrial installation producing alcohol were considered at the time, for which assistance was secured from the Brazilian government to study the feasibility of establishing a gasohol program in the country.

This led up to the purchase of a

distillery from a Brazilian industrial firm, Zannini Equipamentos Pesados *(11)*, with a fermenting capacity of 5,850 tons of wine/day and a nominal distilling capacity of 240,000 litres/day (though up to 390,000 litres/day have been attained through the introduction of minor modifications to the process). The bottle-neck of the plant, according to the plant's management, is found at the fermentation stage which currently takes approximately six hours to complete.

5.2.3 Other Installations:

Additional investment was required for distribution pipelines (from the sugar mill to the distillery, and to and from raw materials and finished product reservoirs), as well as deposit tanks both for raw materials from other sugar mills (molasses) and for final product awaiting shipment (anhydrous ethanol). Below a graph describing in general terms the distillation process is presented. (An integrated diagram of the whole complex is provided in the appendix.)


SUGAR CANE COLLECTION
TRANSPORT
FEEDING OF CANE INTO MILLS
VAPOUR
BOILER
VAPOUR
EXTRACTION OF MIXED JUICES
BAGASSE
WINE PURIFICAT.
SUGAR PRODUCT.
DISTILLERY
MOLASSES
SUGAR
ETHANOL
VINHOTO
CATSA:
SUGAR MILL AND ALCOHOL DISTILLERY SYSTEM

5.3 The Production of Alcohol from Biomass:

Having presented a brief description of CATSA's installations, I shall now concentrate on the alcohol production process. This fuel can be obtained from many sources. In our case, various crops will be evaluated, in an attempt to estimate the suitability of sugar cane as a feedstock.

5.3.1 General Aspects:

When talking about the alternative biomass inputs to the distillation process, one has to be aware of the particular characteristics of each feedstock. The main concerns involve the yield of usable energy per land area, the ease and cost of growing and harvesting each crop, and finally the intricacies of the industrial processes required to convert the raw material into usable energy (combustible liquid fuel, for example). Below, a chart is offered (9), which describes a number of these characteristics for a range of tropical vegetation (most of which can can be cropped in Costa Rica).

Table 5.3.1.a: Comparison of Biomass Sources (Ethanol):

BIOMASS		CONVERSION	BIOLOGICAL FUEL		
SPECIES	*YIELD*	*PROCESS*	*HEAT VALUE*	*YIELD*	
	T/ha		*Kcal/kg*	*li/T*	*li/ha*
Sugar cane	50	Fermentation	6400	70	3500
Cassava	25	Hydrol/Ferm	6600	180	4500
Coconut	4	Hydrol/Ferm	6400	60	240
Sweet Sorghum	45	Hydrol/Ferm	6400	70	3500
Sweet Potato	12	Hydrol/Ferm	6400	160	1920
Sugar Beet	30	Hydrol/Ferm	6400	100	3000
Native Forest	20	Hydrol/Ferm	6400	200	4000

In the present case, we will restrict the analysis only to those sources yielding ethanol as an end product, a consideration which will be explained further along in this chapter . Keeping this in mind we must realize that the first limiting variable is that of availability of good quality land to be used for energy crops . This represents a critical factor, because of the particular conditions of the Costa Rican territory: small country, abrupt topography, and relatively densely populated (this aspect has been discussed previously in Celis, R. *(10)*).

In this respect, from the table, we see that sugar cane, mandioca (also called cassava or yucca), sweet sorghum, and native forest wood present the best performance values. Next, concentrating on the production characteristics required for the transformation of each biomass source, we see that only sugar cane avoids the initial hydrolysis stage common to the other plants. This treatment is required to convert starch and cellulose into simple sugars. As a general rule, the more complex the original molecule is, the more laborious (and therefore the more expensive) this step will be.

Sugar cane is constituted as bi-saccharide molecules (saccharose). All that is required to extract usable energy from it is to separate the original molecules into mono-saccharides (dextrose) as follows:

$$C_{12}H_{22}O_{11} + H_2O \xrightarrow{enzymes} 2(C_6H_{12}O_6)$$

(saccharose)______(water)____________________(dextrose)

and subsequently convert the mono-saccharide substance into ethanol:

$$C_6H_{12}O_6 \xrightarrow{enzymes} 2(C_2H_5OH + CO_2)$$

(dextrose)___________________(ethanol)______(carbon dioxide)

distilling the alcohol to a high purity grade of 99.8%. (The yeast most commonly used for this process is *Saccharomyces cerevisiae* as explained by Lones, T. *(11)*.)

When we examine the other biomass sources nevertheless, we find that the process involved is somewhat more cumbersome.

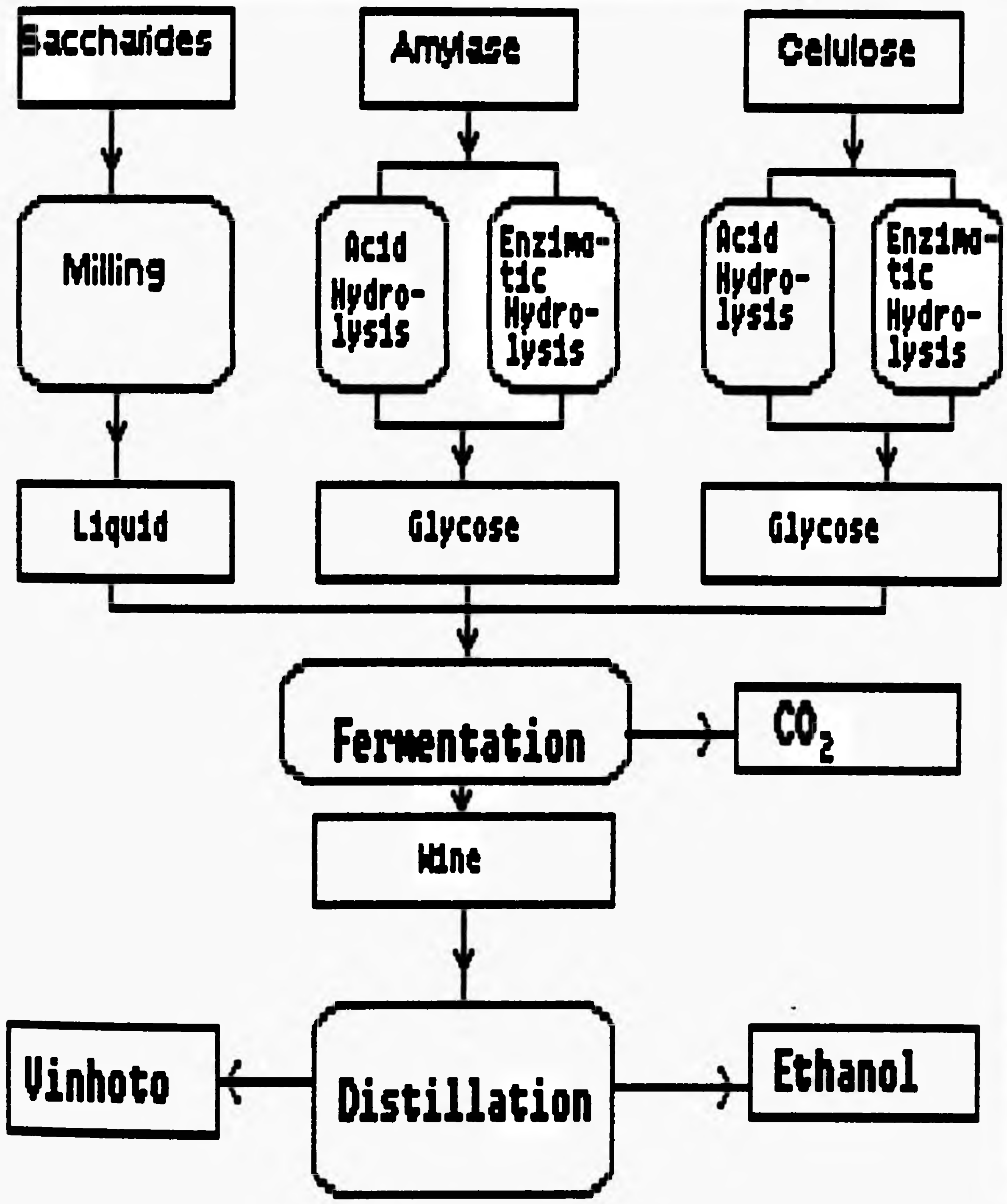
First, in the case of starchy crops, i.e., maize (corn), potatoes, sweet potatoes, cassava, etc., it is necessary to transform more complex carbohydrates (poly-saccharides) formed by multiple molecules of mono-saccharides, joined together by external bonds, into simple sugars. This is achieved, as was stated before, by a process called hydrolysis, where the starchy material is subjected to the attack of acid substances (or sometimes enzymes) in a water environment. The molecules absorb water and break, separating unwanted components from the mono-saccharides. After this, the resulting liquid may be fed into a fermenter in the same fashion as described in relation to sugar cane.

Moving on to fibrous (cellulose) plants, i.e., cotton, forest products, etc. we discover that the treatment necessary is much the same as for starch. Unfortunately, because of the more complex nature of these molecules and the greater abundance of cell wall material (cellulose, i.e., harder, more solid constitution), the conversion (hydrolysis using sulphur dioxide, *(12)* is much more difficult.

Below, I have included a graph which should help visualize the differences between each biomass source.

(From the same study named at the beginning of this section, 9).

Ethanol Production Diagram:

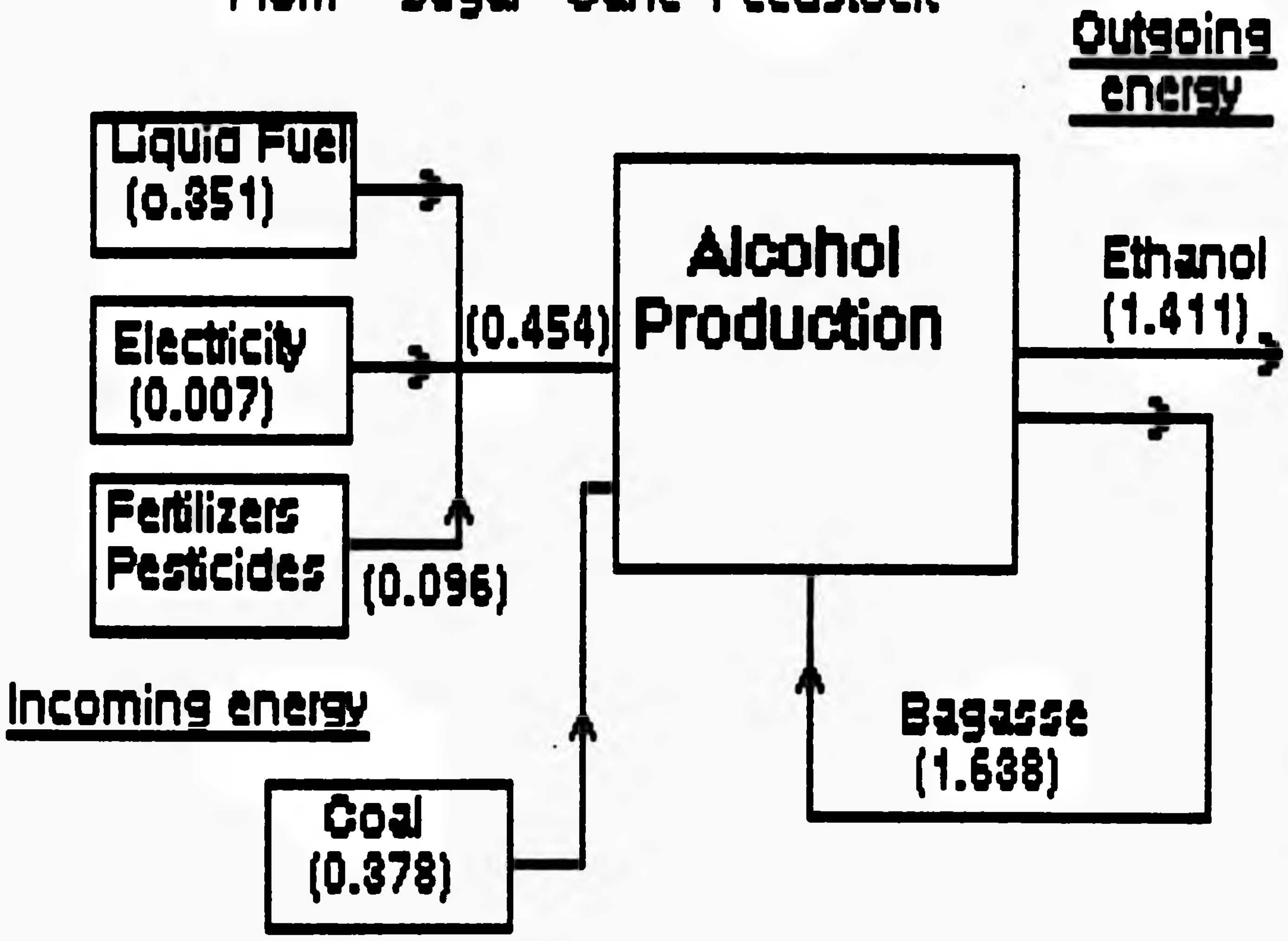


4.3.2 Sugar Cane:

Having discussed some of the characteristics of the available feedstocks for the ethanol production process, we are now ready to examine those which appear to be the most suitable for the Costa Rican case. It is clear from the last few paragraphs that sugar cane is superior to most other biomass sources for a variety of reasons: simpler industrial set-up, vast experience in the country in the agricultural side of the business, since it has been cropped for many years, etc.

Apart from the above, an added bonus is achieved when choosing sugar cane, which is not possible with its competitors (mostly because of the hydrolysis stage): a positive energy balance, *(13)*.

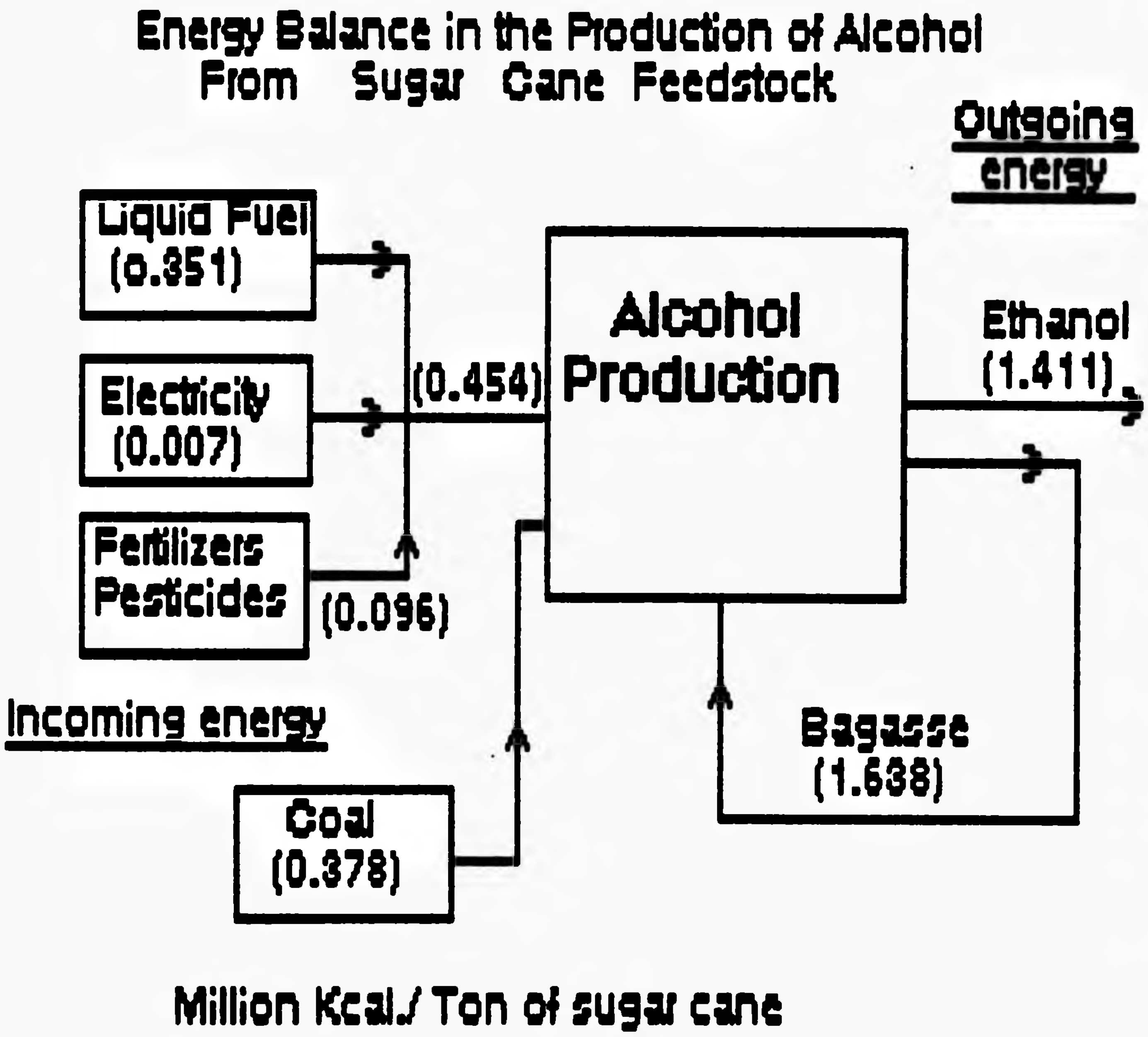
Energy Balance in the Production of Alcohol From Sugar Cane Feedstock



Million Kcal./ Ton of sugar cane

In conclusion, if possible for land and climate considerations (i.e., in Costa Rica: 1500 mm - 3500 mm of rainfall/year, an average temperature of between 22.5 - 28 degrees centigrade year-round, and between 1500 and 2500 average sunshine hours/year, *14*), sugar cane appears to be the best choice for such an application.

The limiting factor, nonetheless,



In conclusion, if possible for land and climate considerations (i.e., in Costa Rica: 1500 mm - 3500 mm of rainfall/year, an average temperature of between 22.5 - 28 degrees centigrade year-round, and between 1500 and 2500 average sunshine hours/year, *14*), sugar cane appears to be the best choice for such an application.

The limiting factor, nonetheless,

concentrates on the availability of land. As was stated before, grave concern has been expressed by various experts about the displacement caused by the use of rich agricultural land for energy purposes instead than for food crops, mainly grains. Such a dilemma intensifies when we consider the size of the agricultural area in a small country like Costa Rica. This leads us to suggest more efficient land use techniques even in those areas set apart specifically for energy crop growing, such as those described in the Proalcool *(7)* work named above (the interspersing of other crops alongside sugar cane (peanuts, beans, soya beans, etc.), and the rotation of different crops in these lands.). These practices have been shown not only to yield acceptable levels of production for all the cultures involved, but also to improve the economic feasibility of biomass based alcohol programs.

SEPSA, the government agency in charge of land use planning has determined that of the country's total area, 50,900 km2, 16,468 km2 of which correspond to rich soil lands suitable for agriculture, 750 km2 can be devoted permanently to energy crops, without upsetting the planned agricultural frontier scenario. *(15)*

To put this figure into perpective, I shall now present an estimate of how much alcohol could be expected yearly from these lands:

Yield: 3,500 litres/ha.

Land extension: 750 sq kms. or 75,000 ha.

Units:

1 US gallon = 3.785 litres

1 barrel = 42 US gals.

a. 3,500 litres/ha. x 75,000 ha. = 262,500,000 litres/year

b. 262,500,000 / 3.785 litres/US gal = 69,352,708 US gal/yr.

c. 69,352,708 US gal / 42 US gal/bb = 1,651,255 bb alcohol/year

If we now compare this value with the current (Celis, R. et al, 1980 *10*) consumption, i.e., 5,500,000 barrels of oil total, of which ~70 % or 3,630,000 bb oil correspond to the transport sector, we find that the ethanol value, when translated to oil equivalent, would amount to between ~41% (1,486,000 bb oil eq., if used as a supplement of petrol), and ~49% (1,783,000 bb oil eq., if used as a complement to petrol, i.e, as gasohol) of the present transport sector requirements.

5.3.3 Cassava:

As can be seen, such an alternative (involving only sugar cane) would be insufficient to eventually provide a total oil substitution potential. It is important, therefore, to consider the implementation of complementary schemes. The most relevant approach appears to be, in the case of Costa Rica, the use of cassava both to extend the period of utilization of the distilling facilities throughout the year, and to increase overall production.

To illustrate the seasonality problem of sugar cane we shall concentrate on Catsa's performance during 1985. During this period, the *zafra* (Spanish term for the cutting season) lasted for 87 days, according to company officials. This provided raw materials for the industrial process for an equal interval: roughly one fourth of the year (in the best of conditions, zafras could last up to ~150 days or five months). It is apparent that increasing the "industrial season" should improve the overall outlook. Cassava, being a perennial crop, not greatly affected by year-round variations, provides an attractive alternative. *(16)*

Various authors have noted the special qualities of this plant to endure sub-optimal conditions. In doing so, they have stressed the outstanding potential it presents as a cheap source of energy, either for human consumption of for ethanol production *(11, 17)*.

Applying such research in the Costa Rican scene is especially important, due to the problems singled out above in relation to the limited access to rich soils.

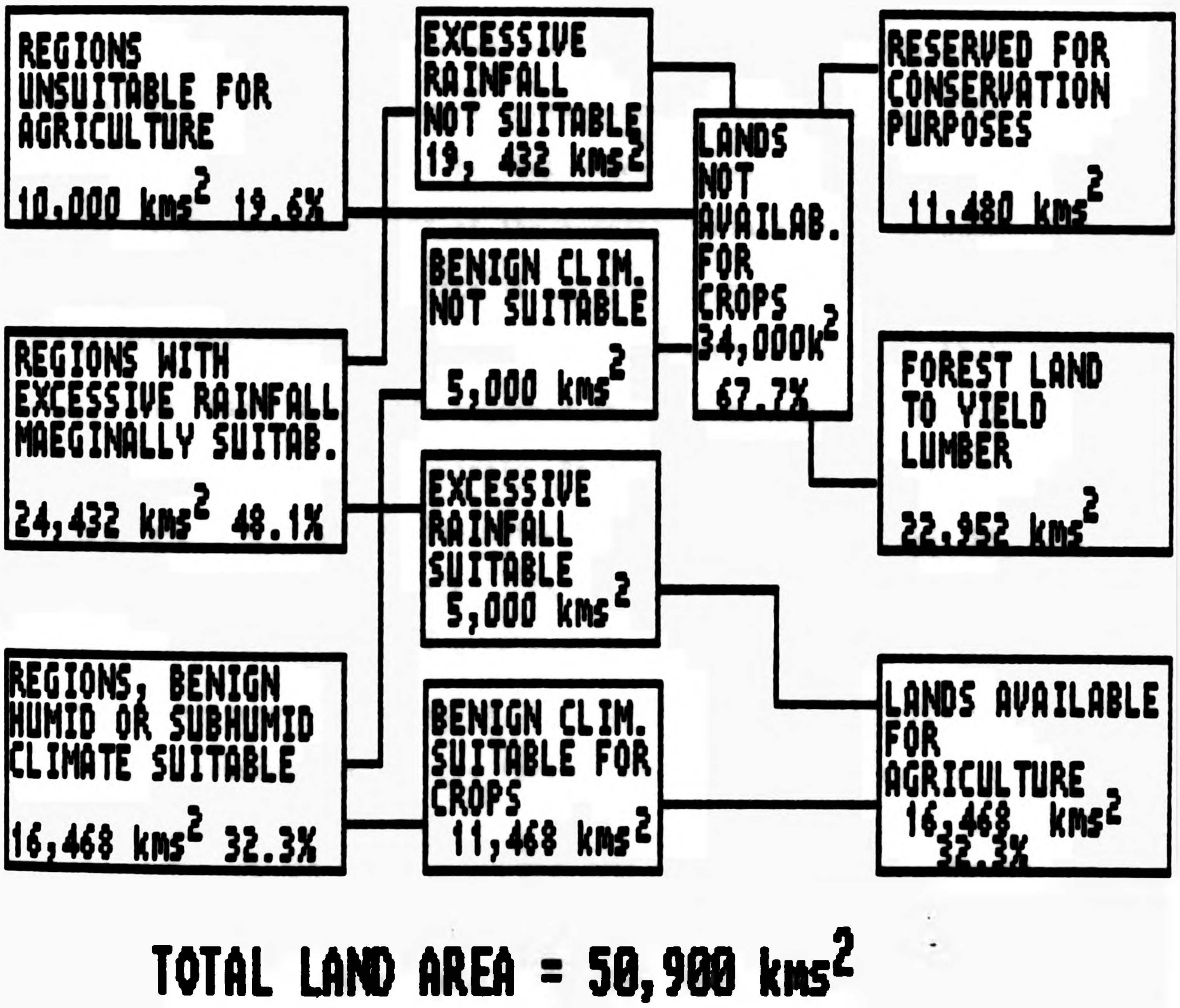
therefore, to consider the implementation of complementary schemes. The most relevant approach appears to be, in the case of Costa Rica, the use of cassava both to extend the period of utilization of the distilling facilities throughout the year, and to increase overall production.

To illustrate the seasonality problem of sugar cane we shall concentrate on Catsa's performance during 1985. During this period, the *zafra* (Spanish term for the cutting season) lasted for 87 days, according to company officials. This provided raw materials for the industrial process for an equal interval: roughly one fourth of the year (in the best of conditions, zafras could last up to ~150 days or five months). It is apparent that increasing the "industrial season" should improve the overall outlook. Cassava, being a perennial crop, not greatly affected by year-round variations, provides an attractive alternative. *(16)*

Various authors have noted the special qualities of this plant to endure sub-optimal conditions. In doing so, they have stressed the outstanding potential it presents as a cheap source of energy, either for human consumption of for ethanol production (*11, 17*).

Applying such research in the Costa Rican scene is especially important, due to the problems singled out above in relation to the limited access to rich soils.

Following the Planning Ministry's classification of the country's lands (OFIPLAN: Plan Nacional de Desarrollo Forestal, 1979, based on Tosi, J.: "El Recurso Forestal Como Base Potencial para el Desarrollo Industrial de Costa Rica, quoted by Umana, Doryan, as above), we have the following picture:



Costa Rica: Land Distribution

From this description, the sugar cane quota for energy use, would be limited to the 750 kms sq. mentioned before, which would be allocated within the 16,468 kms sq. available for conventional agricultural purposes, i.e., rich soils with good weather, (these 750 kms sq. would correspond to 4.55% of the rich lands and 1.47% of the national territory).

Referring back to the land distribution graph, we find that apart from the prosperous land cited in the last paragraph, there exists in Costa Rica, a substantial stretch of land, 5,000 kms sq. or 10% of the overall surface area, of poor quality soil and benign climate (i.e., not too hot, not too cold, not too wet, not too dry, etc.). It is under such conditions that cassava has been reported to yield acceptable crops, requiring little or no attention. For example, Brazil under the Proalcool *(7)* program, is in the process of planting the Cerrado region of the country, 25% of that country's land area or 8.5 million kms sq., with cassava in rotation with soya bean: Cassava prepares the land for soya beans to grow where they would not have been able to before. In return, after the soya season, cassava plants yield better harvests. *(11)*

Under such an arrangement, this energy crop would not, in the Costa Rican case, pose a threat to any food crop as none would grow in these poor lands. There would not be a competition for land between energy and food crops putting in jeopardy the balance of the *"agricultural frontier"*.

If we now examine the potential production of such land area (at a hypothetical 100% usage level), even on the worst of conditions, for example the yield experienced in small farmer's parcels in rural Brazil: 12 tons/ha. (as quoted in Proalcool, ibid., p.56, please note also that under exceptional conditions up to 70 tons/ha. have been attained, and the average yield in Brazil is ~ 25 tons/ha., as can be seen from the chart provided at the beginning of this chapter), we have that these lands would yield on average:

Yield (min.): 12 tons/ha.

Alcohol conversion: 180 litres/ton

Alcohol Yield: 2,160 litres/ha ethanol

Now, using the same units employed in the case of sugar cane we have:

Land area: 5,000 kms sq., or 500,000 ha.

1 US gal = 3.785 l

1 bb = 42 US gal

a. 2,160 litres/ha x 500,000 ha = 1,080,000,000 litres/yr.

b. 1,080,000,000 litres / 3.785 litres/US gal = 285,336,856 gal

c. 285,336,856 US gal / 42 US gal/bb = 6,794,000 bb/yr ETHANOL

This figure on its own, even in the lower case quoted before, would be enough for eventual total substitution of oil imports.

Having analyzed the land restriction situation and found that with a combined sugar cane - cassava input scenario, there would be enough raw material to supply even an energy self sufficiency policy, we shall now turn to the analysis of the technical and economic implications of such endeavours, trying to determine up to what point it is wise to attempt implementation.

5.4 Alternative Uses of Alcohol:

5.4.1 Alcohol as combustion fuel

5.4.1.a Introduction:

The first option available for the use of the alternative end products from the Catsa industrial process, apart from sugar for human consumption, is that of ethanol as a substitute for oil in motor vehicles.

Under the present world oil market conditions, ~US$14.00/bb oil, such a substitution program would be uneconomical. Nevertheless, understanding that oil is an exhaustible resource whereas biomass sources are not, and that therefore extraction costs will, in the long term tend to rise in the case of oil, and remain relatively stable (or even drop because of economies of scale, improved technologies, etc.) in the case of renewable resources, *(19)*. It may well be the case that a contingency plan for eventual or gradual implentation is in order in a small, tropical oil importing developing country (OIDC) like Costa Rica.

Furthermore, if we follow Hotelling's Rule with respect to the price path of oil *(20)*, which states that in the long term, i.e., barring short term inconsistencies brought about by overproduction cartels, embargoes (perfect competition), etc., the price of oil will rise at the prevailing world nominal rate of interest (LIBOR, Prime Rate, etc.), we must recognize the implications of this scenario for a country with chronic hard currency problems, a relatively high internal inflationary / currency depreciation environment and a heavy foreign debt burden.

"Unless the present discounted price for every period is the same, the market will not be in equilibrium. For example, if the price of oil is expected to rise more quickly than the nominal interest rate, then all suppliers will hold on to their oil anticipating higher profits. This raises the price of oil today relative to its price in the future and restores equilibrium. If the price of oil is expected to rise slower than the interest rate, suppliers will try to sell more oil today and invest their profits to receive the nominal interest rate. This flooding of the market leads to a lowering of the price today relative to the future and restores the equilibrium path. Hence under the assumption of perfect competition, costless extraction, and a constant discount rate, the price must rise at the nominal interest rate." *(19)*

The problem is al too clear when we study the case at hand (data from Celis R., *(10)*, and author's elaboration):

During 1980, oil imports amounted to US$185 million or 20% of the country's hard currency earning capacity (~US$925 million in exports. Note: According to government figures for 1985, these values remained almost unchanged).

Checking another parameter, imports for the period were of the order of US$1.409 billion, 13.1% of which went towards the purchase of oil. (Again preliminary figures for 1985 remained relatively unchanged).

On top of this, the foreign debt service during the last year amounted to ~50% of all exports or ~US$450 million.

As can be gathered from the above figures, a concerted effort to reduce the gap between hard currency requirements and earnings in itself could prove to be a reasonable approach, apart from other economic considerations, even when overall Return on Investment may be negative in hard currency equivalences (but paid in local currency). Below I present a set of figures which compare ROI of local investments vs. proposed foreign purchase of oil (or any other convenience from abroad) at the nominal interest rates, in the setting of an unstable LDC (this is a very real situation if a country has to borrow hard currency in order to import):

Example:

Nominal Interest Rate: 10%/year.

Price Increase (Hotelling) of oil: 10%

in order to cover this increase a local investment would have to yield a return of:

{1.i(dep)} x (1.10)

where i(dep) = rate of currency depreciation with respect to the relevant hard currency denomination. Putting some figures to illustrate this situation we have:

Loan--------------1 year-------------> Repayment

(for the purchase of oil for example)

US$1.00 US$1.10

Nevertheless, in national currency this would require (in Costa Rica for year 1985):

CRC 47.00 CRC 59.40

due to a devaluation of 15% during the year or, following the formula:

$$(1.15) \times (1.10) = 1.265,$$

i.e., a net internal interest requirement of 26.5% to cover the 10% increase in hard currency. (If a foreign currency loan was used to purchase the oil, this would be needed to account for a 10% interest rate).

In an opposite fashion, biomass sources such as sugar cane have demanded little foreign currency, after the initial capital investment phase has been executed (imports of plant and equipment). This situation arises due to a number of factors: First, the installations can be run on energy generated locally. Second, because effective programs of biological pest control have been implemented, a reduction in the use of traditional (imported) pesticides has been experienced. Also, vinhoto has been utilized instead of nitrogen fertilizers when possible (this applies to the Brazilian experience, as discussed in Proalcool, *(7)* , pp. 45 - 52, and to a certain extent in Costa Rica, as gathered by the author on field visits to both the Catsa intallations and to LAICA's research station in Grecia). Finally, recent technological breakthroughs have closed the gap between the cost of oil and biomass (mainly in relation to sugar cane and cassava) even further. UNISEARCH, a company formed by the University of New South Wales in Australia has developed a bacterium called *Zimomonas mobilis* (through genetic engineering) which improves fermentation times for sugar cane, cassava, and other feedstocks by four times. *(21,22)*. Furthermore, this new bacterium is capable of converting starch-based feedstuffs, including cassava, directly into glucose (dextrose), without first converting it to sucrose (i.e., bypassing the hydrolisis stage), reducing fermenting costs by ~10% *(23)*.

In conclusion, in the future this biomass scenario comprising sugar cane/cassava inputs, biological pest control, the use of *Zimomonas mobilis* bacterium in place of the *Saccharomyces cerevisiae* yeast (which would improve distillery throughput greatly, requiring proportionally less capital investment in foreign currency), and finally putting the vinhoto outflow to better use, after using its limited potential as fertilizer, could, in the long term, prove to be very beneficial and cost competitive, while releasing foreign currency reserves (and indeed loans) for other uses within the economy.

The following sections will deal in turn, with the alternative strategies available in the substitution of oil by ethanol.

5.4.1.b Gasohol:

There are two main options open to the utilization of ethanol as fuel for motor vehicles: Gasohol, a mixture of up to 20% Ethanol (anhydrous) and 80% petrol, and Hydrated alcohol as an independent fuel. A third application would involve the use of ethanol as an additive to diesel, as a mixture with diesel (diesohol) or as a substitute of diesel in combination with vegetable oils (especially from palm oil, though some attempts have been made to employ coconut oil instead, where this source is very abundant, as is the case of Indonesia), but this possibility is still at the experimental stage even in Brazil (refer to Proalcool, ibid, p. 66).

Exploring the first alternative, i.e., the use of ethanol with petrol, we find that immediate benefits can be quantified.

Ethanol has a higher octane number than petrol. The combination of this fuel with LDC petrol, which has been traditionally been of a low anti-knock rating (~80 octanes versus 92 - 98 octanes in developed countries) produces better efficiency values of approximately 8% (in the Brazilian case).

The table below shows this relationship:

Table 5.4.1.a Octane Number Comparison

	ETHANOL	METHANOL	PETROL
OCTANE No.:			
Experimental:	106-111	106-115	79-98
Engine Conditions:	89-100	82-92	71-90

Source: American Petroleum Institute: (24, 10)

The octane value relates to the propensity of fuel to ignite during combustion. The higher the number, the more efficient the burning of the fuel will be (better anti-knock properties), i.e., the higher Temperature - Pressure conditions it will be able to withstand prior to combustion, resulting in more efficient performance. Low octane numbers on the contrary, cause premature burning of fuel, resulting in more consumption (less efficiency). Combining two fuels with different octane numbers would yield an intermediate rating. The equation to calculate this contribution is as follows:

$$\text{Fuel A Octane No.} \times (Y) + \text{Fuel B Octane No.} \times (1-Y)$$

where Y= % of fuel A concentration in the mix.

An example of the impact such combination could have in our case would be:

Fuel A: LDC Petrol Octane No. 80

Fuel B: Ethanol Octane No. 111

Y: 80 %

using the equation we get:

$$80\ (.80) + 111\ (1-.80) = 86.2$$

an improvement of ~7.75% in octane rating over LDC petrol, resulting as was presented before in an increase in engine efficiency.

The application of dehydrated ethanol to low octane petrol presents therefore a positive effect right away. As will be explained further on, in the Costa Rican case this would result in savings of between US$1,220,000 to US$2,500,000 per year (and between US$4,025,000/yr and US$8,000,000/yr reduction in hard currency demands) if a gasohol policy was adopted (on the basis of Catsa's present potential of 100 kms sq. or 10,000 ha plantations) covering the current gasoline fleet, i.e., a gasohol and diesel scenario, assuming equal costs of production for 1 bb of alcohol and 1 bb of refined petrol, and assuming a total cost of production for refined petrol of between US$14.00/bb and US$28.00/bb.

An additional advantage of the use of

ethanol as a complement to petrol is that no modifications are needed on conventional petrol engines for them to run on the new mix.

The only strict limitation that has to be observed is that of the presence of water in filling station and vehicle tanks. Ethanol is infinitely soluble in water, whereas petrol is insoluble. Adding water to the gasohol mixture, even in very small amounts would lead to a phase separation between the two constituents, resulting in undesirable consequences. Depending on the amount of alcohol present, vehicles would run poorly or not at all. In summary, a capital cost could be expected in relation to ensuring that deposit tanks remain water tight.

Apart from those reservations expressed in the last paragraph, no other drawbacks have been reported with respect to the use of gasohol, apart from corrosion damage, although this condition has been primarily associated with concentrations exceeding 20% ethanol.

Finally, a potential for exports to Developed Countries is also possible. Ethanol can be employed as a substitute for lead as an anti-knock element, keeping octane numbers high and eliminating the adverse effects caused by leaded fuel emissions, *(25)*.

5.4.1.c Hydrated Ethanol:

The use of ethanol (hydrated) as an independent fuel represents a much more controversial issue from that discussed above. The reason for this is that the higher octane values of ethanol are countered by lower specific heat values (both per weight and per volume).

The following table, from the same API source document as above, exposes this characteristic:

Table 5.4.1.b ENERGY CONTENT:

	Btu/lb.	*Kcal/kg.*	*Kcal/l.*	*% Petrol* (1 unit vol yields)
FUELS:				
Gasoline	18,900	10,500	7,700	100
Diesel	18,500	10,280	8,740	113.5
Fuel Oil	17,200	9,560	8,800	114.3
Ethanol	11,500	6,390	5,050	65.6
Methanol	8,570	4,760	3,790	49.2

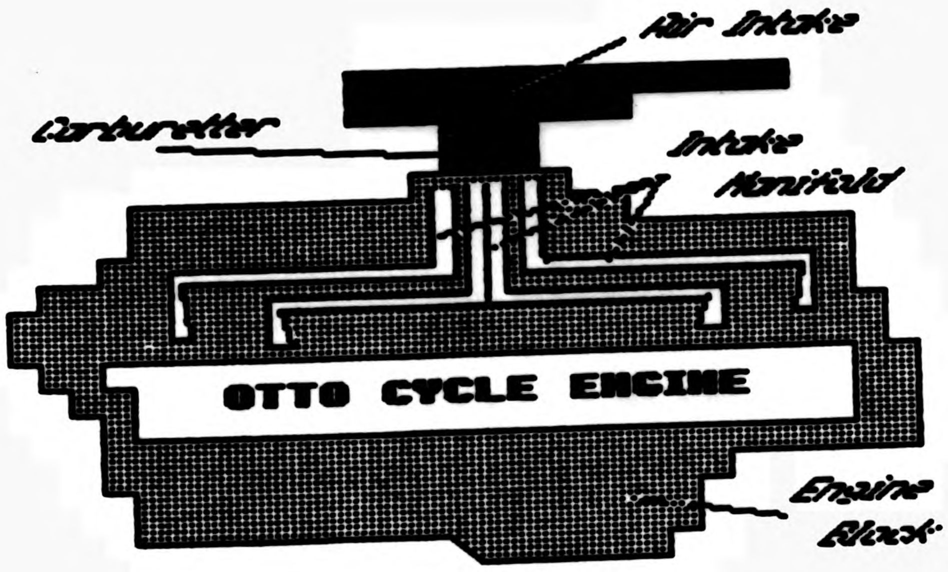
As a result of this shortcoming, pure ethanol vehicles are less efficient than comparable units running on petrol. The net effect of using hydrated ethanol results in between 10% and 20% less efficiency with respect to current petrol consumption values, depending on the sophistication of the alcohol engine design technology quoted *(10,26)*.

Disregarding this fact, which would require the cost of production for a barrel of alcohol to be lower than that of a barrel of oil to yield any overall positive contribution, as will be presented later, other obstacles must be overcome before establishing such a program.

The main stumbling block resides in the fact that alcohol only engines must incorporate a number of modifications to the original OTTO cycle design, in order to function properly. A graph explaining in general terms what these changes are is presented below: (Note: Corrosion protection is especially important in carburetters, where nickel or cadmium electroplating has been found to be appropriate).

Conversion to Hydrated Ethyl Alcohol Operation of an Otto Cycle Engine

1. Protect against rust
2. Introduce higher compression ratios
3. Use larger needles in carburetter
4. Recirculate water in intake manifold to avoid condensation



5. Use higher fuel to air ratios
6. Introduce nylon fuel lines

The cost of such transformations according to Slesser (as above) and Celis, et al., would amount to ~US$500 to US$600 per vehicle. It must be stressed, though, that this cost would be averted if a phase-in program of purpose built alcohol engines is implemented, instead of modifying existing Otto cycle powerplants. A suggestion, as to how such a phase-in program could operate, would be to target fleets of vehicles as the first users, i.e., police cars, taxis, government ministry fleets, etc.. Such a policy has proven to be very successful in Brazil (through partial tax exemption to taxi cab fleets for example).

5.4.1.d Pollution:

d 1. Pollution from Gasohol Engines:

In general terms, alcohol emissions are less harmful to the environment than gasoline ones.

First, in the case of gasohol, the addition of ethanol results in cleaner burning, reducing CO and HC presence. In fact, in the case of Sao Paulo, Brazil's largest city, a significant reduction in smog levels has been documented since the introduction of the Proalcool program. Experimental tests have produced the following results for a 20% ethanol / 80% gasoline mix, with respect to pure petrol (See: Proalcool, (7), p. 64).

Table 5.4.1.c Emmissions From Gasohol Engines in Brazil

57 % reduction in CO emmissions

30 % reduction in HC emmissions

15 % reduction in N(O)2 emmissions

d 2. Pollution from Alcohol Engines:

As was stated earlier, the effect of alcohol emmissions on the environment is in overall terms less harmful than gasoline ones. The main reason for this being that due to the better anti-knock properties of alcohol, no additives such as lead are needed. Also, the levels of CO, and hydrocarbons in these fumes are in general terms lower, due partly to better combustion performance of alcohol when compared to low grade LDC petrol. The table below presents a summary of results from a comparative study of the effects of both types of engines on laboratory rats:

Source: Ier Simposio de Engeniheria Automotiva, Brasilia, 1983 (26).

Pollution Comparison: Ethanol vs. Petrol

RPM	900		1200		1500		1700		2000		3000	
	E	P	E	P	E	P	E	P	E	P	E	P
CO%	2.0	3.5	1.15	1.2	.35	.3	.4	.35	.2	.3	1.75	.45
t	4' 15"	1' 53"	3' 7"	2' 15"	4' 30"	3' 28"	3' 0"	4' 5"	5' 42"	3' 11"	1' 59"	3' 8"
Control Group: Pure Nitrogen t= 17' 12"												

RPM= Revolutions/minute
CO%= Percent level of CO in exhaust fumes
P= Petrol
E= Ethanol
t= Average survival time for 5 groups of mice when exposed to the gases from the engine.

As a general rule of thumb, the most relevant emissions in cities are those associated with low revolution regimes (low rpm's), because of the effect of slow traffic. During rush hour traffic, and most of all, in the middle of traffic jams, where you get the highest vehicle densities, those are the kinds of emissions observed: idling engines, short bursts of power, etc.. In contrast, higher rpm values generally reflect highway conditions, which by definition are less likely to concentrate as static pollution, the main cause of smog. *(27)*

In relation to other substances present in the alcohol exhaust fumes in greater concentration than that of gasoline ones, we find primarily formic and acetic aldehydes. The effect of these substances on the environment is yet to be evaluated thoroughly. Preliminary results show notheless, that even though the mean life of these substances is relatively low, only a few hours, they may cause respiratory deseases such as emphysema (same source as chart above).

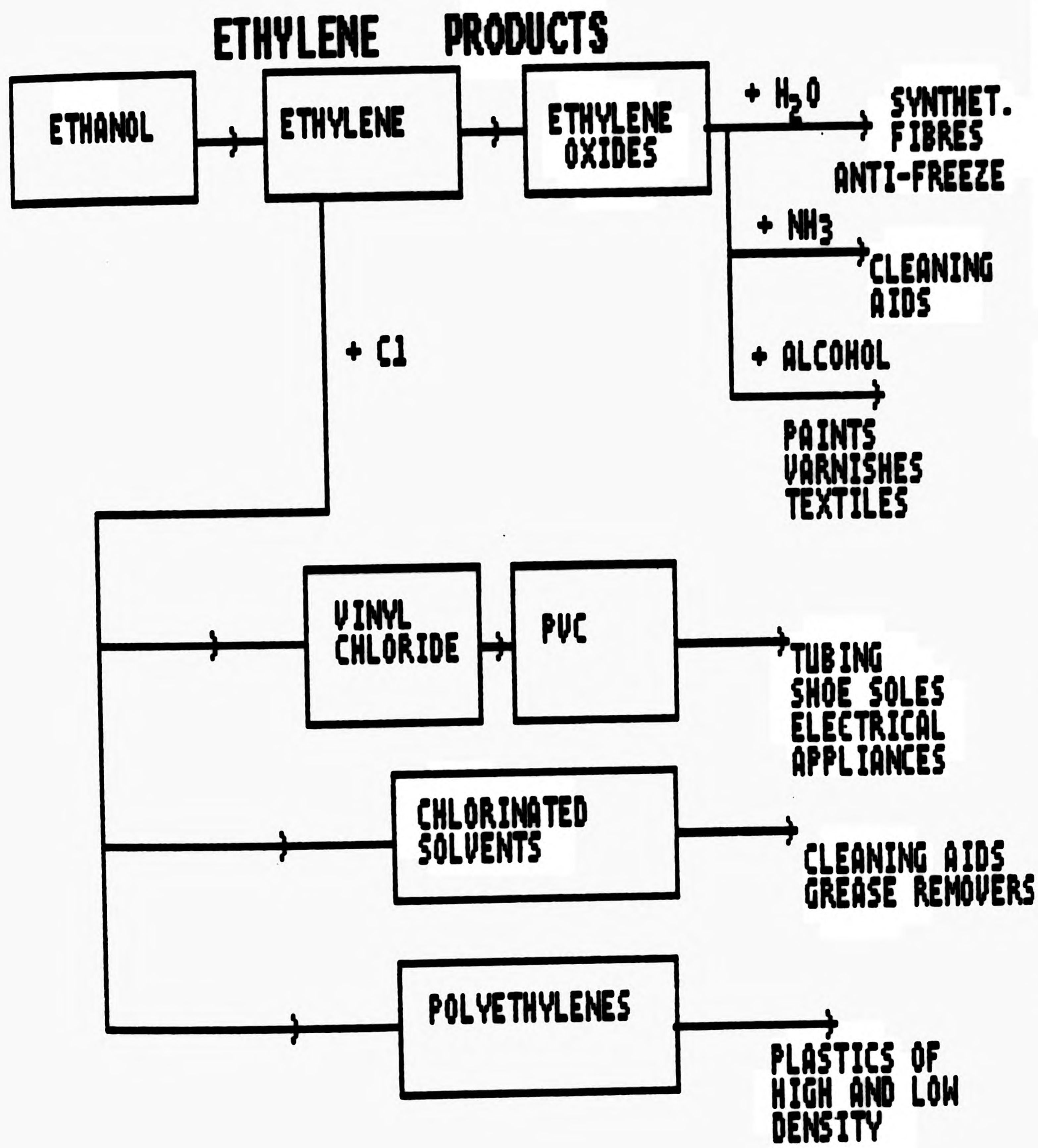
traffic. During rush hour traffic, and most of all, in the middle of traffic jams, where you get the highest vehicle densities, those are the kinds of emissions observed: idling engines, short bursts of power, etc.. In contrast, higher rpm values generally reflect highway conditions, which by definition are less likely to concentrate as static pollution, the main cause of smog. *(27)*

In relation to other substances present in the alcohol exhaust fumes in greater concentration than that of gasoline ones, we find primarily formic and acetic aldehydes. The effect of these substances on the environment is yet to be evaluated thoroughly. Preliminary results show notheless, that even though the mean life of these substances is relatively low, only a few hours, they may cause respiratory deseases such as emphysema (same source as chart above).

5.4.2 Ethanol for Ethylene Industry:

The second broad application for the ethanol (C2-H5-OH) produced at the plant, would be to transform it, exposing it to a dehydration process, to ethane (C2-H6), and subsequently to ethylene (C2-H4), by steam cracking.

The potential applications of ethylene in the industry are very vast. Below, a chart from the World Bank study quoted before (API), depicts just how wide this range is.



The stumbling block at present, nonetheless, concerning any implementation phase along these lines lies with the competitiveness in terms of price of ethanol as a feedstock vs. for example, ethanol from natural gas as is being applied at the ESSO/SHELL complex at Mosmorran, Cowdenbeath, Fife, which opened in May of this year (1986) *(27)*. With the present state of affairs in the oil business this seems a long term proposal, considering the massive additional investment required, both in plant and equipment, and knowhow.

It is for this reason that the final part of this chapter will encompass solely the transport sector substitution option. An industrialization stage for ethylene from sugar cane would not be precluded by the approach chosen. Instead, the option would remain open (since it is a technically viable process) for future linkage efforts.

5.4.3 Programme Implementation:

For this part of the study, I have chosen to follow two main sets of criteria. The first is that set down by T.W. Berrie in *(28)*, which relate to the overall energy sector organizational set-up required to carry out integrated efforts in the field, among all the different institutions responsible for identifiable subsectors, i.e., utility companies, oil companies, etc.

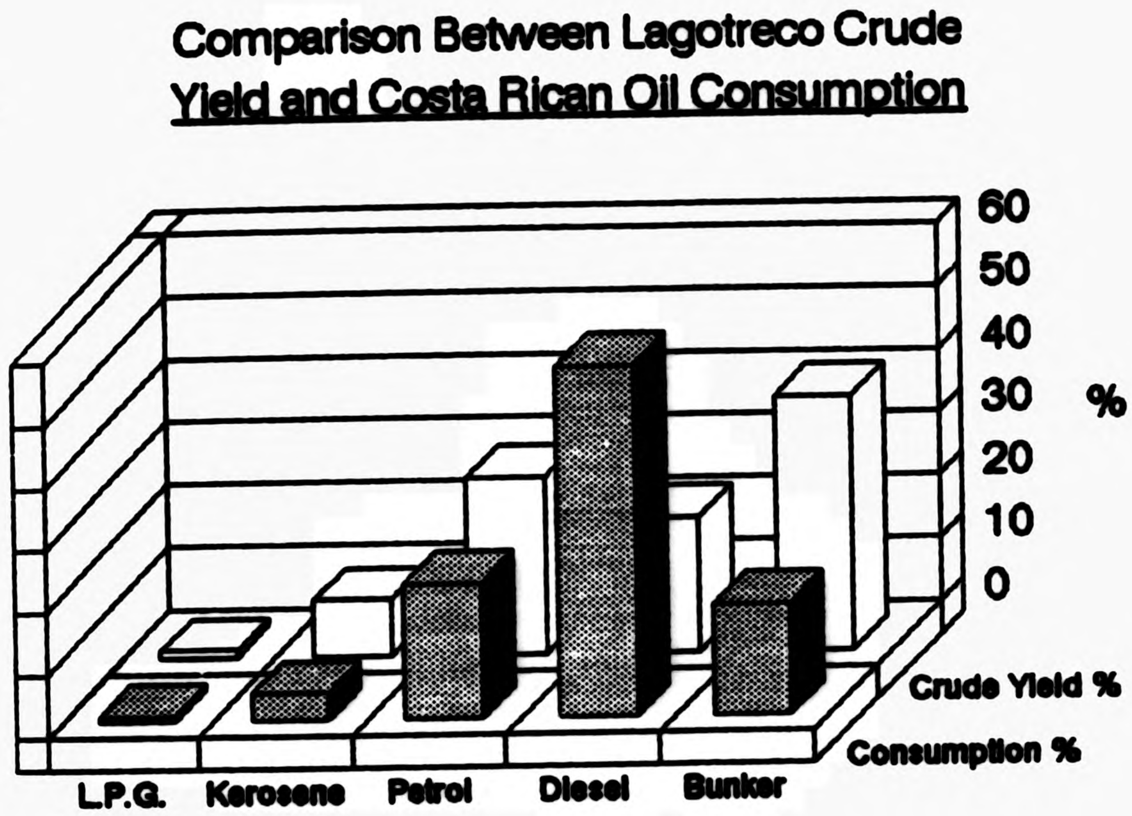
The second set is associated with the

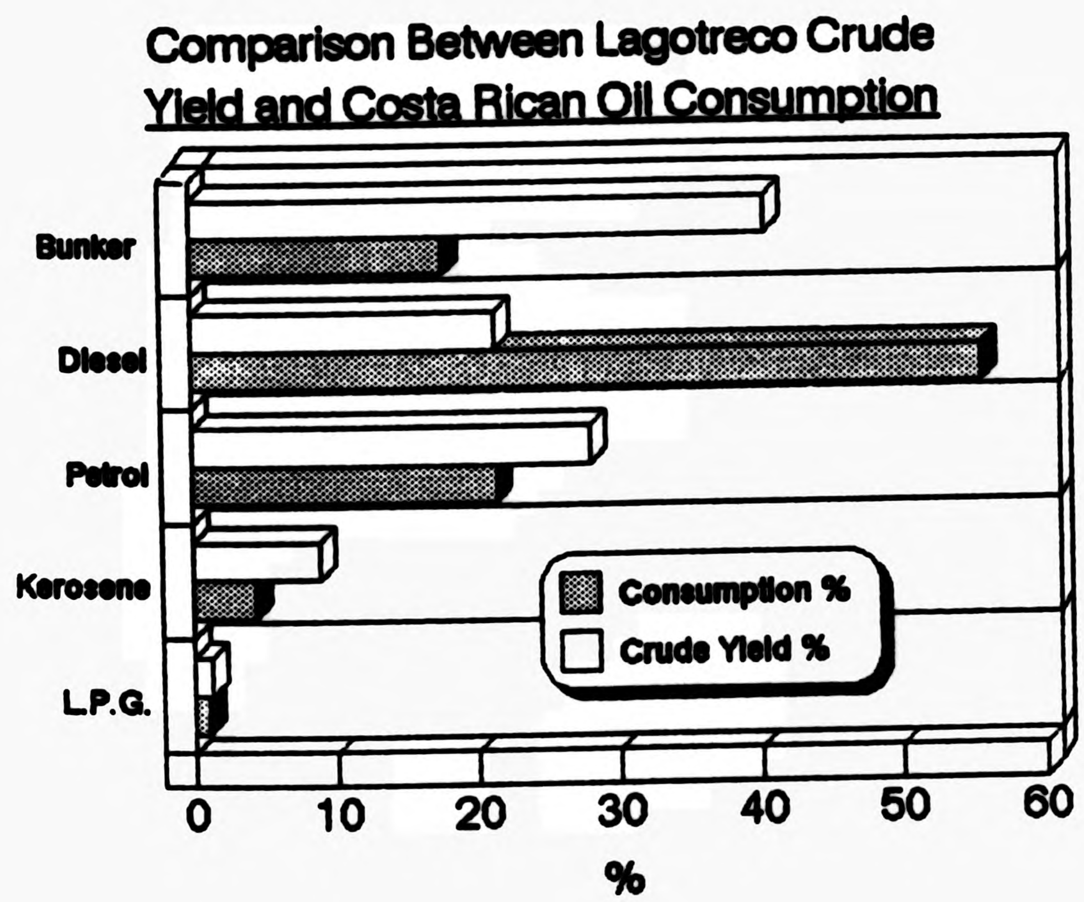
implementation of the alcohol-for-fuel programme itself. Here, the general approach of dynamic decision making will be pursued, taking into account the different sets of alternative courses of action that would be encountered at each point along the way, i.e., initially relying on Catsa's present potential, later working with the 750 kms sq. limit identified for dedicated sugar cane production for alcohol, and finally envisaging a sugar cane / cassava input scenario.

5.4.3.a Organization:

It is important to reduce as far as possible, the potential for duplicity of function, or deviance of goals in any implementation programme in the energy sector. In Costa Rica, various government institutions control different sub-sectors of the energy scene: I.C.E. (Instituto Costarricense de Electricidad) controls electricity (and telecommunications). RECOPE (Refineria Costarricense de Petroleo) manages refining, exploration and distribution of oil products (which are sold by independent stations). The Ministry of Public Works and Transport is in charge of the transport activity including the direct operation of the Electric Railway System (Fecosa) and the close regulation of the country's urban areas, through Transmesa (both Fecosa and Transmesa were Codesa companies until 1985). Finally, the Ministry of Industry, Energy and Mines, deals to some extent with the regulations governing the provision of energy to industry, extension of exploration rights, etc. Concentrating on the case of our interest, CODESA should be added to the list of energy sector institutions (in the case of substitution programmes).

It is evident that decisions taken under the current status quo, by any institution separately, could affect the others quite substantially. It is the author's experience from the time he spent at the CODESA-Ministry of Public Works link-up institution (TRANSMESA), that coordination is usually absent. An example of the consequences resulting from a lack of concerted policy action, is the disproportionate growth in the national diesel powered vehicle fleet during the 1970's, caused mainly by the introduction of (indiscriminate) tax incentives by central government (backed by MOPT), favouring this class of vehicles over petrol ones, and a lower price for the fuel itself (artificially low). As presented at the World Energy Conference in New Delhi, 1983 *(29)*, this heralds important disadvantages. The "incremental cost of diesel", as it is termed, arises when country's (LDC) diesel vehicle fleet vastly outstrips its refining program (diesel proportion of the crude oil yield). The typical crude used in Costa Rica (Lagotreco from Venezuela) yields 21.3% diesel, 28.1% petrol, 40.5% bunker C (fuel oil). In contrast to this, 66% of all the oil used in the country is consumed in the transport sector, where the distribution is roughly divided into 70% diesel and 30% petrol. The resulting imbalance between crude yield and consumption is clearly affecting the refinery's operations.


Comparison Between Lagotreco Crude
Yield and Costa Rican Oil Consumption
60
50
40
30
20
10
0
%
Crude Yield %
Consumption %
L.P.G.
Kerosene
Petrol
Diesel
Bunker


Comparison Between Lagotreco Crude
Yield and Costa Rican Oil Consumption
Bunker
Diesel
Petrol
Kerosene
L.P.G.
Consumption %
Crude Yield %
0
10
20
30
40
50
60
%

There are two options open to RECOPE. The first would be to produce enough diesel (if its installed capacity permits) to satisfy the diesel demand, and subsequently re-export the excedent of petrol, bunker C, and other distillates. The second option would be to satisfy the other demands and import refined diesel (or some option in between those two extreme positions). As was commented by INCSA's (Industria Nacional de Cemento, the private sector competitor of CEMPASA) technical manager, Ing. Jean Pierre Ratton during the author's visit to the company's installations in April 1985 *(30)*, the refinery has in the past sold excess bunker C fuel abroad at prices way below what it charges its local customers (even though large consumers of this specific derivative like INCSA were more than willing to purchase these shipments for themselves). In other words, the oil company has in the past dumped this excess production.

To avoid problems arising in the future from uncoordinated energy policy making, it is essential to opt for a central liason unit. Restricting its scope to the area of our interest, oil substitution programs, such an entity should at the very least include CODESA, Ministry of Industry, Ministry of Transport, and RECOPE.

Following Berrie's classification, we have the following areas of action: *(28)*

"Area No. 1. National supply -

demand energy balances

- Develop an energy sector demand forecasting model for the country in question; train personnel to use and develop the model in that country.

- Examine the physical, economic, financial and institutional substitutability of different primary and secondary fuels in the country concerned.

- Examine the role of new and renewable energy sources.

Area No.2. Institutional / technical assistance required in the energy sector

- Examine what is required for investment planning.

- Examine what is required for coordination between energy ministries. Is there need for a Is there need for a Ministry of Conservation?

Area No.3. Energy planning / pricing

- Examine the cost of extension of present energy systems into industrial, urban and rural sectors and also the question of grants and subsidies.

Consider energy sector pricing policy. Should there be uniform prices geographically? Are prices set approximately according to marginal costs of supply? What would be the effects of using "spot" energy prices.

Area No. 4. Energy conservation

- Consider the need for energy

audits.

- Consider the need for energy management and control.

- Consider the case for improvement of energy efficiency.

- Consider the case for energy loss reduction.

Recommendations for carrying out energy sector assessment studies:

- Be flexible in outlook. Despite the present oil glut, the makings of another oil price rise might already be in the pipeline.

- Do not be dominated by either the supply side or the demand side.

- Develop a simple computer model for forecasting the national demand for energy, starting with macroeconomic parameters, to be used for testing different scenarios for energy planning and energy pricing; do not attempt a sophisticated approach to energy sector optimization.

- Make sure that the need for follow-up to any energy sector assessment study is properly considered during the study and is adequately covered in the report.

- Make allowance for different systems of energy management and energy pricing coming into practice, including energy conservation and spot pricing.

Typical terms of reference for a short energy sector assessment study:

- Examine the historical trend for energy demand in the country in question by commercial fuels and non-commercial fuels and by sector, e.g. transport, electricity, industry, domestic,etc.

- Project the energy demands into the future, bearing in mind projected growth in population, industrial growth, economic growth, etc.

- Split the future energy demand projections by type of fuel and by indigenous and imported fuels; also show the contribution expected to be made by new and renewable energy sources.

- Modify the energy demand projections in the light of likely changes in national fuel policy, pricing, conservation, energy management.

Important points when making an energy sector model:

- Concentrate on making energy sector demand forecasts, not sector optimization.

- Use economic resource costs.

- Use some form of input-output table.

- Be flexible: each country's energy sector is different.

- Be able to cope somehow with poor or inadequate data.

- Concentrate on indicative planning of the energy sector using a scenerio approach.

- Build the model to be able to cope with step function changes, e.g. in fuel prices.

- Build the model to be capable of being used in the field.

- Use a mixed discipline approach of economists, fiscal specialists, technologists, institution specialists and computer scientists. " *(28)*

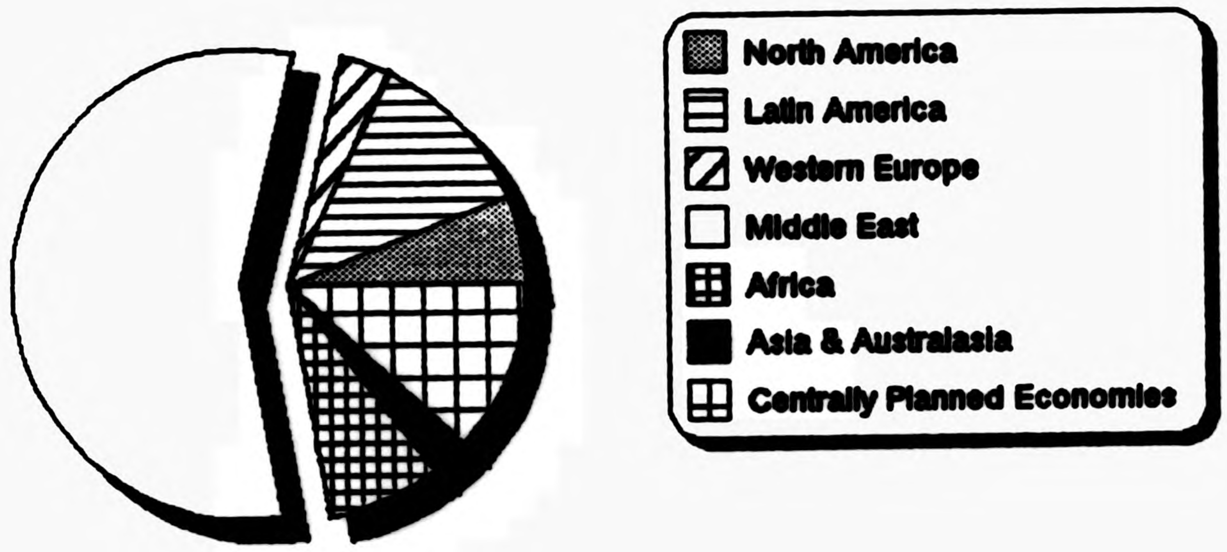
Keeping this broad approach for Energy sector policy making, where alcohol-for-fuel would play an integral, though minor part (i.e., not a panacea) to start with, seems to be the wiser argument to follow.

The next sections will deal in detail with the actual implementation of the ethanol production program to be instituted when and if it is deemed to be appropriate under the fore-mentioned National Energy Strategy.

It may be contended at present that any substitution, or alternative energy effort in the transportation sector appears to be fruitless with the current price level of oil. Nevertheless, it must be reckoned that oil does not represent a stable commodity at all. The imbalance between producing and consuming regions of the world, the concentration of most reserves in politically volatile areas, and the poor record of reserves remaining in the western world, are strong reasons which contend against prices stabilizing around the low levels of today. To make this situation clearer, a number of charts published by British Petroleum *(31)* are included.

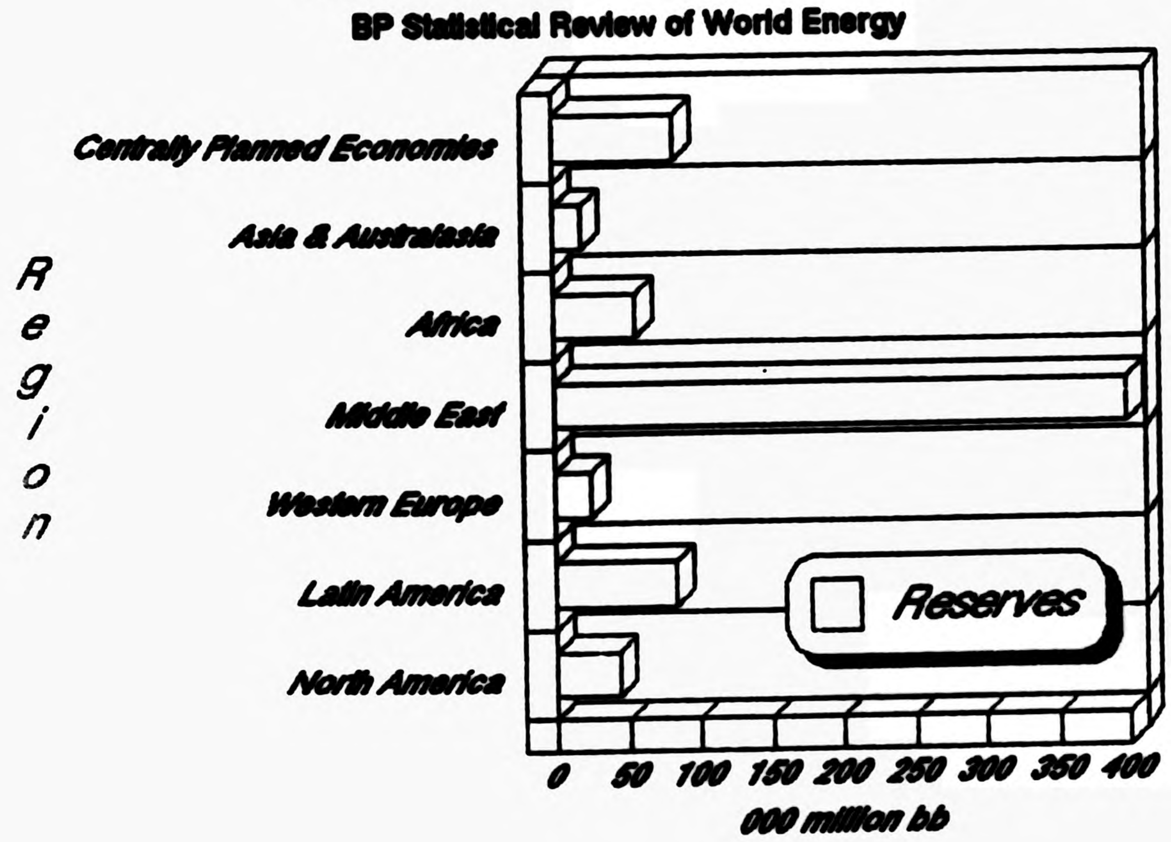
World Oil Reserves at end 1984

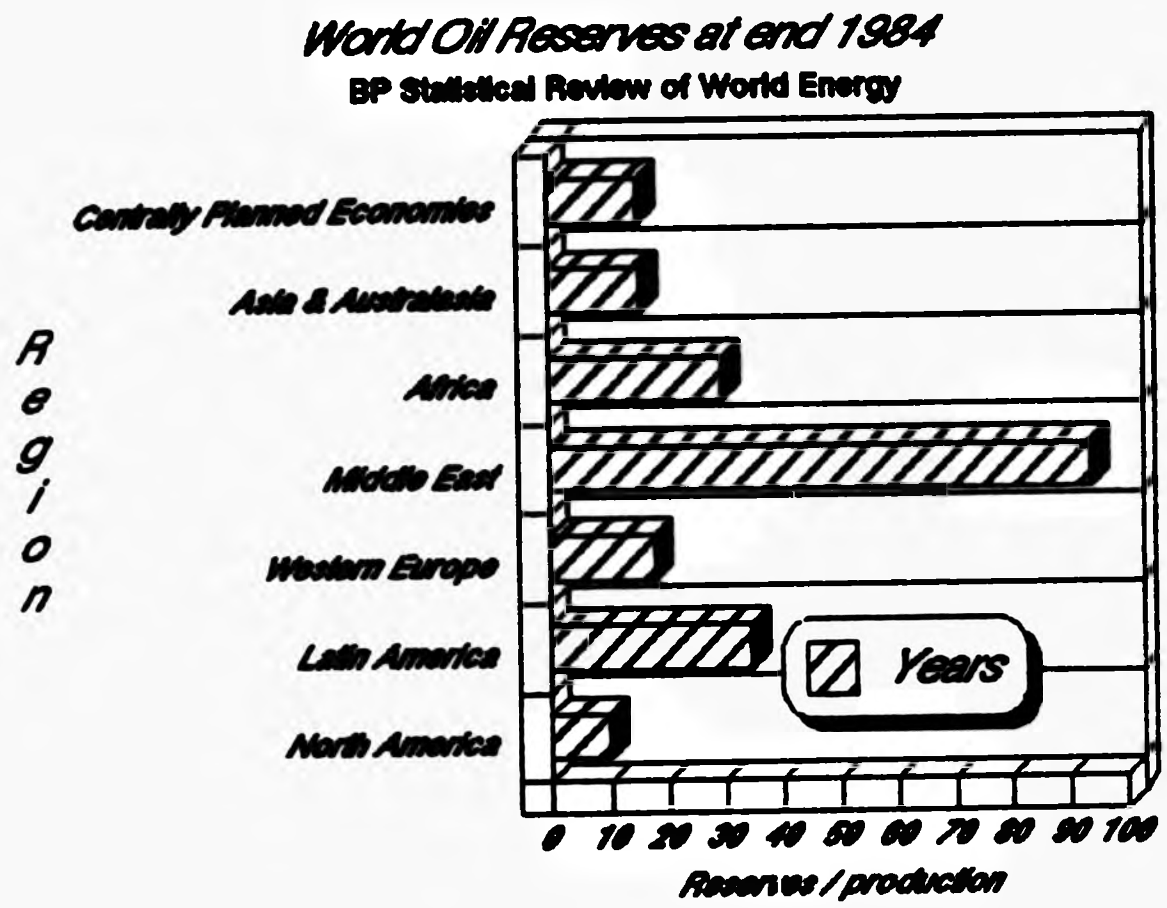
BP Statistical Review of World Energy

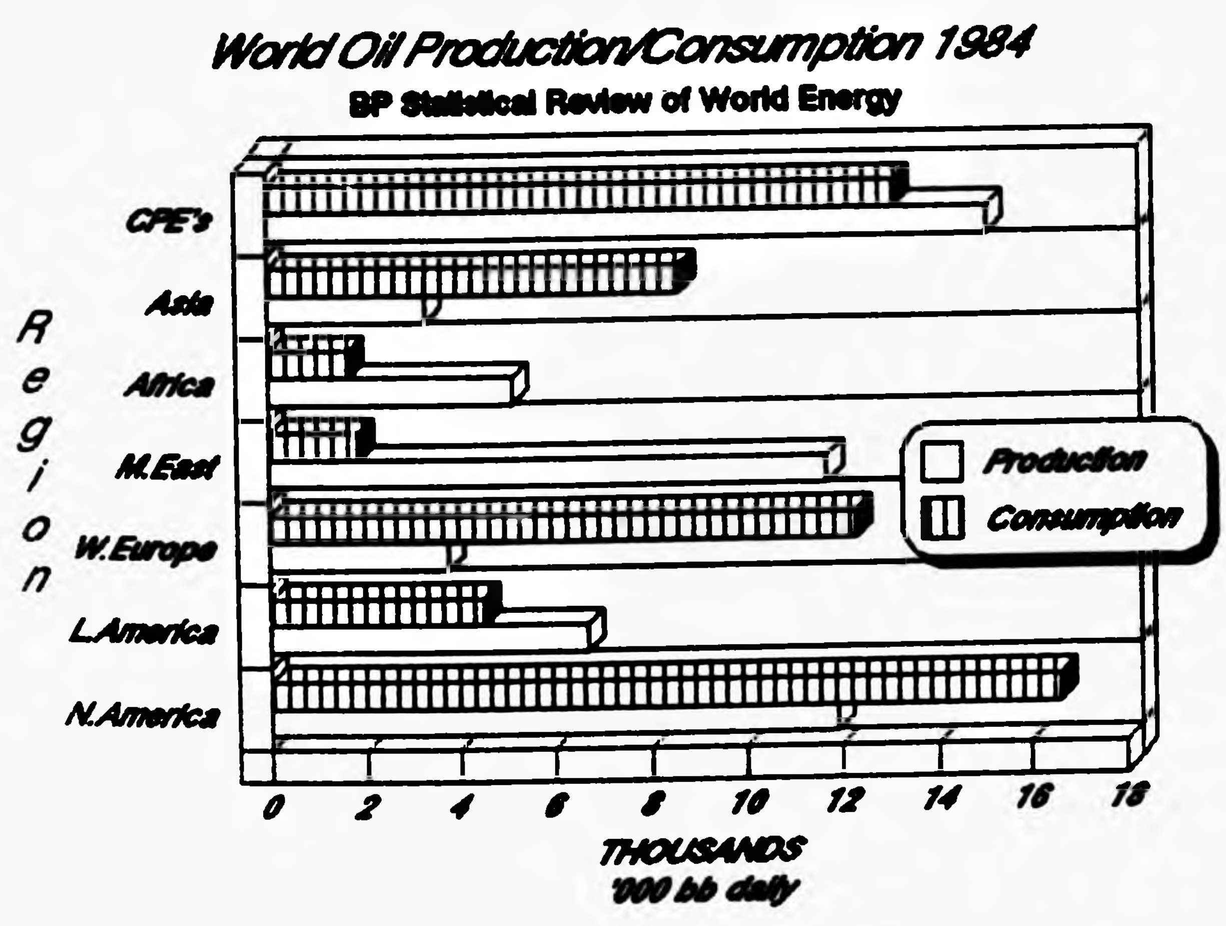


World Oil Reserves at end 1984

BP Statistical Review of World Energy




World Oil Reserves at end 1984
BP Statistical Review of World Energy
Centrally Planned Economies
Asia & Australasia
Africa
Middle East
Western Europe
Latin America
North America
Region
Years
0 10 20 30 40 50 60 70 80 90 100
Reserves / production


World Oil Production/Consumption 1984
BP Statistical Review of World Energy
CPE's
Asia
Africa
M.East
W.Europe
L.America
N.America
Region
Production
Consumption
0 2 4 6 8 10 12 14 16 18
THOUSANDS
'000 bb daily

5.4.3.b Alcohol-for-Fuel Implementation Strategy:

The line of action chosen for this section is broadly based on the principles of dynamic decision making. The accompanying table presents, first, the various stages involved (100 sq.km. land availability, 750 sq.km. land availability, and the ultimate sugar cane/cassava scenario); second, the relevant states within each stage; and third, the action options open at the completion of each state chosen. It is here where the dynamic approach plays such an important role, as it provides at every point along the way, a clear picture as to what policy options are available.

As was presented above, the choice of stages has been defined by the availabilty of land for energy crops. Stage 3 is confined to the current potential of the CATSA production facilities and dedicated lands.

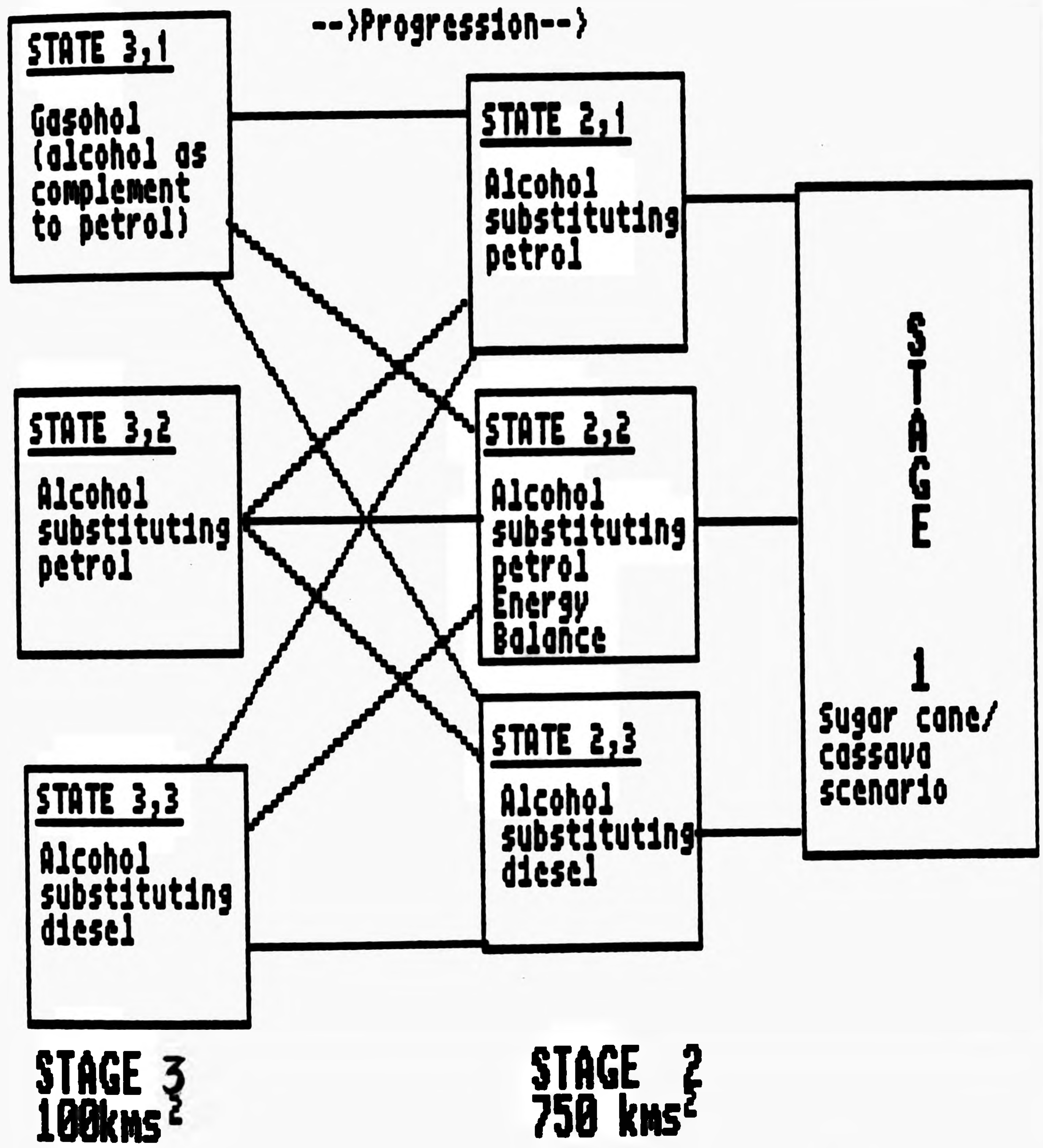
Stages 3 and 2 have been developed numerically, as these are the more easily quantifiable. Stage 1 has been left as a technically feasible future option (long term). The main reason for opting out of extensive analysis at this stage, relates with the difficulty of assessment at this early point in time of the importance of land competition with food crops (if it is ever decided that more than 750 sq.km. of good quality land are to be devoted to energy crops), as well as the evaluation of negative energy balance conditions when using feedstocks other than sugar cane, etc.

5.4.3.b Alcohol-for-Fuel Implementation Strategy:

The line of action chosen for this section is broadly based on the principles of dynamic decision making. The accompanying table presents, first, the various stages involved (100 sq.km. land availability, 750 sq.km. land availability, and the ultimate sugar cane/cassava scenario); second, the relevant states within each stage; and third, the action options open at the completion of each state chosen. It is here where the dynamic approach plays such an important role, as it provides at every point along the way, a clear picture as to what policy options are available.

As was presented above, the choice of stages has been defined by the availabilty of land for energy crops. Stage 3 is confined to the current potential of the CATSA production facilities and dedicated lands.

Stages 3 and 2 have been developed numerically, as these are the more easily quantifiable. Stage 1 has been left as a technically feasible future option (long term). The main reason for opting out of extensive analysis at this stage, relates with the difficulty of assessment at this early point in time of the importance of land competition with food crops (if it is ever decided that more than 750 sq.km. of good quality land are to be devoted to energy crops), as well as the evaluation of negative energy balance conditions when using feedstocks other than sugar cane, etc.



Description of Alcohol Implementation Programme

a. Formulation:

The purpose of the present exercise is to build a basic system of analysis, by which the decision-making process may be aided, in the event of implementation. The ultimate outputs of the process would yield the price level of alcohol required to provide viable options to given prices of the oil derivatives it is to substitute at each state, within each of the stages mentioned before. The influence of other variables, such as the cost and output potential of new plant and equipment, the alcohol yield per land area, etc., would be reflected in the prices for alcohol provided as a result of the calculations.

Note: The use of a spreadsheet programme (Sorcim's Supercalc) has enhanced the scope of this approach, as it provides the benefits of accuracy and quick recalculation, offering the possibility of a "what if?" (sensitivity analysis) approach. Keeping this in mind, most of the cells in the worksheet have been linked, in order to be able to quantify the impact of variations in input values.

Stage 3:

1. General Values:

a. Land available: 100 kms sq. x 100 ha/km sq.= 10,000 ha.

b. Alcohol yield from sugar cane:

70 litres/ton x 50 tons/ha = 3,500 litres/ha.

c. Total potential of alcohol production:

3,500 litres/ha x 10,000 ha = 35,000,000 litres/yr.

d. Convert to US gallons:

35,000.000 litres/3.785 litres/gal = 9,247,028 gal.

e. Convert to barrels:

9,247,028/42 US gal/bb = 220,167.3 bb/yr.

2. Oil Consumption:

Oil imports peaked in 1978 when the level reached 6,927,000 barrels/yr *(32)*. Nevertheless, this figure dropped to ~5,500,000 bb/yr by 1980 *(10)*, and has remained around that value ever since (according to current estimates from Recope *(33)*. Therefore for the purposes of this study, the base figure of 5,500,000 bb/yr will be used.

a. Total consumption: 5,500,000 bb oil/yr.

b. Consumption in transport sector: 66% *(10)* or

5,500,000 bb oil x .66 = 3,630,000 bb/yr.

c. Diesel / petrol distribution *(10)* 70:30 or

Petrol: 1,089,000 bb/yr.

Diesel: 2,541,000 bb/yr.

State 3,1:

Description: Substitute 20% of petrol by adding anhydrous ethanol (C2-H5 @ 99.8%) to gasoline, i.e., to gasoline: gasohol on a 80% Petrol, 20% Alcohol mix.

a. Capital investment required: Sealing of distribution tanks to avoid water leaking into the reservoirs, which could cause phase separation between the two constituents.

b. Alcohol required: Due to better overall mileage because of the better anti-knock properties of ethanol over petrol, presented earlier in this chapter, an efficiency gain of ~8% is feasible over LDC petrol.

Hence:

1,089,000 bb gas/yr - (0.08 x 1,089,000) or

1,089,000 -87,120 = 1,001,880 bb gasohol

would be needed, yielding savings of ~ 87,120 oil/yr.

Of these:

20% would be alcohol or: 200,376 bb/year.

(~10% less than available).

and 80% would correspond to petrol: 801,504 bb/yr.

c. Reduction in imports:

1,089,000 bb - (87,120 + 200,376) bb = 801,504 bb/yr.

Present Imports - (eff.gain+ alcohol) = Future imports

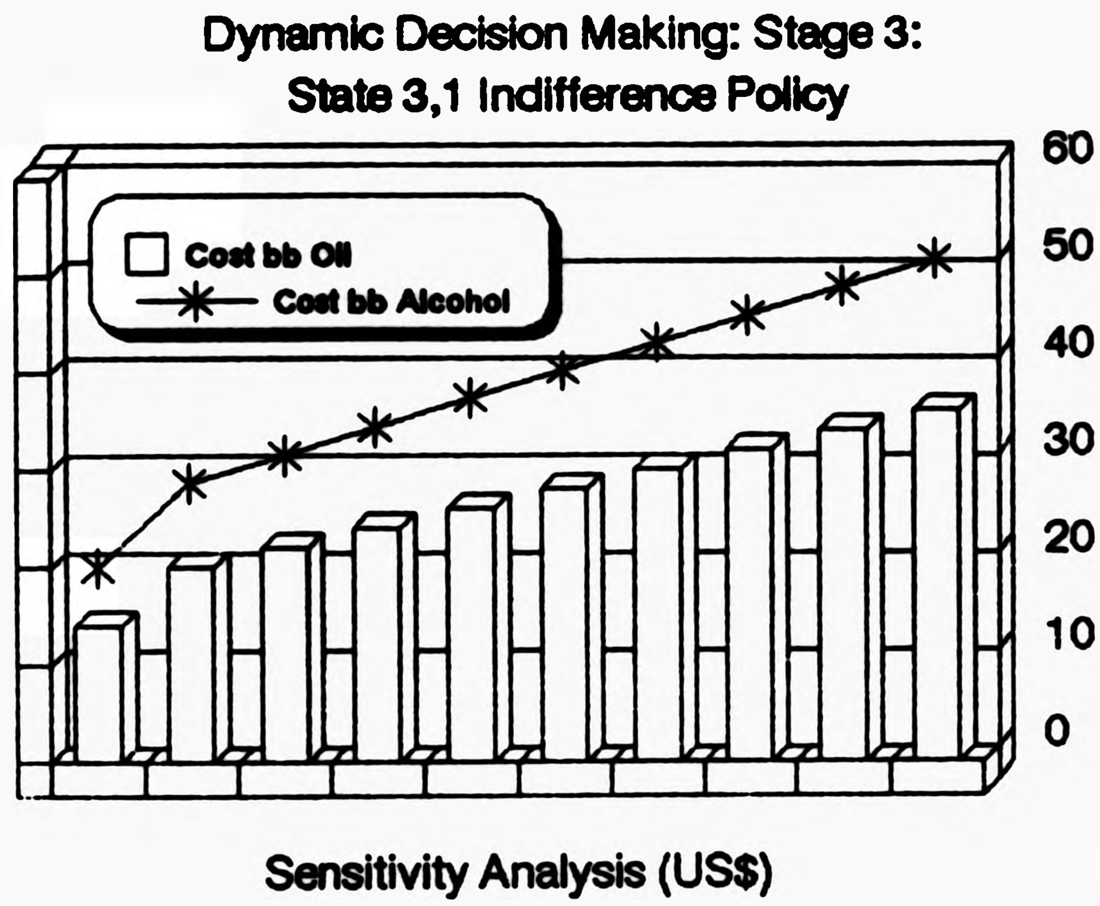
a reduction of 26.4%, of which 8% would not be consumed at all, yielding therefore a positive energy balance (along with quantifiable savings).

Below the complete formulation, using Supercalc, is presented. Also an energy structure table, including fleet distributions and alcohol production schedules is provided.

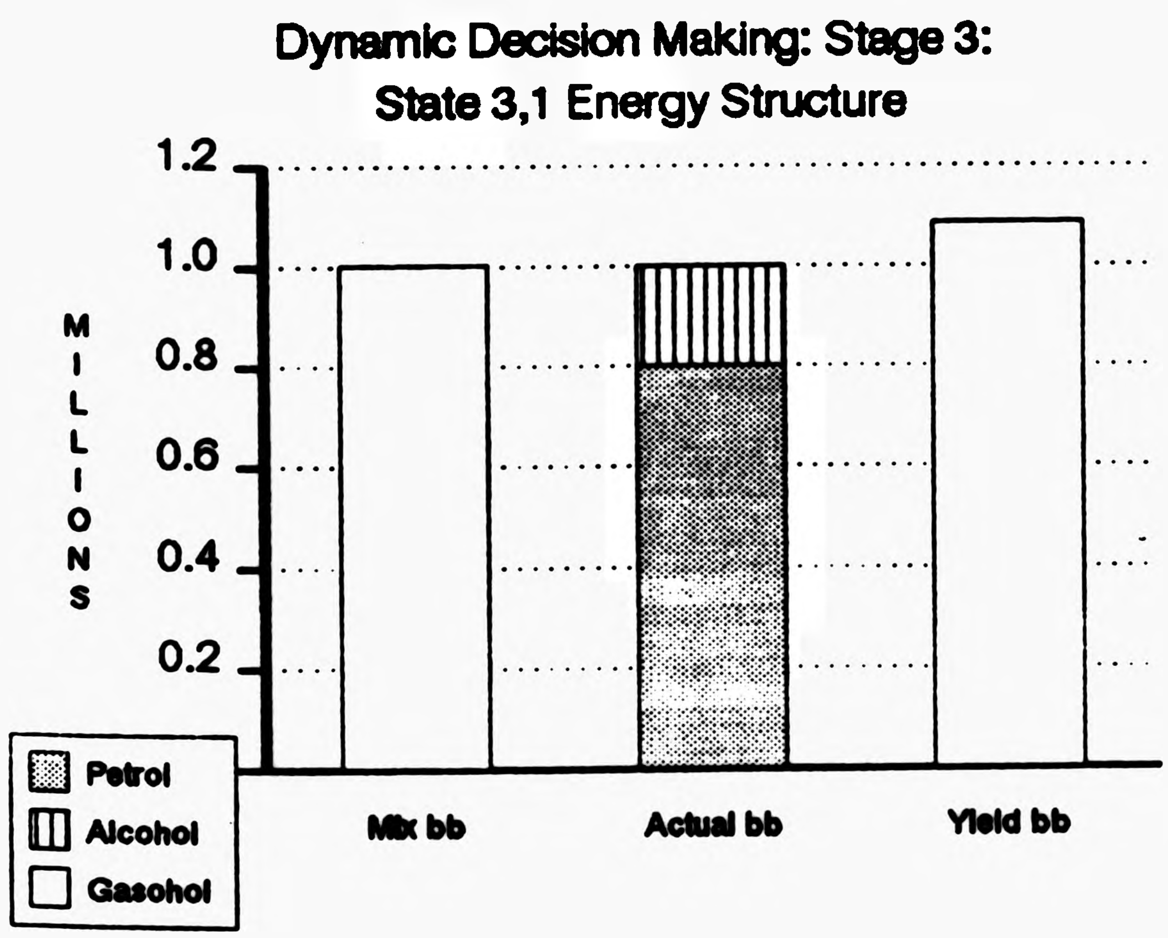
a. Sensitivity analysis for the oil price range: US$14.00/bb, and US$ 22.00/ bb to US$36.00, at two dollar intervals. Note: In all of the above, both overall balance values and balance of payments figures are given.

b. The corresponding Energy Balance situation, resulting from the implementation of State 3.1. Here the respective values for each fuel used are presented in bb/yr and %. Also, the energy ratio between implementing state 3.1 and continuing with the present import policy is given. Finally, the estimate of land use requirements to carry out the policy and the corresponding plant-days needed to produce the necessary alcohol volume is put forward.

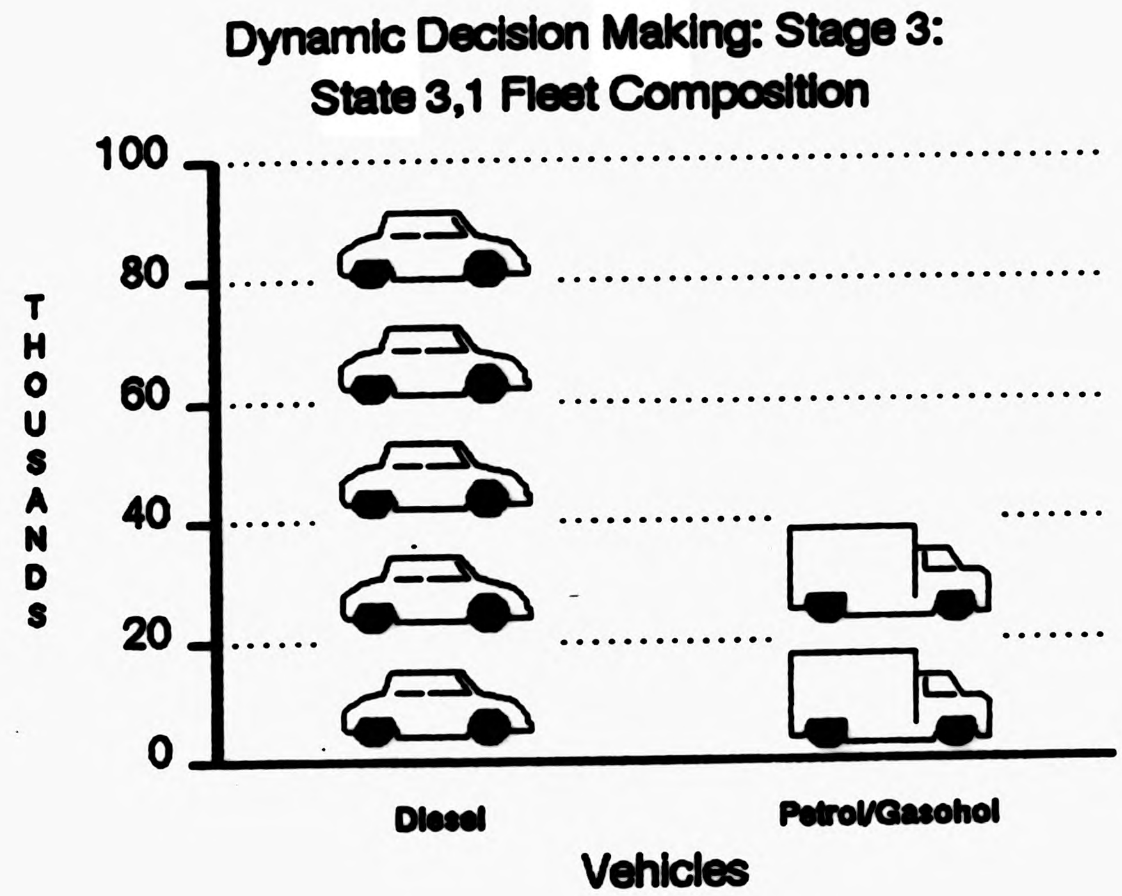
Note: This same order is followed for all the successive states, i.e, State 3,2; state 3,3; state 2,1; state 2,2; and state 2,3.

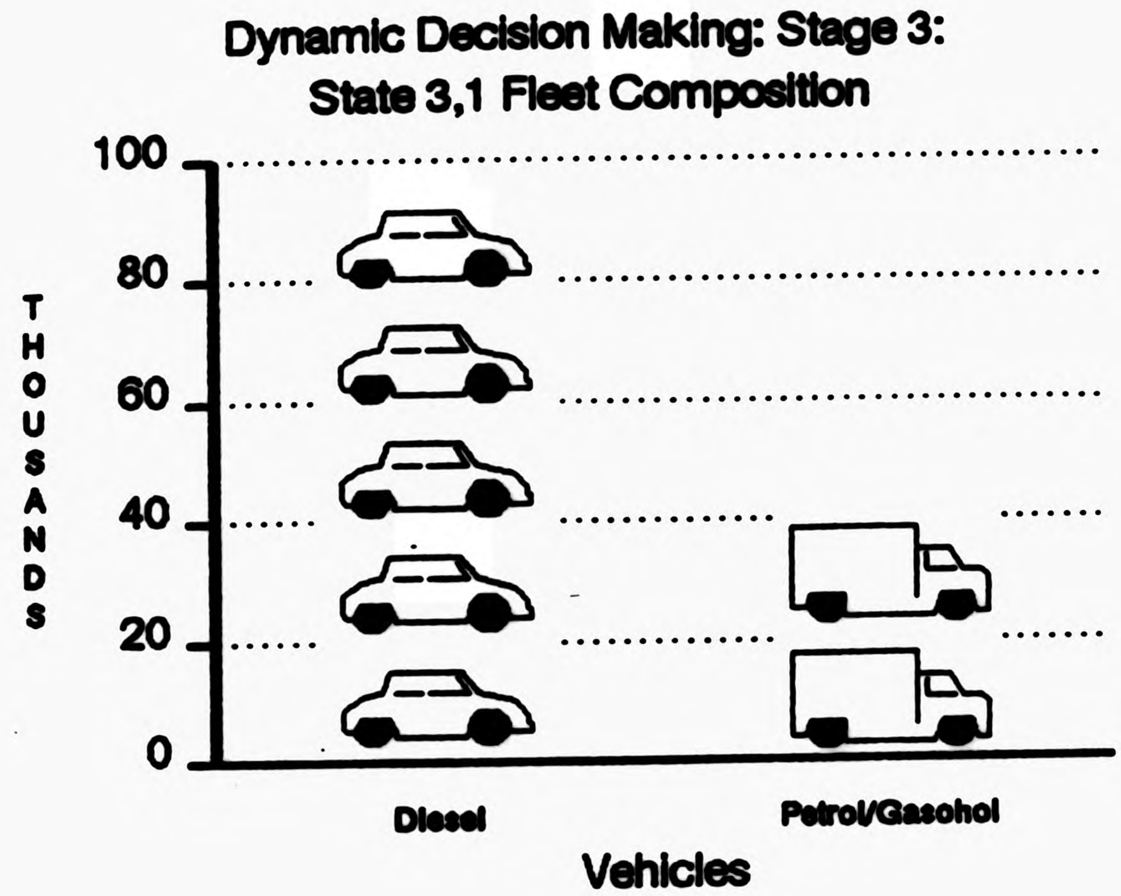


Dynamic Decision Making: Stage 3:
State 3,1 Indifference Policy
Cost bb Oil
Cost bb Alcohol
60
50
40
30
20
10
0
Sensitivity Analysis (US$)



Dynamic Decision Making: Stage 3:
State 3,1 Energy Structure
MILLIONS
1.2
1.0
0.8
0.6
0.4
0.2
Petrol
Alcohol
Gasohol
Mix bb
Actual bb
Yield bb


Dynamic Decision Making: Stage 3:
State 3,1 Fleet Composition
100
80
60
40
20
0
THOUSANDS
Diesel
Petrol/Gasohol
Vehicles


Dynamic Decision Making: Stage 3:
State 3,1 Fleet Composition
100
80
60
40
20
0
THOUSANDS
Diesel
Petrol/Gasohol
Vehicles

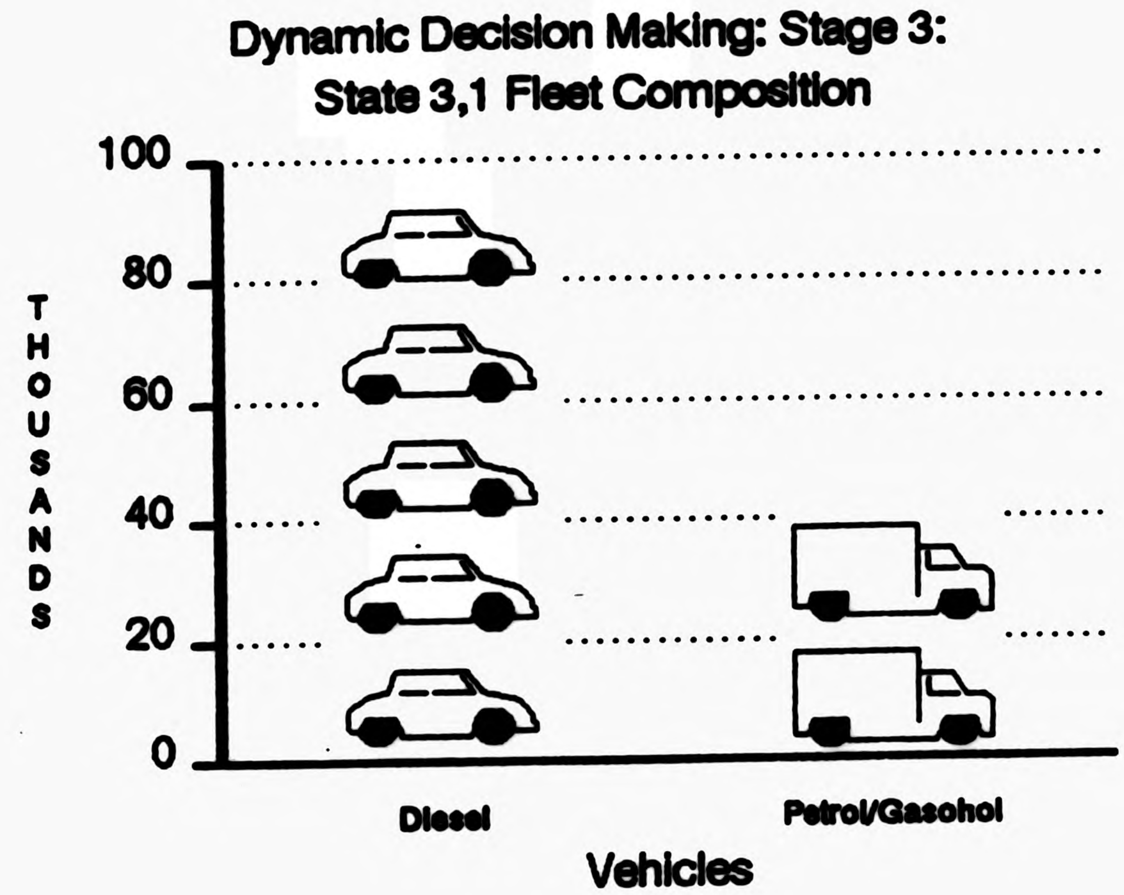

Dynamic Decision Making: Stage 3:
State 3,1 Fleet Composition
100
80
60
40
20
0
THOUSANDS
Diesel
Petrol/Gasohol
Vehicles

TABLE 5.ST3-1.a: Dynamic Decision Making: Stage 3: State 3,1 For the Implementation of a Petrol Substitution Program in Costa Rica

	Sens. Analysis US$14/bb crude	Sens. Analysis US$20/bb crude	Sens. Analysis US$22/bb crude
Cost of Policy			
Cost US$/bb of Oil:	14.00	20.00	22.00
Consumption bb:	1089000.00	1089000.00	1089000.00
1. Present---> $	15246000.00	21780000.00	23958000.00
2. Proposed---> $			
Gasohol Savings: bb	87120.00	87120.00	87120.00
Gasohol Consumption: bb	1001880.00	1001880.00	1001880.00
Ethanol Component: bb	200376.00	200376.00	200376.00
Petrol Component: bb	801504.00	801504.00	801504.00
a. Foreign Currency: $	11221056.00	16030080.00	17633088.00
b. Local Currency: $ equiv.	2805264.00	4007520.00	4408272.00
3. Net Proposed ---> $	14026320.00	20037600.00	22041360.00
4. Balances:			
a. OVERALL ---> $	1219680.00	1742400.00	1916640.00
B. Balance of Payments ---> $	4024944.00	5749920.00	6324912.00

Indifference Policy:

Cost/bb of ETHANOL --> $	20.09	28.70	31.57
Cost/US gal ETHANOL --> $	.48	.68	.75
Cost/litre ETHANOL --> $	.13	.18	.20

	E	F	G	H	I
5	Sens. Analysis	Sens. Analysis	Sens. Analysis	Sens. Analysis	Sens. Analysis
6	US$24/bb crude	US26/bb crude	US$28/bb crude	US$30/bb crude	US$32/bb crude
7	----------	----------	----------	----------	----------
11	24.00	26.00	28.00	30.00	32.00
12	1089000.00	1089000.00	1089000.00	1089000.00	1089000.00
14	26136000.00	28314000.00	30492000.00	32670000.00	34848000.00
17	87120.00	87120.00	87120.00	87120.00	87120.00
18	1001880.00	1001880.00	1001880.00	1001880.00	1001880.00
20	200376.00	200376.00	200376.00	200376.00	200376.00
21	801504.00	801504.00	801504.00	801504.00	801504.00
23	19236096.00	20839104.00	22442112.00	24045120.00	25648128.00
24	4809024.00	5209776.00	5610528.00	6011280.00	6412032.00
26	24045120.00	26048880.00	28052640.00	30056400.00	32060160.00
30	2090880.00	2265120.00	2439360.00	2613600.00	2787840.00
32	6999904.00	7474896.00	8049888.00	8624880.00	9199872.00
34	----------	----------	----------	----------	----------
38	34.43	37.30	40.17	43.04	45.91
39	.82	.89	.96	1.02	1.09
40	.22	.23	.25	.27	.29

	J	K
1		
2		
3		
4		
5	Sens. Analysis	Sens. Analysis
6	US$34/bb crude	US$36/bb crude
7	------------------------------	
8		
9		
10		
11	34.00	36.00
12	1089000.00	1089000.00
13		
14	37026000.00	39204000.00
15		
16		
17	87120.00	87120.00
18	1001880.00	1001880.00
19		
20	200376.00	200376.00
21	801504.00	801504.00
22		
23	27251136.00	28854144.00
24	6812784.00	7213536.00
25		
26	34063920.00	36067680.00
27		
28		
29		
30	2962080.00	3136320.00
31		
32	9774864.00	10349856.00
33		
34	------------------------------	
35		
36		
37		
38	48.78	51.65
39	1.16	1.23
40	.31	.32

ENERGY STRUCTURE FOR STAGE 3: STATE 3,1
USE OF GASOHOL (80 - 20)% MIX

St31b

ENERGY STRUCTURE	MIX bb	%	ACTUAL bb	%	FLEET veh	%	YIELD bb % (oil eq)
PETROL			801504	22.62			
ALCOHOL			200376	5.656			
GASOHOL	1001880	28.28			42000	30	1089000
DIESEL	2541000	71.72	2541000	71.72	98000	70	2541000
TOTAL	3542880	100	3542880	100	140000	100.0	3630000

ENERGY RATIO 1.025
(Yield Total/Actual Total)

PRODUCTION VALUES:

ALCOHOL (litres/year) 31853773

LAND USE (hectares) 9101.078

% of Land Available 91.01

Production Days Nominal Cap.: 132.7241

Production Days Achieved Cap.: 31.67634

State 3.2

Description: Introduction of alcohol, resulting from 100 km.sq. of land dedicated to the production of sugar cane (as an energy crop), as a substitute of petrol.

a. Total Alcohol Production: from Stage 3: 220,167 bb/yr.

b. Approximate fleet affected: based on the estimates presented in Celis, 1980, there are currently 140,000 vehicles in operation in Costa Rica. Considering that the total consumption in the transport sector is of approximately 3,630,000 barrels/yr (again from Stage 3) we have that the average consumption per vehicle is:

3,630,000 bb/yr / 140,000 vehicles = 25.93 bb/yr.

Taking into account that ethanol on its own is a less efficient fuel than LDC petrol (due to lower specific heat values , as was explained before), the best yield that could be expected from this fuel, when converted to petrol oil equivalent, would be around 90%. This means that:

220,167 bb ethanol would correspond to:

220,167 bb x .9 = 198,150.3 bb oil equiv. (petrol)

Transforming this figure into the number of vehicles affected we get that:

198,150.3 bb oil eq./yr / 25.93 bb/veh/yr = 7,642 veh/yr would run on alcohol, when substituting petrol units.

c. Conversion Cost: if present petrol vehicles were to be converted to alcohol ones, (instead of a phase-in of purpose built alcohol units), a conversion cost would have to be accounted for, in the selection of this policy option. According to Slesser *(16)* and Celis *(10)*, the per unit investment required would be around $500 (~£400). Based on the fleet estimate this would constitute an added cost of:

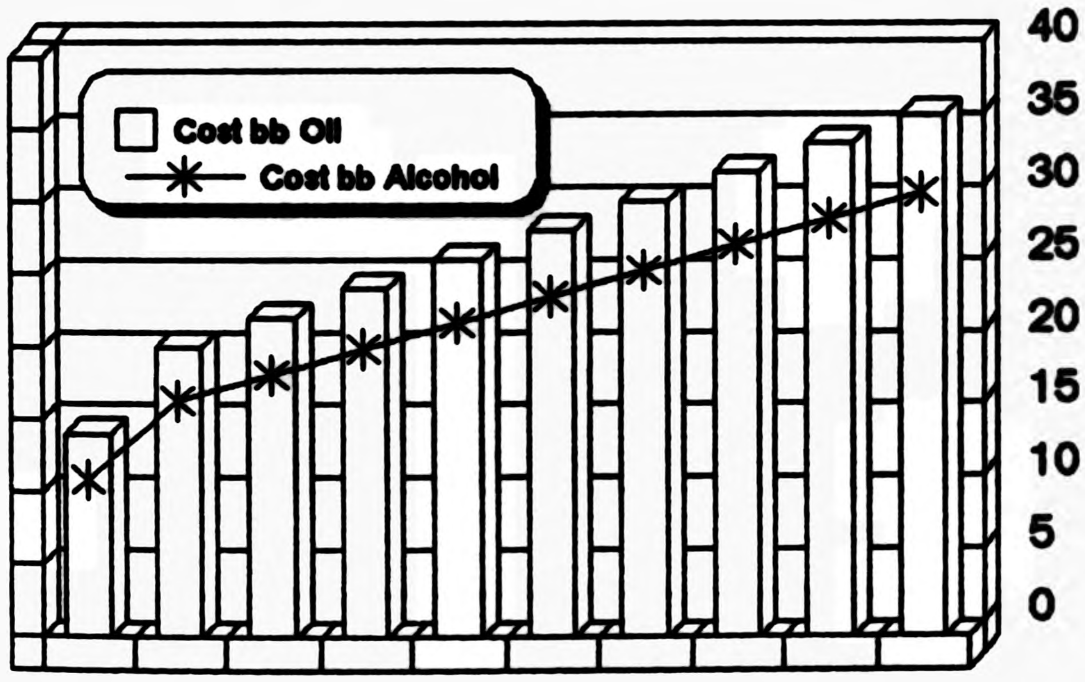
7642 vehicles x $500 = $3,821,000.

It must be noted though, that such a cost could be avoided by implementing fleet targetting (taxi fleet, police cars, etc.) to provide the initial user base of purpose built alcohol units. In the calculations provided below, both options are examined. First, values for an indifference policy, are given before the inclusion of conversion costs. Subsequently, this parameter is provided after this investment has been accounted for, based on a 10 year vehicle service life.

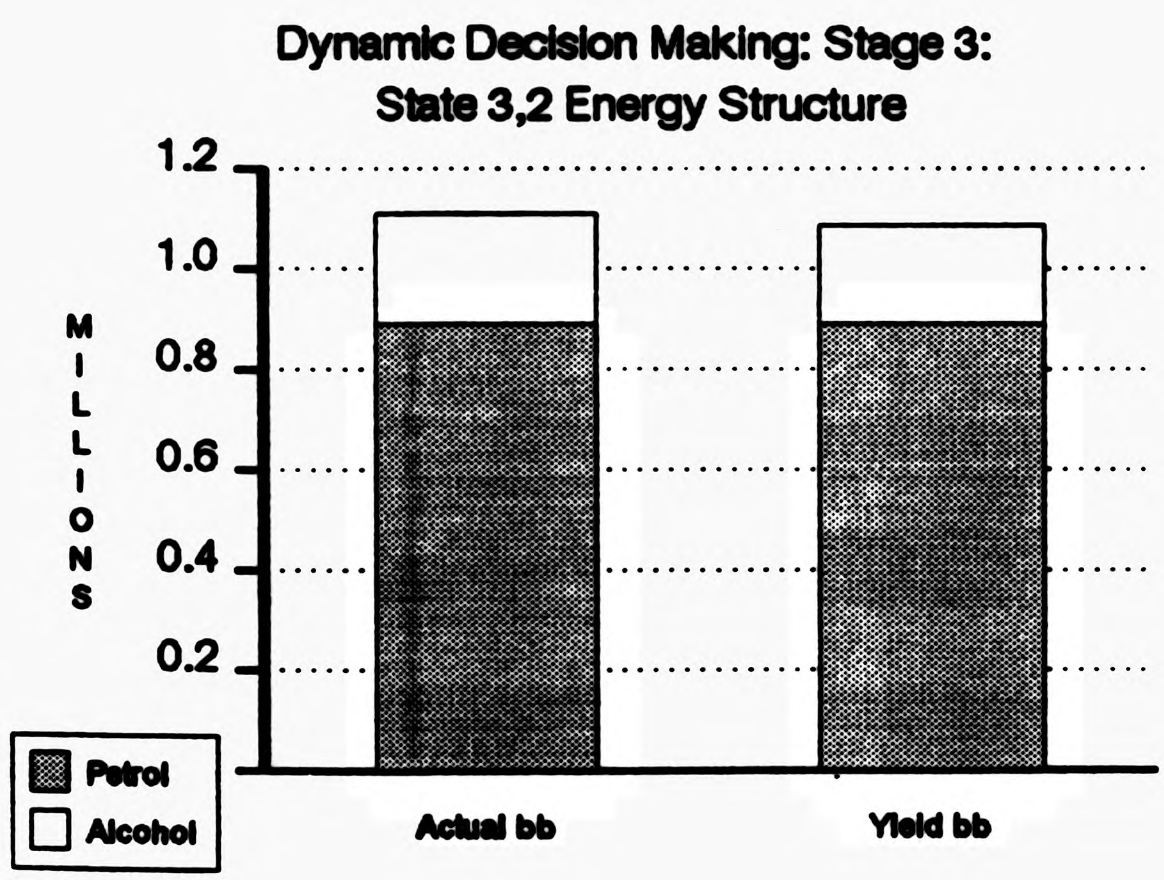
d. Moving on to the second table, we must note the following. Due to the reduced efficiency of ethanol (when compared with petrol) used as an independent fuel, an energy ratio of less than unity would result. This means that more barrels of fuel would be needed overall, when compared to the current petrol/diesel policy.

The reflection of this condition on the indifference policy calculation would be that the cost per barrel of alcohol must be lower than that of petrol. Also, this would yield a negative overall balance, when assuming equal costs of production, as is presented in the first set of tables. For more detailed analysis, the full numerical development of State 3.2 has been included below; please note that the sequence of tables follows the same order as described for State 3.1:

Dynamic Decision Making: Stage 3:
State 3,2 Indifference Policy



Sensitivity Analysis (US$)


Dynamic Decision Making: Stage 3:
State 3,2 Energy Structure
MILLIONS
1.2
1.0
0.8
0.6
0.4
0.2
Petrol
Alcohol
Actual bb
Yield bb

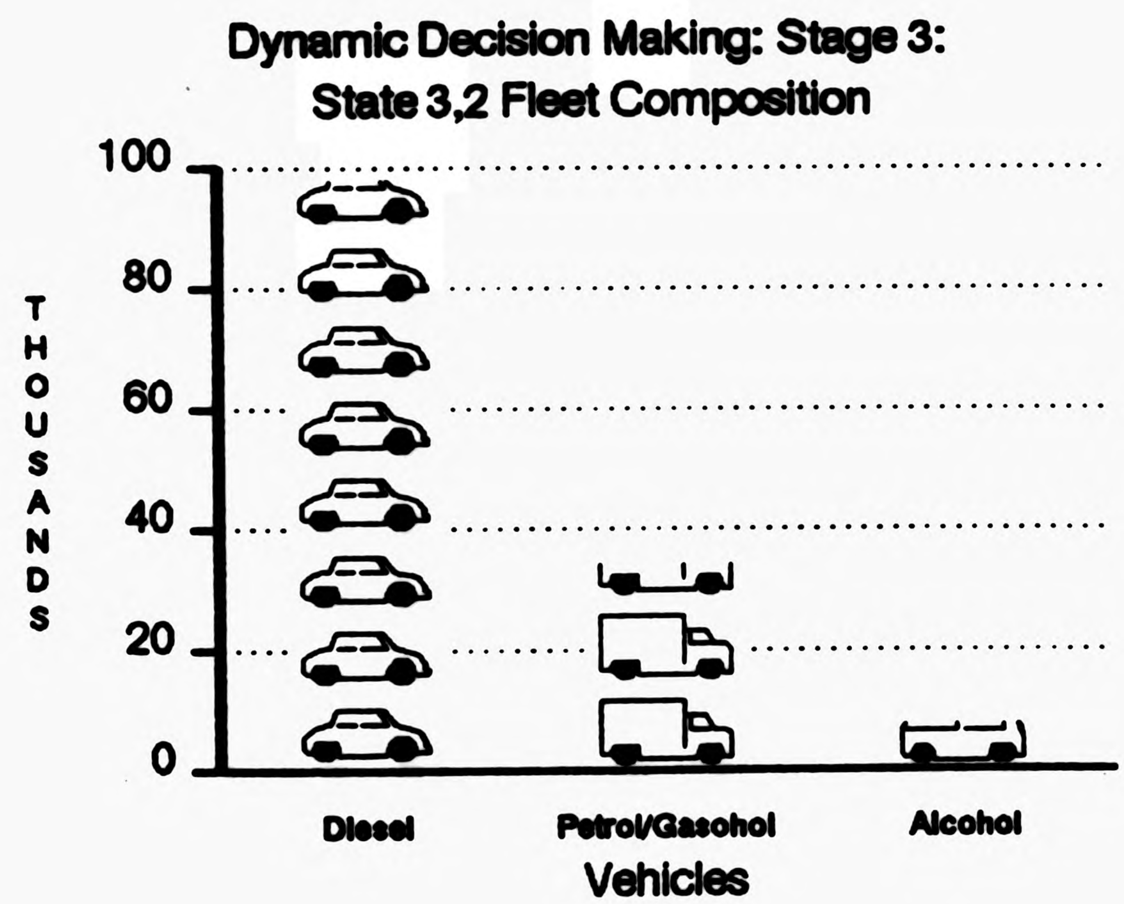

Dynamic Decision Making: Stage 3:
State 3,2 Fleet Composition
100
80
60
40
20
0
THOUSANDS
Diesel
Petrol/Gasohol
Alcohol
Vehicles

TABLE 5. ST3-2.A

Dynamic Decision Making: Stage 3: State 3.2
Direct Substitution of Hydrated Alcohol Vehicles for Petrol Ones

	Sens. Analysis_ US $14/bb crude	Sens. Analysis_ US $20/bb crude	Sens. Analysis_ US $22/bb crude
COST OF POLICY:			
Cost US$/bb of Oil:	14.00	20.00	22.00
Consumption bb:	1089000.00	1089000.00	1089000.00
1. Present ---> $	15246000.00	21780000.00	23958000.00
2. Proposed:			
Available Land: hectares	10000.00	10000.00	10000.00
Alcohol Yield: l/hectare	3500.00	3500.00	3500.00
Hydrated Alcohol: bb	220167.33	220167.33	220167.33
Ethanol Component: bb	198150.59	198150.59	198150.59
Petrol Component: bb	890849.41	890849.41	890849.41
a. Foreign Currency: $	12471891.68	17816988.11	19598686.92
b. Local Currency: $ equiv.	3082342.58	4403346.54	4843681.20
3. Net Proposed ---> $	15554234.26	22220334.65	24442368.12
BALANCES:			
a. OVERALL ---> $	-308234.26	-440334.65	-484368.12
b. BALANCE OF PAYMENTS ---> $	2774108.32	3963011.89	4359313.08
INDIFFERENCE POLICY:			
Cost/bb of Ethanol ---> $	12.60	18.00	19.80
Cost/US gal Ethanol ---> $	.30	.43	.47
Cost/litre Ethanol ---> $	.08	.11	.12
INCLUDING CONVERSION COST:			
Conversion Cost: $/vehicle	500.00	500.00	500.00
Total Consumption: bb oil eq.	3630000.00	3630000.00	3630000.00
Total No. of Vehicles:	140000.00	140000.00	140000.00
Av. Consumption: bb/veh/yr	25.93	25.93	25.93
Affected Fleet: Vehicles	7642	7642	7642
Total Conv. Costs: $	3821000.00	3821000.00	3821000.00
5. Total Cost ---> $	19375234.26	26041334.65	28263368.12
10 yr Straight Line Dep.:			
Cost/bb Ethanol ---> $	10.86	16.26	18.06
Cost/US gal Ethanol ---> $	.26	.39	.43
Cost/litre Ethanol ---> $	.07	.10	.11

	E	F	G	H	I
1					
2					
3					
4					
5					
6	Sens. Analysis_	Sens. Analysis_	Sens. Analysis_	Sens. Analysis_	Sens. Analysis_
7	US $24/bb crude	US $26/bb crude	US $28/bb crude	US $30/bb crude	US $32/bb crude
8	----------------	----------------	----------------	----------------	----------------
9					
10					
11					
12	24.00	26.00	28.00	30.00	32.00
13	1089000.00	1089000.00	1089000.00	1089000.00	1089000.00
14					
15	26136000.00	28314000.00	30492000.00	32670000.00	34848000.00
16					
17					
18	10000.00	10000.00	10000.00	10000.00	10000.00
19	3500.00	3500.00	3500.00	3500.00	3500.00
20	220167.33	220167.33	220167.33	220167.33	220167.33
21					
22	198150.59	198150.59	198150.59	198150.59	198150.59
23	890849.41	890849.41	890849.41	890849.41	890849.41
24					
25	21380385.73	23162084.54	24943783.36	26725482.17	28507180.98
26	5284[illegible]15.85	5724350.51	6164685.16	6605019.82	7045354.47
27					
28	26664401.59	28886435.05	31108468.52	33330501.98	35552535.45
29					
30					
31					
32	-528401.59	-572435.05	-616468.52	-660501.98	-[illegible]4535.45
33					
34	4755614.27	5151915.46	5548216.64	5944517.83	6340819.[illegible]
35					
36	----------------	----------------	----------------	----------------	----------------
37					
38					
39					
40	21.60	23.40	25.20	27.00	28.80
41	.51	.56	.60	.64	.69
42	.14	.15	.16	.17	.18
43					
44					
45					
46	500.00	500.00	500.00	500.00	500.00
47	3630000.00	3630000.00	3630000.00	3630000.00	3630000.00
48	140000.00	140000.00	140000.00	140000.00	140000.00
49	25.93	25.93	25.93	25.93	25.93
50					
51	7642	7642	7642	7642	7642
52					
53	3821000.00	3821000.00	3821000.00	3821000.00	3821000.00
54					
55	[illegible]485401.59	[illegible]	34929468.52	[illegible]151501.98	39373535.45
56					
57					
58					
59	19.86	21.66	23.46	25.26	27.06
60	.47	.52	.56	.60	.64
61	.12	.14	.15	.16	.17

	J	K	L
1			
2			
3			
4			
5			
6	Sens. Analysis_	Sens. Analysis_	
7	US $34/bb crude	US $36/bb crude	
8	------------------------	------------------------	------
9			
10			
11			
12	34.00	36.00	
13	1089000.00	1089000.00	
14			
15	37026000.00	39204000.00	
16			
17			
18	10000.00	10000.00	
19	3500.00	3500.00	
20	220167.33	220167.33	
21			
22	198150.59	198150.59	
23	890849.41	890849.41	
24			
25	30288879.79	32070578.60	
26	7485689.12	7926023.78	
27			
28	37774568.91	39996602.38	
29			
30			
31			
32	-748568.91	-792602.38	
33			
34	6737120.21	7133421.40	
35			
36	------------------------	------------------------	------
37			
38			
39			
40	30.60	32.40	
41	.73	.77	
42	.19	.20	
43			
44			
45			
46	500.00	500.00	
47	3630000.00	3630000.00	
48	140000.00	140000.00	
49	25.93	25.93	
50			
51	7642	7642	
52			
53	3821000.00	3821000.00	
54			
55	41595568.91	43817602.38	
56			
57			
58			
59	28.86	30.66	
60	.69	.73	
61	.18	.19	

St3.2.b

ENERGY STRUCTURE	ACTUAL bb%		FLEET veh%		YIELD bb % (oil eq)	
PETROL	890849	24.39	34358	24.54	890849	24.54
ALCOHOL	220167	6.029	7642	5.459	198151	5.459
GASOHOL						
DIESEL	2541000	69.58	98000	70	2541000	70
TOTAL	3652017	100.0	140000	100.0	3630000	100

ENERGY RATIO (Yield Total/Actual Total) .9940

PRODUCTION VALUES:

ALCOHOL (litres/year) 35000000

LAND USE (hectares) 10000

% of Land Available 100

Production Days Nominal Cap.: 145.8333

Production Days Achieved Cap.: 19.74359

St3.2.b

ENERGY STRUCTURE	ACTUAL bb	%	FLEET veh	%	YIELD bb (oil eq)	%
PETROL	890849	24.39	34358	24.54	890849	24.54
ALCOHOL	220167	6.029	7642	5.459	198151	5.459
GASOHOL						
DIESEL	2541000	69.58	98000	70	2541000	70
TOTAL	3652017	100.0	140000	100.0	3630000	100

ENERGY RATIO .9940
(Yield Total/Actual Total)

PRODUCTION VALUES:

ALCOHOL (litres/year) 35000000

LAND USE (hectares) 10000

% of Land Available 100

Production Days Nominal Capacity 145.8333

Production Days Actualised Capacity 99.74359

State 3.3:

Description: Substitution of diesel vehicles by alcohol powered units, using the potential provided by 100 sq.km. planted with sugar cane.

a. Total Alcohol Production:

from Stage 3: 220,167 bb/yr.

b. Approximate fleet affected: Similar to the situation discussed in State 3.2, alcohol is a less efficient fuel than diesel. Unfortunately, because of differences in engine design (higher compression ratios, up to 20:1 in the case fo diesel power plants vs. ~11:1 for alcohol, and reduced rpm ranges: ~1000rpm idle to ~2,600 rpm at full power; diesel yields similar economy figures for city and highway driving vs. ~500 - 6000 rpm for alcohol), the disparity in this instance is even greater than before. The best relation possible, according to various sources quoted before in this chapter, would be: .8 bb diesel = 1 bb alcohol. From this it follows that only

.80 x 220,167 bb/alcohol = 176,133.9 bb/oil equivalent (diesel)

would be available for this substitution option. Translating this potential oil equivalent production to the number of vehicles that would be affected, we get:

176,133.9 / 25.93 = ~6793 vehicles

(average consumption/yr = 25.93 bb/yr/veh)

c. Conversion Costs: Choosing this policy option would entail important conversion costs, which would involve the exchange of diesel engines, substituting them with alcohol ones. The cost of such an action has been estimated at around $3,000/unit by Celis *(10)*. Again, this capital cost could be avoided by a phase-in program, as explained in State 3.2. Similar to the approach chosen before, results for an indifference policy have been calculated with and without accounting for this investment.

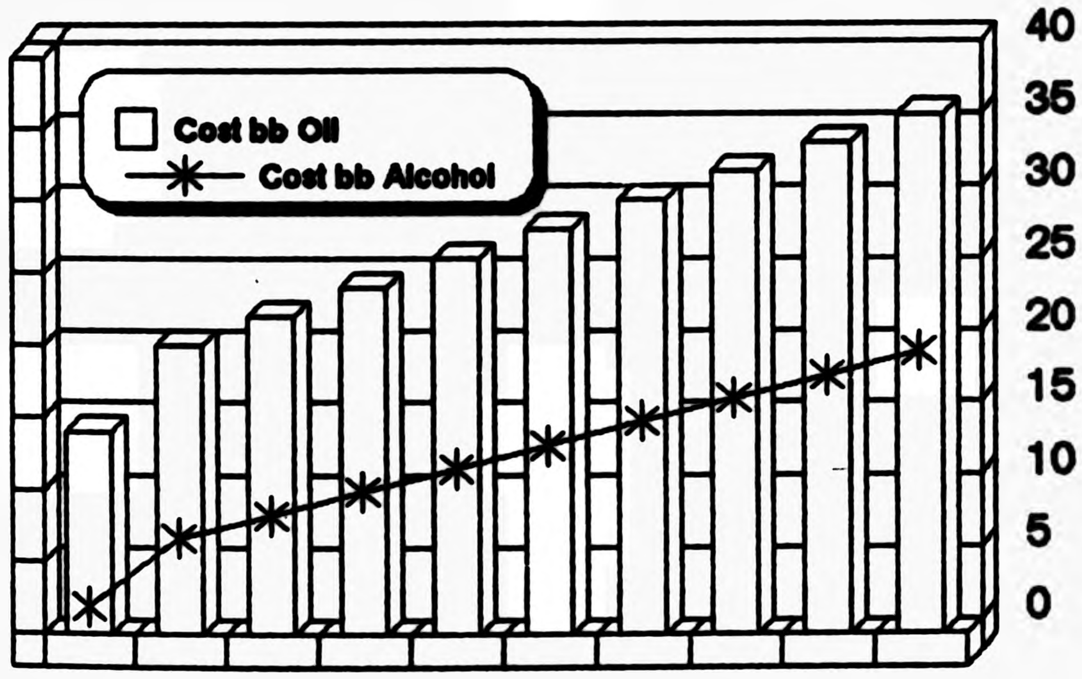
d. Energy: Concentrating on the second set of tables for this State, we note that as in the previous case (3.2), an energy ratio of less than one has resulted. Nevertheless, because of the greater separation in terms of efficiency between alcohol and diesel, than between alcohol and petrol, the ratio in this case is lower (than in State 3,2). In fuel terms (barrels) such a policy would consume even more barrels overall than State 3,2 to cover the present oil equivalent demand. In money terms, again, implementing State 3,3 would require the price of alcohol (per barrel) to be lower than that of diesel, in order not to yield a negative overall balance. The complete numerical analysis of this State follows:

(average consumption/yr = 25.93 bb/yr/veh)

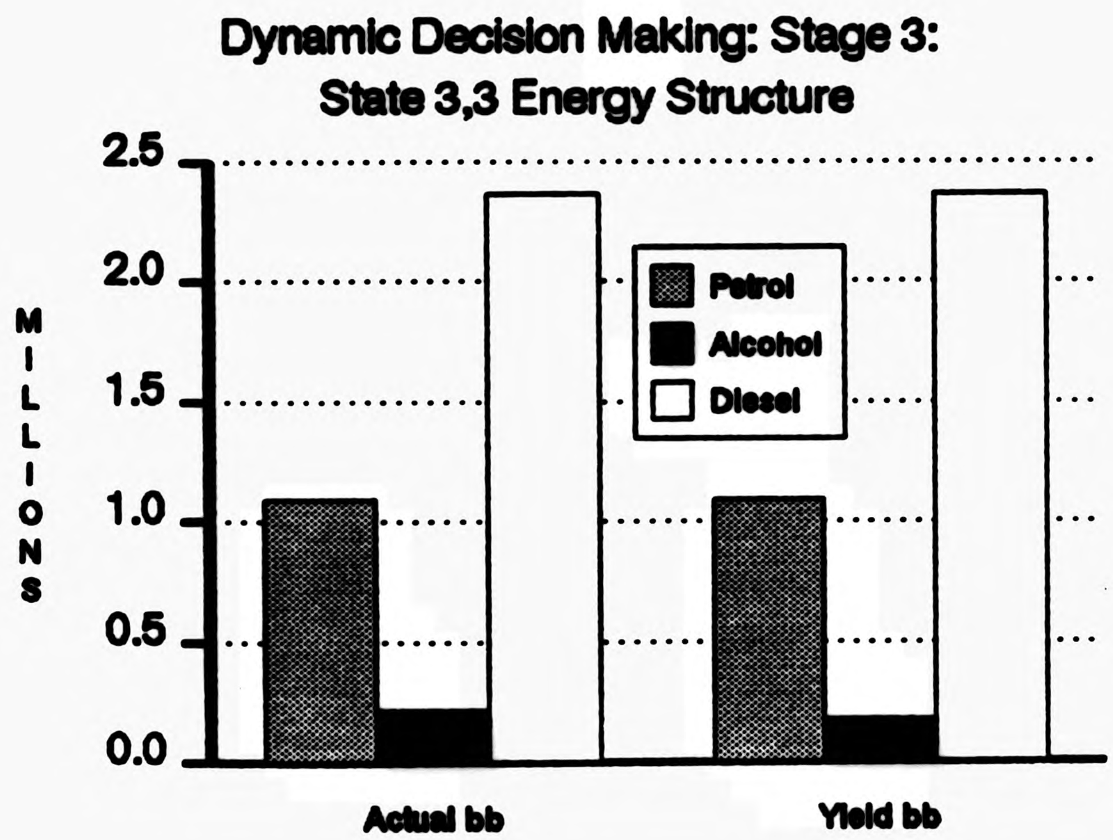
c. Conversion Costs: Choosing this policy option would entail important conversion costs, which would involve the exchange of diesel engines, substituting them with alcohol ones. The cost of such an action has been estimated at around $3,000/unit by Celis *(10)*. Again, this capital cost could be avoided by a phase-in program, as explained in State 3.2. Similar to the approach chosen before, results for an indifference policy have been calculated with and without accounting for this investment.

d. Energy: Concentrating on the second set of tables for this State, we note that as in the previous case (3.2), an energy ratio of less than one has resulted. Nevertheless, because of the greater separation in terms of efficiency between alcohol and diesel, than between alcohol and petrol, the ratio in this case is lower (than in State 3,2). In fuel terms (barrels) such a policy would consume even more barrels overall than State 3,2 to cover the present oil equivalent demand. In money terms, again, implementing State 3,3 would require the price of alcohol (per barrel) to be lower than that of diesel, in order not to yield a negative overall balance. The complete numerical analysis of this State follows:

Dynamic Decision Making: Stage 3:
State 3,3 Indifference Policy



Sensitivity Analysis (US$)


Dynamic Decision Making: Stage 3:
State 3,3 Energy Structure
2.5
2.0
1.5
1.0
0.5
0.0
MILLIONS
Petrol
Alcohol
Diesel
Actual bb
Yield bb

Dynamic Decision Making: Stage 3:
State 3,3 Fleet Composition

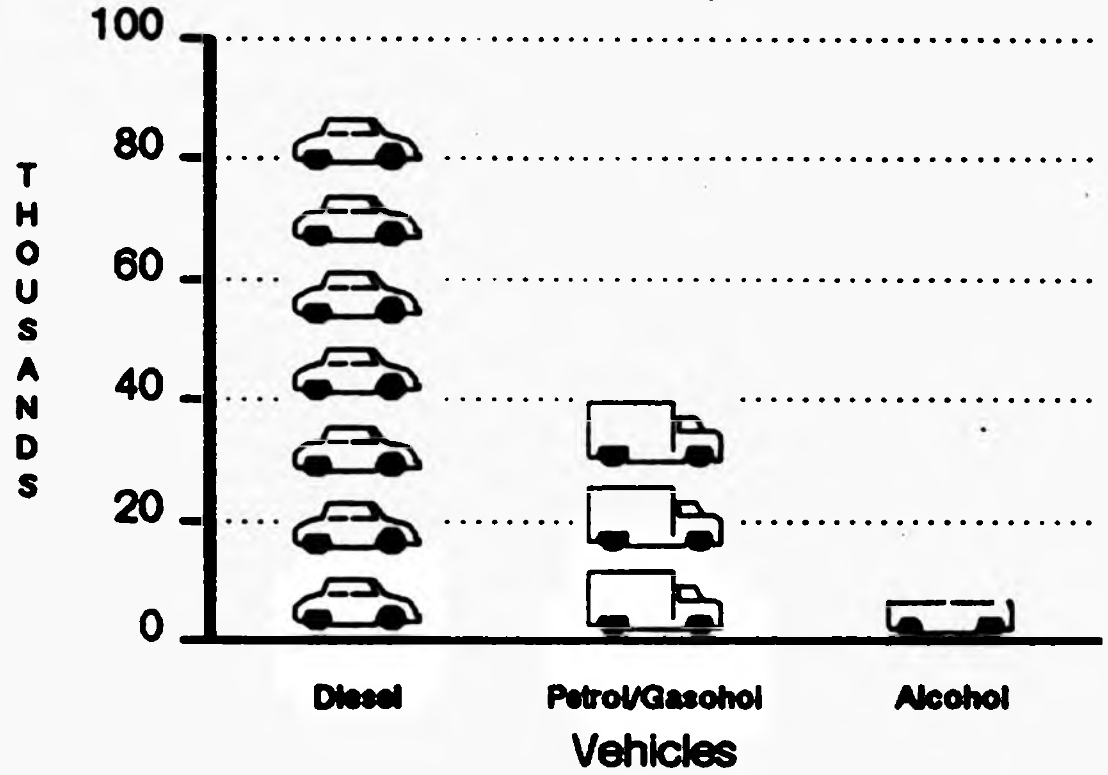


TABLE 5. ST3-3.A

Dynamic Decision Making: Stage 3 State 3,3
Conversion of Diesel Vehicles To Use
Hydrated Ethanol as Fuel (Ethanol Fleet)

	Sens. Analysis_ US $14/bb crude	Sens. Analysis_ US $20/bb crude	Sens. Analysis_ US $22/bb crude
COST OF POLICY:			
Cost US$/bb of Oil:	14.00	20.00	22.00
Consumption bb:	2541000.00	2541000.00	2541000.00
1. Present ---> $	35574000.00	50820000.00	55902000.00
2. Proposed:			
Available Land: hectares	10000.00	10000.00	10000.00
Alcohol Yield: l/hectare	3500.00	3500.00	3500.00
Hydrated Alcohol: bb	220167.33	220167.33	220167.33
Ethanol Component: bb	176133.86	176133.86	176133.86
Diesel Component: bb	2364866.14	2364866.14	2364866.14
a. Foreign Currency: $	33108125.94	47297322.77	52027055.04
b. Local Currency: $ equiv.	3082342.58	4403346.54	4843681.20
3. Net Proposed ---> $	36190468.52	51700669.31	56870736.24
BALANCES:			
a. OVERALL ---> $	-616468.52	-880669.31	-968736.24
b. BALANCE OF PAYMENTS --> $	2465874.06	3522677.23	3874944.96
INDIFFERENCE POLICY:			
Cost/bb of Ethanol --> $	11.20	16.00	17.60
Cost/US gal Ethanol --> $	.27	.38	.42
Cost/litre Ethanol --> $	.07	.10	.11
INCLUDING CONVERSION COST:			
Conversion Cost: $/vehicle	3000.00	3000.00	3000.00
Total Consumption: bb oil eq.	3630000.00	3630000.00	3630000.00
Total No. of Vehicles:	140000.00	140000.00	140000.00
Av. Consumption: bb/veh/yr	25.93	25.93	25.93
Affected Fleet: Vehicles	6793	6793	6793
Total Conv. Costs: $	20379000.00	20379000.00	20379000.00
5. Total Cost ---> $	56569468.52	72079669.31	77249736.24
10 yr Straight Line Dep.:			
Cost/bb Ethanol ---> $	1.94	6.74	8.34
Cost/US gal Ethanol ---> $	.05	.16	.20
Cost/litre Ethanol ---> $	.01	.04	.05

	E	F	G	H	I
1					
2					
3					
4					
5					
6	Sens. Analysis_	Sens. Analysis_	Sens. Analysis_	Sens. Analysis_	Sens. Analysis_
7	US $24/bb crude	US $26/bb crude	US $28/bb crude	US $30/bb crude	US $32/bb crude
8	---------------	---------------	---------------	---------------	---------------
9					
10					
11					
12	24.00	26.00	28.00	30.00	32.00
13	2541000.00	2541000.00	2541000.00	2541000.00	2541000.00
14					
15	60984000.00	66066000.00	71148000.00	76230000.00	81312000.00
16					
17					
18	10000.00	10000.00	10000.00	10000.00	10000.00
19	3500.00	3500.00	3500.00	3500.00	3500.00
20	220167.33	220167.33	220167.33	220167.33	220167.33
21					
22	176133.86	176133.86	176133.86	176133.86	176133.86
23	2364866.14	2364866.14	2364866.14	2364866.14	2364866.14
24					
25	56756787.32	61486519.59	66216251.87	70945984.15	75675716.42
26	5284015.85	5724350.51	6164685.16	6605019.82	7045354.47
27					
28	62940803.17	67210870.10	72380937.03	77551003.96	82721070.89
29					
30					
31					
32	-1056803.17	-1144870.10	-1232937.03	-1321003.96	-1409070.89
33					
34	4227212.68	4579480.41	4931748.13	5284015.85	5636283.58
35					
36	---------------	---------------	---------------	---------------	---------------
37					
38					
39					
40	19.20	20.80	22.40	24.00	25.60
41	.46	.50	.53	.57	.61
42	.12	.13	.14	.15	.16
43					
44					
45					
46	3000.00	3000.00	3000.00	3000.00	3000.00
47	3630000.00	3630000.00	3630000.00	3630000.00	3630000.00
48	140000.00	140000.00	140000.00	140000.00	140000.00
49	25.93	25.93	25.93	25.93	25.93
50					
51	6793	6793	6793	6793	6793
52					
53	20379000.00	20379000.00	20379000.00	20379000.00	20379000.00
54					
55	82419803.17	87589870.10	92759937.03	97930003.96	103100070.89
56					
57					
58					
59	9.94	11.54	13.14	14.74	16.34
60	.24	.27	.31	.35	.39
61	.06	.07	.08	.09	.10

	J	K	L
1:			
2:			
3:			
4:			
5:			
6:	Sens. Analysis_	Sens. Analysis_	
7:	US $34/bb crude	US $36/bb crude	
8:	-------------	-------------	-------------
9:			
10:			
11:			
12:	34.00	36.00	
13:	2541000.00	2541000.00	
14:			
15:	86394000.00	91476000.00	
16:			
17:			
18:	10000.00	10000.00	
19:	3500.00	3500.00	
20:	220167.33	220167.33	
21:			
22:	176133.86	176133.86	
23:	2364866.14	2364866.14	
24:			
25:	80405448.70	85135180.98	
26:	7485689.12	7926023.78	
27:			
28:	87991137.82	93061204.76	
29:			
30:			
31:			
32:	-1497137.82	-1595204.76	
33:			
34:	5988551.30	6340819.02	
35:			
36:	-------------	-------------	-------------
37:			
38:			
39:			
40:	27.20	28.80	
41:	.65	.69	
42:	.17	.16	
43:			
44:			
45:			
46:	3000.00	3000.00	
47:	3630000.00	3630000.00	
48:	140000.00	140000.00	
49:	25.93	25.93	
50:			
51:	6793	6793	
52:			
53:	20379000.00	20379000.00	
54:			
55:	108270137.82	113440204.76	
56:			
57:			
58:			
59:	17.94	19.54	
60:	.43	.47	
61:	.11	.12	

ENERGY STRUCTURE STAGE 3: STATE 3,3
INTRODUCTION OF ALCOHOL-ONLY VEHICLES
(Instead of Diesel Ones)

St3.3.b

ENERGY STRUCTURE	ACTUAL bb	%	FLEET veh	%	YIELD bb (oil eq)	%
PETROL	1089000	29.64	42000	30	1089000	30
ALCOHOL	220167	5.993	6793	4.852	176134	4.852
GASOHOL						
DIESEL	2364866.	64.37	91207	65	2364866.	65.15
TOTAL	3674033	100	140000	100.0	3630000	100.0

ENERGY RATIO .9880
(Yield Total/Actual Total)

PRODUCTION VALUES:

ALCOHOL (litres/year) 35000000

LAND USE (hectares) 10000

% of Land Available 100

Production Days Nominal Cap.: 145.8333

Production Days Achieved Cap.: 89.74359

Stage 3: Summary

Having reviewed the three options available at this point, it is clear that State 3,1 is the most favourable alternative. This would be the case not only because of a net energy ratio of more than one (which would mean direct savings as a result), but because no conversion costs would be involved.

On top of this, the distribution of the new fuel would require no new installations, since a two fuel system (gasohol and diesel) instead of the current (petrol and diesel) set-up would be maintained. In the case of the other two states, most probably new investment in distribution equipment is called for, since a three fuel system (alcohol, petrol, diesel) would result.

Note: Please observe that the choice of State 3,1 would not constrain the decision making process at Stage 2, since all Stage 2 states can be reached from any Stage 3 state. It would depend on what the ultimate goal of the policy making process is to be, to determine what stage 3 state is chosen. For Example, if the aim is to reduce the diesel problem (State 3,3) explained before, the easiest path would be to target present fleet users (and therefore be able to count this base for further substitution), even though the inicial results are not to be as encouraging as state 3,1.

Stage 2:

The second stage, as has been explained before, is determined by the limit of 750 sq.km. (650 sq.km. and the CATSA 100 sq.km.) of agricultural land in Costa Rica (SEPSA) for energy crop cultivation.

Three states can be identified here: the substitution of the present petrol fleet (State 2,1), the balancing of the national demand for vehicle fuels to equal the typical yield of the crude refined locally (using alcohol as the fuel to achieve this parity), (State 2,2), and finally, the partial substitution of diesel by alcohol (State 2,3).

The potential production of alcohol available for this stage is:

75,000 ha x 3,500 litres/ha = 1,651,255 bb alcohol/yr.

When translated to oil equivalent this figure would become:

1,651,255 x .9 = ~1,486,129.5 bb petrol eqiuvalent

or: 1,651,255 x .8 = ~ 1.321,004 bb diesel equivalent.

The next pages are devoted to the development of all three options in detail.

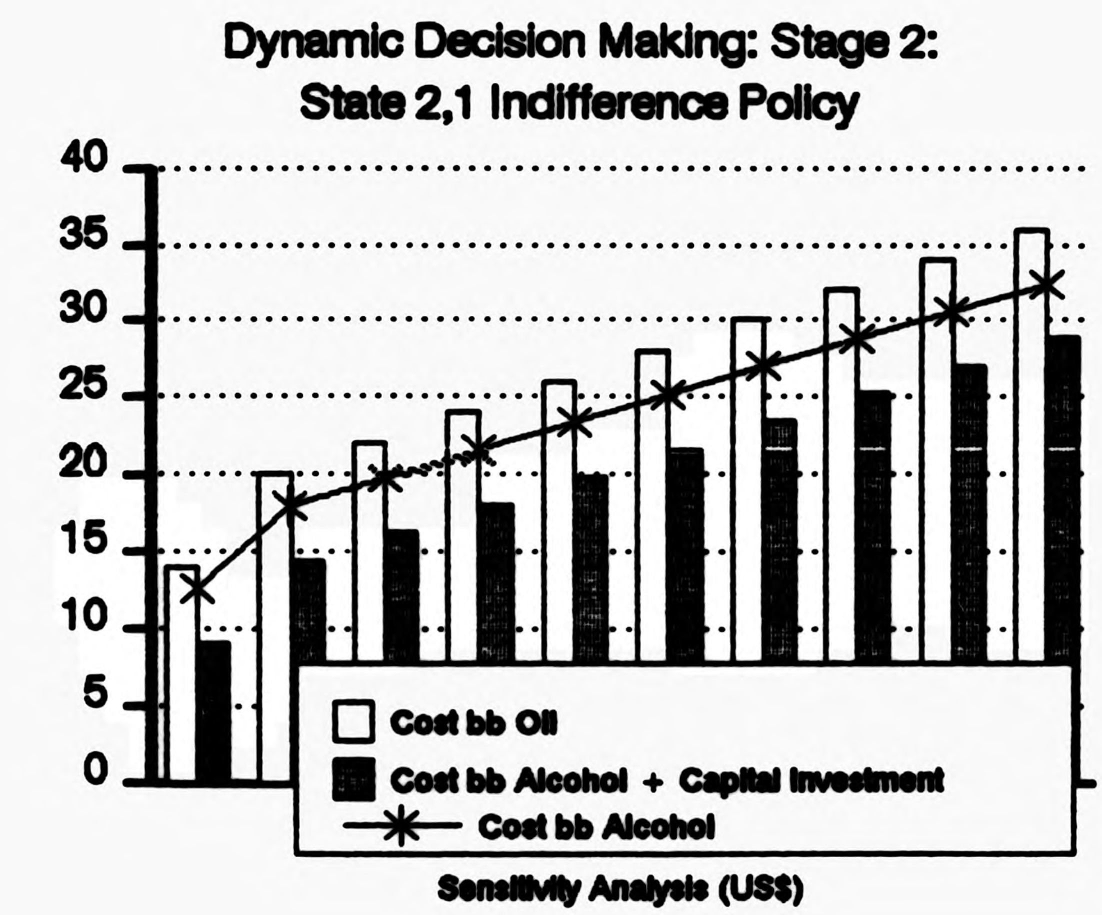
State 2,1:

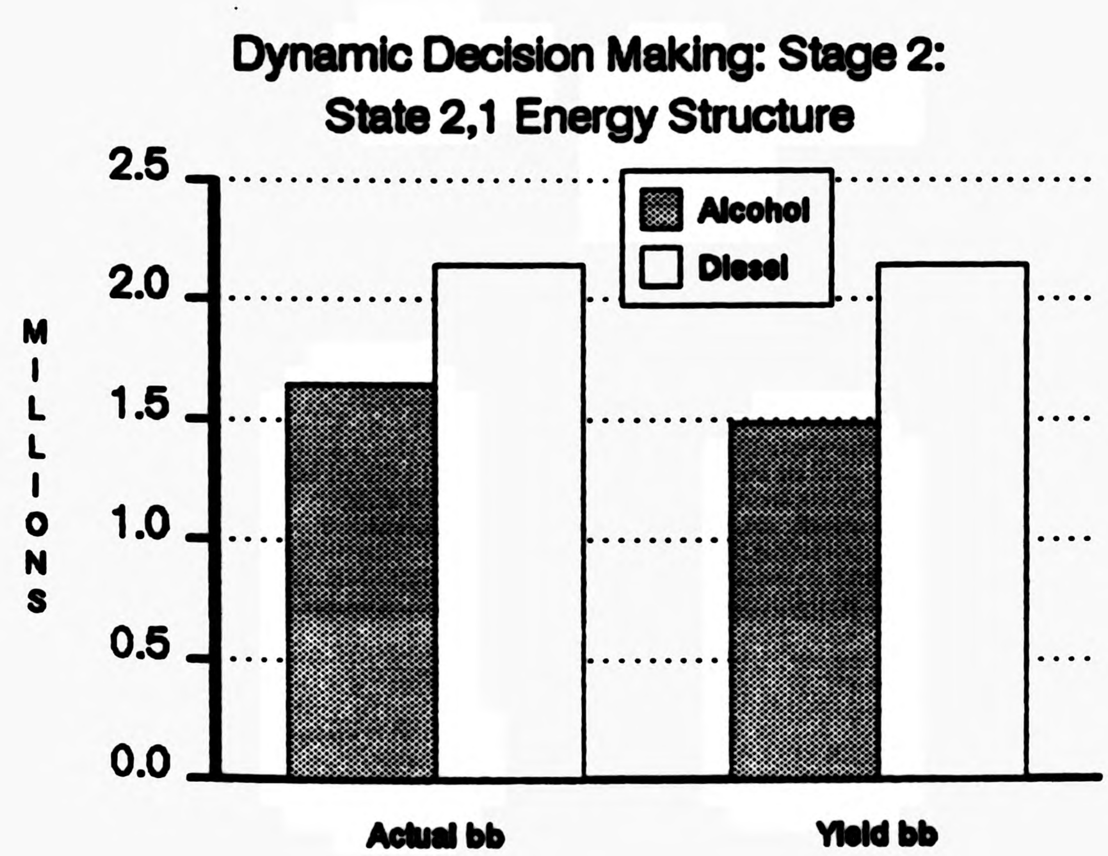
Description: Direct substitution of hydrated ethanol vehicles for petrol ones, based on 750 sq.km. dedicated to sugar cane growing for energy purposes.

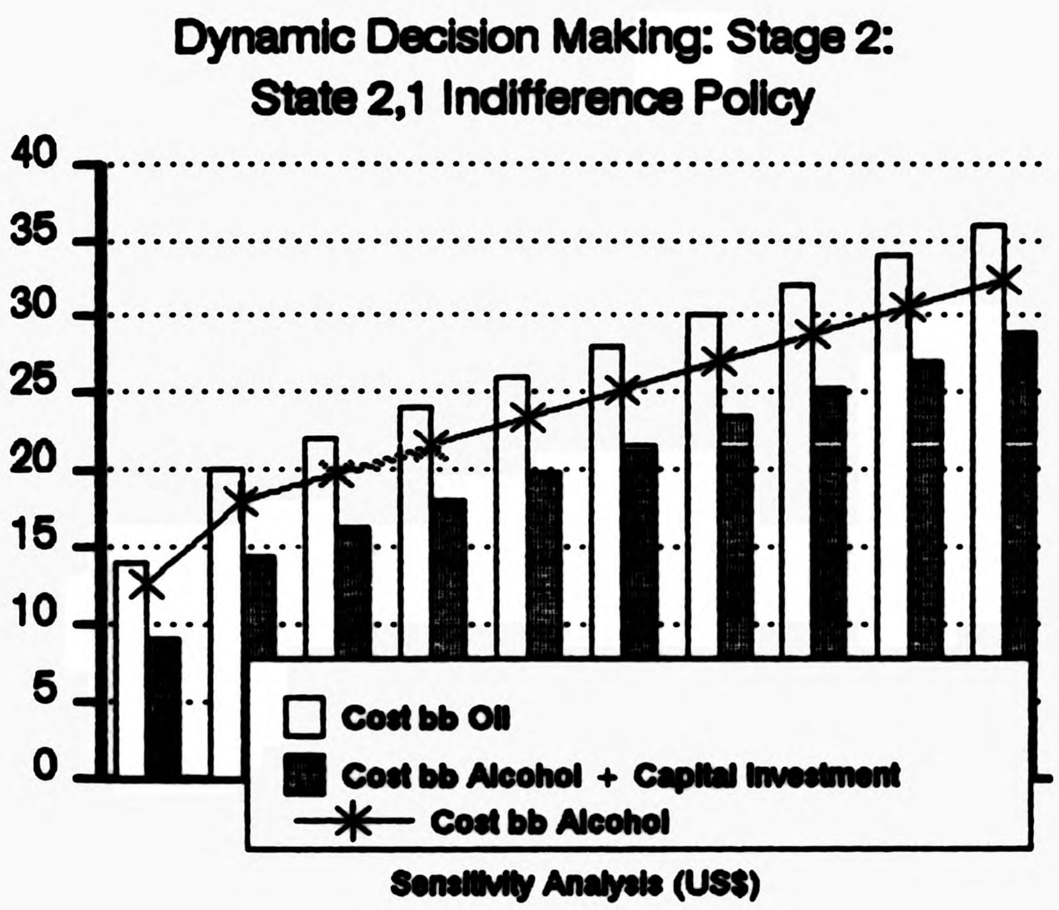
Two alternatives have been studied here. The first would be restricted to the total substitution of the present fleet by alcohol vehicles. The second would entail the total use of the available alcohol, to carry the program further by substituting some of the diesel fleet (which could gradually be changed to petrol before the Stage 2 time comes).

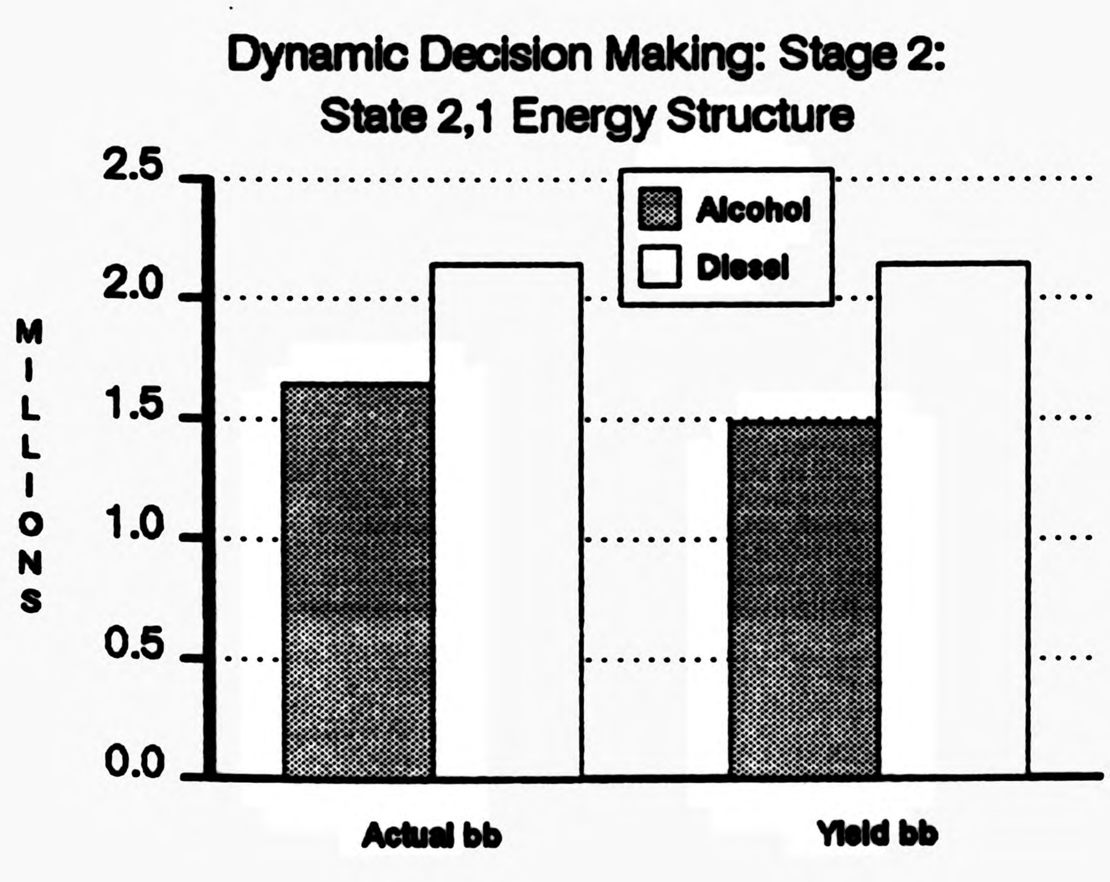
Apart from this difference, the general approach followed when describing Stage 3, is observed. Nonetheless, the computation exercise is more extensive, since capital costs for new distilling capacity would have to be taken into account. Here a marked difference between the two options described above exists, for as when the substitution is held to the present petrol fleet, approximately two distilleries less would be necessary, reducing the overall cost by some $28,000,000, according to Slesser *(16)*.

Due to the above condition, option 2 appears to be the better alternative for State 2,1, as can be seen from the indifference policy values quoted at the end of the first set of tables. To provide a more detailed analysis, the complete set of calculations is presented next:


Dynamic Decision Making: Stage 2:
State 2,1 Indifference Policy
40
35
30
25
20
15
10
5
0
Cost bb Oil
Cost bb Alcohol + Capital Investment
Cost bb Alcohol
Sensitivity Analysis (US$)


Dynamic Decision Making: Stage 2:
State 2,1 Energy Structure
2.5
2.0
1.5
1.0
0.5
0.0
MILLIONS
Alcohol
Diesel
Actual bb
Yield bb


Dynamic Decision Making: Stage 2:
State 2,1 Indifference Policy
40
35
30
25
20
15
10
5
0
Cost bb Oil
Cost bb Alcohol + Capital Investment
Cost bb Alcohol
Sensitivity Analysis (US$)


Dynamic Decision Making: Stage 2:
State 2,1 Energy Structure
2.5
2.0
1.5
1.0
0.5
0.0
MILLIONS
Alcohol
Diesel
Actual bb
Yield bb

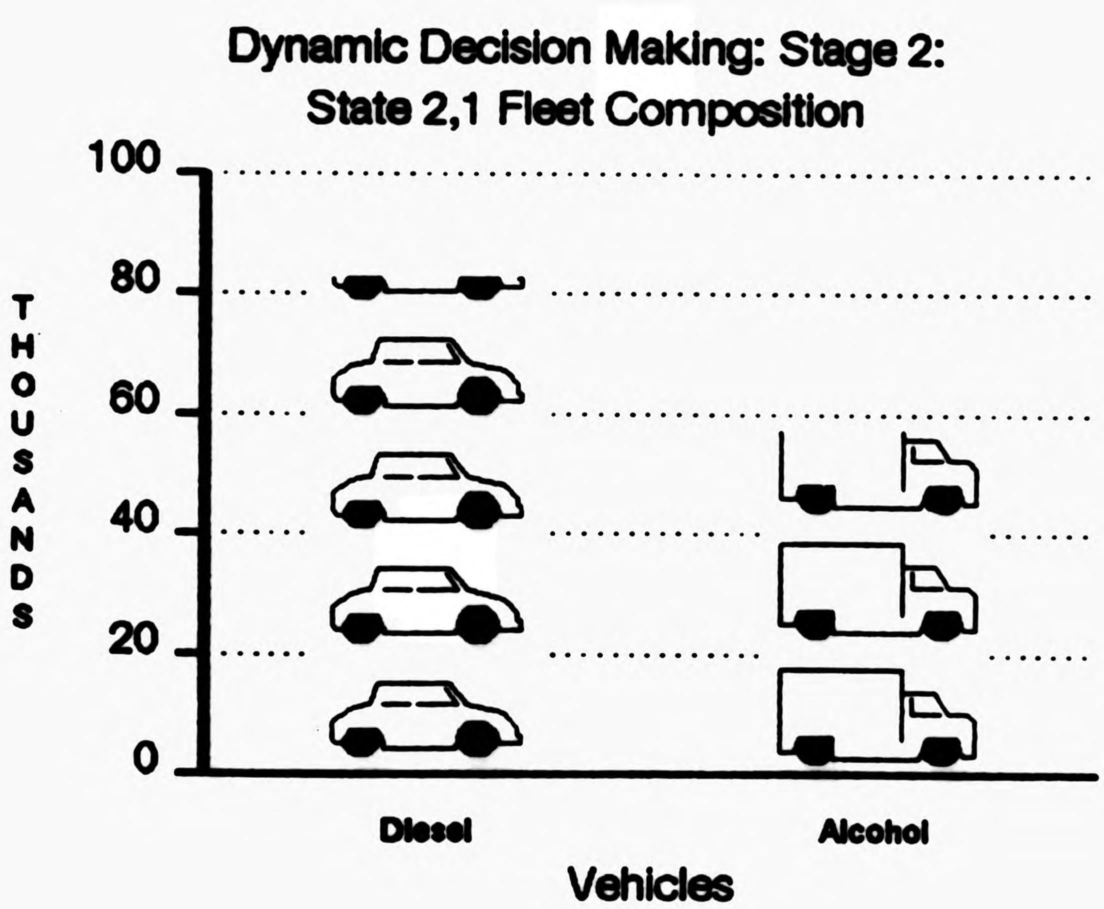

Dynamic Decision Making: Stage 2:
State 2,1 Fleet Composition
THOUSANDS
100
80
60
40
20
0
Diesel
Alcohol
Vehicles

TABLE 5. ST2-1.A

Dynamic Decision Making: Stage 2: State 2.1
DIRECT SUBSTITUTION OF HYDRATED ETHANOL
VEHICLES FOR PETROL ONES

Cost of Policy	Sens. Analysis US $14/bb crude	Sens. Analysis US $20/bb crude	Sens. Analysis US $22/bb crude
Cost US$/bb of Oil:	14.00	20.00	22.00
Consumption: bb	3630000.00	3630000.00	3630000.00
1. Present ---> $	50820000.00	72600000.00	79860000.00
2. Proposed:			
Available Land:	75000.00	75000.00	75000.00
Alcohol Yield: l/hectare	3500.00	3500.00	3500.00
Alcohol: bb	1651254.95	1651254.95	1651254.95
Gasohol Savings: bb			
Gasohol Consumption: bb			
Ethanol Component: bb Oileq.			
Petrol Component: bb			
OPTION No. 1: (Using all available land)			
Ethanol Component: bb OiLeq.	1486129.46	1486129.46	1486129.46
Diesel Component: bb	2143870.54	2143870.54	2143870.54
a. Foreign Currency: $	30014187.58	42877410.83	47165151.92
b. Local Currency: $ equiv.	23117569.35	33025099.08	36327608.98
Net Proposed -(1)--> $	53131756.94	75902509.91	83492760.90
OPTION No. 2: (Up to Present Petrol Use)	1089000.00	1089000.00	1089000.00
Land Usage: hectares	54958.20	54958.20	54958.20
Alcohol Yield: l/hectare	3500.00	3500.00	3500.00
Alcohol: bb	1210000.00	1210000.00	1210000.00
Ethanol Component: bb OILeq	1089000.00	1089000.00	1089000.00
Diesel Component: bb	2541000.00	2541000.00	2541000.00
a. Foreign Currency: $	35574000.00	50820000.00	55902000.00
b. Local Currency: $ equiv.	16940000.00	24200000.00	26620000.00
Net Proposed -(2)--> $	52514000.00	75020000.00	82522000.00
3. BALANCES:			
a. OVERALL:			
OPTION No. 1: ---> $	-2311756.94	-3302509.91	-3632760.90
OPTION No. 2: ---> $	-1694000.00	-2420000.00	-2662000.00
b. BALANCE OF PAYMENTS:			
OPTION No. 1: ---> $	20805812.42	29722589.17	32694848.08

OPTION No. 2: ---> $	15246000.00	21780000.00	23958000.00

4. INDIFFERENCE POLICY:

a. Option No. 1:			
Cost/bb of Ethanol ---> $	12.60	18.00	19.80
Cost/US gal of Ethanol ---> $	.30	.43	.47
Cost/litre Ethanol ---> $	.08	.11	.12
b. Option No. 2:			
Cost/bb of Ethanol ---> $	12.60	18.00	19.80
Cost/US gal of Ethanol ---> $	.30	.43	.47
Cost/litre Ethanol ---> $	.08	.11	.12

5. CAPITAL COSTS:

a. VEHICLE CONVERSION:

Conversion Cost: $/vehicle	500.00	500.00	500.00
Total Consumption: bb OILeq	3630000.00	3630000.00	3630000.00
Total No. of Vehicles:	140000.00	140000.00	140000.00
Av. Consumption: bb/veh OILeq	25.93	25.93	25.93
Affected Fleet: vehicles			
Option No. 1:	57316.00	57316.00	57316.00
Option No. 2:	42000.00	42000.00	42000.00
Subtotal Vehicle Conversion:			
Option No. 1: $	28658000.00	28658000.00	28658000.00
Option No. 2: $	21000000.00	21000000.00	21000000.00

b. PLANT AND EQUIPMENT:

Cost/Distillery (Slesser) $	14620000.00	14620000.00	14620000.00
No. New Distilleries: noa cap			
Option No. 1: (approx.)	6.00	6.00	6.00
Option No. 2: (approx.)	4.00	4.00	4.00
Subtotal Plant and Equipment:			
Option No. 1: $	87720000.00	87720000.00	87720000.00
Option No. 2: $	58480000.00	58480000.00	58480000.00

TOTAL CAPITAL COSTS:

OPTION No. 1: $	116378000.00	116378000.00	116378000.00
OPTION No. 2: $	79480000.00	79480000.00	79480000.00

6. DEPRECIATION:

a. 10 yr Straight Line Dep.: (Vehicles: Dep/yr)			
OPTION No. 1: $	2865800.00	2865800.00	2865800.00
OPTION No. 2: $	2100000.00	2100000.00	2100000.00
b. 15 yr Straight Line Dep.: (Plant and Equip.: Dep/yr)			
OPTION No. 1: $	5848000.00	5848000.00	5848000.00
OPTION No. 2: $	3898666.67	3898666.67	3898666.67

TOTAL Depreciation/yr.:			
OPTION No. 1: $	8713800.00	8713800.00	8713800.00
OPTION No. 2: $	5998666.67	5998666.67	5998666.67

7. TOTAL COST:

OPTION No. 1: $	61845556.94	84616309.91	92206560.90
OPTION No. 2: $	58512666.67	81018666.67	88520666.67

8. NEW BALANCES:

a. OVERALL:

OPTION No. 1: $	-11025556.94	-12016309.91	-12346560.90
OPTION No. 2: $	-7692666.67	-8418666.67	-8660666.67

b. BALANCE OF PAYMENTS:

OPTION No. 1: $	14957812.42	23874589.17	26846848.08
OPTION NO. 2: $	11347333.33	17881333.33	20059333.33

9. NEW INDIFFERENCE POLICY:

a. OPTION No. 1:			
Cost/bb of Ethanol ---> $	9.06	14.46	16.26
Cost/US gal of Ethanol ---> $	.22	.34	.39
Cost/litre Ethanol ---> $	.06	.09	.10
b. OPTION No. 2:			
Cost/bb of Ethanol ---> $	9.38	14.78	16.58
Cost/US gal of Ethanol ---> $	.22	.35	.39
Cost/litre Ethanol ---> $	.06	.09	.10

TOTAL Depreciation/yr.:			
OPTION No. 1: $	8713800.00	8713800.00	8713800.00
OPTION No. 2: $	5998666.67	5998666.67	5998666.67

7. TOTAL COST:

OPTION No. 1: $	61845556.94	84616309.91	92206560.90
OPTION No. 2: $	58512666.67	81018666.67	88520666.67

8. NEW BALANCES:

a. OVERALL:

OPTION No. 1: $	-11025556.94	-12016309.91	-12346560.90
OPTION No. 2: $	-7692666.67	-8418666.67	-8660666.67

b. BALANCE OF PAYMENTS:

OPTION No. 1: $	14957812.42	23874589.17	26846848.08
OPTION NO. 2: $	11347333.33	17881333.33	20059333.33

9. NEW INDIFFERENCE POLICY:

a. OPTION No. 1:			
Cost/bb of Ethanol ---) $	9.06	14.46	16.26
Cost/US gal of Ethanol ---) $	.22	.34	.39
Cost/litre Ethanol ---) $	.06	.09	.10
b. OPTION No. 2:			
Cost/bb of Ethanol ---) $	9.38	14.78	16.58
Cost/US gal of Ethanol ---) $	.22	.35	.39
Cost/litre Ethanol ---) $	.06	.09	.10

Cost of Policy	_Sens. Analysis_ US $24/bb crude	_Sens. Analysis_ US $26/bb crude	_Sens. Analysis_ US $28/bb crude
Cost US$/bb of Oil:	24.00	26.00	28.00
Consumption: bb	3630000.00	3630000.00	3630000.00
1. Present --- $	87120000.00	94380000.00	101640000.00
2. Proposed:			
Available Land:	75000.00	75000.00	75000.00
Alcohol Yield: l/hectare	3500.00	3500.00	3500.00
Alcohol: bb	1651254.95	1651254.95	1651254.95
Gasohol Savings: bb			
Gasohol Consumption: bb			
Ethanol Component: bb Oileq.			
Petrol Component: bb			
OPTION No. 1: (Using all available land)			
Ethanol Component: bb OILeq.	1486129.46	1486129.46	1486129.46
Diesel Component: bb	2143870.54	2143870.54	2143870.54
a. Foreign Currency: $	51452893.[illegible]	55740634.08	60028375.17
b. Local Currency: $ equiv.	39630118.89	42932628.60	46235138.71
Net Proposed --(1)--, $	[illegible]	98673262.38	106263513.87
OPTION No. 2: (Up to Present Petrol Use)	1089000.00	1089000.00	1089000.00
Land Usage: hectares	54955.20	54958.20	54958.20
Alcohol Yield: l/hectare	3500.00	3500.00	3500.00
Alcohol: bb	1210000.00	1210000.00	1210000.00
Ethanol Component: bb OILeq	1089000.00	1089000.00	1089000.00
Diesel Component: bb	2541000.00	2541000.00	2541000.00
a. Foreign Currency: $	60984000.00	66066000.00	71148000.00
b. Local Currency: $ equiv.	29040000.00	31460000.00	33880000.00
Net Proposed -(2)-- $	90024000.00	97526000.00	105028000.00

3. BALANCES:

a. OVERALL:

OPTION No. 1: --- $	-3963011.89	-4293262.88	-4623513.87
OPTION No. 2: --- $	-2904000.00	-3146000.00	-3388000.00

b. BALANCE OF PAYMENTS:

OPTION No. 1: ---> $	35667107.00	38639365.92	41611624.83
OPTION No. 2: ---> $	26136000.00	28314000.00	30492000.00

a. Option No. 1:			
Cost/bb of Ethanol ---> $	**21.60**	**23.40**	**25.20**
Cost/US gal of Ethanol ---> $	**.51**	**.56**	**.60**
Cost/litre Ethanol ---> $	**.14**	**.15**	**.16**
b. Option No. 2:			
Cost/bb of Ethanol ---> $	21.60	23.40	25.20
Cost/US gal of Ethanol ---> $	.51	.56	.60
Cost/litre Ethanol ---> $	.14	.15	.16

5. CAPITAL COSTS:

a. VEHICLE CONVERSION:

Conversion Cost: $/vehicle	500.00	500.00	500.00
Total Consumption: bb OILeq	3630000.00	3630000.00	3630000.00
Total No. of Vehicles:	140000.00	140000.00	140000.00
Av. Consumption: bb/veh OILeq	25.93	25.93	25.93
Affected Fleet: vehicles			
Option No. 1:	57316.00	57316.00	57316.00
Option No. 2:	42000.00	42000.00	42000.00
Subtotal Vehicle Conversion:			
Option No. 1: $	28658000.00	28658000.00	28658000.00
Option No. 2: $	21000000.00	21000000.00	21000000.00

b. PLANT AND EQUIPMENT:

Cost Distillery (Slasser) $	14620000.00	14620000.00	14620000.00
No. New Distilleries: rom cap			
Option No. 1: (approx.)	6.00	6.00	6.00
Option No. 2: (approx.)	4.00	4.00	4.00
Subtotal Plant and Equipment:			
Option No. 1: $	87720000.00	87720000.00	87720000.00
Option No. 2: $	58480000.00	58480000.00	58480000.00

TOTAL CAPITAL COSTS:

OPTION No. 1: $	116378000.00	116378000.00	116378000.00
OPTION No. 2: $	79480000.00	79480000.00	79480000.00

6. DEPRECIATION:

a. 10 yr Straight Line Dep.:
(Vehicles: Dep/yr)

OPTION No. 1: $	2865800.00	2865800.00	2865800.00
OPTION No. 2: $	2100000.00	2100000.00	2100000.00

b. 15 yr Straight Line Dep.:
(Plant and Equip.: Dep/yr)

OPTION No. 1: $	5848000.00	5848000.00	5848000.00
OPTION No. 2: $	3898666.67	3898666.67	3898666.67

TOTAL Depreciation/yr.:

OPTION No. 1: $	8713800.00	8713800.00	8713800.00
OPTION No. 2: $	5998666.67	5998666.67	5998666.67

7. T O T A L   C O S T :

OPTION No. 1: $	99796811.89	107387062.88	114977313.87
OPTION No. 2: $	96022666.67	103524666.67	111026666.67

8. NEW BALANCES:

a. OVERALL:

OPTION No. 1: $	-12676811.89	-13007062.88	-13337313.87
OPTION No. 2: $	-8902666.67	-9144666.67	-9386666.67

b. BALANCE OF PAYMENTS:

OPTION No. 1: $	29819107.00	32791365.92	35763624.83
OPTION NO. 2: $	22237333.33	24415333.33	26593333.33

9. NEW INDIFFERENCE POLICY:

a. OPTION No. 1:			
Cost/bb of Ethanol ---> $	18.06	19.86	21.66
Cost/US gal of Ethanol ---> $	.43	.47	.52
Cost/litre Ethanol ---> $	.11	.12	.14
b. OPTION No. 2:			
Cost/bb of Ethanol ---> $	18.38	20.18	21.98
Cost/US gal of Ethanol ---> $	.44	.48	.52
Cost/litre Ethanol ---> $	.12	[illegible]	.14

Cost of Policy	_Sens. Analysis_ US $30/bb crude	_Sens. Analysis_ US $32/bb crude	_Sens. Analysis_ US $34/bb crude
Cost US$/bb of Oil:	30.00	32.00	34.00
Consumption: bb	3630000.00	3630000.00	3630000.00
1. Present ---- $	108900000.00	116160000.00	123420000.00
2. Proposed:			
Available Land:	75000.00	75000.00	75000.00
Alcohol Yield: l/hectare	3500.00	3500.00	3500.00
Alcohol: bb	1651254.95	1651254.95	1651254.95
Gasohol Savings: bb			
Gasohol Consumption: bb			
Ethanol Component: bb Oileq.			
Petrol Component: bb			
OPTION No. 1: (using all available land)			
Ethanol Component: bb OILeq.	1486129.46	1486129.46	1486129.46
Diesel Component: bb	2143870.54	2143870.54	2143870.54
a. Foreign Currency: $	64316116.25	68603857.33	72891598.41
b. Local Currency: $ equiv.	49537648.61	52840158.52	56142668.47
Net Proposed -(1)-- $	113853764.86	121444015.85	129034266.84
OPTION No. 2: (Up to Present Petrol Use)	1089000.00	1089000.00	1089000.00
Land Usage: hectares	34958.20	34958.20	34958.20
Alcohol Yield: l/hectare	3500.00	3500.00	3500.00
Alcohol: bb	1210000.00	1210000.00	1210000.00
Ethanol Component: bb OILeq	1089000.00	1089000.00	1089000.00
Diesel Component: bb	2541000.00	2541000.00	2541000.00
a. Foreign Currency: $	76230000.00	81312000.00	86394000.00
b. Local Currency: $ equiv.	36300000.00	38720000.00	41140000.00
Net Proposed -(2)--- $	112530000.00	120032000.00	127534000.00
3. BALANCES:			
a. OVERALL:			
OPTION No. 1: ---- $	-4953764.86	-5284015.85	-5614266.84
OPTION No. 2: ---- $	-3630000.00	-3872000.00	-4114000.00
b. BALANCE OF PAYMENTS:			
OPTION No. 1: ---- $	44583883.75	47556142.67	50528401.59
OPTION No. 2: ---- $	32670000.00	34848000.00	37026000.00

4. INDIFFERENCE POLICY:

a. Option No. 1:			
Cost/bb of Ethanol ---> $	**27.00**	**28.80**	**30.60**
Cost/US gal of Ethanol ---> $	**.64**	**.69**	**.73**
Cost/litre Ethanol ---> $	**.17**	**.18**	**.19**
b. Option No. 2:			
Cost/bb of Ethanol ---> $	**27.00**	**28.80**	**30.60**
Cost/US gal of Ethanol ---> $	**.64**	**.69**	**.73**
Cost/litre Ethanol ---> $	**.17**	**.18**	**.19**

5. CAPITAL COSTS:

a. VEHICLE CONVERSION:			
Conversion Cost: $/vehicle	500.00	500.00	500.00
Total Consumption: bb OILeq	3630000.00	3630000.00	3630000.00
Total No. of Vehicles:	140000.00	140000.00	140000.00
Av. Consumption: bb/veh OILeq	25.93	25.93	25.93
Affected Fleet: vehicles			
Option No. 1:	57316.00	57316.00	57316.00
Option No. 2:	42000.00	42000.00	42000.00
Subtotal Vehicle Conversion:			
Option No. 1: $	28658000.00	28658000.00	28658000.00
Option No. 2: $	21000000.00	21000000.00	21000000.00
b. PLANT AND EQUIPMENT:			
Cost/Distillery (Glasser) $	14620000.00	14620000.00	14620000.00
No. New Distilleries: nom cap			
Option No. 1: (approx.)	6.00	6.00	6.00
Option No. 2: (approx.)	4.00	4.00	4.00
Subtotal Plant and Equipment:			
Option No. 1: $	87720000.00	87720000.00	87720000.00
Option No. 2: $	58480000.00	58480000.00	58480000.00

TOTAL CAPITAL COSTS:

OPTION No. 1: $	116378000.00	116378000.00	116378000.00
OPTION No. 2: $	79480000.00	79480000.00	79480000.00

6. DEPRECIATION:

a. 10 yr Straight Line Dep.:			
(Vehicles: Dep/yr)			
OPTION No. 1: $	2865800.00	2865800.00	2865800.00
OPTION No. 2: $	2100000.00	2100000.00	2100000.00
b. 15 yr Straight Line Dep.:			
(Plant and Equip.: Dep/yr)			
OPTION No. 1: $	5848000.00	5848000.00	5848000.00
OPTION No. 2: $	3898666.67	3898666.67	3898666.67

TOTAL Depreciation/yr.:

OPTION No. 1: $	8713800.00	8713800.00	8713800.00
OPTION No. 2: $	5998666.67	5998666.67	5998666.67

7. TOTAL COST:

OPTION No. 1: $	122567564.86	130157815.85	137748066.84
OPTION No. 2: $	118528666.67	126030666.67	133532666.67

8. NEW BALANCES:

a. OVERALL:

OPTION No. 1: $	-13667564.86	-13997815.85	-14328066.84
OPTION No. 2: $	-9628666.67	-9870666.67	-10112666.67

b. BALANCE OF PAYMENTS:

OPTION No. 1: $	38735883.75	41708142.67	44680401.59
OPTION NO. 2: $	28771333.33	30949333.33	33127333.33

9. NEW INDIFFERENCE POLICY:

a. OPTION No. 1:			
Cost/bb of Ethanol ---> $	23.46	25.26	27.06
Cost/US gal of Ethanol --- $	.56	.60	.64
Cost/litre Ethanol --- $	.15	.16	.17
b. OPTION No. 2:			
Cost/bb of Ethanol ---> $	23.78	25.58	27.38
Cost/US gal of Ethanol --- $	.57	.61	.65
Cost/litre Ethanol --- $	.15	.16	.17

7. TOTAL COST:

OPTION No. 1: $	122567564.86	130157815.85	137748066.84
OPTION No. 2: $	118528666.67	126030666.67	133532666.67

8. NEW BALANCES:

a. OVERALL:

OPTION No. 1: $	-13667564.86	-13997815.85	-14328066.84
OPTION No. 2: $	-9628666.67	-9870666.67	-10112666.67

b. BALANCE OF PAYMENTS:

OPTION No. 1: $	38735883.75	41708142.67	44680401.59
OPTION NO. 2: $	26771333.33	30949333.33	33127333.33

9. NEW INDIFFERENCE POLICY:

a. OPTION No. 1:

Cost/bb of Ethanol ---> $	23.46	25.26	27.06
Cost/US gal of Ethanol ---> $	.56	.60	.64
Cost/litre Ethanol ---> $	.15	.16	.17

b. OPTION No. 2:

Cost/bb of Ethanol ---> $	23.78	25.58	27.38
Cost/US gal of Ethanol ---> $	.57	.61	.65
Cost/litre Ethanol ---> $	.15	.16	.17

_Sens. Analysis US $14/bb crude	Cost of Policy	_Sens. Analysis_ US $36/bb crude
14.00	Cost US$/bb of Oil:	36.00
3630000.00	Consumption: bb	3630000.00
50820000.00	1. Present ---> $	130680000.00
	2. Proposed:	
75000.00	Available Land:	75000.00
3500.00	Alcohol Yield: l/hectare	3500.00
1651254.95	Alcohol: bb	1651254.95
	Gasohol Savings: bb	
	Gasohol Consumption: bb	
	Ethanol Component: bb Oileq.	
	Petrol Component: bb	
	OPTION No. 1: (Using all available land)	
1486129.46	Ethanol Component: bb OILeq.	1486129.46
2143870.54	Diesel Component: bb	2143870.54
30014187.58	a. Foreign Currency: $	77179339.50
23117569.35	b. Local Currency: $ equiv.	59445178.34
53131756.94	Net Proposed -(1)--> $	136624517.83
	OPTION No. 2:	
1089000.00	(Up to Present Petrol Use)	1089000.00
54958.20	Land usage: hectares	54958.20
3500.00	Alcohol Yield: l/hectare	3500.00
1210000.00	Alcohol: bb	1210000.00
1089000.00	Ethanol Component: bb OILeq	1089000.00
2541000.00	Diesel Component: bb	2541000.00
35574000.00	a. Foreign Currency: $	91476000.00
16940000.00	b. Local Currency: $ equiv.	43560000.00
52514000.00	Net Proposed -(2)--> $	135036000.00
	3. BALANCES:	
	a. OVERALL:	
-2311756.94	OPTION No. 1: ---> $	-5944517.83
-1694000.00	OPTION No. 2: ---> $	-4356000.00
	b. BALANCE OF PAYMENTS:	
20805812.42	OPTION No. 1: ---> $	53500660.50
15246000.00	OPTION No. 2: ---> $	39204000.00

4. INDIFFERENCE POLICY:

a. Option No. 1:

12.60	Cost/bb of Ethanol ---> $	32.40
.30	Cost/US gal of Ethanol --- $	.77
.08	Cost/litre Ethanol --- $	.20

b. Option No. 2:

12.60	Cost/bb of Ethanol --- $	32.40
.30	Cost/US gal of Ethanol --- $	.77
.08	Cost litre Ethanol --- $	.20

5. CAPITAL COSTS:

a. VEHICLE CONVERSION:

500.00	Conversion Cost: $/vehicle	500.00
3630000.00	Total Consumption: bb OILeq	3630000.00
140000.00	Total No. of Vehicles:	140000.00
25.93	Av. Consumption: bb/veh OILeq	25.93
	Affected Fleet: vehicles	
57316.00	Option No. 1:	57316.00
42000.00	Option No. 2:	42000.00
	Subtotal Vehicle Conversion:	
28658000.00	Option No. 1: $	28658000.00
21000000.00	Option No. 2: $	21000000.00

----

b. PLANT AND EQUIPMENT:

14620000.00	Cost Distillery (Slesser) $	14620000.00
	No. New Distilleries: nom cap	
6.00	Option No. 1: (approx.)	6.00
4.00	Option No. 2: (approx.)	4.00
	Subtotal Plant and Equipment:	
87720000.00	Option No. 1: $	87720000.00
58480000.00	Option No. 2: $	58480000.00

TOTAL CAPITAL COSTS:

116378000.00	OPTION No. 1: $	116378000.00
79480000.00	OPTION No. 2: $	79480000.00

----

6. DEPRECIATION:

a. 10 yr Straight Line Dep.:
(Vehicles: Dep/yr)

2865800.00	OPTION No. 1: $	2865800.00
2100000.00	OPTION No. 2: $	2100000.00

----

b. 15 yr Straight Line Dep.:
(Plant and Equip.: Dep/yr)

5848000.00	OPTION No. 1: $	5848000.00
3898666.67	OPTION No. 2: $	3898666.67

TOTAL Depreciation/yr.:

8713800.00	OPTION No. 1: $	8713800.00
5998666.67	OPTION No. 2: $	5998666.67

7. T O T A L   C O S T :

61845556.94	OPTION No. 1: $	145338317.83
58512666.67	OPTION No. 2: $	141034666.67

8. NEW BALANCES:

a. OVERALL:

-11025556.94	OPTION No. 1: $	-14658317.83
-7692666.67	OPTION No. 2: $	-10354666.67

b. BALANCE OF PAYMENTS:

14957812.42	OPTION No. 1: $	47652660.50
11347333.33	OPTION NO. 2: $	35305333.33

9. NEW INDIFFERENCE POLICY:

a. OPTION No. 1:

9.06	Cost/bb of Ethanol --- $	28.86
.22	Cost/US gal of Ethanol --- $	.69
.06	Cost/litre Ethanol --- $	.18

b. OPTION No. 2:

9.38	Cost/bb of Ethanol --- $	29.18
.22	Cost/US gal of Ethanol --- $	[illegible]
.06	Cost/litre Ethanol --- $	.18

```
  :              A            ::   B   :: C ::   D   :: E ::   F   :: G :
 1:TABLE 5. ST2.1.B            ENERGY STRUCTURE STAGE 2: STATE 2,1
 2:
 3:
 4:-----------------------------------------------------------------------
 5:ENERGY STRUCTURE            ACTUAL bb%     FLEET veh%     YIELD bb %
 6:-------------------------------------------------------(oil  eq)------
 7:
 8:PETROL                              0      0        0      0        0      0
 9:ALCOHOL                       1651255  43.51    57316  40.94  1486129  40.94
10:GASOHOL
11:DIESEL                        2143871.  56.49   82684     59  2143871.  59.06
12:.......................................................................
13:
14:TOTAL                         3795125    100   140000  100.0  3630000    100
15:
16:-----------------------------------------------------------------------
17:
18:
19:ENERGY RATIO                                         .9565
20:(Yield Total/Actual Total)
21:
22:-----------------------------------------------------------------------
23:
24:PRODUCTION VALUES:
25:------------------
26:
27:ALCOHOL (litres/year)          2.625e8
28:OPTION NO.2                    1.7312e8
29:LAND USE (hectares)              75000
30:
31:% of Land Available                      100
32:
33:Production Days Nominal Cap.:  182.2917
34:OPTION NO. 2                   180.3316
35:
36:
37:-----------------------------------------------------------------------
```

State 2,2:

The purpose of this stage would be to re-structure consumption by introducing alcohol supply to counter the pravailing imbalance between the yield of the crude oil refined in Costa Rica, and the consumption of oil derivatives in the transport sector.

Alcohol would a serve a catalyst role, maintaining (as far as possible) an equilibrium state in the oil sector of the economy. Relevant features of the state are presented below:

a. Alcohol available: 1,651,255 bb/yr.

b. Consumption Profile:

Current Oil Consumption values (15):

	Overall	Relative (Petrol+Diesel=100)
Petrol	22.08 %	37.57 %
Diesel	36.69 %	62.43 %
Other	41.23 %	

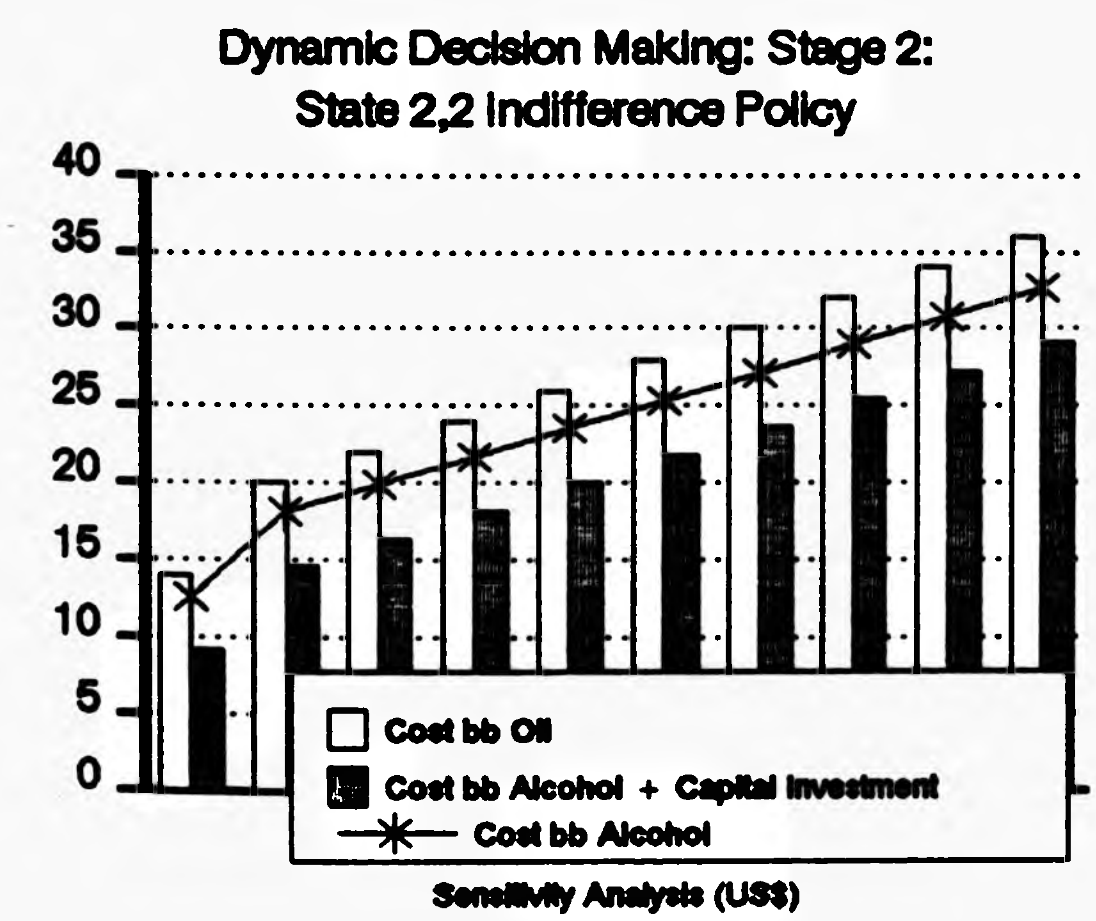
Equilibrium Consumption %'s (= Lagotreco crude yield)

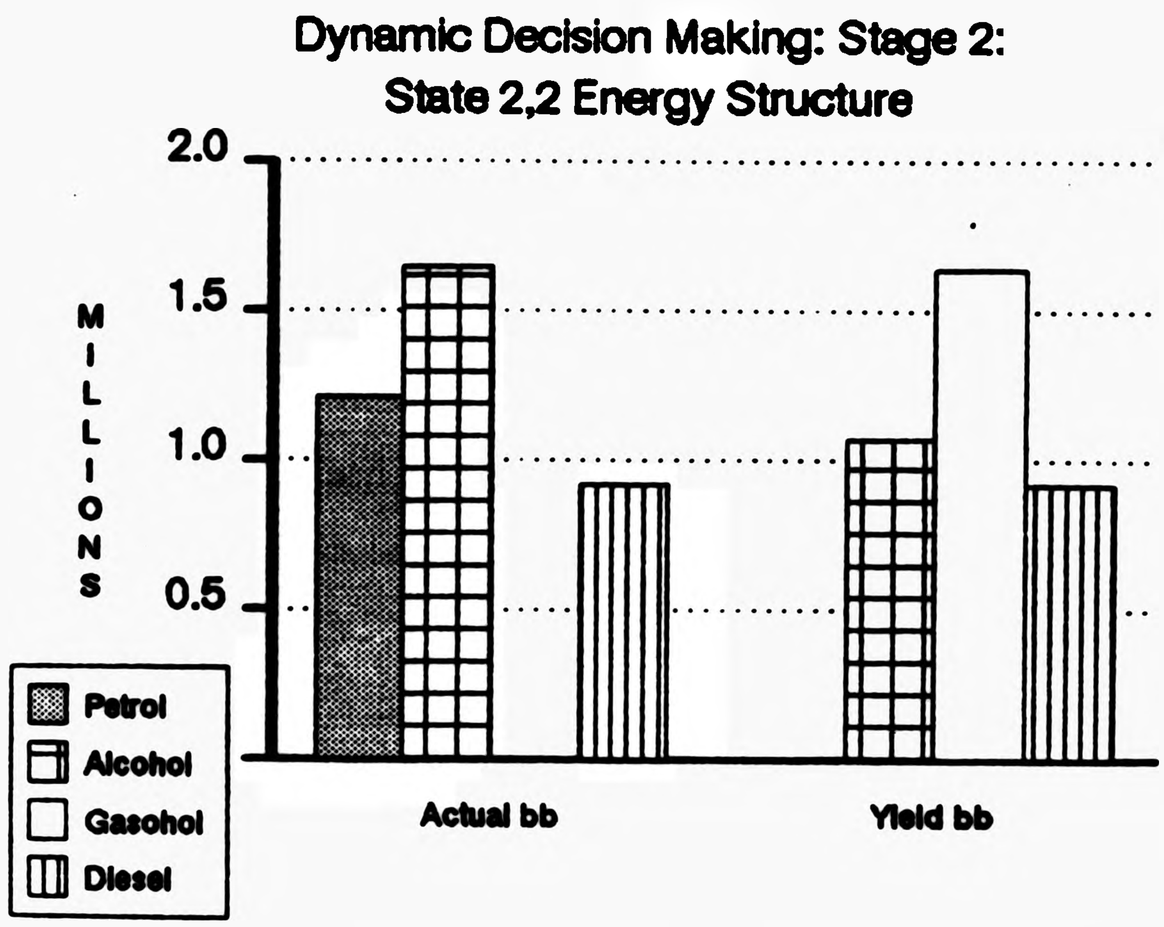
Petrol	28.1 %	56.88
Diesel	21.3 %	43.12

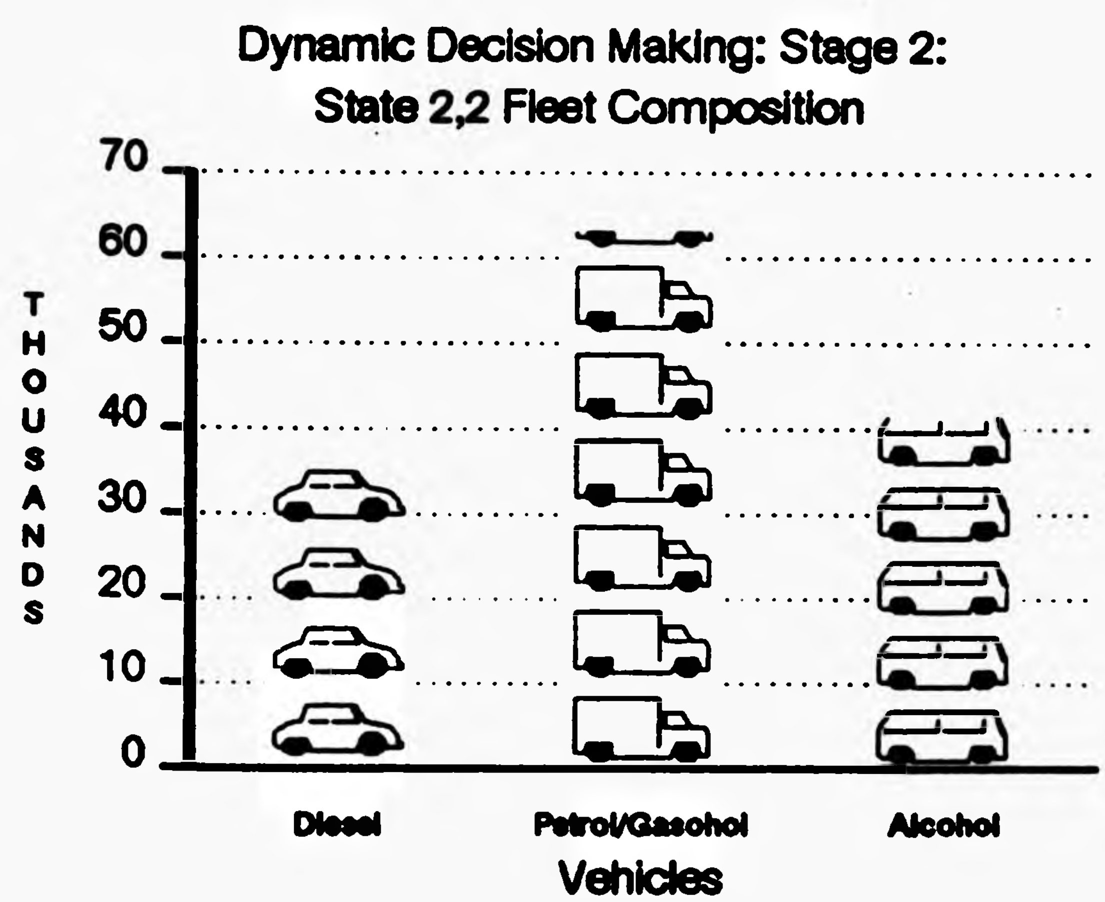
Other 50.6 % (which would be provided by the alcohol, either as gasohol, or as hydrated ethanol substituting diesel vehicles.)

The figures below provide an insight into the benefits of adopting this course of action. The tangible result of this policy is a better energy ratio, than either of the two other states available at this stage. The intangible benefits, nevertheless, may be even more important, as the country would be able to purchase the oil it will still require in a more structured manner, avoiding "incremental cost of diesel" situations, as described before.

The full description follows:




Dynamic Decision Making: Stage 2:
State 2,2 Energy Structure
MILLIONS
2.0
1.5
1.0
0.5
Petrol
Alcohol
Gasohol
Diesel
Actual bb
Yield bb


Dynamic Decision Making: Stage 2:
State 2,2 Fleet Composition
THOUSANDS
70
60
50
40
30
20
10
0
Diesel
Petrol/Gasohol
Alcohol
Vehicles

A	B	C	D
Table 5. St2-2.a	Dynamic Decision Making Stage 2 State 2,2		
	Energy Balance Situation With Respect To		
	Lagotreco Crude Yield		
	Sens. Analysis	_Sens. Analysis_	_Sens. Analysis_
Cost of Policy	US $14/bb crude	US $20/bb crude	US $22/bb crude
Cost US$/bb of Oil:	14.00	20.00	22.00
Consumption: bb	3630000.00	3630000.00	3630000.00
1. Present ---> $	50820000.00	72600000.00	79860000.00
2. Proposed:			
Available Land:	75000.00	75000.00	75000.00
Alcohol Yield: l/hectare	3500.00	3500.00	3500.00
Alcohol: bb	1651254.95	1651254.95	1651254.95
Gasohol Consumption: bb	1516886.25	1516886.25	1516886.25
Gasohol Oileq	1638237.15	1638237.15	1638237.15
Ethanol Component: bb Oileq.	303377.25	303377.25	303377.25
Petrol Component: bb	1213509.00	1213509.00	1213509.00
Gasohol Savings: bb	121350.90	121350.90	121350.90
Gasohol Savings $:	1698912.60	2427018.00	2669719.80
Ethanol Available for Diesel	1347877.70	1347877.70	1347877.70
Ethanol Component: bb OILeq.	1071920.85	1071920.85	1071920.85
Diesel Component: bb	919842.00	919842.00	919842.00
Ethanol Not Used bb	6381.31	6381.31	6381.31
a. Foreign Currency: $	29866914.00	42667020.00	46933722.00
b. Local Currency: $	23028230.97	32897472.82	36187220.10
Net Proposed -(1)--> $	52895144.97	75564492.82	83120942.10
3. BALANCES:			
a. OVERALL:			
OPTION No. 1: ---> $	-2075144.97	-2964492.82	-3260942.10
b. BALANCE OF PAYMENTS:			
OPTION No. 1: ---> $	20953086.00	29932980.00	[illegible]
4. INDIFFERENCE POLICY:			
a. Option No. 1:			
Cost/bb of Ethanol ---> $	12.69	18.13	19.94
Cost/US gal of Ethanol ---> $	.30	.43	.47
Cost/litre Ethanol ---> $	.08	.11	.13

5. CAPITAL COSTS:

a. VEHICLE CONVERSION:

Conversion Cost: $/vehicle	500.00	500.00	500.00
Total Consumption: bb OILeq	3630000.00	3630000.00	3630000.00
Total No. of Vehicles:	140000.00	140000.00	140000.00
Av. Consumption: bb/veh OILeq	25.93	25.93	25.93

Affected Fleet: vehicles			
Option No. 1:	41341.00	41341.00	41341.00

Subtotal Vehicle Conversion:			
Option No. 1: $	20670500.00	20670500.00	20670500.00

b. PLANT AND EQUIPMENT:

Cost/Distillery (Slesser) $	14620000.00	14620000.00	14620000.00
No. New Distilleries: nom cap			
Option No. 1: (approx.)	6.00	6.00	6.00

Subtotal Plant and Equipment:			
Option No. 1: $	87720000.00	87720000.00	87720000.00

TOTAL CAPITAL COSTS:

OPTION No. 1: $	108390500.00	108390500.00	108390500.00

6. DEPRECIATION:

a. 10 yr Straight Line Dep.:
(Vehicles: Dep/yr)

OPTION No. 1: $	2067050.00	2067050.00	2067050.00

b. 15 yr Straight Line Dep.:
(Plant and Equip.: Dep/yr)

OPTION No. 1: $	5848000.00	5848000.00	5848000.00

TOTAL Depreciation/yr.:

OPTION No. 1: $	7915050.00	7915050.00	7915050.00

7. T O T A L C O S T :

OPTION No. 1: $	60810194.97	83479542.82	91035992.10

8. NEW BALANCES:

a. OVERALL:

OPTION No. 1: $	-9990194.97	-10879542.82	-11175992.10

b. BALANCE OF PAYMENTS:

OPTION No. 1: $	15105096.00	24084880.00	27078276.00

9. NEW INDIFFERENCE POLICY:

a. OPTION No. 1:

Cost/bb of Ethanol ---> $	9.15	14.59	16.40
Cost/US gal of Ethanol ---> $	.22	.35	.39
Cost/litre Ethanol ---> $	.06	.09	.10

	E	F	G	H	I
1					
2					
3					
4					
5					
6					
7	_Sens. Analysis_	_Sens. Analysis_	_Sens. Analysis_	_Sens. Analysis_	_Sens. Analysis_
8	US $24/bb crude	US $26/bb crude	US $28/bb crude	US $30/bb crude	US $32/bb crude
9	----------------	----------------	----------------	----------------	----------------
10					
11	24.00	26.00	28.00	30.00	32.00
12	3630000.00	3630000.00	3630000.00	3630000.00	3630000.00
13					
14	87120000.00	94380000.00	101640000.00	108900000.00	116160000.00
15	----------------	----------------	----------------	----------------	----------------
16					
17					
18	75000.00	75000.00	75000.00	75000.00	75000.00
19	3500.00	3500.00	3500.00	3500.00	3500.00
20	1651254.95	1651254.95	1651254.95	1651254.95	1651254.95
21					
22	1516886.25	1516886.25	1516886.25	1516886.25	1516886.25
23	1638237.15	1638237.15	1638237.15	1638237.15	1638237.15
24					
25	303377.25	303377.25	303377.25	303377.25	303377.25
26	1213509.00	1213509.00	1213509.00	1213509.00	1213509.00
27	....	....	....	....	....
28	121350.90	121350.90	121350.90	121350.90	121350.90
29	2912421.60	3155123.40	3397825.20	3640527.00	3883228.80
30					
31	1347877.70	1347877.70	1347877.70	1347877.70	1347877.70
32	1071920.85	1071920.85	1071920.85	1071920.85	1071920.85
33	919842.00	919842.00	919842.00	919842.00	919842.00
34	6381.31	6381.31	6381.31	6381.31	6381.31
35					
36	51200424.00	55467126.00	59733828.00	64000530.00	68267232.00
37	39476967.38	42766714.66	46056461.94	49346209.22	52635956.50
38					
39	90677391.38	98233840.66	105790289.94	113346739.22	120903188.50
40	----------------	----------------	----------------	----------------	----------------
41					
42					
43					
44					
45					
46					
47					
48	================	================	================	================	================
49	-3557391.38	-3853840.66	-4150289.94	-4446739.22	-4743188.50
50	================	================	================	================	================
51					
52					
53	================	================	================	================	================
54	35919576.00	38912874.00	41906172.00	44899470.00	47892768.00
55	================	================	================	================	================
56					
57					
58					
59					
60					
61	21.75	23.57	25.38	27.19	29.00
62	.52	.56	.60	.65	.69
63	.14	.15	.16	.17	.18
64					

72	500.00	500.00	500.00	500.00	500.00
73	3630000.00	3630000.00	3630000.00	3630000.00	3630000.00
74	140000.00	140000.00	140000.00	140000.00	140000.00
75	25.93	25.93	25.93	25.93	25.93
78	41341.00	41341.00	41341.00	41341.00	41341.00
81	20670500.00	20670500.00	20670500.00	20670500.00	20670500.00
86	14620000.00	14620000.00	14620000.00	14620000.00	14620000.00
88	6.00	6.00	6.00	6.00	6.00
91	87720000.00	87720000.00	87720000.00	87720000.00	87720000.00
96	108390500.00	108390500.00	108390500.00	108390500.00	108390500.00
103	2067050.00	2067050.00	2067050.00	2067050.00	2067050.00
108	5848000.00	5848000.00	5848000.00	5848000.00	5848000.00
112	7915050.00	7915050.00	7915050.00	7915050.00	7915050.00
117	98592441.38	106148890.66	113705339.94	121261789.22	128818238.50
125	-11472441.38	-11768890.66	-12065339.94	-12361789.22	-12658238.50
130	30071576.00	33064874.00	36058172.00	39051470.00	42044768.00

18.21	20.02	21.84	23.65	25.46
.43	.48	.52	.56	.61
.11	.13	.14	.15	.16

	J	K	L
1			
2			
3			
4			
5			
6			
7	_Sens. Analysis_	_Sens. Analysis_	
8	US $34/bb crude	US $36/bb crude	
9	----------------	----------------	----------------
10			
11	34.00	36.00	
12	3630000.00	3630000.00	
13			
14	123420000.00	130680000.00	
15	----------------	----------------	----------------
16			
17			
18	75000.00	75000.00	
19	3500.00	3500.00	
20	1651254.95	1651254.95	
21			
22	1516886.25	1516886.25	1516886.25
23	1638237.15	1638237.15	1638237.15
24			
25	303377.25	303377.25	303377.25
26	1213509.00	1213509.00	1213509.00
27	....	....	....
28	121350.90	121350.90	121350.90
29	4125930.60	4368632.40	.00
30			
31	1347877.70	1347877.70	-303377.25
32	1071920.85	1071920.85	-1638237.15
33	919842.00	919842.00	.00
34	6381.31	6381.31	1395535.35
35			
36	72533934.00	76800636.00	.00
37	55925703.79	59215451.07	.00
38			
39	128459637.79	136016087.07	
40	----------------	----------------	----------------
41			
42			
43			
44			
45			
46			
47			
48	================	================	================
49	-5039637.79	-5336087.07	
50	================	================	================
51			
52			
53	================	================	================
54	50886066.00	53879364.00	
55	================	================	================
56			
57			
58			
59			
60			
61	30.82	32.63	
62	.73	.78	
63	.19	.21	
64			

Row		
72	500.00	500.00
73	3630000.00	3630000.00
74	140000.00	140000.00
75	25.93	25.93
78	41341.00	41341.00
81	20670500.00	20670500.00
86	14620000.00	14620000.00
88	6.00	6.00
91	87720000.00	87720000.00
96	108390500.00	108390500.00
103	2067050.00	2067050.00
108	5848000.00	5848000.00
112	7915050.00	7915050.00
117	136374687.79	143931137.07
125	-12954687.79	-13251137.07
130	45038066.00	48031364.00

==

27.28	29.09
.65	.69
.17	.18

TABLE 5 ST2-2.B — ENERGY STRUCTURE STAGE 2 STATE 2,2

ENERGY STRUCTURE	ACTUAL bb	%	FLEET veh	%	YIELD bb (oil eq)	%
PETROL	1213509	32.12	0	0		0
ALCOHOL	1644874	43.54	41341	29.53	1071921	29.53
GASOHOL			63182.7	45.13	1638237.	45.13
DIESEL	919842	24.35	35476	25	919842	25.34
TOTAL	3778225	100	140000	100	3630000	100

ENERGY RATIO (Yield Total/Actual Total): .9608

PRODUCTION VALUES:

ALCOHOL (litres/year)	2.6149e6
LAND USE (hectares)	75000
% of Land Available	100
Production Days Nominal Cap.:	181.5872

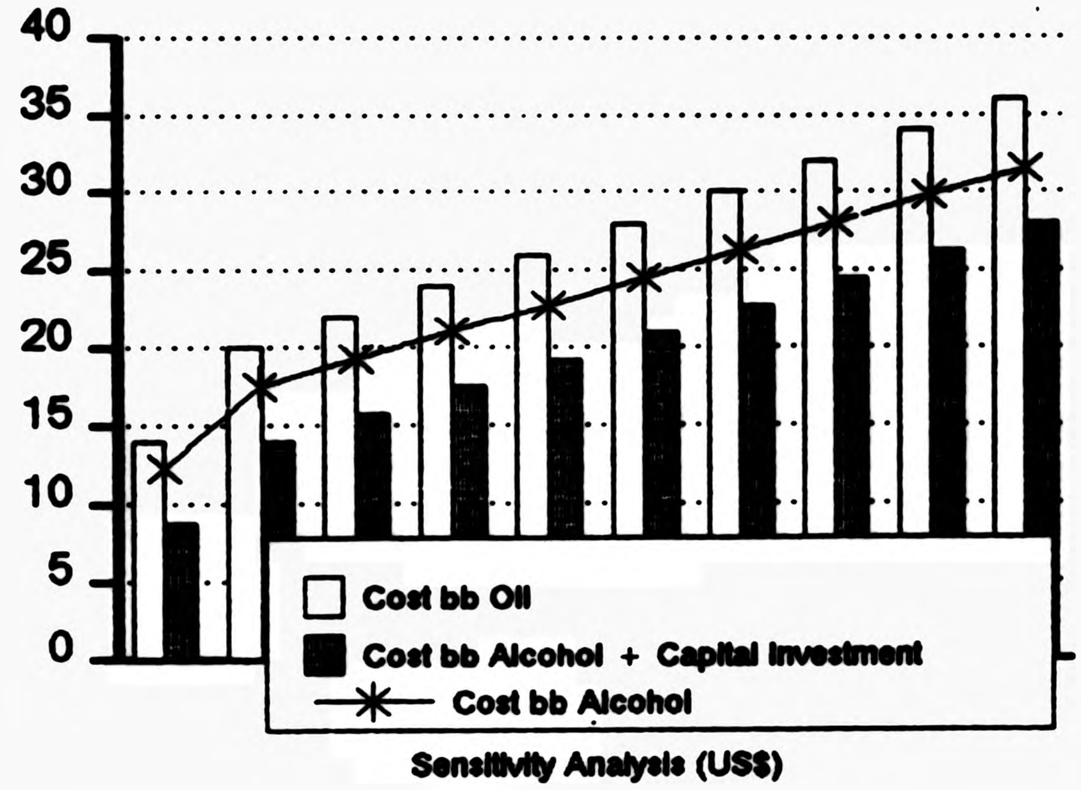
State 2,3:

The final state to be considered at stage 2, would be that of using alcohol as a complement to petrol (gasohol), and substituting diesel thereafter.

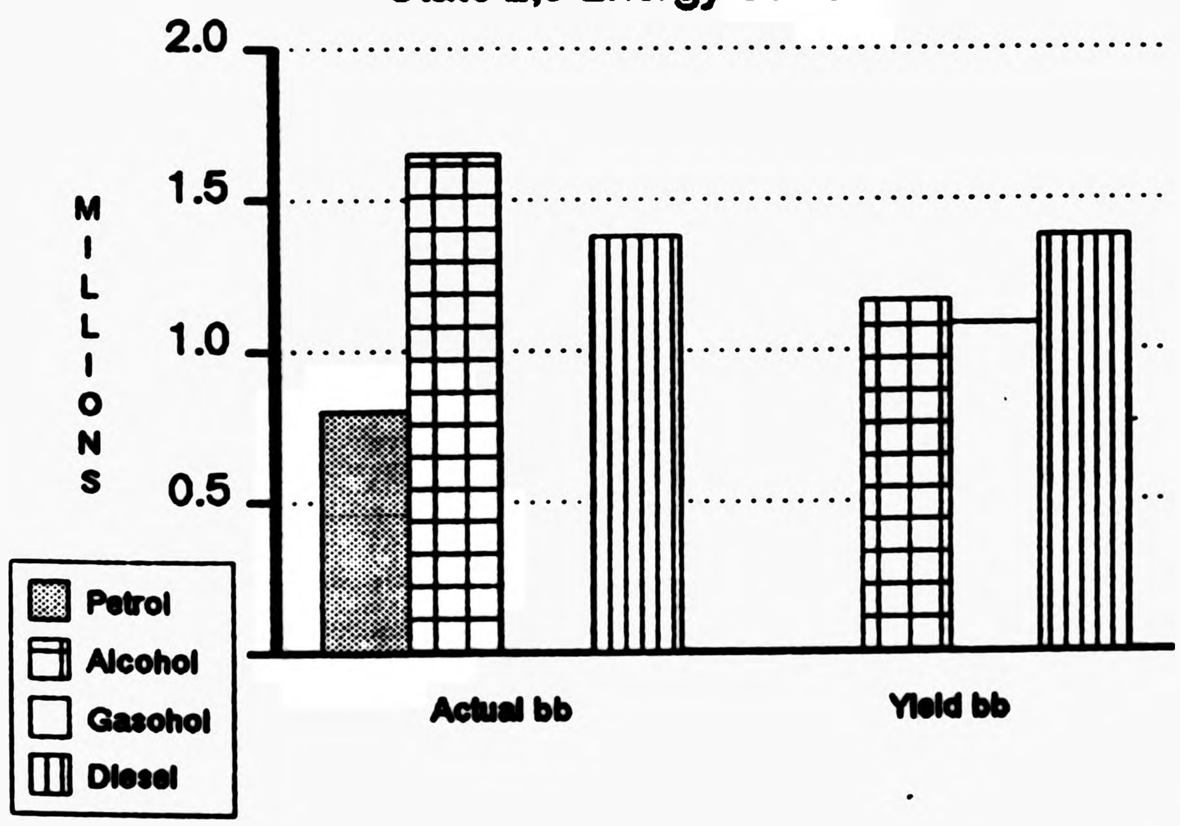
There would be an immediate benefit (as described in state 3,1) with the first step. Unfortunately, this would not be enough to offset the relative inefficiency of alcohol with respect to diesel (as presented in section 3,3).

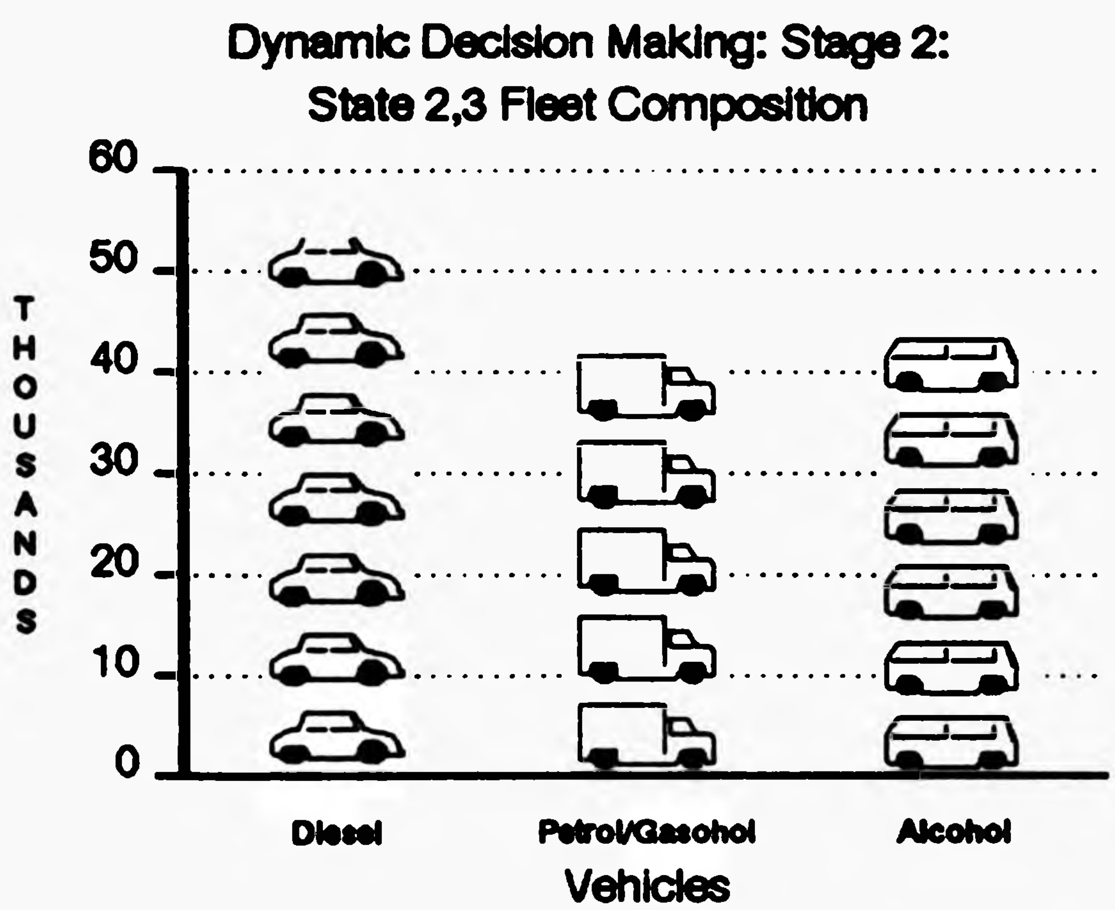
Overall, the results here are less encouraging than those found in states 2,1 and 2,2. For this reason extensive analysis of the state, does not seem relevant. Even so, as a matter of illustration, the results of the stage are presented in the following pages.

Dynamic Decision Making: Stage 2:
State 2,3 Indifference Policy



Dynamic Decision Making: Stage 2:
State 2,3 Energy Structure




Dynamic Decision Making: Stage 2:
State 2,3 Fleet Composition
60
50
40
30
20
10
0
THOUSANDS
Diesel
Petrol/Gasohol
Alcohol
Vehicles

A	B	C	D
Table 5. St2-3.a	Dynamic Decision Making Stage 2 State2,3		
	Gasohol, Diesel, and Alcohol Substitution		
	Of Diesel up to Available Production Limit		
	Sens. Analysis	_Sens. Analysis_	_Sens. Analysis_
Cost of Policy	US $14/bb crude	US $20/bb crude	US $22/bb crude
Cost US$/bb of Oil:	14.00	20.00	22.00
Consumption: bb	3630000.00	3630000.00	3630000.00
1. Present ---> $	50820000.00	72600000.00	79860000.00
2. Proposed:			
Available Land:	75000.00	75000.00	75000.00
Alcohol Yield: l/hectare	3500.00	3500.00	3500.00
Alcohol: bb	1651254.95	1651254.95	1651254.95
Gasohol Consumption: bb	1001880.00	1001880.00	1001880.00
Gasohol Oileq	1089000.00	1089000.00	1089000.00
Ethanol Component: bb Oileq.	200376.00	200376.00	200376.00
Petrol Component: bb	801504.00	801504.00	801504.00
Gasohol Savings: bb	80150.40	80150.40	80150.40
Gasohol Savings $:	1122105.60	1603008.00	1763308.80
Ethanol Available for Diesel	1450878.95	1450878.95	1450878.95
Ethanol Component: bb Oileq.	1160703.16	1160703.16	1160703.16
Diesel Component: bb	1380296.84	1380296.84	1380296.84
Ethanol Not Used bb	.00	.00	.00
a. Foreign Currency: $	30545211.72	43636016.74	47999618.41
b. Local Currency: $	23117569.35	33025099.08	36327608.98
Net Proposed -(1)--> $	53662781.07	76661115.82	84327227.40
3. BALANCES:			
a. OVERALL:			
OPTION No. 1: ---> $	-2842781.07	-4061115.82	-4467227.40
b. BALANCE OF PAYMENTS:			
OPTION No. 1: ---> $	20274788.29	28963983.26	31860381.59
4. INDIFFERENCE POLICY:			
a. Option No. 1:			
Cost/bb of Ethanol ---> $	12.28	17.54	19.29
Cost/US gal of Ethanol ---> $	.29	.42	.46
Cost/litre Ethanol ---> $	.08	.11	.12

5. CAPITAL COSTS:			
a. VEHICLE CONVERSION:			
Conversion Cost: $/vehicle	500.00	500.00	500.00
Total Consumption: bb OILeq	3630000.00	3630000.00	3630000.00
Total No. of Vehicles:	140000.00	140000.00	140000.00
Av. Consumption: bb/veh OILeq	25.93	25.93	25.93
Affected Fleet: vehicles			
Option No. 1:	44765.00	44765.00	44765.00
Subtotal Vehicle Conversion:			
Option No. 1: $	22382500.00	22382500.00	22382500.00
b. PLANT AND EQUIPMENT:			
Cost/Distillery (Slesser) $	14620000.00	14620000.00	14620000.00
No. New Distilleries: nom cap			
Option No. 1: (approx.)	6.00	6.00	6.00
Subtotal Plant and Equipment:			
Option No. 1: $	87720000.00	87720000.00	87720000.00
TOTAL CAPITAL COSTS:			
OPTION No. 1: $	110102500.00	110102500.00	110102500.00
6. DEPRECIATION:			
a. 10 yr Straight Line Dep.:			
(Vehicles: Dep/yr)			
OPTION No. 1: $	2238250.00	2238250.00	2238250.00
b. 15 yr Straight Line Dep.:			
(Plant and Equip.: Dep/yr)			
OPTION No. 1: $	5848000.00	5848000.00	5848000.00
TOTAL Depreciation/yr.:			
OPTION No. 1: $	8086250.00	8086250.00	8086250.00
7. T O T A L C O S T :			
OPTION No. 1: $	61749031.07	84747365.82	92413477.40
8. NEW BALANCES:			
a. OVERALL:			
OPTION No. 1: $	-10929031.07	-12147365.82	-12553477.40
b. BALANCE OF PAYMENTS:			
OPTION No. 1: $	14426788.28	23115983.26	26012381.59

9. NEW INDIFFERENCE POLICY:

a. OPTION No. 1:

Cost/bb of Ethanol ---> $	8.74	14.00	15.75
Cost/US gal of Ethanol ---> $	.21	.33	.38
Cost/litre Ethanol ---> $	.05	.09	.10

	E	F	G	H	I
1					
2					
3					
4					
5					
6					
7	_Sens. Analysis_	_Sens. Analysis_	_Sens. Analysis_	_Sens. Analysis_	_Sens. Analysis_
8	US $24/bb crude	US $26/bb crude	US $28/bb crude	US $30/bb crude	US $32/bb crude
9	----------------	----------------	----------------	----------------	----------------
10					
11	24.00	26.00	28.00	30.00	32.00
12	3630000.00	3630000.00	3630000.00	3630000.00	3630000.00
13					
14	87120000.00	94380000.00	101640000.00	108900000.00	116160000.00
15	----------------	----------------	----------------	----------------	----------------
16					
17					
18	75000.00	75000.00	75000.00	75000.00	75000.00
19	3500.00	3500.00	3500.00	3500.00	3500.00
20	1651254.95	1651254.95	1651254.95	1651254.95	1651254.95
21					
22	1001880.00	1001880.00	1001880.00	1001880.00	1001880.00
23	1089000.00	1089000.00	1089000.00	1089000.00	1089000.00
24					
25	200376.00	200376.00	200376.00	200376.00	200376.00
26	801504.00	801504.00	801504.00	801504.00	801504.00
27	....	....	....	....	....
28	80150.40	80150.40	80150.40	80150.40	80150.40
29	1923609.60	2083910.40	2244211.20	2404512.00	2564812.80
30					
31	1450878.95	1450878.95	1450878.95	1450878.95	1450878.95
32	1160703.16	1160703.16	1160703.16	1160703.16	1160703.16
33	1380296.84	1380296.84	1380296.84	1380296.84	1380296.84
34	.00	.00	.00	.00	.00
35					
36	52363220.09	56726821.76	61090423.44	65454025.11	69817626.78
37	39630118.89	42932628.80	46235138.71	49537648.61	52840158.52
38					
39	91993338.98	99659450.56	107325562.14	114991673.72	122657785.30
40	----------------	----------------	----------------	----------------	----------------
41					
42					
43					
44					
45					
46					
47					
48	================	================	================	================	================
49	-4873338.98	-5279450.56	-5685562.14	-6091673.72	-6497785.30
50	================	================	================	================	================
51					
52					
53	================	================	================	================	================
54	34756779.91	37653178.24	40549576.56	43445974.89	[illegible]
55	================	================	================	================	================
56					
57					
58					
59					
60					
61	21.05	22.80	24.56	26.31	28.06
62	.50	.54	.58	.63	.67
63	.13	.14	.15	.17	.18
64					

500.00	500.00	500.00	500.00	500.00
3630000.00	3630000.00	3630000.00	3630000.00	3630000.00
140000.00	140000.00	140000.00	140000.00	140000.00
25.93	25.93	25.93	25.93	25.93
44765.00	44765.00	44765.00	44765.00	44765.00
22382500.00	22382500.00	22382500.00	22382500.00	22382500.00
14620000.00	14620000.00	14620000.00	14620000.00	14620000.00
6.00	6.00	6.00	6.00	6.00
87720000.00	87720000.00	87720000.00	87720000.00	87720000.00
110102500.00	110102500.00	110102500.00	110102500.00	110102500.00
2238250.00	2238250.00	2238250.00	2238250.00	2238250.00
5848000.00	5848000.00	5848000.00	5848000.00	5848000.00
8086250.00	8086250.00	8086250.00	8086250.00	8086250.00
100079588.98	107745700.56	115411812.14	123077923.72	130744035.30
-12959588.98	-13365700.56	-13771812.14	-14177923.72	-14584035.30
28908779.91	31805178.24	34701576.56	37597974.89	40494373.22

17.51	19.26	21.02	22.77	24.52
.42	.46	.50	.54	.58
.11	.12	.13	.14	.15

	J	K	L
1			
2			
3			
4			
5			
6			
7	_Sens. Analysis_	_Sens. Analysis_	
8	US $34/bb crude	US $36/bb crude	
9	----------------	----------------	----------------
10			
11	34.00	36.00	
12	3630000.00	3630000.00	
13			
14	123420000.00	130680000.00	
15	----------------	----------------	----------------
16			
17			
18	75000.00	75000.00	
19	3500.00	3500.00	
20	1651254.95	1651254.95	
21			
22	1001880.00	1001880.00	1001880.00
23	1089000.00	1089000.00	1089000.00
24			
25	200376.00	200376.00	200376.00
26	801504.00	801504.00	801504.00
27	....	....	....
28	80150.40	80150.40	80150.40
29	2725113.60	2885414.40	.00
30			
31	1450878.95	1450878.95	-200376.00
32	1160703.16	1160703.16	-160300.80
33	1380296.84	1380296.84	-[illegible]28699.[illegible]
34	.00	.00	.00
35			
36	74181228.46	78544830.13	.00
37	56142668.4[illegible]	59445178.34	.00
38			
39	130323896.89	137990008.47	
40	----------------	----------------	----------------
41			
42			
43			
44			
45			
46			
47			
48	================	================	================
49	-6903896.89	-7310008.47	
50	================	================	================
51			
52			
53	================	================	================
54	49238771.54	52135169.87	
55	================	================	================
56			
57			
58			
59			
60			
61	29.82	31.57	
62	.71	.75	
63	.19	.20	
64			

	J	K	L
1			
2			
3			
4			
5			
6			
7	_Sens. Analysis_	_Sens. Analysis_	
8	US $34/bb crude	US $36/bb crude	
9	----------------	----------------	----------------
10			
11	34.00	36.00	
12	3630000.00	3630000.00	
13			
14	123420000.00	130680000.00	
15	----------------	----------------	----------------
16			
17			
18	75000.00	75000.00	
19	3500.00	3500.00	
20	1651254.95	1651254.95	
21			
22	1001880.00	1001880.00	1001880.00
23	1089000.00	1089000.00	1089000.00
24			
25	200376.00	200376.00	200376.00
26	801504.00	801504.00	801504.00
27	....	....	....
28	80150.40	80150.40	80150.40
29	2725113.60	2885414.40	.00
30			
31	1450878.95	1450878.95	-200376.00
32	1160703.16	1160703.16	-160300.80
33	1380296.84	1380296.84	-928699.20
34	.00	.00	.00
35			
36	74181228.46	78544830.13	.00
37	56142668.43	59445178.34	.00
38			
39	130323896.89	137990008.47	
40	----------------	----------------	----------------
41			
42			
43			
44			
45			
46			
47			
48	================	================	================
49	-6903896.89	-7310008.47	
50	================	================	================
51			
52			
53	================	================	================
54	49238771.54	52135169.87	
55	================	================	================
56			
57			
58			
59			
60			
61	29.82	31.57	
62	.71	.75	
63	.19	.20	
64			

Row		
72	500.00	500.00
73	3630000.00	3630000.00
74	140000.00	140000.00
75	25.93	25.93
78	44765.00	44765.00
81	22382500.00	22382500.00
86	14620000.00	14620000.00
88	6.00	6.00
91	87720000.00	87720000.00
96	110102500.00	110102500.00
103	2238250.00	2238250.00
108	5848000.00	5848000.00
112	8086250.00	8086250.00
117	138410146.89	146076258.47
125	-14990146.89	-15396258.47
130	43390771.54	46287169.87

132:		
133:		
134:		
135:		
136:	26.28	28.03
137:	.63	.67
138:	.17	.18

TABLES. ST2.3.B ENERGY STRUCTURE STAGE2: STATE 2,3

ENERGY STRUCTURE	ACTUAL bb	%	FLEET veh	%	YIELD bb (oil eq)	%
PETROL	801504	20.91	0	0		0
ALCOHOL	1651255	43.08	44765	31.98	1160703	31.98
GASOHOL			42000	30	1089000	30
DIESEL	1380297.	36.01	53235	38	1380297.	38.02
TOTAL	3833056	100.0	140000	100.0	3630000	100

ENERGY RATIO .9470
(Yield Total/Actual Total)

PRODUCTION VALUES:

ALCOHOL (litres/year)	2.6250e8
LAND USE (hectares)	75000
% of Land Available	100
Production Days Nominal Cap.:	182.2917

Stage 1: The Scope Beyond

As can be gathered from the calculations presented above, (barring specific substitution aims), in general, the preferred path of implementation would be state 3,1 and subsequently state 2,2.

If this was achieved, (through the technological and managerial expertise gained) the country would be in a position to develop additional schemes using ethanol as an input.

The variety of possibilities at that stage would be very great: from the total substitution of oil (if it ever becomes a reasonable proposition), to the establisment of an ethylene industry, or even the establishment of a complex producing ammonia (33) for FERTICA's process, a much desired synergy situation so lacking in the present day operations between the corporation's subsidiaries.

Nevertheless, the first stepping stone would be that of the relative position of the cost of production for alcohol and oil derivatives, due to the similarity in the two industry's field of action. This restriction is not limited to the transport sector, for as discussed before, in the case of ammonia production, ethylene, etc., both input groups, alcohol and oil derivatives, serve as alternatives.

Alcohol Production References

1. Comision Nacional Para la Reestructuracion de Codesa: Preliminary Report to the President of the Republic, April, 1986.

2. IMF: International Financial Statistics, Supplement on Price Statistics, Supplement Series, IMF, 1981.

3. Visit to Liga Agroindustrial de la cana (LAICA) Research Center in Grecia, Costa Rica, February, 1985.

4. Financial Times 7 June 1985, p. 32, and 6 December 1985, p. 40.

5. UNFAO: Sugar: Major Trade and Stabilization Issues in the Eighties, FAO Commodities and Trade Division, Rome, 1985, quoted in Financial Times 7 June, 1985, p. 38.

6. Visit to Catsa Installations, April 1985.

7. Pamplona C.: Proalcool: Impactos em Termos Tecnico-economicos e Sociais do Programa no Brasil, Belo Horizonte, 1984. (Techno-economic and Social Impact of the Alcohol Programme in Brazil).

8. La Nacion, p. 3A, 28 February, 1985.

9. Coelho J.C., Biomassa, Biocombutiveis, Bioenergia, Brasilia, 1982.

10. Celis R. et al.: La Produccion de Alcohol Carburante en Costa Rica: Evaluacion y Perspectivas, IICE, UCR, San Jose, 1981.

11. Lones, T.: "*Brazil Avoids Hiccups with Alcoholic Car Fuels*", Grow Your Own Energy, Michael Cross, editor, New Scientist, London, 1984.

12. Wochensblatt fur Paper Fabrikation (Key Article), Issue 81.04.30, pp. 270-274, 1981.

13. Llorente, J.C.: "*El Alcohol Como Combustible Alternativo*", Proceedings, International Symposium on Energy and Food Industries, 6-8 Oct. 1980 (Madrid), p. 183.

14. Aguilar F.: El Cultivo de la Cana de Azucar, EUNED, San Jose, 1983.

15. Doryan, Umana: Energia para el Desarrollo, Editorial Tecnologica, Cartago, 1981, p. 292.

16. Slesser M., Lewis C.: Biological Energy Resources, E + FN Spon Ltd., London, 1979, pp. 132-136.

17. Cook J.H. (CIAT): Science (Key Article), issue 82.11.19 pp. 755-762.

18. Ofoplan: **Plan Nacional de Desarrollo Forestal, 1979. Based of=n** Tosi J.: El Recurso Forestal como Base Potencial para el Desarrollo Industrial de Costa Rica, quoted in (15).

19. Anand, Nalebuff: Issues in the Appraisal of Energy Projects for Oil Importing Developing Countries, WBSWP No. 738. The World Bank, Washington D.C., p. 53.

20. Hotelling, H.: *"The Economics of Exhaustible Resources"* , Journal of Political Economy, Vol. 39, pp 137-175., quoted in (19).

21. European Chemical News: *"Technology: New Ethanol Process"*, Issue 84.08.06, p. 16.

22. Reserve-Conserve-Alimentation: *" CSR (Australia) and Grain Processing (USA) have signed a contract with New South Wales U.,..."*, Issue 83.03.00 p. 13 1983.

23. Chemistry-Industry, *"Australia: a process converting starch directly into glucose...has been developed at New South Wales U."*, Issue 82.10.16, page 784, 1982.

24. API: Alcohol Production from Biomass, Potential and Prospects in Developing Countries, World Bank, 1980.

25. Petroleum Times, key article Issue 81.06.00, *"U.K. alkyl additions to motor spirit will fall..."*, pages 28-31, 1981.

26. Volkswagen do Brasil (various articles), Proceedings, Primer Simposio de Engeniheria Automotiva, Brasilia, 1983.

27. ESSO Chemical U.K.: **Fife Ethylene Plant**

28. Berrie, T.W.: *"Making Energy Sector Assessment Studies in LDC's"*, Energy Policy, vol. 11 No. 4, 1983.

29. World Energy Conference: Oil Substitution Task Force Report, New Delhi, 1983.

30. Interview with J.P. Ratton, Technical Manager, INCSA, April 1985.

31. BP Statistical Review of World Energy 1985

32. Wilkie, J.W., Statistical Abstract of Latin America, Los Angeles, 1980.

33. Chemistry-Industry, *"Zimbabwe: plans projects for ammonia and methanol based synthesis gas and ethanol from sugar cane..."*, Issue 81.10.00., 1981.

6. Organization

6. Organizational Structure

6.1 Original Structure: (1)

As discussed in the Introduction, CODESA was originally set up to serve as a transitory investor in enterprises of "national interest", where either because of the size of the outlays required, or because of the initial risks involved in the ventures, the private sector was unable or unwilling to participate. It was clear from this, that the establishment of a permanent hierarchical management structure was not to be a main concern.

CODESA in those early days consisted of a Board of Directors formed by seven members (four being appointed by central government, two by the Chamber of Industry, and one by the Chamber of Agriculture, i.e., four members from the public sector and three from the private sector), and a small group of specialists (consultants in engineering, economics, etc., from various backgrounds: industry, development institutions) either paid employees of the corporation, or advisers from international organizations, who served as support staff for the Board.

This organization was to receive proposals from central government and private investors. After a study period, during which the projects were analyzed, often with the participation of outside (foreign) consultants, a decision was taken whether to accept or reject the proposal. (Proposals were to include technical, as well as economic feasibility studies. In addition, the suggested sources of financing were also required).

If accepted, the proper contacts were made to carry the necessary work to establish the time frame for the completion of the project, its cost, and other relevant information. After all this process was finalized, the dossier was remmitted to the Asamblea Legislativa (Congress), for the necessary discussion and approval.

From this point onwards, the corporation's role became a supervisory one, overlooking the progress of each investment, the selection of personnel, and finally the start-up of each enterprise. In theory it was here where CODESA's participation was to end, and where the private sector with its supposed "better efficiency" record and superior management knowhow was to take over.

All in all, the initial corporate structure involved mainly the activities of a Development Bank, which in some instances was to undertake start-up management situations *(1)*.

6.2 Analysis of Current Structure:

6.2.1. Introduction:

It was not long before clashes took place within CODESA's board, mainly because of the pressure exerted on the Directors by members of the new Administration, 1974 - 1978, and particularly by the President of the Republic, Daniel Oduber, promoting some very large investment programmes. The most controversial of these proposals, Cementos del Pacifico, had previously been rejected by the corporation when it had been processed through the normal channels, as was explained in an earlier section.

During this period (November, 1974) new members, were appointed to the board replacing even the first executive president, Mr. Rafael A. Zuniga *(2)*, who resigned before accepting the indiscriminate intervention of central government in CODESA's decision-making-processes *(3)*. From this point on, the company became more and more a direct executor of central government orders. First, close associates of Mr. Oduber were appointed to the Board as "advisers", and finally on 1st. March, 1976, four Directors: the second executive president, Roberto Dobles, the vice-president, Mr. Jose F. Aguilar, and the two representatives from the Chamber of Industry, Mr. Richard Beck and Mr. Alvaro Hernandez, were officially separated from their posts by the Government Council (President Oduber and his ministers)(4).

This created the most important schism in the institution's history. All the other members of the Board resigned, and since then, a strong lobby from the Chamber of Industry has attacked the very existence of CODESA. The corporation thus became a state-owned holding company, and within a short period of time, three of the four largest investment projects (sugar and alcohol production, cement production, and aluminium semi-processing) were well under way. Concurrently, service oriented enterprises (not directly related with industrial planning) were created, over-extending the reaches first envisaged for the role an industrial (and agro-industrial) development institution was to play, therefore, preparing the ground for "trash can investment" practices (1.- Rescuing private sector companies - either by providing soft loans, purchasing substantial amounts of stock, or effectively nationalizing the enterprises - of no significant macro-economic importance, whose poor financial situation was the result of fundamental flaws in their strategic positions. 2.- Investing in subsidiaries where financial performance was difficult to assess, without the necessary planning - these are enterprises created to attack percieved problem areas for central government, for example mass transport, where the subsidiary in question was to operate as nothing else but an extension of the Ministry of Public Works and Transport).

The purpose of this short review of events is not to seek culprits, but instead to stress the fact that CODESA, as an organization, had not been prepared to function as a well structured on going business-oriented enterprise, prior to the moment when there was no other viable option but to take on, precipitately, new responsibilities (investments amounted to CR C1,516.4 million or ~ US $176.3 million during 1975 and 1976 alone) *(4)*.

Due to these developments, grave institutional deficiencies were generated. The following sections are dedicated to their analysis.

6.2.2. Personnel Stability:

As is clear from the latter section, job stability at CODESA's top management position has been low. The trend has not varied much since those days, for during the thirteen years (16th. February 1973 to February 1986) the company has operated, eight changes have taken place at the Chief Executive Officer (CEO) level (called executive president in the Costa Rican Public Sector). The average tenure therefore, has been of just over one and one half years.

It is unreasonable to expect many important accomplishments in such short periods. Moreover, it seems unlikely that CEO's may have attempted to develop far reaching, long term policies, knowing they probably would hold that post for only a few months. Lastly, it is not probable that in the future, the most suited individuals, with management skills and experience, as well as knowledge of and commitment to the development role the corporation should play in Costa Rican society, will be attracted to the job.

Replacements in other key positions have not been as frequent, but on the average, the posts have changed hands four times in the corporation's history, a mean stay of three and one quarter years. More important here, is the fact that the posts themselves have been modified repeatedly through numerous re-organizations of the mangement chart, as will be discussed in the following section.

It is important to note that no executive president has come from within the ranks of the organization, a situation which is also true for other high level offices. From this, it can be said that career development has not been exercised to the present, a condition which appears to suggest that young professionals will be discouraged from joining the corporation, because of poor advancement prospects.

In summary, the record does not show a promising picture for people at either end of the management scale. The lack of planning and on-going training schemes, developing career options for valuable employees at all levels, can only lead to stagnation and bureaucratization of the organization.

The assurance of job stability throughout the management structure, within generally accepted limits, is an essential element in any sound business enterprise. CODESA's orientation has been seriously affected by political struggle. Intervention by central government in the appointment of key personnel more by affinity than by merit, is just an example of such influence in the internal affairs of the company. Unless clear procedures are established to regulate this relationship, no substantial progress can be envisaged.

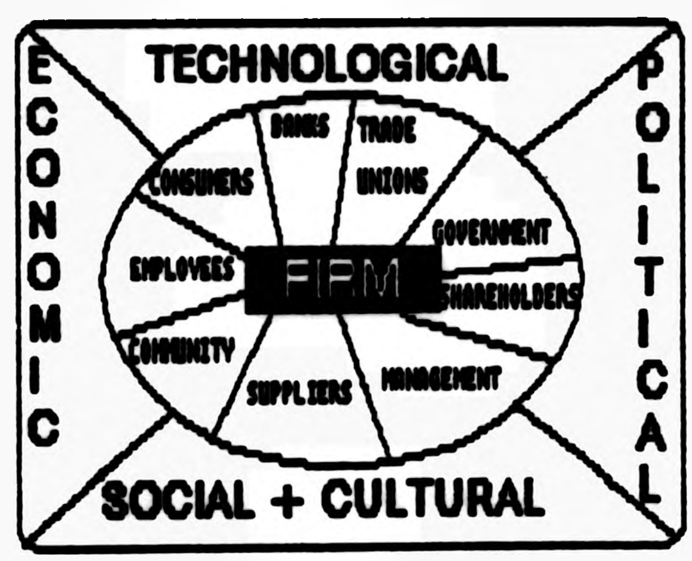
It is important to note that similar enterprises in Latin America have been able to operate with considerable independence (Mexico and Brazil, for example) *(5, 6)* under what is known as the "bureaucratic authoritarian" regime:

> "BA, in the eyes of its advocates, offers the shortest route to the kind of stability and social predictability conducive to the emergence of a broad based and complex industrial sector. By sanitizing a country's politics, BA can defuse the threat businessmen face from sudden changes in political moods (a common problem in Costa Rica). In quelling political activity and concentrating economic decisionmaking in the hands of technocrats commanding bureaucracies with developed surveillance and control capabilities, BA exalts economic goals above all others." *(6)*

6.2.3. Political Distortions on Performance:

6.2.3.a Stakeholder Approach:

As a first step, I shall present a review of the relationship between companies and their stakeholders (3, 7).



Any firm has important interactive relations with members of its immediate environment: consumers, bankers, trade unions, workers, suppliers, government officials, management, shareholders, and the community in general. Also, every enterprise is influenced by the set of rules governing the wider environment in which it operates, namely: legislative (or political), cultural, technological and economic circumstances or attitudes.

Under ideal conditions, a firm competes with other companies for the favour of the "interested groups" listed above, under the guidelines regulating the wider environment, which affect all entrants in a specific industry in the same manner.

Changes are generally brought about at this broader level. In turn, because of the new scenario, pressures build up at the stakeholder level, which the firm must relieve by effective and timely policy-making, in order to keep its place in the market.

It is essential that any business learns to recognize, and is prepared to react to new conditions facing it, so as to survive in the bad times, and also to take advantage of hidden opportunities which may improve overall performance. If distorsions of any kind creep into a company's decision making process (DMP) in its dealings with the factors of decision-making (FDM) and hinder its capacity to identify its scope of decision-making (SDM), its competitive position may be seriously impaired.

The following two examples present the ways in which firms react to new conditions, modifying their behaviour, by careful examination of their position with respect to other companies, thus enabling them to be competitive.

Example No. 1: Changes in Technology:

If a direct competitor starts offering a better deal for a certain product, either by improving the product's performance and selling at the same price as before (product improvement), or selling the same product as before but at a lower price (process improvement), or both, a firm should choose between launching a similar entry, to preserve consumer loyalty, or withdraw from that specific line, moving the emphasis to other more promising activities. Reluctance to adjust to the new environment almost invariably will lead to significant financial loss.

A short review of the world video cassette recorder (VCR) market may illustrate how these factors affect company behaviour. *(8)*

Product innovator *par excellence* SONY, introduced the VCR (the Betamax system) to the general consumer in the mid seventies, enjoying the priviledge of a 100% share of the market, due to patent protection.

The launch by SONY of this product line, forced home electronics giant, MATSUSHITA, a recognized process innovator, to embark on the design of a better and cheaper video recording machine. As a result of this effort the VHS system, a longer playing, cheaper version of the Beta-system was introduced. The situation ten years after is that MATSUSHITA produces "two out of three"*(8)* or ~66% of all VCR's sold worldwide (under different brands). SONY still caters for the high end quality conscious consumer, (Black Trinitron TV's, Beta-scan III VCR's, etc.), but has progressed on to the introduction of a new, successful product line : the "MAN" (Watchman, Walkman, Discman) group of "personal entertainment" gadgets. Also continuing with its tradition, the company has developed (with NV Philips) new leading edge CD-ROM technology *(9)* for future commercialization.

Both companies have developed very well defined strategies in order to adjust to changing conditions. Each has concentrated on what it can do best, thereby creating its niche in the marketplace.

Technology, both with respect to the product and to the process involved in manufacturing it, was the determining factor from the wider environment. The relationship most affected between each company and its FDM's was that with the consumers. On the one hand, SONY knows it would be hazardous to compete in an all out price war with MATSUSHITA, something it would have to confront if it decided to preserve market share. On the other hand, MATSUSHITA understands that it might not be as successful at product innovation as its competitor, and is therefore reluctant to venture into that field, even though it may mean losing out on priviledged initial high profit/unit sales.

Example No. 2: Changes in Legislation:

The ability to adapt to political changes is another important characteristicof successful enterprises. The de-regulation of the airline industry in the United States is an example that should make the point clearer.*(10)*

When the new rules came into effect, existing air carriers had to re-structure in order to be in a position to compete with new entrants who did not have to deal with the legacy of the former protected, non-market lead environment. Existing companies which resisted to exercise policies towards this end are currently either fighting for their survival (Eastern) *(10)* or have declared themselves in bankruptcy (Braniff International, which later was re-launched as a small regional operator in southern USA).

There have been two stakeholder relationships that have experienced changes: first, the consumer has become more cost conscious. Second, we have the employees. Since personnel was the only readily available category for cost reduction, (it amounted to approximately 50% of total costs prior to de-regulation), new companies (the likes of People's Express) came into the market reducing over-manning, and offering lower salaries across the board. As a result they were able to offer lower fares.

Established companies have since had to devise new employment practices such as the encouragement of voluntary temporary lay-offs and early retirement schemes for older workers, and the recruitment of new personnel at much lower (up to 50% lower) salaries and bonus plans. Through these tactics, manpower costs have been reduced as a proportion of total costs to around 33%, which has enabled them to be competitive again.

Further adjustment has been achieved by the introduction of discriminating (similar to discriminating monopolies) policies. New companies have almost invariably catered for the charter and low-fare traveller in high density routes. Older companies have concentrated on targeting new services to specific users (using extensive segmentation: first class, business class, Y class, M class, stand-by, off-peak, and apex fares, etc.) in an attempt to keep up high levels of seat occupancy/flight, juggling the numbers of seats to be made available for each class/flight using very sophisticated monitoring systems (Northwest Orient, for example, is in the process of developing a computer based expert system).

What is important to note from these previous examples, within the scope of this thesis, is that came into the market reducing over-manning, and offering lower salaries across the board. As a result they were able to offer lower fares.

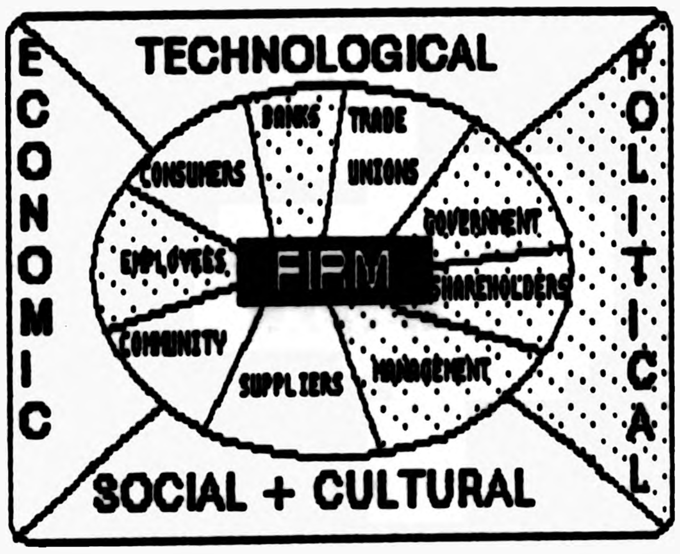
Established companies have since had to devise new employment practices such as the encouragement of voluntary temporary lay-offs and early retirement schemes for older workers, and the recruitment of new personnel at much lower (up to 50% lower) salaries and bonus plans. Through these tactics, manpower costs have been reduced as a proportion of total costs to around 33%, which has enabled them to be competitive again.

Further adjustment has been achieved by the introduction of discriminating (similar to discriminating monopolies) policies. New companies have almost invariably catered for the charter and low-fare traveller in high density routes. Older companies have concentrated on targeting new services to specific users (using extensive segmentation: first class, business class, Y class, M class, stand-by, off-peak, and apex fares, etc.) in an attempt to keep up high levels of seat occupancy/flight, juggling the numbers of seats to be made available for each class/flight using very sophisticated monitoring systems (Northwest Orient, for example, is in the process of developing a computer based expert system).

What is important to note from these previous examples, within the scope of this thesis, is that successful firms must be in touch with the environment in which they exist. Their behaviour must be shaped by careful analysis of the threats and opportunities which they face. When companies loose sight of this important contingency approach, they become vulnerable, reducing their potential to function as independent concerns. CODESA, as many other development institutions elsewhere has grown under very protected conditions. Moreover, in the case of this corporation, the addition of another element, administrative immaturity, has resulted in chaotic performance.

6.2.3.b The special Case: CODESA

Central government intervention in CODESA has led to important distortions in FDM relationships. A summarized description of how this power has been exercised and its consequences follows.



Direct Influence:

- Management: Naming executives and substituting them at will, has in most instances, transformed their role into that of "yes-men". Due to this, the expectations of people in management positions (as was discussed earlier) are very different from those of their counterparts in the private sector.

- Workers: Because of poor management practices, the winning party has been able to replace large numbers of employees after each election. (Within a two party democracy, the incumbent party has traditionally failed to stay in power since 1948. Only in 1974 and more recently in February 1986, has this been reversed, both times by the PLN). Contrary to central government employees, CODESA's workforce is not protected by any "civil service" legislation rights. Consequently, the process of mass substitition of employees has not encountered important obstacles, even though the motives for substitutions have seldom been associated with performance. This awkward practice has led to interruptions in normal trading due to the training of new personnel. Another fault that has become common practice in recent times is the transfer of employees, paid by the corporation or its subsidiaries, to work directly for central government dependencies. This has been brought about by freezes imposed by negotiations with the IMF and other financial instituitions, on the opening of new civil service posts,i.e., CODESA has served as a tool to get around employment legislation. (An example of this is TRANSMESA employees at MOPT, the Ministry of Public Works and Transportation).

- Banks: Central government has facilitated the corporation's access to the nationalized banking system's credit. Also, government guarantees have been granted to back large investments where foreign capital was required. Thus, bankers, having the assurance of responsibility by the "Government of Costa Rica" (not CODESA) have not worried unduly about the possibility of default on loan repayments.

- Shareholders: CODESA's shares are held by the government. As a result, the corporation's fate is handled by the council of ministers. Because of legal restrictions, no president may ever run for re-election, and therefore, long term planning is discouraged, since short term results are more relevant. This situation clearly constitutes one of the most important defficiencies of the performance of the corporation and its subsidiaries. Shareholders (or more precisely, their representatives) do not have incentives to think in the long term survival of the enterprise.

Indirect Influence:

- Suppliers: Similar to foreign

finance companies, because of government endorsement of CODESA's investments, suppliers have not worried about the potential (RDI) of company launch turnkey projects (ALUNASA, CATSA, CEMENTOS DEL PACIFICO) to which they have provided equipment. In this manner, the corporation's constraints on choosing its investment portfolio have not been significant, which has undoubtedly led to careless scrutiny procedures, and wrong decision-making.

- Consumers: Because of the duality of the government's function as an investor, and as a regulator of the global aspects of the economy, arbitrary price control policies have led to significant financial loss for some subsidiaries. Subsidies have not been allocated from elsewhere in the economy (through specific tax revenue for example), to counter the effect.

- Community: Apart from price control policies, over-employment at CODESA has been common, especially at the administrative level (as opposed to the production level). (For example, at TRANSMESA and HQ (author's experience), and at CEMPASA, according to the technical manager Ing. Jorge Delgado, when comparing his company's operations with that of Incsa). *(11)*

- Trade Unions: Unclear definitions of where the corporation's employees stand with respect to their employers: private or public, has led to poor company-employee association coordination. For example, two different trade unions have been established in a same subsidiary to represent the worker's interests.

6.2.3.c Conclusions:

Having presented the distortions brought about on CODESA's dealings with its environment by the influence exercised by central government, it is relevant to relate this experience with the examples introduced in the previous section (b.). Having more independence, CODESA might not have ventured into uncertain projects, such as ALUNASA. Having more financial limitations and controls, the corporation's management of infrastructural, service oriented enterprises might have been less extensive. Having been more aware of the conditions prevailing both in the immediate, as well as the wider environment, at the national and international level, it is certain that overall performance would have been more sound, erected on more solid bases.

6.2.4. Management Structures

6.2.4.a Conceptual Framework:

Schools of Thought

(Based on Mintzberg *(12)*, Twiss and Weinshall *(3)*, and Pugh, Hickson and Hinnings *(13)*)

Definition: Formal Structure: Documented, official relationships among members of the organization.

Since the beginning of this century, various approaches have been recorded concerning the way a company is to be structured, so that it can conduct its business in an efficient manner. Some of the more relevant are presented below.

- Principles of Management School: This movement, whose main exponent was Henri Fayol, introduced the basic notions of formal authority, the role of direct supervision within the organization. Terms developed by this school include:

Unity of Command: the rule that any "subordinate" should report to only one "superior".

Scalar Chain: the direct hierarchy of command from CEO, through superiors to subordinates, to workers.

Span of Control: the number of subordinates a superior is to supervise.

- Standardization of Work Schools: Another broad strategy presented by other authors concentrated on standardization of the tasks to be performed. Two groups can be identified within this framework:

Scientific Management:

First developed by Frederick Taylor in 1903, while working at Bethlehem Steel in Pennsylvania. This system laid down the basis of the traditional functional structure we know nowadays. Its aim was to program the contents of operating work; developing separate standard departments to handle specific tasks, as opposed to having one main operating unit handling all the work, from beginning to end.

A similar line was followed by Max Weber in Germany. Nonetheless, here the emphasis was on the regulation of the activities to be carried out. Formalized by rules, job descriptions, and training, a "by the book", machine-like structure was suggested: the bureaucracy.

- The Importance of Informal Structures:

Definition: Informal Structure: Unofficial relationships within work groups.

In the second half of this century, an increasing emphasis has been given to the study of the importance of mutual adjustment between members of an organization. These relationships may in reality vary substantially from that stated on organizational charts, thus the term informal structure.

An exponent of this approach, Michael Crozier discussed how unofficial power relationships affected standardization and formal systems of authority in The Bureaucratic Phenomenon (1964). *(12)*

Another important work by Jay Galbraith, Designing Complex Organizations (1973) *(13)*, analyzed the role of mutual adjustment devices such as task forces and matrix forms within wider formal structures (at Boeing).

- Contingency Theory: A separate line of thought involving the study a firm's operations, and the effect this had on its structure, has been advanced by various researchers.

As in all the previous cases, special importance has been given by different people to specific areas of study. For example, Joan Woodward *(3,12)* embarked on a project to identify if there was a "most appropriate alternative structural form" for a firm under a specific set of conditions. She concluded, after studying numerous companies in South Essex (1950's) that a firm's structure is related to the technical system of production it uses.

Taking a similar approach, but this time with *size* as the determining factor, a series of studies were carried out at the University of Aston during the years 1963 - 1969, under the leadership of Derek Pugh and David Hickson. The conclusions here were that size is the variable that better explains the characteristics of the structure of an organization. The larger a company is, the more important standardization becomes as a means of coordinating its activities.*(12,13)*

More Definitions:

(From Mintzberg, 1979) *(12)*

a. Organizational Structure: The sum total of the ways in which an organization divides its labour into distinct tasks and then achieves coordination among them.

b. Coordinating Mechanisms: Means by which control and communication are achieved: mutual adjustment, direct supervision, standardization of work processes, standardization of work outputs, standardization of worker skills.

c. Mutual Adjustment: Coordination of work by the simple process of informal communication, i.e., the control of the work rests on the hands of those involved in it directly. (the doers).

d. Direct Supervision: One individual taking the responsibility for the work of others, issuing instructions to them and monitoring their actions.

e. Standardization: When coordination of parts is incorporated into a structure from the time it is established, reducing the need for continuing communication. Coordination is therefore developed "at the drawing board" before the work is carried out.

e1. Standardization of work processes: When the contents of the work are specified or programmed beforehand.

e2. Standardization of outputs: When the results of the work are pre-established: dimensions, performance, etc.

e3. Standardization of skills: When the kind of training required to perform the work is specified.

Stages in the Development of a Firm With Respect to the Complexity of its Activities *(12)*

Simple <--> Complex

Mutual ------>	Direct ------->	Standardization --------->	Mutual
Adjustment	Supervision	(3 types)	Adjustment

of informal communication, i.e., the control of the work rests on the hands of those involved in it directly. (the doers).

d. Direct Supervision: One individual taking the responsibility for the work of others, issuing instructions to them and monitoring their actions.

e. Standardization: When coordination of parts is incorporated into a structure from the time it is established, reducing the need for continuing communication. Coordination is therefore developed "at the drawing board" before the work is carried out.

e1. Standardization of work processes: When the contents of the work are specified or programmed beforehand.

e2. Standardization of outputs: When the results of the work are pre-established: dimensions, performance, etc.

e3. Standardization of skills: When the kind of training required to perform the work is specified.

Stages in the Development of a Firm With Respect to the Complexity of its Activities *(12)*

Simple <--> Complex

Mutual ------>	Direct ------->	Standardization --------->	Mutual
Adjustment	Supervision	(3 types)	Adjustment

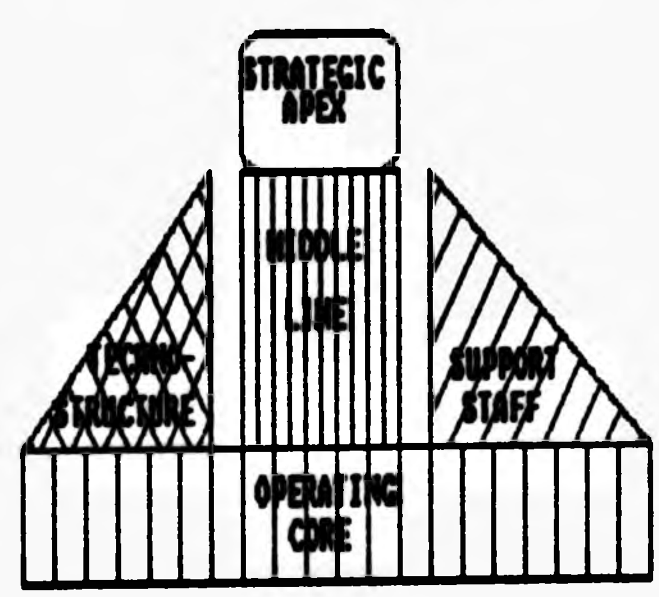
The Five Basic Parts of the Organization:

(From Mintzberg, 1979)

- Introduction: James D. Thompson stated (1967) *(12)* that uncertainty constitutes the fundamental problem of complex organizations. He proposed that companies reduce uncertainty by sealing off their core from the outside world, so that operating activities can be protected. They seek to dominate their environment and with this reduce uncertainty (fixing prices, creating cartels, integrating themselves vertically).

This is accomplished in two ways: first, by the standardization of work processes; second, by anticipation (planning, stockpiling, doing preventive maintenance, levelling production, conducting intelligence activities).

PARTS OF THE ORGANIZATION



- Strategic Apex: At this level, people are charged with overall responsibilty for the company. This part of the organization is constituted by the Chief Executive Officer, any top level officials whose concerns are global, and their clerical staff, assistants, etc. Also, the strategic apex is responsible to those people who control or otherwise have power over the firm: owners, government agencies, unions of employees, etc.

- Middle Line: This level is constituted by the chain of superiors and subordinates (in a succession of formal authority) that joins the Strategic Apex and the Operating component of the organization. The number of steps down the hierarchy of the firm is determined by the desired span of control. Therefore, the middle manager operates in the flow of direct supervision, controlling his subordinates, and passing on feedback to his superiors. Also, he relates horizontally to fellow middle managers, and customers. Depending on the company middle managers may or may not have a say in strategic matters concerning their own units.

- Technostructure: People here are analysts, and clerical staff, who develop standards and changes within organizations, so affecting the work of others. They are not involved in the workflow itself, but instead design it, plan it, change it, and train people to do it.

The technostructure is the most important part in standardization programs. The more a firm relies on standardization the more it relies on its technostructure, and at the same time, through standardization, the need for direct supervision is reduced.

- Support Staff: These are specialized units which provide support to the organization as a whole but are removed from the workflow itself; for example: legal counsel, public relations, industrial relations, reception, mailroom, cafeteria, etc.

- Operating Core: These are the members of the organization who carry out the the basic work related directly towards the output of goods or services. It is here where inputs are secured and turned into final products (or services).

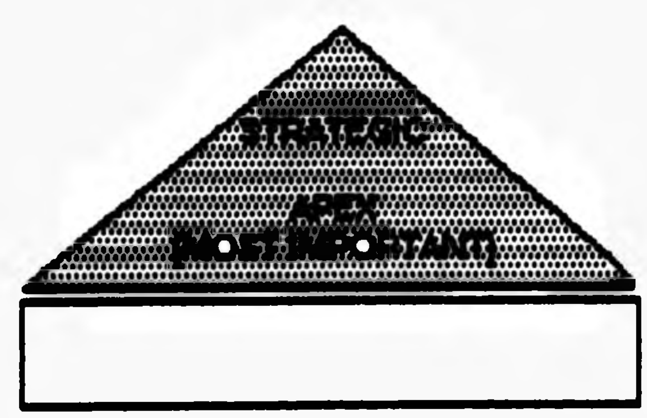
Note: As a general rule, the lower one goes in an organization, the more standardized working conditions are. As a result, the decision making process is simpler at the operating level than at the strategic apex (more concrete and prompt solutions are possible, to problems which may arise).

Variations of Organizational Structure:

(Based on Mintzberg (12), Majaro (7), Twiss and Weinshall (3))

Definition: Variations: The ways in which different components can be arranged to reach an appropriate structure for the activity to be developed.

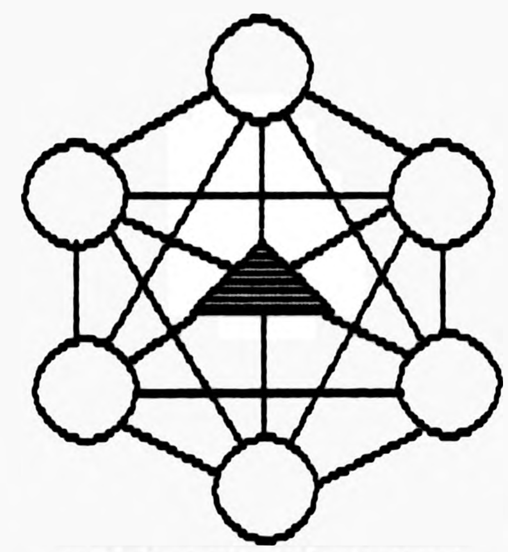
- The Simple Structure: This is the layout generally associated with small, young firms. The most important part of the organization is the strategic apex, which in many cases may be an entrepreneur. The main design parameters are centralization and organic structure (no staff or technostructure). I would divide this level of organization into two distinct alternatives.



SIMPLE STRUCTURE A

The first alternative

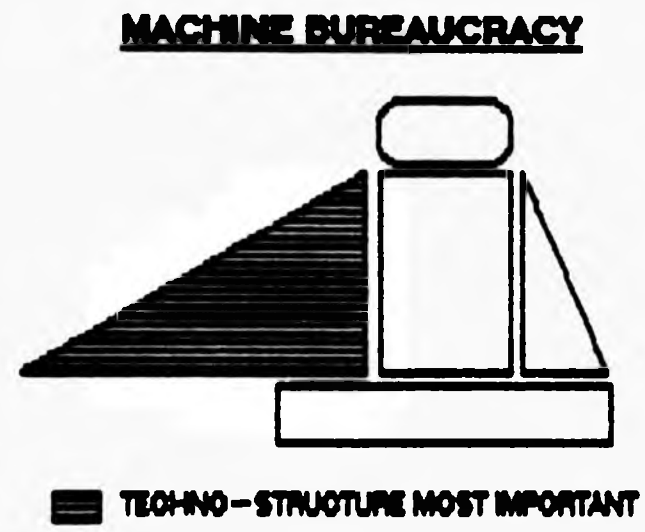
involves companies where the level of technology is not the determining factor. Instead the whole organization may consist of a manager-owner and a few relatively unskilled (replaceable) operators. Contrary to the structure presented in the next paragragh, direct supervision will become the most important coordinating practice.



SIMPLE STRUCTURE B

STRATEGIC APEX MOST IMPORTANT

The second is associated with initial innovation (what gives an enterprise the opportunity to enter the marketplace) launched firms where relatively sophisticated technical systems may be common. Here, the people in the organization must have considerable expertise in the subject they are involved in. As a result of this the prime coordinating mechanism is mutual adjustment.



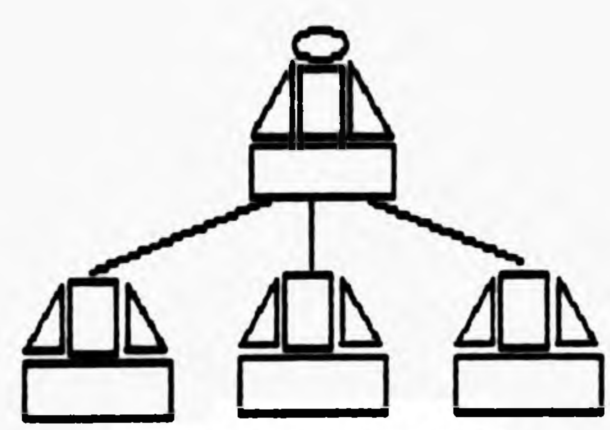
- The Machine Bureaucracy: In this form of organization, common in many large institutions (especially in government), the most important element is the standardization of work processes. The design goals involve: the formalization of behaviour, job specialization (both horizontal and vertical), the grouping of activities in functional units, high vertical centralization, and restricted horizontal independence. An important feature is that coordination and control are achieved by direct supervision, in an environment where staff and line activities are clearly separated.

The technostructure within this form becomes the most important part of the organization, since it is there where standard processes are developed. The strategic apex is involved primarily in fine tuning and not in long term planning.

- The Professional Bureaucracy: The unifying factor here is the standardization of skills (universities, hospitals for example). The most important part of the organization becomes the operating core. The design characteristics involve training, horizontal job specialization, as well as vertical and horizontal decentralization, relying on the expertise of the personnel involved (only highly trained and indoctrinated specialists). Through sophisticated training programs specific patterns of behaviour are developed for different employees (example: different types of doctors). In this process inherent coordinating features are introduced, and hence the term "bureaucracy" is used.

- Divisionalized Form: The regulating force in this structure used extensively by transnational corporations is the standardization of outputs. The most important units are those associated with middle management. The main design considerations are the grouping of activities by market (by product, service, client or region), the establishment of performance control systems and the limitation of vertical decentralization. An important aspect which sets this approach apart from any other is the fact that each division devotes all of its effort to its own task or business.

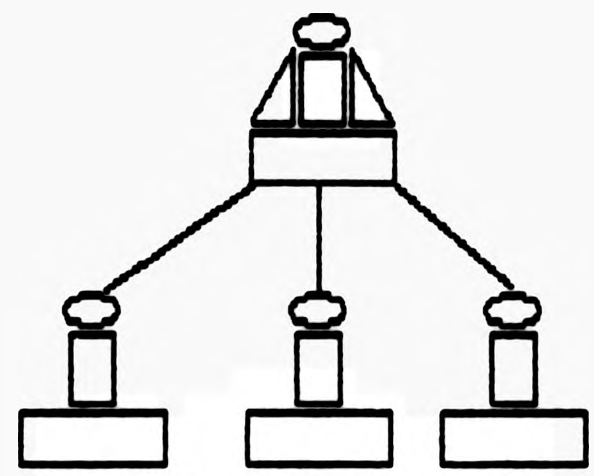
Majaro has described various ways in which divisionalized organizations may go about their business, based on the level of independence of the divisions (headless or thinking divisions). These are as follows: (7)



DIVISIONALIZED FORM A: MACROPYRAMID

MIDDLE LINE MOST IMPORTANT

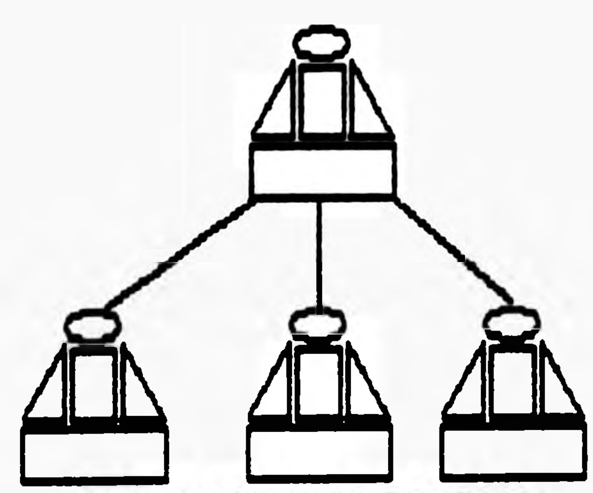
The Macropyramid: In this organization, all strategic level decisions are taken at the corporate headquarters. Also, since a complete "backup" structure exists at HQ, middle and operating decisions are also closely monitored from here. The divisions are therefore composed by only four parts: middle line, staff, technostructure, and operating core.



DIVISIONALIZED FORM B: UMBRELLA

MIDDLE LINE MOST IMPORTANT

The Umbrella: This set-up calls for thinking HQ's as well as divisions, nevertheleses, technostructure and support activities are reserved for the corporate unit, leaving each division with three parts: strategic apex, middle line and operating core.



DIVISIONALIZED FORM C: CONGLOMERATE

MIDDLE LINE MOST IMPORTANT

The Conglomerate (Interglomerate *(7)*) : Finally, a last structure exists where divisions operate for all practical purposes, as separate entitities, i.e., they preserve all five essential parts of an organization. HQ, only affect performance at the strategic level, leaving the rest of the activities to its subsidiary companies.

- The Adhocracy: This term developed by Toffler in The Future Shock (1970) *(12)*, is reserved for companies operating under rapidly changing conditions (at the forefront of technological development, for example: space exploration, genetic engineering, etc.). Reflecting these characteristics, the structure itself is constantly redefined , jobs are transformed, responsabilities shift, titles change, etc. Not surprisingly, the means for coordination most commonly used is mutual adjustment.

In these firms, matrix organizations are the order of the day, since repetitive work is not common. Instead,operations are conducted on a project basis (specified beginning and end). The design parameters relevant here are liason devices, organic structure, selective decentralization, horizontal job specialization, and training programs. By definition, the firm must avoid all bureaucratic practices as this would impede its flexibility.

Two distinct

subdivisions are defined by Mintzberg in his book The Structuring of Organizations (1979) *(12)*, which are:

The Operating Adhocracy: These are companies that solve problems for others on request. Examples of such firms are "think tank" consulting firms, advertising agencies, and manufacturers of engineering prototypes. As may be inferred, such a firm must rely on expert personnel: a professional bureaucracy.

The Administrative Adhocracy: This type of organization undertakes projects to serve its own ends and not those of others. A sharp distinction is made between its two main components: administration and operating core. If necessary, the latter is isolated (operating as an independent unit) from the main structure so that the administrative component can be managed as an adhocracy. The goal of practice is to keep one step ahead into the future; company executives are concerned more with the development of future projects than with managing those already operating.

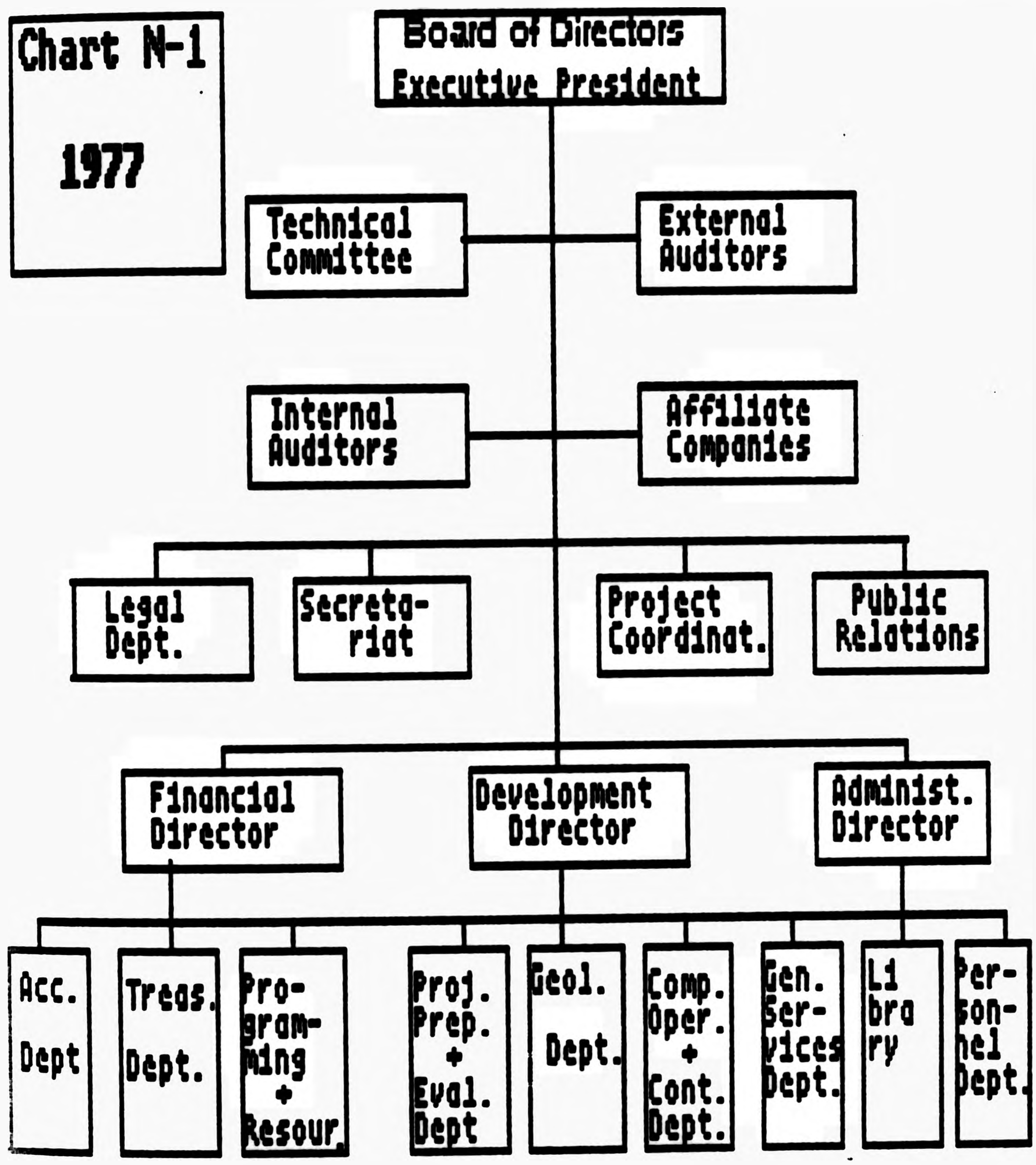
6.2.4.b Analysis of CODESA's Charts:

Having reviewed relevant literature on the subject of organizational structure, CODESA's organigrams will now be presented in chronological order. A standardized analysis and classification of the charts (based on the concepts set down on the last section) will be carried out, in order to spot errors or inconsistencies in these layouts. Furthermore, modifications will be introduced, when deemed necessary, to explain alternative approaches which would have enabled the company to function better under the circumstances. An effort will be made to limit these changes to relocation of existing departments, in order to avoid the advantage of hindsight. Only when absolutely necessary will a new department be created.

No less than five different structures have been officially recognized by the corporation during the period between late 1977 and early 1984. These have been published in the annual reports of 1977, 1978, 1980, 1981, 1982/3.

Chart No. 1: As at December 1977: *(15)*

The first available official chart, as mentioned above, was presented as part of CODESA's 1977 annual report.



In general terms, it appears to show the working arrangements of a white collar machine bureaucracy, having financial, administrative, and development operating groups: the financial activity would be in charge of securing funds (or means), the administrative sections would seek the resources (human and material: recruitment of qualified personnel, drafting bid cartels, purchasing equipment, etc.), and finally the development area would study proposals and execute approved projects.

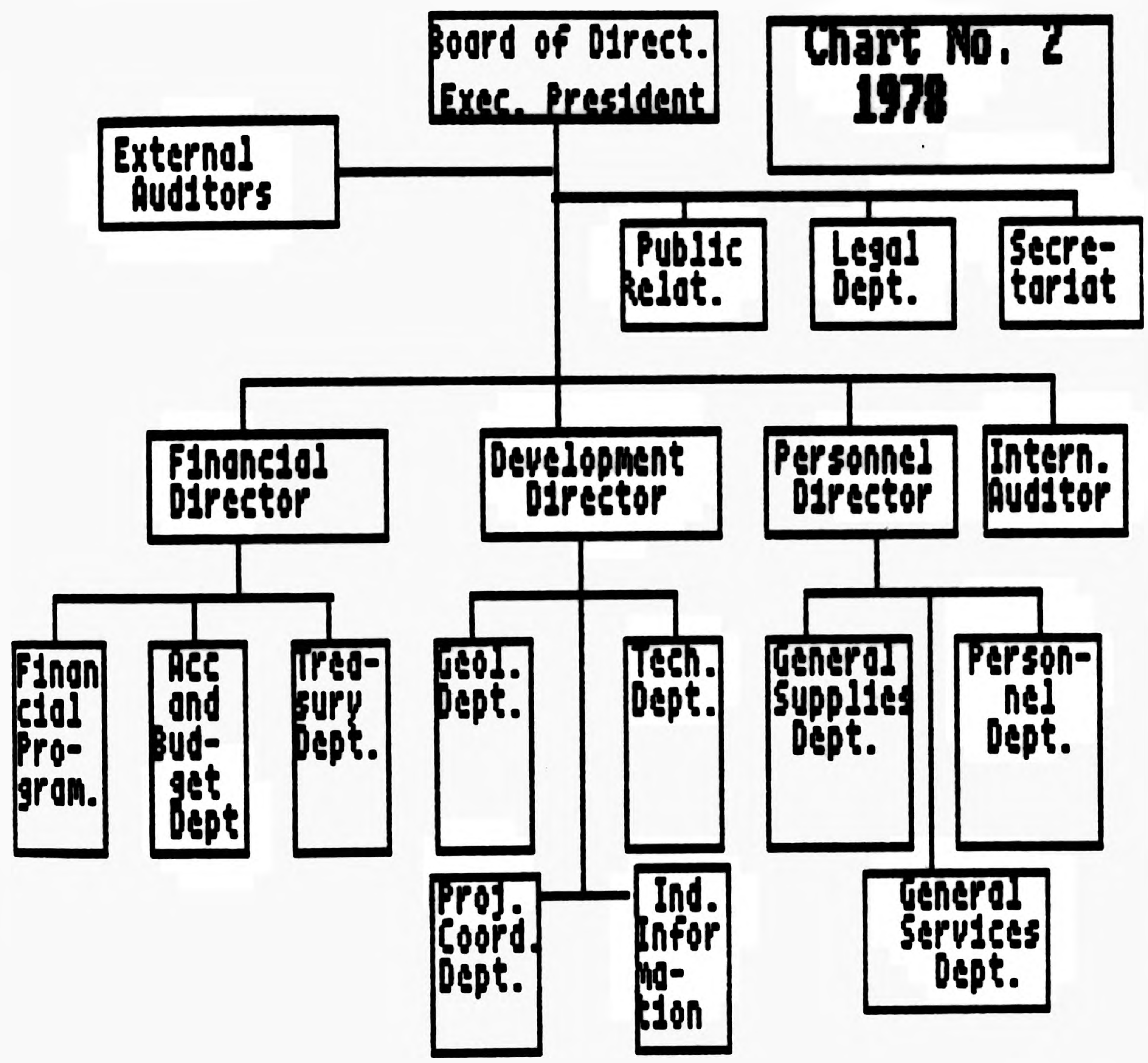
Taking a closer look, two important formal errors can be spotted. The first is, where the External Auditors are placed. At such a level, they would not even have seniority over the Internal Auditors. Even more so, the Executive President (EP) would be left free of any control mechanisms governing his behaviour.

The second is related with the relationship between the Board of Directors and the EP. Under the present layout, the top executive operates both as a Chief Executive Officer (CEO) and as a Chief Operating Officer (COO). Nonetheless, the authority of the Board as a whole (of which the EP is a voting member) is much greater than his, and should so be depicted in the charts. If not, collusion would be ubiquitous, eliminating altogether the purpose of constituting a responsible Board of Directors.

Another flaw relates to an inconsistency situation. The problem area is project formulation and execution. Project coordinators, as presented (in a staff or technostructure role), have no direct authority over the development of the projects themselves, and therefore, it may be inferred, no responsibility. On the other hand, the preparation and evaluation department, which does not actually execute projects, appears at the operating level of the organization. Matrix formats, task forces, and the like were already in common use by 1978 (for example, Jay Galbraith in 1973 discussed the subject thoroughly in his book Designing Complex Organizations, *(13)*). Such a concept would have aided in the definition of the channels of authority and responsibility, in a project-based orgnization such as the one CODESA was intended to be. Other minor changes have been carried out to clarify the bearing of each unit on the company's performance as a whole.

Chart No. 2: As at 31 December 1978: *(16)*

Apart from the External Auditors being maintained on the same level as before, another formal error is introduced into this second organigram. This concerns the Internal Auditors office. It not only has been placed in a line as opposed to a staff role (as its external counterparts), but also the department's hierarchy has been reduced to that of middle management. At this level, it is not reasonable to expect much cooperation from other divisions in the control function.



Auditors are supposed to observe that "the accepted accounting practices" are followed by all members of the enterprise, but most of all, by those involved in line activities. For this reason, they should appear on a support role (outside the normal workflow) and above middle management.

Finally, the technostructure components have been eliminated, and project coordination has been dropped to the operating core below the development director's supervision.

Chart No. 3: As at 30 September 1980: *(17)*

This may well represent the corporation's most unfortunate attempt to present an organizational chart. In it numerous formal, as well as inconsistency conflicts are present.

Apart from some already mentioned above, other formal errors appear in the definition of hierarchical levels:

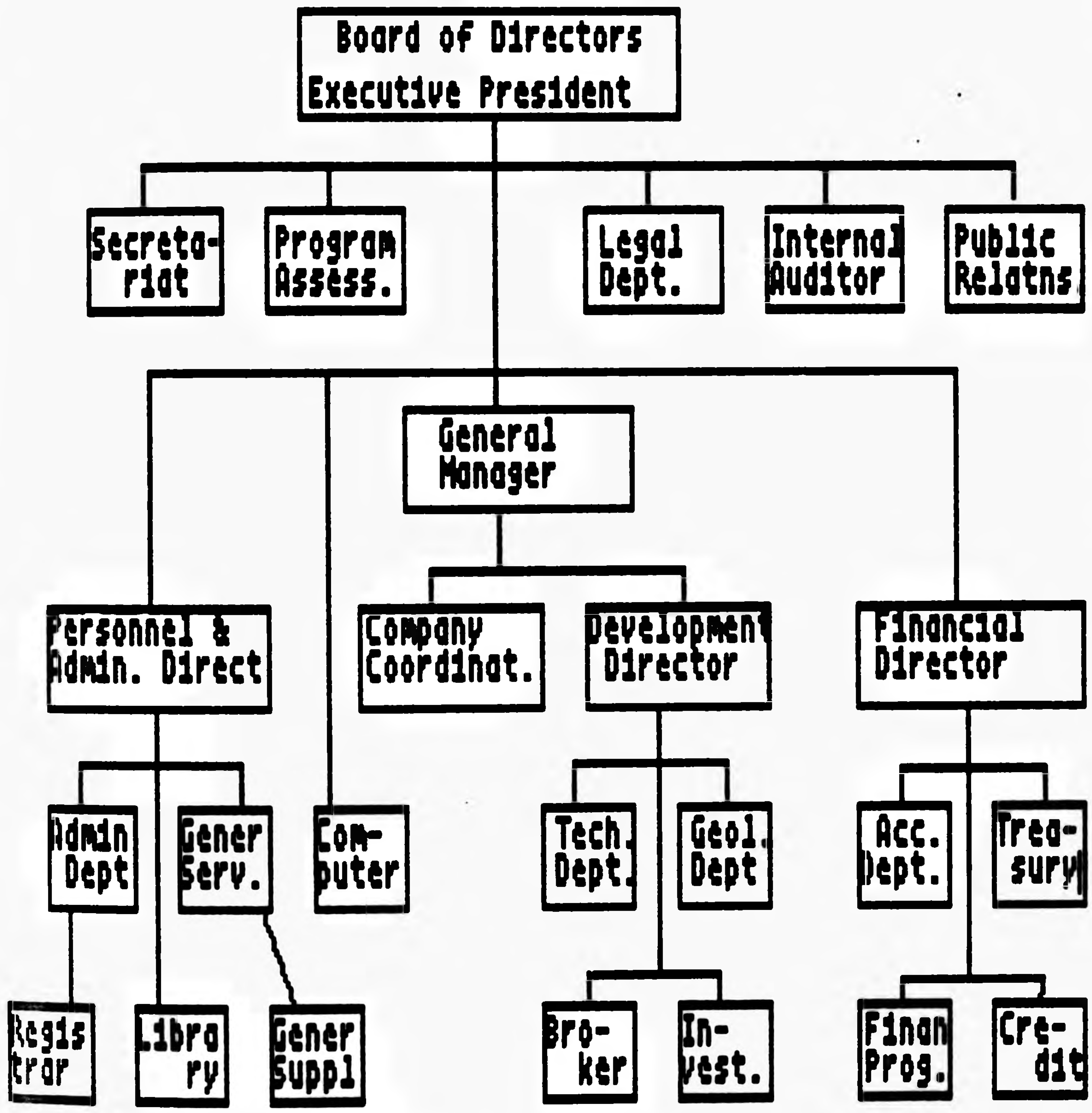


Chart No. 3: 1980

First, the general manager's (COO) office is introduced, but its authority is restricted to the development and company coordination areas only. This leaves beyond the COO's span of control both the administrative and financial functions, which are essential operating groups, within the layout presented.

Second, the computer services department is placed at the operating core but with no superiors other than the EP.

Third, within the administrative and development offices, different hierarchical levels are presented without the appropriate definition of superior-subordinate relationships:

- the jump of scalar authority, similar to the computer case above with respect to the library, broker and investment promotion offices
- the division of departments into single subordinate dependencies: Technical Administration --> Registrar's Office and General Services --> General Supplies Office.

Furthermore, , inconsistency situations are also visible. A new change has been exercised with respect to program management: program assessment is introduced at the technostructure level, and the project coordination unit has been raised in seniority to the middle line.

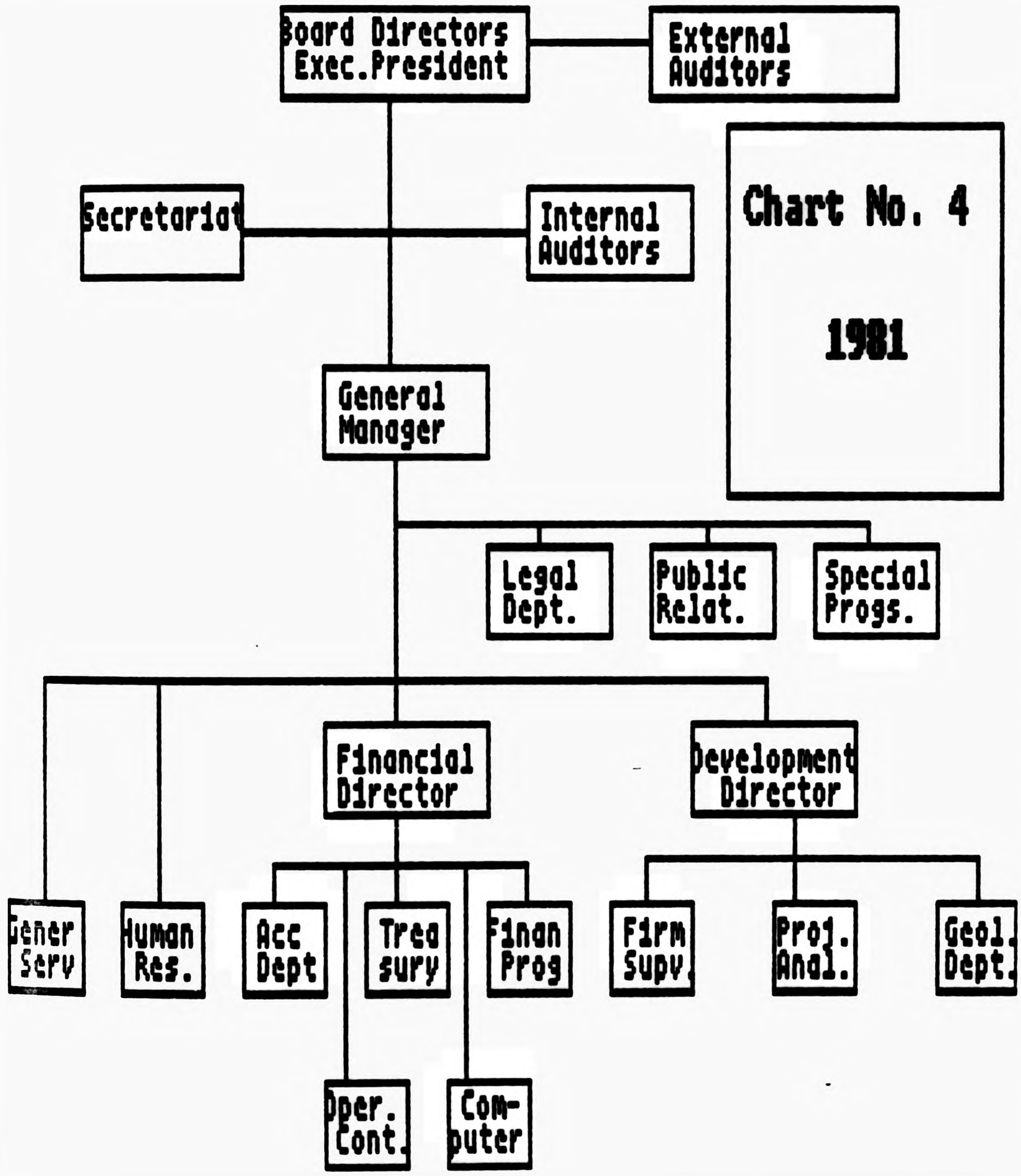

Board Directors
Exec.President
External
Auditors
Chart No. 4
1981
Secretariat
Internal
Auditors
General
Manager
Legal
Dept.
Public
Relat.
Special
Progs.
Financial
Director
Development
Director
Gener
Serv
Human
Res.
Acc
Dept
Trea
sury
Finan
Prog
Firm
Supv.
Proj.
Anal.
Geol.
Dept.
Oper.
Cont.
Com-
puter

Chart No. 4: As at September 1981: (18)

Moving on to the next organigram, we see that some of the flaws found on that of the previous year, have been eliminated. Nevertheless, some major problem areas persist.

The more important formal aspect is that of the scalar jump concerning the General Services and Personnel Departments. In the present plan, clear definition has been given to the offices of the EP (as a CEO) and the General Manager (as a COO), a welcome improvement from the previous year. Even so, we find that because of the dual role the GM is to play, as COO and as Administrative Director, serious levels of authority misunderstandings may easily crop up. This problem would arise either by the subordinates in the administrative area behaving as directors, or the Financial and Development Directors considering the GM as an equal (as nothing more than the Administrative Director).

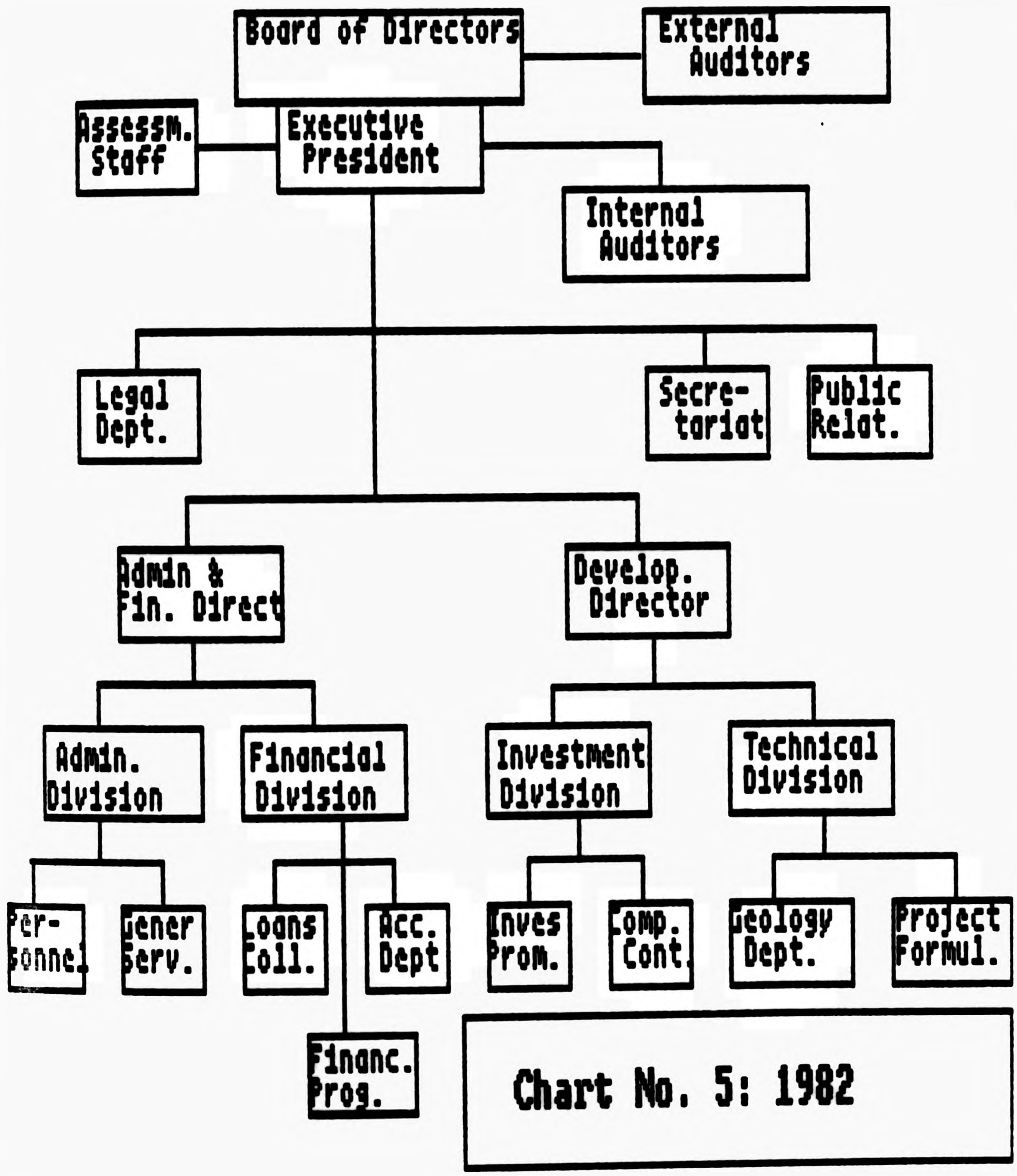
In relation to inconsistency situations, we encounter that the project activity has been juggled about the organization once more: the Coordination Director has disappeared, and in its place a company and project supervision unit is now presented at the operating core. Also, the analysis function has been divided into two: the Special Programs Assessment department at the technostructure level and the Project Analysis and Evaluation office operating under the Development Director.

It is apparent that this shifting policy with respect to project management proves that the corporation had a poor concept of how to deal with the most important activity it was created to perform.

Chart No. 5: Since July 1982 (Annual Report 1983) *(19)*

This brings us to study the final available chart. In general terms it shows a clearer set up. No great formal variations are pertinent (no modified structure applies). In contrast, fundamental philosophical questions are raised.

It can be argued that this layout reflects a more rigid structure than ever before. Such an approach makes project coordination a difficult proposition. A new hierarchical level has been implicitly created by introducing two managers. In essence, the EP has once more become CEO and COO, since he would have to coordinate (hopefully only through exception management) between the two defined broad areas of activity: Administrative and Financial, and Development.



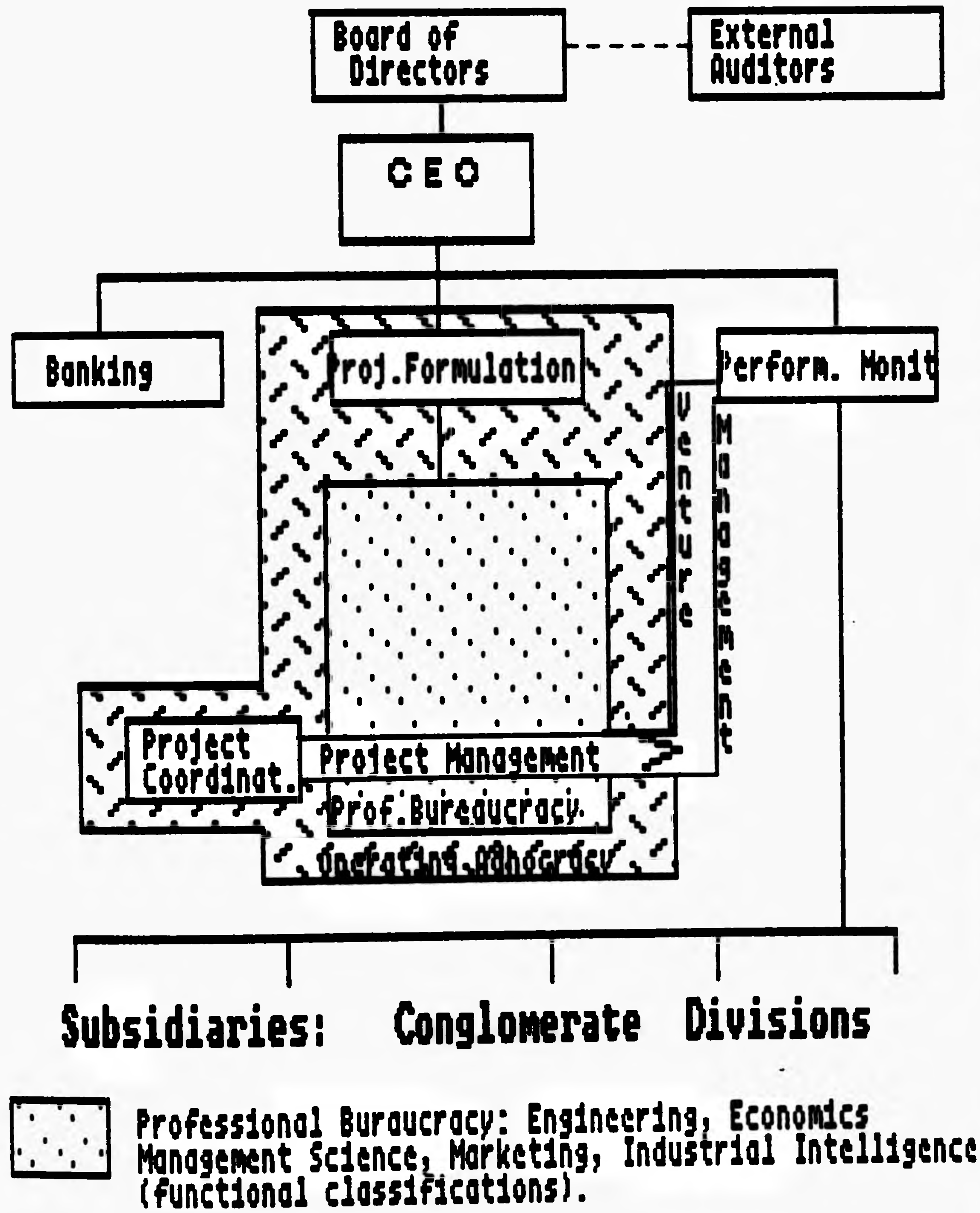
What this suggests is that CODESA operates more like a ministry than a project oriented institution, thereby losing its *raison d'etre*, i.e., the machine bureaucracy has been decidedly adopted as the organizational structure most appropriate to guide the corporation's behaviour.

Excessive hierarchical levels lead to poor coordination, unless the tasks undertaken are standardized routine functions. Such a practice leads to overmanning (146 "professional employees" in 1980, 177 in 1981, at HQ, taking into account that each subsidiary has its own complete organization), as well as to loss of direction, as the project concept (start and end processes) is superseded.

It is probable that the above problems have arisen as a result of two main factors: the first being the ministry-like approach, and the second the general level of management expertise and responsibility of the people involved (immaturity of the administrative structure) which leaves much to be desired.

A new organizational chart for the future activities of CODESA will be suggested in a later section. In it an effort will be made to link the structure of the institution to the role it is to play in the Costa Rican economy, as an integral development tool.

6.3 CODESA: The Future Structure:



It is now time to present a proposal for the corporation's future structure.

The first element that must be considered is independence. This term must be understood here as the restriction of entrance of shifting party politics into CODESA, as well as, an aim towards financial self-reliance (as has been possible in other Latin American countries: Mexico and Brazil in particular). This would provide the company the opportunity of serving as a long term industrial development tool. Unless this independence is achieved, the introduction of other improvements would be a futile exercise.

In order to accomplish this end, the original "national concensus" principle (similar to the French case of indicative planning) must be re-instated. Multi-sector representation on CODESA's board, including permanent bipartisan presence, is indispensible. A five member board is suggested as follows: one member from the government, who would preside, one member from the opposition party, one member from the party in power, one member from the Chamber of Industry, and one member from the Chamber of Agriculture. Note that with such a working arrangement it is feasible that on critical issues the governing party could face a two to three losing margin. Such a condition would encourage long term planning over a present day political tactics approach. To ensure further commitment to development oriented activities, it could be that the use of strategic management, as defined by Glueck and Jauch *(20)*, should be instituted on a permanent basis.

The resulting unit, combining the above elements, a) independence, b) bipartisan representation, c) explicit commitment to development activities (long term), would constitute the strategic apex of the new organization.

This brings us down to the structuring of the corporate unit (or headquarters). Three activities are deemed to be important here: banking, project formulation, and performance monitoring, all being handled on a separate basis. (A similar approach has been adopted in Sweden *(21)* where the *Statsforetag* is in charge of running enterprises, where as the Labour Market Board handles planning - project development and approval - as well as a credit function, to give financial support to successful proposals).

a. The Banking function:

Working with approximately ten people (in liaison with the SBN), this would constitute the corporation's link to the banks (national and foreign capital raising activities). Further funds would be secured through the already existing channels: foreign exchange transactions contribution, financial services - intermediary role between international financial agencies (mainly US AID) and private banks, and new policies such as subsidiary contributions (proportion of profits after adequate working capital reserves have been appropriated) and independent bond (debenture) issues, for example.

The idea behind a centralized funding activity is to provide incentives and restrictions for subsidiary companies to compete for the available capital, hence stimulating efficiency and sound proposal management (for extensions, plant renewal,etc.), to develop technical capability as defined by Dahlman, et al. (This policy is used by some large transnational corporations such as Matsushita).

b. Project Formulation:

With approximately fifty people, this unit would work along the lines of an operating adhocracy, using five distinct subunits within a professional bureaucracy (engineering, management science, economics, marketing - including international marketing, and industrial worldwide intelligence such as links to Datastar and other tehcnical and business information databases - as its supporting structure. Extensive utilization of mutual adjustment practices, i.e., matrix organigrams, task forces, etc., could be envisaged here. Potential projects would be analyzed, subjected to Board approval, and if the implementation phase is reached, "venture management" (on the lines of the Du Pont definition, Twiss p. 196), would take over. The prime goal of following such an approach is to increase as much as possible, the technical proficiency of the members of the adhocracy, by providing concrete incentives. After the venture management stage, when operations call for a standardized approach, the child company would be "spun-off", i.e., sold to private investors (totally or partially) or passed on to the third element of the structure: the performance monitoring unit.

c. Enterprise Control:

The performance monitoring unit, would consist of a small team of specialists supervising company performance. From this department, the operating structure could follow on a hierarchical arrangement, similar to a conglomerate divisionalized form. Under such set up, for all practical purposes (except for funding) as independent enterprises, with HQ intervention at the strategic level only, and emphasizing the principle of exception management.

Organizational Structure References

1. Initial 30 Sessions of Board of Directors, Codesa, 1972 - 1973.

2. Interviews with Mr. Rafael A. Zuniga, first Executive President of the corporation, Dec. 84, Jan. 85, San Jose.

3. Twiss, Weinshall: Managing Industrial Organizations, Pitman, London, 1980.

4. Vega, M.: Codesa y la Fraccion Industrial, Editorial Hoy, San Jose, 1982.

5. Sojo A.: Empresa Estatal y Desarrollo en America Latina, IICE-DDT No. 38, UCR, San Jose, 1982.

6. Yusuf, Peters: Capital Accumulation and Economic Growth: The Korean Paradigm, WBSWP No. 712, Washington D.C., 1985.

7. Majaro, S.: International Marketing, George Allen and Unwin, London, 1983.

8. Athos, Tanner Pascale: The Art of Japanese Management, Penguin Books, Middlesex, 1984.

9. Porter M.: ***"Compact Dics Pack in Data"***, High Technology, Jan. 1985.

10. Pierce, K.: ***"The Perils of Competition"***, Time Magazine, p. 37, Sept. 8, 1986.

11. Interview with Ing. Jorge Delgado, Technical Manager, CEMPASA, April 1985.

12. Mintzberg, H.: The Structuring of Organizations, Prentice-Hall, New Jersey, 1979.

13. Galbraith, J.: Designing Complex Organizations, Addison-Wesley, Reading , Mass., 1973.

15. Codesa: Memoria Anual 1977.

16. Codesa: Memoria Anual 1978.

17. Codesa: Memoria Anual 1980.

18. Codesa: Memoria Anual 1981.

19. Codesa: Memoria Anual 1983

20. Glueck and Jauch: Strategic Management and Business Policy, McGraw-Hill, New York, 1984.

21. Jones, H.G.: Planning and Productivity in Sweden, Croom Helm, London, 1976.

Conclusion

General Findings

There are a number of facts which can be drawn from the analysis of the corporation's present situation.

The most important is the lack of a universal approach which would solve all of the corporation's (subsidiaries and corporate unit) problems.

Privatization as such (which has been regarded by many in Costa Rica as a panacea), may in some cases provide an appropriate alternative to the present status quo. This may well be advisable for ALUNASA, since its activity constitutes an intermediate stage in a business where vertical integration is particularly important. Supply and market links would appear to be necessary to ensure a more stable position for the current plant's future.

Nevertheless, in the case of the other subsidiaries studied, (especially in the case of CEMVA and FERTICA, which come from the private sector), the expectations of prosperity due to a transfer of ownership is unrealistic. These enterprises are more directly affected by strategic factors prevalent at the present time. In the first sector (cement), the excess supply of the product in the national market, and the poor comparative position with respect to other producers in the bulk export arena, offers

General Findings

There are a number of facts which can be drawn from the analysis of the corporation's present situation.

The most important is the lack of a universal approach which would solve all of the corporation's (subsidiaries and corporate unit) problems.

Privatization as such (which has been regarded by many in Costa Rica as a panacea), may in some cases provide an appropriate alternative to the present status quo. This may well be advisable for ALUNASA, since its activity constitutes an intermediate stage in a business where vertical integration is particularly important. Supply and market links would appear to be necessary to ensure a more stable position for the current plant's future.

Nevertheless, in the case of the other subsidiaries studied, (especially in the case of CEMVA and FERTICA, which come from the private sector), the expectations of prosperity due to a transfer of ownership is unrealistic. These enterprises are more directly affected by strategic factors prevalent at the present time. In the first sector (cement), the excess supply of the product in the national market, and the poor comparative position with respect to other producers in the bulk export arena, offers little scope for action, other than to increase aggregate internal demand, or to develop package deals or "specialist" capability.

In the case of FERTICA, the Central American war, the obsolescence of some of the processes used, and the strategic role it plays as a support activity to the whole of the agriculture sector of the country, would again leave little scope for action other than the optimization (tactical) of the present operation, leaving more substantial strategic decisions for the future.

Finally, in the case of CATSA, it is unclear what its contribution to the economy is to be. If viewed as a source of energy substitution, its links with the rest of the energy sector (publicly owned) should remain strong so that global sectorial planning and implementation is possible (synergy considerations). If on the other hand its macroeconomic impact is to be limited to the production of additional goods for local consumption (sugar), or for potential export (alcohol), privatization could one day be considered if prevailing conditions changed for the better provididng an environment of financial self-sufficiency for the enterprise.

On the whole, it may well be the case that a balance between the management of the current industrial base and the planning activity at CODESA must be found, as suggested in the previous chapters. This, in order to establish clearer goals; to identify target areas where investment may be of significant macroeconomic importance (seeking synergy between investments, for example); be able to select appropriate technological processes suited to the local environment (as well as the conditions under which the transfer of technology involved is to occur); and finally implement policy/incentive schemes (as are required in mixed economies) to promote the succesful contribution of the selected projects to the national economy (i.e., avoiding confrontation with the private sector, and instead persuading it to participate).

It is important to recognize the society in which CODESA is to operate: the flaws of the political system of which the corporation is part of, the relatively unsophisticated economic environment (with respect to developed countries) it has to operate in, etc. Only acknowledging these initial shortcomings (and problem areas), will it be possible to conduct strategic management activities, the main aim of a development institution. Development planning is a long term task, for which stability in the DMP is a vital part.

The next section investigates important aspects of the acquisition of technology and the consequent import of new business practices into LDC's so that the context of CODESA's future role is better understood.

New Technological and Administrative Practices in LDC's

Industrial development in Less Developed Countries (LDC's) depends usually on the introduction of new technological knowhow, as well as new business practices into the picture. This is due to the fact that a country would probably be embarking on a new industry altogether.

Taking into account that in the best of cases there already exists a "management gap"*(1)* (current state of management in developing countries vs. management in industrialized countries: number, education, practical experience and competence of managers, the techniques and systems used and the performance and effectiveness achieved), the task of being competitive is not an easy one by any standard.

Adding to the above, the paramount undertaking of becoming proficient in the technology employed to the point of mastering it to adapt the processes to local needs, or to changing circumstances in order to achieve the best possible return on the investment made, it is clear that very well oriented efforts both from government and the private sector are required to attain success.

To stress the importance of this aspect, an analysis of what is understood by technology follows.

Definition: Technology:*(2)* Method of transforming inputs into outputs. There are three levels:

1. Means of transformation (*)
2. Information about the method (*)
3. Understanding of how and why the method works.

When a turnkey plant is constructed in a LDC (such as ALUNASA, CATSA, and CEMPASA, in the Costa Rican context), the first and to some extent, the second level (*) presented above are provided. Nonetheless, it is the third step which is really important, as it provides the possibility of more technological independence. Unfortunately, black boxes are common, and the newer the technology used, the more difficult it will be to unravel the mysteries hidden inside them.

As presented by Dahlman et al. *(2)*, because of this it is not always wise for an LDC to go for the most advanced technologies available. Instead, it should search for those where it is likely to acquire the most knowledge from. (Was this the case at ALUNASA? The process is highly automatized, the capacity of the plant is relatively large; for example, to date, an installed moulding line that produces utensils such as spoons, forks, knives, etc., has not yet been used). Such an approach would enable technical personnel to manage more efficiently, and in the process develop technological capability.

As described in the same work (2), technological capability usually progresses in a reverse fashion in LDC's than that in industrialized economies, i.e.:

From Production to Investment to Innovation (in LDC's)

vs.

From Innovation to Investment to Production (in Dev. Countries)

This is clear from the fact that LDC's start out with imported technological processes. Further along in time, expertise is required in choosing technology (expansions of existing facilities, for example). Finally, through experience and concerted efforts to get better performance from the equipment, process innovations may follow (minor innovations). The added impact of various minor innovations may lead to dramatic increases in performance as was the case at Usiminas in Brazil: a steel producer which through adaptation of existing Japanese supplied machinery, to the Brazilian conditions, as well as the introduction of new minor innovations, was able to double output (nominal) with little new investment. It is important to note that this effort came about due to the fact that the country faced an economic recession at the time, and the company, having been denied financial assistance for expansion, had to adjust to the changing environment.

Country Comparison:

Some LDC's appear to be more successful at acquiring and managing technology than others. It is relevant therefore, to note which of these countries have been successful, as some experience may be drawn from them to aid in the case at hand.

Within the Latin American context, Brazil and Mexico (2,3) appear as the most experienced and successful countries in this field.

These two nations initially geared their emphasis towards Import Substitution Industrialization (ISI) (which was used throughout Latin America since 1960 -- CEPAL directives), and have gradually shifted to Export Oriented Industrialization (EOI), not in the least because they have been able to master the technologies they had previously acquired from developed countries.

A striking similarity in the two cases of industrial development (Brazil and Mexico) is the vast government intervention: Mexico with wholly state owned companies, and Brazil with its "associate development" approach involving joint ventures with foreign companies and private local investors.

The other successful LDC's (now NIC's - Newly Industrialized Countries) in the technological field are the Southeast Asian countries of Singapore, Taiwan, Korea, and Hong Kong. All of the above oriented their aims towards an EOI policy (mainly) at the latest since the early 1960's, and through it achieved very respectable results.

With respect to these countries, it has been argued that market forces ruled the transformation of their economies into successful ones. The evidence, according to various authors, points to another source: government planning *(4)*, not so much by direct investment (even though, for example, in Korea this was still an important element in the mid - 1970's -- 14% of exports originated, directly or indirectly, from public enterprises) but by dirigiste policy making.

The other common claim, that EOI is superior to ISI is yet to be substantiated according to Kirkpatrick et al.*(3)*. It may well be the case that it is expertise, and technological and managerial competence, irrespective of the special emphasis on EOI or ISI, (which may depend more on particular situations demanding a contingency approach) which ultimately gives an edge.

For example, Korea, Brazil and Mexico have benefitted from their experience with adapting technology imports from developed countries (meant for ISI), so that in time they have been able to re-export their own modified processes to other LDC's. Dahlman *(2)* goes as far as to state that such exports are more suited to operate in LDC environments than those coming from DC's. (CATSA's distillery is Brazilian).

CODESA's Role in the Future

Having discussed important aspects of the LDC economic situation, it is now time to briefly analyze what role the corporation is to play in the future.

In the short term one has to consider the current trends set by the agreements with the World Bank Finance Corporation *(5,6)*, now in the consideration of the Asamblea Legislativa. Second, it is imperative to study the conditions of a donation of $140 million by USAID to clear up the terrible debt situation faced by most subsidiaries, in the idea that the companies are transferred to the private sector (national or international). Finally, the creation of CINDE, a "private sector only" equivalent of CODESA must be examined closely.

Having looked at the above, it is clear that CODESA will be limited to the development of a small number of minor scale new businesses, in the near future. Nevertheless, for various reasons, it will have to manage at least three of its major concerns, i.e., Cementos del Pacifico, Central Azucarera del Tempisque (CATSA), and Fertilizantes de Centroamerica (FERTICA), which represent more than 65% of the corporation's investment portfolio to date. For this combination of variables (liberalization and sale on one side, and restrictions for sale on the other), the firm will apparently lead, in the predictable future, a streamlined version of its present operation with little liberty to invest in large new projects.

In the longer term, it would be necessary to provide the enterprise with mechanisms to conduct strategic decision making, as described in Chapter 6, before attempting new investment schemes.

Through sound policies in this field, the corporation could provide a number of contributions to the local economy:

For example, it could represent an alternative source of income for the government by generating new revenue from exports or local dealings (without crowding out the private sector, of course). This would rasult in a lesser appropriation from the private sector by way of taxes, towards covering central government commitments, which should make the former more competitive internationally.

Also, and if the day comes when the country's most basic needs are fulfilled to an acceptable degree, the firm's companies could then provide a source of wealth distribution by shared ownership schemes with the workforce and the general public.

In conclusion, it is worthwhile to preserve institutions such as CODESA in LDC's, as they can play a vital role in the guidance towards the attainment of development goals. Until a broad sector of the population has access (defined as: economic maturity, access to information and disposable income) to share the benefits of the system, economic liberalization ("private enterprise only" policies) will result in a greater gap in the distribution of wealth. Until such a status-quo is achieved, concerns of the type of this corporation will be beneficial.

Conclusion References:

1. Kubr, Wallace: Successes and Failures Meeting the Management Challenge, WBSWP No. 585, Washington D.C. 1983.

2. Dahlman, Ross-Larson, Westphal: Managing Technological Development, WBSWP No. 717, Washington, D.C., 1985.

3. Kirkpatrick, Lee, Nixson: Industrial Structure and Policy in LDC's, George Allen and Unwin, London, 1984.

4. Yusuf, Peters: Capital Accumulation and Economic Growth, WBSWP No. 712, Washington D.C., 1985.

5. World Bank: SAL Appraisal for Costa Rica, CODESA component, Washington D.C., 1984.

6. La Gaceta (Official Newspaper) No. 76, Alcance No. 7, 23 April, 1985.

Background Bibliography

BIBLIOGRAPHY:

AGRICULTURAL SUPPLY INDUSTRY
"U.K.: Cereals substitutes rose to 2.3 mill m tons in 1981-82...", Agricultural Supply Industry, Issue 82.10.08, 1982.

AGUILAR, F.
El Cultivo de la Cana de Azucar, Editorial, Universidad Estatal a Distancia, San Jose, 1983.

ALUNASA
Catalogo de Productos, Alunasa, San Jose, (no date).

ALUNASA
Manual de Laminas de Aluminio, Alunasa, San Jose, (no date).

AMERICAN PETROLEUM INSTITUTE
Alcohol Production from Biomass, Potential and Prospects in Developing Countries, Report No. 3021, The World Bank, 1980.

ANAND S., NALEBUFF B.
Issues in the Apprraisal of Energy Projects for Oil Importing Countries, World Bank Staff Working Paper No. 738, The World Bank, Washington D.C., 1985.

ANSOFF, H.I.
Business Strategy, Penguin Books, Middlesex, 1983.

ANSOFF, H.I.
Corporate Strategy, Penguin Books, Middlesex, 1982.

ANTHONY, R.
Management Accounting (Spanish Edition), U.T.E.H.A, Mexico, 1980.

ARGENTI, J.
Practical Corporate Planning, George Unwin & Allen, London, 1983.

ASAMBLEA LEGISLATIVA
File No. 5122, Asamblea Legislativa, San Jose, 16 de Noviembre, 1972.

ASIAN DEVELOPMENT BANK
Asian Development Bank Annual Report 1984, Manila, 1985.

ATHOS A.G., TANNER PASCALE R.
The Art of Japanese Management, Penguin Books, Middlesex, 1984.

BALDWIN H., ROSS-LARSON B.
The Development Databook, The World Bank, Washington D.C., 1984.

BALL, R.
Management Techniques & Quantitative Methods, Heinemann, London, 1984.

BANETH J., GRILLI E.
Sustaining World Economic Recovery, World Bank Staff Working Paper No. 737, The World Bank, Washington D.C., 1985.

BAOXI, Z.
Modernizacion Tipo China, Beijing Informa, Beijing, 1984.

BAOXI, Z.
Reajuste y Reforma de la Economia, Beijing Informa, Beijing, 1983.

BEHRENS, A.
"Energy & Output Implications of Income Redistribution in Brazil", Energy Economics, Volume 6 No. 2, April, 1984.

BENN F.R., EDEWOR, J.O., McAULIFFE C.A.
Production and Utilization of Synthetic Fuels: An Energy Economics Study, Applied Science Publishers Ltd., London, 1981.

BERRIE, T.W.
"Making Energy Sector Assessment Studies in LDC's", Energy Policy, Volume 11 No. 4, December 1983.

BILLERBECK K., YASUGI Y.
Private Direct Foreign Investment in LDC's, World Bank Staff Working Paper No. 348, Washington D.C., 1979.

BLACK, R.P.
Analysis of Technology Transfer Cases (discussion paper), Denver Research Institute, University of Denver, Colorado, 1985.

BLACK, R.P.
R & D Project Management Workshop (manual), Denver Research Institute, University of Denver, Denver, Colorado, 1985.

BOANO, P.
Alunasa: Situacion Actual y Perspectivas Futuras, New Hunter Engineering, Italy, 1985.

BONEO, H.
Saber Ver las Empresas Publicas, EDUCA-ICAP, San Jose, 1980.

BONILLA, J.
Notas de Prensa Nos. 1,2,3,4, CODESA, San Jose, 1984.

BOYLES, D.T.
"Fuels from Renewables", Chemistry and Industry, 7 Aug. 1982.

BRITISH PETROLEUM
BP Statistical Review of World Energy 1985, British Petroleum, London, 1985.

BROADBENT, S.
Twenty Advertising Case Histories, Halt, Reinhart, and Win, East Sussex, 1984.

BROWN M., DAMERT A., MEERAUS A., STOUTJESDIJK A.
Worldwide Investment Analysis: The Case of Aluminum, World Bank Staff Working Paper No. 603, The World Bank, Washington, D.C., 1983.

CANNON T., WILLIS M.
How to Buy and Sell Overseas, Business Books Ltd., London, 1986.

CAVE M., HARE P.J.
Alternative Approaches to Economic Planning, Macmillan, London, 1981.

CEDAL/FUNDACION FRIEDERICH EBERT
Comercializacion Exterior de los Productos Agricolas de Costa Rica, CEDAL, San Jose, 1983.

CEFSA
La Industria del Cemento en Costa Rica, San Jose, 1984.

CELIS R., et al.
La Produccion de Alcohol Carburante en Costa Rica, Serie Divulgacion Economica No. 22, IICE-UCR, San Jose, 1981.

Cemento Hormigon, Revista Tecnica No. 55, 1980.

CHEMICAL, ECONOMY, ENGINEERING REVIEW (formerly Japan Chemical Quarterly)
"Alcohol Fuel Development", Chemical, Economy, Engineering Review, Issue 84.08.00, 1984.

CHEMICAL ENGINEERING
"ALCON BIOTECHNOLOGY has developed a continous fermentation ethanol process...", Chemical Engineering, Issue 83.05.30, 1983.

CHEMICAL MARKETING REPORTER
"David Mckee and International Plant Research Institute will develop technologies to produce commercially important chemicals...", Chemical Marketing Reporter, Issue 81.08.10, 1981.

CHEMISTRY-INDUSTRY
"Australia: A process converting starch directly to glucose developed...", Chemistry-Industry, Issue 82.10.16, 1982.

CHEMISTRY-INDUSTRY
"Zimbabwe: Plans projects for ammonia and methanol based synthesis gas and ethanol from sugar cane...", Chemistry-Industry, Issue 81.10.00, 1981.

CHINESE COMMUNIST PARTY
Decision del Partido Comunista de China sobre la Reforma de la Estructura Economica, Ediciones en Lenguas Extranjeras, Beijing, 1984.

CINDE
CINDE (Information Bulletin), Nov. 1984, Dec. 1984, Jan. 1985, Feb. 1985, Cinde, San Jose, 1984, 1985.

CODESA
CODESA en la Actividad Minera, Serie Informes y Estudios No. 2, San Jose, 1984.

CODESA
Constitutive Law of the Costa Rican Development Corporation, Codesa, San Jose, 1979.

CODESA
Memoria Anual 1976, Codesa, San Jose, 1976.

CODESA
Memoria Anual 1977, Codesa, San Jose, 1977.

CODESA
Memoria Anual 1978, Codesa, San Jose, 1978.

CODESA
Memoria Anual 1980, Codesa, San Jose, 1980.

CODESA
Memoria Anual 1981, Codesa, San Jose, 1981.

CODESA
Memoria Anual 1982, Codesa, San Jose, 1982.

CODESA
Memoria Anual 1983, Codesa, San Jose, 1983.

CODESA
Obligaciones Directas e Indirectas con el Banco Central de Costa Rica al 30 de Septiembre de 1984, Codesa, San Jose, 1984.

CODESA
Organo Informativo No. 8, La Nacion, San Jose, 8 Nov. 1984.

COELHO J.C.
Biomassa. Biocombustiveis. Bioenergia, Secretaria Geral de Tecnologia, Ministerio das Minas e Energia, Brasilia, 1982.

COMISION NACIONAL PARA LA REESTRUCTURACION DE CODESA
Informe Preliminar al Presidente de la Republica, San Jose, April 1986.

CONICIT
"Diez Millones de Toneladas de Carbon en el Pais", Prociencia, Vol.9, No. 49, San Jose, 1984.

COOK J.H., CIAT
"Developing countries: the cultivation of Cassava, a perannial vegetable shrub that can grow on poor quality soil...", Science (key article), Issue 82.11.19, 1982.

COOMBS J.
"Biogas and Power Alcohol", Chemistry-Industry, 4 april 1981.

DAHLMAN C., SERCOVICH F.
Local Development and Exports of Technology, World Bank Staff Working Paper, No. 667, The World Bank, Washington, D.C., 1984.

DAHLMAN C., ROSS-LARSON B., WESTPHAL L.
Managing Technological Development, World Bank Staff Working Paper No. 717, The World Bank, Washington, D.C., 1985.

DE LA MADRID M.
"Mexico: La Politica Economica para 1985", Comercio Exterior, vol. 35, No. 1, Mexico, 1985.

DENISON E.F., CHUNG W.K.
How Japan's Economy Grew so Fast, The Brookings Institution, Washington, D.C., 1976.

DERNBURG AND MACDUGALL
Macroeconomics, (6th ed.), McGraw/Hill Int., Tokyo, 1980.

DORYAN E., UMANA A.
Energia para el Desarollo, Editorial Tecnologica, Cartago, 1981.

DROHAN M.
"Energy Futures for Oil-importing Developing Countries", Energy Policy, vol. 3, 1985.

DUN & BRADSTREET LTD., BUSINESS MARKETING DIVISION
Who Owns Whom 1986, (North America, Continental Europe, United Kingdom, and Republic of Ireland), Unwin Brothers Ltd., Old Woking, Surrey, 1986.

DUNKERLEY J.
"Energy Needs of the Developing World", Energy Policy, vol. 10, No. 4, Dec. 1982.

ESSO CHEMICAL
Fife Ethylene Plant, Hawk Publishing and Communications Ltd., (no date).

EUROPEAN CHEMICAL NEWS
"Papua, New Guinea will produce up to 130 million L/yr. of ethanol...", European Chemical News, Issue 81.10.05, 1981.

EUROPEAN CHEMICAL NEWS
"Technology: New Ethanol Process", European Chemical News, Issue 84.08.06, 1984.

FERTICA, SERVICIOS TECNICOS
Manual Descriptivo de Planta (Carrizal), Fertica, Puntarenas, 1982.

FINANCIAL TIMES
"World Sugar Production Estimates Raised", Financial Times, May 15, 1985.

FINANCIAL TIMES
"New Spirit for a Sagging Market", Financial Times, 23 May 1985.

FINANCIAL TIMES
"China to Turn Maize into Ethanol", Financial Times, 24 May 1985.

FINANCIAL TIMES
"Brazil and the IMF, 'Realism': The New Watchword", Financial Times, 29 May 1985.

FINANCIAL TIMES
"Colombia will launch a major program to produce fuel alcohol from sugar cane...", Financial Times, 31 May 1985.

FLINK J.
"Innovation in Automotive Technology", American Scientist, No. 73, 1985.

FRENCH D., SAWARD H.
A Dictionary of Management, Pan Books, London, 1983.

GACETA, LA (Diario Oficial)
Numero 76, Alcance No. 7, 23 de abril de 1985.

GALBRAITH J.
Designing Complex Organizations, Addison-Wesley, Reading Mass., 1973.

GLUECK W.F., JAUCH L.R.
Strategic Management and Business Policy, McGraw/Hill, New York, 1984.

GUTIERREZ L.
Decisiones Financieras y Costo del Dinero en Economias Inflacionarias, Editorial Norma, Cali, 1985.

HARE P.J.
Privatization, University of Stirling, Stirling 1984.

HARE P.J., RADICE H., AND SWAIN N.
Hungary: A Decade of Economic Reform, George, Allen and Unwin, London, 1981.

HEATH R., MULCKHUYSE J., VENKATARAM S.
Potential Energy Efficiency in the Fertilizer Industry, World Bank Technical Paper No. 35, The World Bank, Washington, D.C., 1985.

HERRERO, VILLALTA, Y ASOC.
CODESA: Auditoraje Externo 1983, Deloitte, Haskins, + Sells, San Jose, 1984.

HESSELBACH W.
Las Empresas de la Economia de Interes General, Siglo XXI, Mexico, 1978.

HOTELLING H.
"The Economics of Exhaustible Resources", Journal of Political Economy, vol. 39, 1931.

HOUGH J.R.
The French Economy, Croom Helm, London, 1982.

IMBRASA
Estudo Setorial sobre o Alcool (versau prelim.), IMBRASA, Brasilia, 1981.

IMF
International Financial Statistics, Supplement on Price Statistics, IMF Supplement Series, Washington, D.C., 1981.

INCSA
Memoria Anual 1983, INCSA, San Jose, 1983.

INCSA
Memoria Anual 1984, INCSA, San Jose, 1985.

INCSA
Report to the Author, Dec. 1985.

ITCR
Energia Renovable, ITCR, Cartago, 1983.

IYER R.N.
The Moral and Political Thought of Mahatma Gandhi, Oxford University Press, New York, 1973.

JAPAN CHEMICAL WEEK
"Thailand: will build a Y400 million experimental tapioca plant to produce alcohol...", Japan Chemical Week, Issue 82.06.17, 1982.

JAPAN ECONOMIC JOURNAL
"Singapore...", Japan Economic Journal, Issue 84.04.17, Tokyo, 1984.

JONES H.G.
Planning and Productivity in Sweden, Croom Helm, London, 1976.

JONG B., LAMBERTINI A., POLLAK P.
Global Energy Prospects, World Bank Staff Working Paper No. 489, The World Bank, Washington, D.C., 1981.

KIRKPATRICK C.H., LEE N., NIXSON F.I.
Industrial Structure and Policy in Less Developed Countries, George, Allen, and Unwin, London, 1984.

KISSINGER H., et al.
The Report of the President's National Bipartisan Commission on Latin America, Macmillan, New York, 1984.

KOCHAR N.K., MERIMS R., PADIA A.S.
"Ethylene from Ethanol", CEP, June 1981.

KUBR M., WALLACE J.
Successes and Failures Meeting the Management Challenge, World Bank Staff Working Paper No. 585, The World Bank, Washington, D.C., 1983.

LETHEM F., COOPER L.
Managing Project Related Technical Assistance, World Bank Staff Working Paper No. 586, The World Bank, Washington, D.C., 1983.

LEVIN R.
Statistics for Management, (2nd ed.), Prentice Hall Int., New Jersey, 1981.

LIPSEY R.G.
Positive Economics, (6th ed.), Weidenfeld and Nicolson, London, 1983.

LLORENTE J.C.
"El Alcohol como Combustible Alternativo", Proceedings, International Symposium on Energy and Food Industries, (Madrid), CIIA, Paris, 1980.

LONES T.
"Brazil Avoids Hiccups with Alcoholic Car Fuels", Grow Your Own Energy, Michael Cross editor, New Scientist, London, 1984.

JAPAN CHEMICAL WEEK
"Thailand: will build a Y400 million experimental tapioca plant to produce alcohol...", Japan Chemical Week, Issue 82.06.17, 1982.

JAPAN ECONOMIC JOURNAL
"Singapore...", Japan Economic Journal, Issue 84.04.17, Tokyo, 1984.

JONES H.G.
Planning and Productivity in Sweden, Croom Helm, London, 1976.

JONG B., LAMBERTINI A., POLLAK P.
Global Energy Prospects, World Bank Staff Working Paper No. 489, The World Bank, Washington, D.C., 1981.

KIRKPATRICK C.H., LEE N., NIXSON F.I.
Industrial Structure and Policy in Less Developed Countries, George, Allen, and Unwin, London, 1984.

KISSINGER H., et al.
The Report of the President's National Bipartisan Commission on Latin America, Macmillan, New York, 1984.

KOCHAR N.K., MERIMS R., PADIA A.S.
"Ethylene from Ethanol", CEP, June 1981.

KUBR M., WALLACE J.
Successes and Failures Meeting the Management Challenge, World Bank Staff Working Paper No. 585, The World Bank, Washington, D.C., 1983.

LETHEM F., COOPER L.
Managing Project Related Technical Assistance, World Bank Staff Working Paper No. 586, The World Bank, Washington, D.C., 1983.

LEVIN R.
Statistics for Management, (2nd ed.), Prentice Hall Int., New Jersey, 1981.

LIPSEY R.G.
Positive Economics, (6th ed.), Weidenfeld and Nicolson, London, 1983.

LLORENTE J.C.
"El Alcohol como Combustible Alternativo", Proceedings, International Symposium on Energy and Food Industries, (Madrid), CIIA, Paris, 1980.

LONES T.
"Brazil Avoids Hiccups with Alcoholic Car Fuels", Grow Your Own Energy, Michael Cross editor, New Scientist, London, 1984.

LUCHI N.R., TRINIDADE S.C.
"Ethanol vs. Naphta under Brazil's Economy", Hydrocarbon Processing, May 1982.

LUMBI S.
Investment Appraisal, Van Nostrand, Reinhold, Berkshire, 1983.

MAJARO S.
International Marketing, George, Allen and Unwin, London, 1983.

MAKOWER M., WILLIAMSON
Operational Research, TYB/Hodder and Stought, Kent, 1981.

MAYNARD H.B.
Industrial Engineering Handbook (Spanish Edition), Reverte, Barcelona, 1978.

MEIER G.M.
Leading Issues in Economic Development (4th edition), Oxford University Press, New York, 1984.

MINISTERIO DAS MINAS E ENERGIA, SECRETARIA DE TECNOLOGIA BRAZIL
Fontes Alternativas de Energia, Ministerio das Minas e Energia, Brasilia, 1983.

MINTZBERG H.
Power In and Around Organizations, Prentice Hall, New Jersey, 1983.

MINTZBERG H.
The Structuring of Organizations, Prentice Hall, New Jersey, 1979.

MIXSON J.W.
"Economic Welfare with Exhaustible Natural Resources", Energy Economics, vol. 1 No. 4, Oct. 1979.

NEW SCIENTIST
"International plant research institute is using genetic engineering to improve the cassava plant to double its yield...", New Scientist, Issue 81.09.03, 1981.

NEW YORK TIMES NATIONAL EDITION
"War on Pests in Africa Merges Nature and High Technology", New York Times, Issue 84.10.22, 1982.

NEWSPAPER ENTERPRISE ASSOCIATION
The World Almanac and Book of Facts 1985, NEA, New York, 1984.

NOVE A.
The Soviet Economic System (2nd edition), George, Allen and Unwin, London, 1980.

NUNNENKAMP P.
"State Enterprises in Developing Countries", Intereconomics, vol. 21, July/Aug. 1986.

ODUBER D.
CODESA: Decimo Aniversario, Codesa, San Jose, 1983.

OFIPLAN (COSTA RICA)
Plan Nacional de Desarollo Forestal, OFIPLAN, San Jose, 1979.

PAMPLONA C.
Proalcool: Impacto em Termos Tecnico-economicos e sociais do Programa no Brasil, Ministerio da Industria e do Comercio/Instituto do Acucar e do Alcool, Belo Horizonte, 1984.

PARKER R.H.
Understanding Company Financial Statements, Pelican, Penguin Books, Middlesex, 1982.

PARTIDO LIBERACION NACIONAL
Programa de Gobierno: Volvamos a la Tierra, Artes Graficas, San Jose, 1981.

PETERS T., WATERMAN R.
In Search of Excellence, Harper and Row, New York, 1982.

PETROLEUM TIMES
"U.K. lead alkyl to motor spirits will fall...", Petroleum Times (key article), Issue 81.06.00, 1981.

PIERCE K.
"The Perils of Competition", Time Magazine, Sept. 8, 1986.

POLACK J.A., BIRKETT H.S., WEST M.D.
"Sugar Cane: Positive Energy Source for Alcohol", CEP, June, 1981.

PORTER M.
"Compact Discs Pack in Data", High Technology, January, 1985.

PUGH D.S., HICKSON D.J., HININGS C.R.
Writers On Organizations (3rd. Edition), Penguin Books, Middlesex, 1984.

RATTAN, R.
Gandhi's Concept of Political Obligation, The Minerva Associates, Calcutta, 1972.

RECOPE
"Recope Hoy", La Nacion, San Jose, Dec. 8, 1985.

REDWOOD J., HATCH J.
Controlling Public Industries, Basil Blackwell, Oxford, 1982.

REES, R.
Public Enterprise Economics, Weidenfeld & Nicolson, London, 1976.

RENAUD, B.
Housing Financial Institutions in Developing Countries, World Bank Staff Working Paper No. 658, The World Bank, Washington D.C., 1984.

RESERVE-CONSERVE-ALIMENTATION
"CSR (Australia) and Grain Processing (USA) have signed a $ 500,000 ethanol production contract with New South Wales University", Reserve-Conserve-Alimentation, Issue 83.03.00, 1983.

ROBERTS, C. P.
Estudio de Viabilidad Tecnologica, Economica y Financiera de Aluminios Nacionales Sociedad Anonima (ALUNASA), Cougar Metals International, 28th. June, 1983.

ROVIRA J. editor
Costa Rica Hoy, EUNED, San Jose, 1984.

SALVATORE D.
International Economics, Schaum's Outline Series, MacGraw/Hill, New York, 1975.

SANDERSON W., WILLIAMSON J.
How Should Developing Countries Adjust to External Shocks in the 1980's?, World Bank Staff Working Paper No. 708, The World Bank, Washington D.C., 1985.

SCHMITZ A.
Commodity Price Stabilization, World Bank Staff Working Paper No. 668, The World Bank, Washington D.C., 1984.

SHERWIN D.
"The Meaning of Control", Dun's Review, 1956.

SILVA HERZOG J.
"Confieso que he Trabajado", Comercio Exterior, vol. 35, No. 4, Mexico, 1985.

SLESSER M.
Energy in the Economy, Macmillan, London, 1978.

SLESSER M., LEWIS C.
Biological Energy Resources, E and FN Spon ltd., London, 1979.

SOJO A.
Crisis del Estado Empresario?, IICE Documentos de Trabajo No. 42, UCR, San Jose, 1982.

SOJO A.
Empresa Estatal y Desarrollo Economico en America Latina, IICE Documentos de Trabajo No. 38, UCR, San Jose, 1982.

SOJO A.
Tareas del Estado y la Empresa Publica, IICE Documentos de Trabajo No. 79, UCR, San Jose, 1984.

SOJO A.
Trayectoria Financiera de CODESA (1975-1982), IICE Documentos de Trabajo No. 76, UCR, San Jose, 1984.

SOJO A., PORRAS R.
Bibliografia Sobre Empresa Publica, IICE Documentos de Trabajo No. 34, UCR, San Jose, 1982.

SOLAR ENERGY DIGEST
"Indonesia: Y1.55 bill contract awarded to build biomass energy R&D center...", Solar Energy Digest, Issue 82.06.00, 1982.

SOTO M., SEVILLA C., FRANK C.
Integracion Economica y Empleo en la Industria Centroamericana, EDUCA, San Jose, 1983.

SUBPRODUCTOS DEL CAFE
Descripcion del Proceso, Subproductos del Cafe, Heredia, 1984.

SWAMI S.
Indian Economic Planning, Vikas Publications, New Delhi, 1971.

THOMAS R.E.
Business Policy (2nd edition), Philip Allan, Oxford, 1983.

TUCKER J.B.
"Managing the Industrial Miracle", High Technology, Aug. 1985.

TWISS B.
Managing Technological Innovation (2nd edition), Longman, Essex, 1982.

TWISS B., WEINSHALL T.
Managing Industrial Organizations, Pitman, London, 1980.

UNA TALLER DE COYUNTURA
De los Empresarios Politicos a los Politicos Empresarios, UNA, Heredia, 1981.

UNDP/WORLD BANK
Energy Sector Programs: 1985, UN/World Bank, New York, Washington D.C., 1985.

UN/FAO COMMODITIES AND TRADE DIVISION
Sugar: Major Trade and Stabilization Issues in the 'eighties, UN/FAO, Rome, 1985.

UNIDO
"UNIDO Focus: Fuelling up for the Future", UNIDO Newsletter No. 204, April 1985.

UPAL J.S.
Economic Development in South Asia, Saint Martin's Press, New York, 1977.

USAID
Project Evaluation Guidelines, USAID, Washington D.C., 1974.

UTTERBACK J.
"The Role of Applied Research Institutes in the Transfer of Technology in Latin America", World Development, vol. 3 No. 9, 1975.

VEGA M.
CODESA y la Fraccion Industrial, Editorial Hoy, San Jose, 1982.

VEGA M.
Effectos de la Politica de Inversiones de CODESA 1974-1978, IICE Documentos de Trabajo No. 64, UCR, San Jose, 1983.

VEGA M.
Perspectivas del Estado Empresario Costarricense: el Caso de CODESA, IICE Documentos de Trabajo No. 84, UCR, San Jose, 1985.

VEGA M.
Politica de CODESA en el Pericdo 1974-1978, IICE Documentos de Trabajo No. 43, UCR, San Jose, 1982.

VEGA M.
Politica de CODESA durante el Gobierno de Carazo 1974-1978, IICE Documentos de Trabajo No. 68, UCR, San Jose, 1984.

VEGA M.
Politica de CODESA en el Gobierno de Monge, IICE Documentos de Trabajo No. 75, UCR, San Jose, 1984.

VEGA M., FERNANDEZ O.
Creacion de CODESA, IICE Documentos de Trabajo No. 39, UCR, San Jose, 1982.

VILLET R.H.
"Developing a Chemicals Fuel Industry from Renewable Resources", CEP, June 1981.

VOLKSWAGEN DO BRASIL
Alcohol Automobile Design (various articles), Proceedings, Primer Simposio da Engeniheria Automotiva, Brasilia, 1983.

WARD R.F.
"Alcohols as Fuels - The Global Picture", Solar Energy, vol. 26 No.2, Pergamon Press, Oxford, 1981.

WILKIE J.W. editor
Statistical Abstract of Latin America, UCLA Latin American Center Publications, Los Angeles, 1980.

WILSON A.
The Assessment of Industrial Markets, Cassell, London, 1973.

WINTERS L.A.
Imports of Developing Countries, World Bank Staff Working Paper No. 740, The World Bank, Washington D.C., 1985.

WOCHENSBLATT FUR PAPER FABRIKATION
Key Article Issue 81.04.30., page 270-274, 1981.

WOODBRIDGE J.
"El Estado Empresario", La Nacion, San Jose, 14 Sept. 1984.

WORLD BANK THE
IDA in Retrospect, The World Bank, Washington D.C., 1982.

WORLD BANK THE
World Bank Atlas 1983, The World Bank, Washington D.C., 1983.

WORLD BANK THE
World Bank Atlas 1985, The World Bank, Washington D.C., 1985.

WORLD ENERGY CONFERENCE
Oil Substitution Task Force Report, World Energy Conference, New Delhi, 1983.

WORLD STATISTICAL REVIEW
Issue February 1983, Paris, 1983.

YOUNGSON A.J.
Hong Kong: Economic Growth and Policy, Oxford University Press, Hong Kong, 1982.

YUSUF S., PETERS R.K.
Capital Accumulation and Economic Growth, The Korean Paradigm, World Bank Staff Working Paper No. 712, The World Bank, Washington D.C., 1985.

Appendices

Appendix A: Codesa's Constitutive Law

CODESA
Corporación Costarricense
de Desarrollo

Constitutive Law of the Costa Rican Development Corporation

SAN JOSE, COSTA RICA

LEGISLATIVE ASSEMBLY

No. 5122

The Legislative Assembly of the Republic of Costa Rica

Decrees:

The Following Law Constituting the

COSTA RICAN DEVELOPMENT CORPORATION

CHAPTER I

Name, Legal Representation, Domicile and Purpose

Article 1.—A mixed capital enterprise is hereby created having its own legal representation and equity. The name shall be Costa Rican Development Corporation, which may be abbreviated as CODESA.

Article 2.—CODESA is constituted with the characteristics of a private corporation and shall be governed by the provisions of this Law, by its own by—laws and, in a supplementary manner, by such provisions which on this matter are stipulated in the Commercial Code.

Article 3.—The Corporation will have its place of business in the city of San José and may establish any agencies and/or branches elsewhere in Costa Rica as well as abroad.

Article 4.—The purpose of the Corporation is to promote the economic development of the country by strengthening private Costa Rican enterprises within the prevailing mixed capital economic system. The objectives sought are, among others, the following:

a) To modernize, rationalize and enlarge existing productive activities;

b) To develop new productive activities towards a more integral use of human, natural and capital resources; and

c) To take advantage of the present market opportunities available to the country.

Article 5.—The Corporation shall determine with a selective criterion the activities referred to in paragraphs a) and b) of article 4 above. To this effect, such activities shall be considered from the standpoint of their present and future contribution to:

a) Direct and promote the substitution of imports in a healthy economic sense, always keeping in mind the possibilities and limitations of international trade;

b) Foment and diversify the export of goods and services;

c) Integrate more closely the diverse sectors and regions that constitute the country's economic system, towards a fuller exploitation of productive developments; and

d) To facilitate the country's participation in trade and economic integration agreements with other countries.

CHAPTER II

Functions and Faculties

Article 6.—Pursuant to the purpose, criteria and activities referred to in articles 4 and 5 above, the Corporation shall carry out the following functions:

a) To prepare and execute specific programs and projects designed to further the economic activities on a regional or national level;

b) To participate in international or multinational programs or projects;

c) To form and organize new enterprises;

d) To manage, consolidate and provide technical assistance to existing enterprises;

e) To grant loans to new or existing enterprises. Companies which are shareholders of CODESA will be given priority over non—shareholder enterprises under similar conditions;

f) To endorse or grant security bonds to guarantee credit operations requested by new or existing enterprises from other national or foreign institutions;

g) To promote systematically and permanently the development of the national stock exchange; and

h) To promote exports.

Article 7.—The Corporation is hereby authorized to carry out any and all technical, financial and promotional activities necessary for the performance of its duties, such as:

a) To contract out or directly perform technical studies and other pre-investment activities pertaining to specific programs and projects that foment economic development as referred to in paragraphs a) and b) of article 6 above;

b) To issue bonds and securities in local or foreign currency;

c) To obtain credit loans in the country or abroad;

d) To receive long—term deposits;

e) To subscribe, purchase and sell shares, documents or other securities of such enterprises owned by CODESA or by third parties;

f) To issue participation certificates on the ownership of diverse kinds or groups of securities of which it may be a holder;

g) To obtain concessions or rights to exploit natural resources, being hereby authorized to assign, rent or use them within the present legal stipulations regarding the exploitation of natural resources. All things being equal, CODESA will have priority over private individuals or corporations in obtaining such rights or concessions;

h) To administer concerns and to act as agent of such businesses as CODESA may promote;

i) To guarantee, upon request, the validity of securities issued by private companies, to warrant payment on principal and on interest of such securities, to accept payments and to represent the holders of such securities at board, shareholders' or creditors' meetings;

j) To issue and negotiate bonds or securities for private enterprises;

k) To grant short, medium and long—term loans to its own companies and to those owned by the private sector.

l) To endorse or guarantee loan operations requested by its own or private enterprises within the country or abroad; and

m) To discount credit documents at the Central Bank of Costa Rica.

Article 8.—The Corporation shall adopt all necessary provisions to regulate and direct such operations referred to in article 7 above, in

accordance with present legal stipulations and with the objetives mentioned in Chapter I hereof.

Article 9.—The Corporation shall carry out all its activities in due coordination with the Planning Bureau, the Central Bank, the Ministry of Economics, Industry and Commerce, the Ministry of the Treasury, and with other public institutions when so called for by the nature of specific programs and projects of economic development.

CHAPTER III

Social Capital, Shares and Shareholders

Article 10.—The initial authorized capital of the Corporation shall amount to one hundred million colones (₡ 100,000,000.00) represented by two series of stock: Series "A" consists of 33,000 nominative, common shares of one thousand colones each to be offered to the private sector. No single individual or enterprise shall be allowed to purchase over 1,500 shares.

This limitation does not hold in the event of capital increases when such shareholders may subscribe to an additional number of shares in proportion to the number of shares then owned.

Series "B" consists of nominative, common shares, nontransferable, of one thousand colones each, to be wholly subscribed by the Government which shall pay for such shares by means of an issuance of bonds in the amount of sixty—seven million colones (₡ 67,000,000.00) hereby duly authorized. The payment of interest and principal of such bonds and of subsequent issues, as well as payments to cover other needs of the Corporation shall be provided for by the proceeds from an increase in the exchange tax on all dollar purchase in the official and free markets of ₡0.03 per dollar, such proceeds to be directly credited to the Corporation by the Central Bank of Costa Rica. The exchange tax of all other foreign currencies shall likewise be increasen by ₡ 0.03 per dollar. The Central Bank shall directly effect payment of such bonds.

The aforementioned ₡0.03 increase in the sale price of dollars shall be within the margins stipulated by the International Monetary Fund. As deemed necessary, the Central Bank of Costa Rica shall reduce the rate of purchase in the free market by ₡ 0.03 per dollar instead of increasing the sale price so that the Corporation can depend on a permanent source of income.

Article 11.—The fiscal year of the Corporation shall extend from October first to September thirtieth.

CHAPTER IV

Management

Article 12.—The management and administration of the Corporation shall be effected by a Board of Directors.

Article 13.—The Board will consist of seven members chaired by an Executive President or, in his temporary absence, by an Executive Vice-President, both elected from among the board members and who shall be full time officers of the Corporation.

Four board members shall be representatives of Series "B" shares and shall be appointed by the Government at a Cabinet Meeting and shall include the Minister of Economics, Industry and Commerce. The other members shall be representatives of Series "A" shareholders.

Article 14—All members of the Board of Directors shall be Costa Rican by origin or by naturalization having resided in this country for at least ten years; over twenty—five years old and fully capable and in good standing.

Article 15—The following persons may not be members of the Board of Directors:

a) Members and employees of the Legislative, Judicial and Executive powers, except for the Minister of Economics, Industry and Commerce and such officers who might substitute for him should he be temporarily absent;

b) Officers and employees of CODESA;

c) Managers, representatives or employees of any autonomous institution;

d) Those persons who for one year prior to their appointment have had suits brought against them for default in personal payments due, or for bankruptcy or insolvency;

e) Two or more persons belonging to the same commercial concern;

f) Those persons related among themselves by consanguinity or by affinity up to and including third degree; and

g) Those persons holding a position of public election while in office.

Article 16.—Board members shall serve for four—year terms and may be reelected. They may not be removed from office during such term unless they have incurred in punishable acts according to the law

Article 17.—The Board will meet regularly twice a month and extraordinarily when called by the Executive President, by the Executive Vice—President or by two of the Board members.

Article 18.—At Board of Directors' meetings quorum shall be constituted by four members and all agreements shall be adopted by majority vote among those present, except in those cases when by special provision a greater number of votes is required. In the event of a tie, the President is entitled to a double vote.

Article 19.—The Board of Directors shall have full powers to perform such duties and to execute such actions as the Corporation may be authorized to perform. In furtherance whereof the Board of Directors shall have, among others, the following rights:

a) To approve the by—laws which regulate the activities of the Corporation;

b) To approve any contracts and agreements related to the activities and objectives of the Corporation;

c) To approve the yearly budget of the Corporation;

d) To take the necessary decisions pertaining to the management of the assets owned by the Corporation;

e) To agree upon the issuance of credit documents; and

f) To grant powers to administrative committees or commissions formed among Board members, or to the Executive President, defining clearly their duties and powers.

Article 20.—The Board of Directors is hereby authorized to sell Series "A" shares at higher than their face value whenever the accrued profits of the Corporation so permit

Article 21.—The Executive President shall report to the Board of Directors on the fulfillment of his work and shall have the following powers:

a) To represent the Corporation in and out of Court, with full powers of attorney as provided for in article 1253 of the Civil Code having such limitations as are stipulated herein. In addition, he may

CHAPTER IV

Management

Article 12.—The management and administration of the Corporation shall be effected by a Board of Directors.

Article 13.—The Board will consist of seven members chaired by an Executive President or, in his temporary absence, by an Executive Vice-President, both elected from among the board members and who shall be full time officers of the Corporation.

Four board members shall be representatives of Series "B" shares and shall be appointed by the Government at a Cabinet Meeting and shall include the Minister of Economics, Industry and Commerce. The other members shall be representatives of Series "A" shareholders.

Article 14—All members of the Board of Directors shall be Costa Rican by origin or by naturalization having resided in this country for at least ten years; over twenty—five years old and fully capable and in good standing.

Article 15—The following persons may not be members of the Board of Directors:

a) Members and employees of the Legislative, Judicial and Executive powers, except for the Minister of Economics, Industry and Commerce and such officers who might substitute for him should he be temporarily absent;

b) Officers and employees of CODESA;

c) Managers, representatives or employees of any autonomous institution;

d) Those persons who for one year prior to their appointment have had suits brought against them for default in personal payments due, or for bankruptcy or insolvency;

e) Two or more persons belonging to the same commercial concern;

f) Those persons related among themselves by consanguinity or by affinity up to and including third degree; and

g) Those persons holding a position of public election while in office.

Article 16.—Board members shall serve for four—year terms and may be reelected. They may not be removed from office during such term unless they have incurred in punishable acts according to the law

Article 17.—The Board will meet regularly twice a month and extraordinarily when called by the Executive President, by the Executive Vice—President or by two of the Board members.

Article 18.—At Board of Directors' meetings quorum shall be constituted by four members and all agreements shall be adopted by majority vote among those present, except in those cases when by special provision a greater number of votes is required. In the event of a tie, the President is entitled to a double vote.

Article 19.—The Board of Directors shall have full powers to perform such duties and to execute such actions as the Corporation may be authorized to perform. In furtherance whereof the Board of Directors shall have, among others, the following rights:

a) To approve the by—laws which regulate the activities of the Corporation;

b) To approve any contracts and agreements related to the activities and objectives of the Corporation;

c) To approve the yearly budget of the Corporation;

d) To take the necessary decisions pertaining to the management of the assets owned by the Corporation;

e) To agree upon the issuance of credit documents; and

f) To grant powers to administrative committees or commissions formed among Board members, or to the Executive President, defining clearly their duties and powers.

Article 20.—The Board of Directors is hereby authorized to sell Series "A" shares at higher than their face value whenever the accrued profits of the Corporation so permit

Article 21.—The Executive President shall report to the Board of Directors on the fulfillment of his work and shall have the following powers:

a) To represent the Corporation in and out of Court, with full powers of attorney as provided for in article 1253 of the Civil Code having such limitations as are stipulated herein. In addition, he may delegate his mandate in whole or in part for a definite or an indefinite period of time, and he may revoke such delegation of powers without in any way impairing the full exercise of his own powers. With prior consent by the Board of Directors he may: grant full and special powers, or in any way mortgage the property, chattels, securities or assets of the Corporation; purchase any and all goods, property, chattels or rights, his word being sufficient to account for his acts. The Executive Vice—President shall have the same rights and they may act jointly or separately;

b) To carry out all acts inherent to his position of general administrator of the Corporation, entering into such agreements and implementing such duties as is normally required by the daily operation of the Corporation;

c) To submit to the Board of Directors, for their information and approval, the budgets and financial statements of the Corporation;

d) To carry out the resolutions agreed upon by the Board of Directors;

e) To authorize, by signing, jointly with the Executive Vice-President, all securities issued by the Corporation;

f) To organize, with prior approval of the Board of Directors, any departments or sections necessary to perform the functions that this law herein assigns to the Corporation;

g) To appoint and remove the Corporation's personnel;

h) To carry out all other duties and functions in accordance with the Law and the by-laws of the Corporation.

Article 22.—The Board of Directors shall, upon request of the Executive President, appoint such manager or managers that are neccessary, and whose powers and obligations shall be expressly assigned to them by the Board of Directors and the Executive President.

Article 23.—The Corporation may have an auditor for internal auditing and fiscalization who will report to the Executive President and to the Board of Directors or may contract the services of a well—known auditing firm, which will certify the annual financial statements that are to be presented at the Shareholders' Meeting.

CHAPTER V

Miscellaneous

Article 24.—CODESA cannot negotiate with any single individual or corporation for an amount that exceeds 15% of its capital and reserves. This percentage may be raised to 25% in special cases, provided it has been so voted by no less than five members of the Board of Directors.

Article 25.—The Executive President and the Executive Vice—President of the Corporation may authorize credit operations up to five hundred thousand colones and two hundred thousand colones, respectively. A credit committee consisting of the Executive President, the Executive Vice—President and the Credit Department Manager or his substitute may authorize short—term credit operations for higher amounts up to 2% of equity of the Corporation; operations for higher amounts may only be negotiated with the authorization of the Board of Directors, which shall be fully informed of all credit operations carried out each month. The Shareholders' Meeting may modify the amounts to be authorized by the Executive President or by the Credit Committee as provided herein.

Article 26.—Entities in which any member of the Board of Directors has a direct or indirect relationship, may not effect any credit operation with the Corporation.

Article 27.—The Board of Directors of the Corporation shall draw up its by—laws.

The amount or percentage participation of CODESA in each individual project, whether through credit or by equity participation, shall be governed by special provision.

Article 28.—Governmental institutions are hereby authorized to invest their own resources in securities issued by the Corporation, excepting shares, and shall accept such securities as participation and performance guarantees in agreements they may enter into.

Article 29.—The Costa Rican Development Corporation will enjoy the same privileges and rights granted by virtue of the Organic Law of the Central Bank of Costa Rica to State banks regarding loans and re—discounts, and especially those contemplated in the provisions of article 62 of the above mentioned Law.

The Central Bank will discount "Costa Rican Development Corporation Bonds" up to a maximum of five years. In such cases the Central Bank, together with the Corporation, shall determine the annual payments on principal which will be obtained from the fund created for this purpose as referred to in article 10.

For this type of loan, the Central Bank may not charge a higher interest rate than that stipulated in the "Costa Rican Development Corporations Bonds".

Article 30.—The Corporation shall inform the Central Bank on December first of each year of its program and projections for the following year. Similarly, before February first of each year, it shall report to the Central Bank the results obtained during the previous period.

In furtherance hereof, each period will extend from January first to December thirty—first of each year.

Article 31.—This law is in force from the date of its publication.

CHAPTER VI

Transitory Provisions

Transitory Provision I.—The bond issue referred to in article 10 shall have the following characteristics:

Name: Costa Rican Development Corporation Bonds;

Amount: Sixty seven million colones;

Term of debt: 8 years;

Interest: Four per cent per annum, payable quarterly; and

Form of payment: Annual random drawing.

Interest coupons and bonds shall be accepted by Government institutions in payment of all kinds of taxes.

Payment on principal as well as on interest shall be effected from the proceeds of the exchange rate increase referred to in article 10 hereof. Payment on principal may be effected prior to the expiration date if the amount of such proceeds so permits.

For subsequent capital increases the same procedure for the issuance of bonds and payments herein established shall be used, differentiating clearly each bond issue.

Transitory Provision II.—In order for CODESA to initiate operations, the Central Bank will lend to the Corporation all necessary amounts to cover installation and operating expenses. The guarantee offered by the Corporation to secure such loans shall be the bonds issued by the Government as payment for its contribution to the capital stock.

The Central Bank shall deduct annually one third of all loans granted for the purpose stipulated above from the total amount of income destined to the Corporation from proceeds obtained from the rate of exchange difference referred to in article 10 of this Law.

For this type of loan the interest rate charged by the Central Bank may not exceed the amount stipulated for the bonds referred to in the preceding transitory provision.

Transitory Provision III.—The modification in the rate of exchange referred to in article 10 shall commence the moment that the central Bank issues the corresponding decree within thirty days following the date in which the Corporation shall initiate operations. In furtherance hereof, it is construed that the Corporation has initiated operations once the members of the Board of Directors have been duly appointed and sworn in, all to be done within ninety days following the date of publication of this Law.

Transitory Provision IV.—The first Series "A" representatives shall be appointed by the President's Cabinet for a two—year term. Two of these will be chosen from two lists of three candidates each submitted by the Chamber of Industries and one from a list of three candidates submitted by the Chamber of Agriculture. Before the term of office expires, shareholders of Series "A" shares shall appoint their representatives for the following two—year term provided they represent at least 25% of the Series "A" shares; in its default, the President's Cabinet will continue effecting such appointments of the representatives of Series "A" shares for two—year terms, using the same system described above until 25% of these shares are subscribed and the shareholders may thus effect the appointment of their representatives in accordance with article 13 of this Law.

To be communicated to the Executive Power

Legislative Assembly, San José, this sixteenth day of the month of November of the year one thousand nine hundred and seventy—two.

Daniel Oduber Quirós
President

Antonio Jacob Habit
First Secretary

Manuel Carballo Quintana
Second Secretary

Presidential House, San José, this sixteenth day of November of the year one thousand nine hundred and seventy two.

To be executed and published

José Figueres

The Minister of Economics, Industry and Commerce,
Jorge Sánchez Méndez

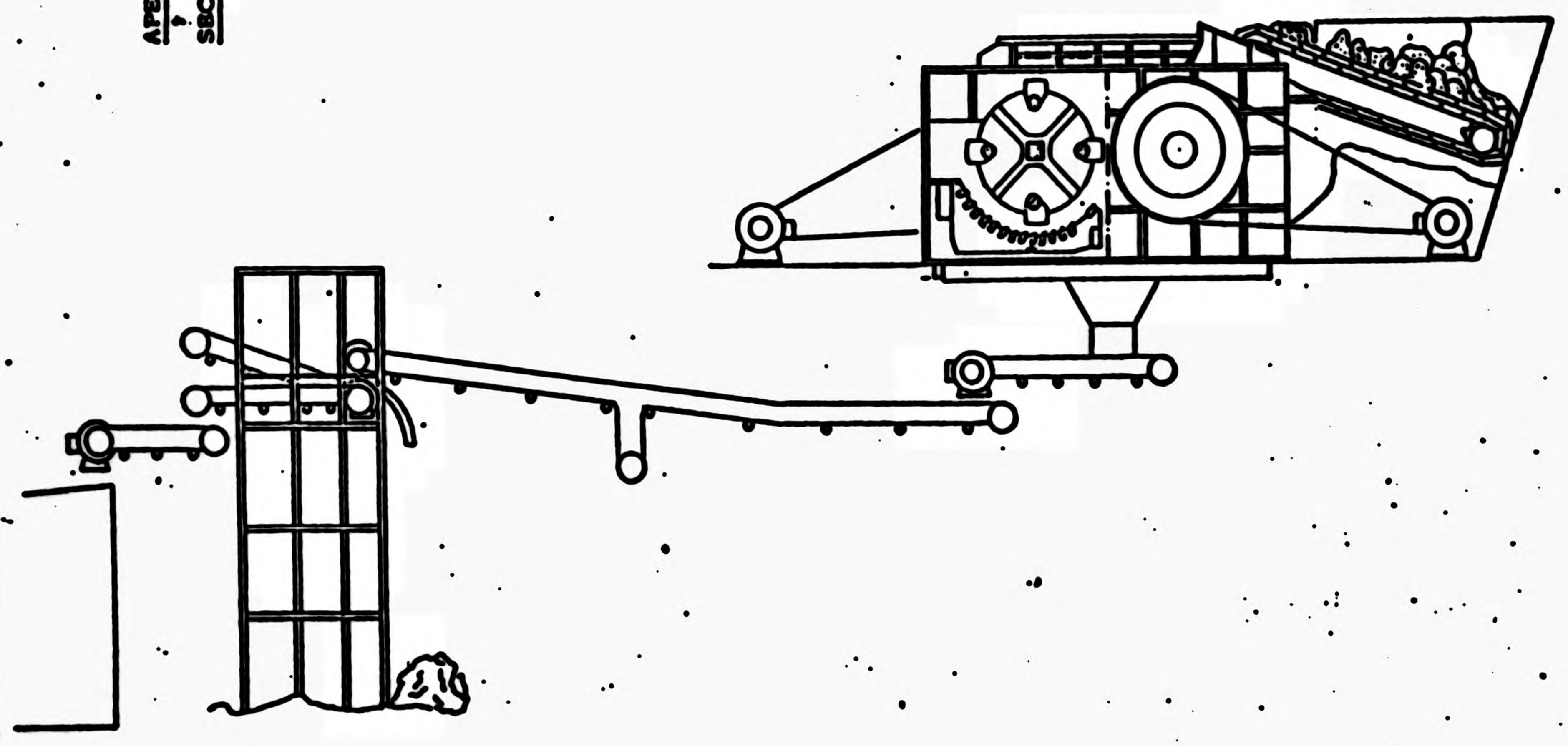
Appendix B: Plant Diagrammes

Appendix B 1:

CEMVASA

APENDICE No. 2-1

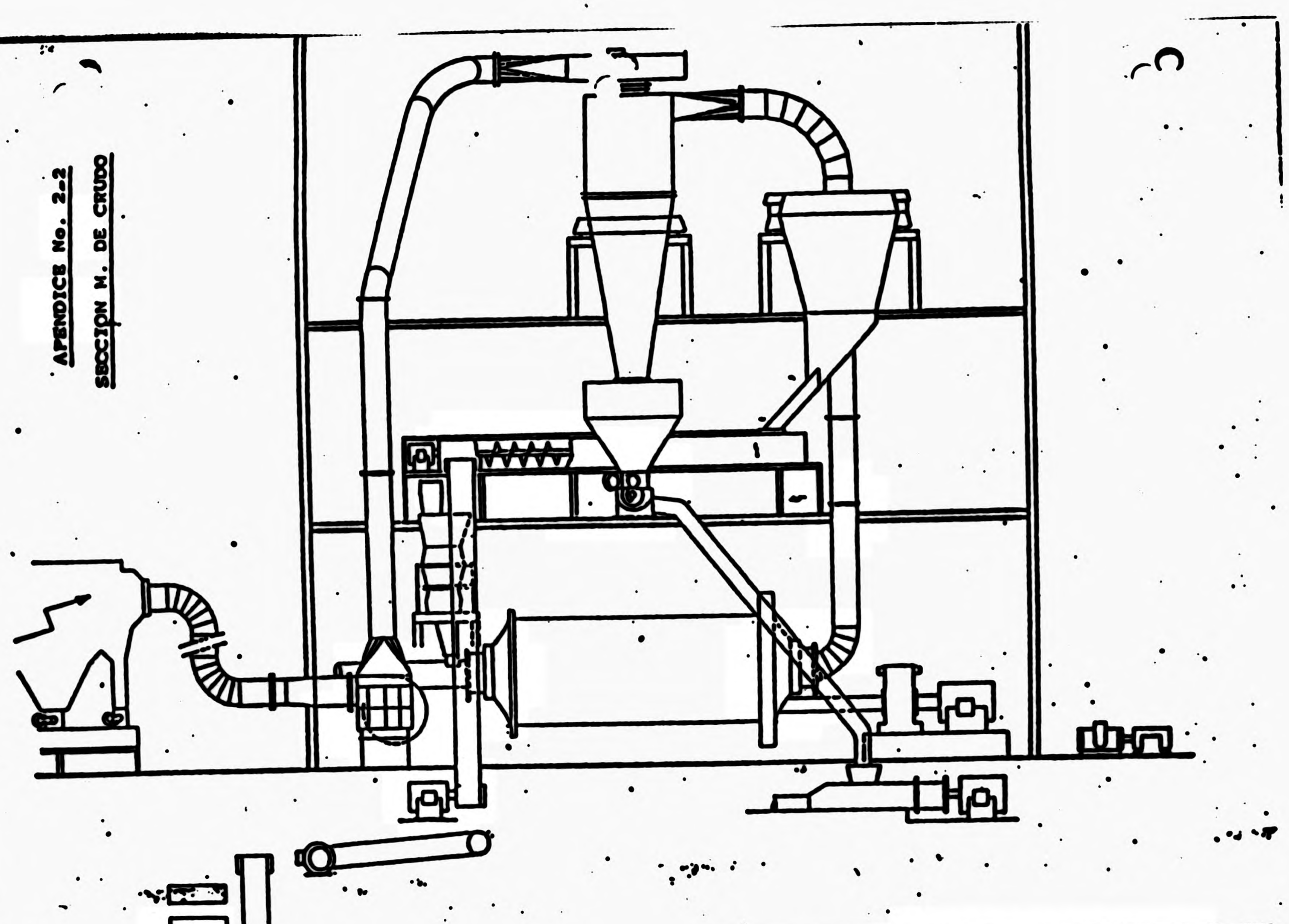
SECCION MACHAQUEO



CEMENTOS DEL VALLE S.A. SAN JOSE C.R.		
HOJA #1	SECCION MACHAQUEO	26-12-80

APENDICE No. 2-2

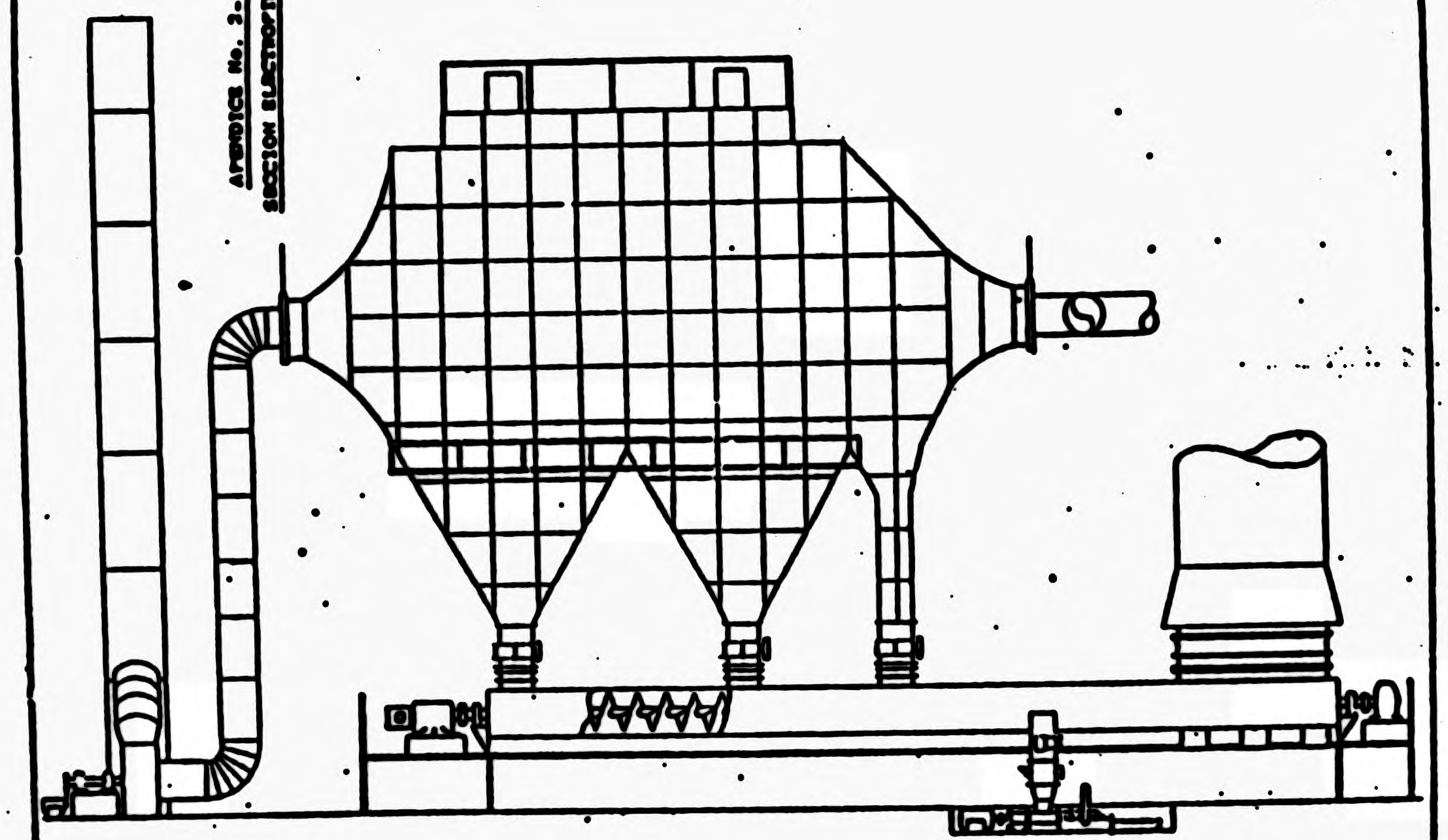
SECCION M. DE CRUDO



CEMENTOS DEL VALLE S.A. SAN JOSE C.R.		
HOJA #2	SECCION M. DE CRUDO	27-12-80

APENDICE No. 2-3

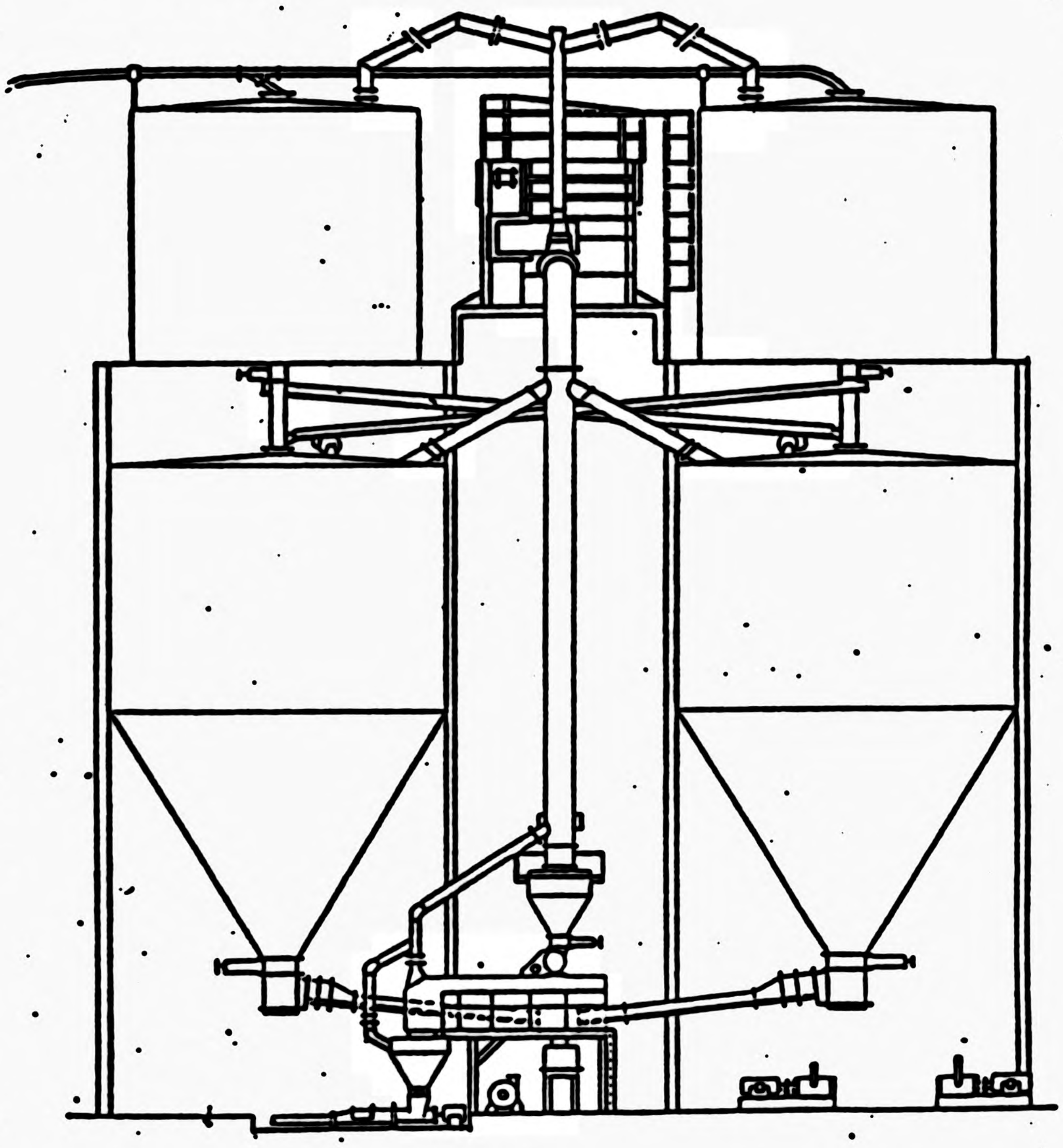
SECCION ELECTROFILTRO



CEMENTOS DEL VALLE S.A. SAN JOSE C.R.		
HOJA # 20	SECCION ELECTROFILTRO	8-1-81

APENDICE No. 2-4

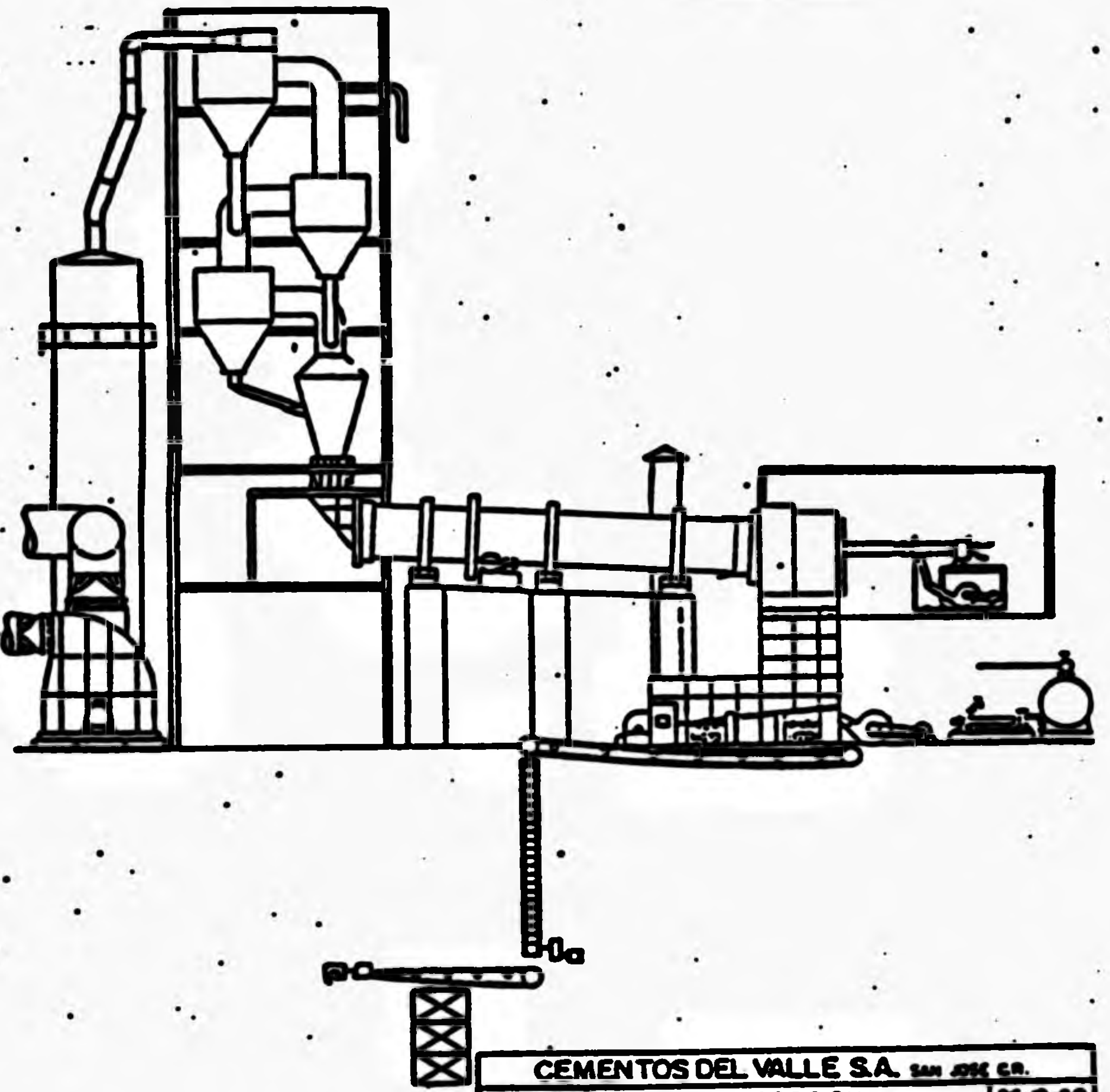
SECCION HOMOGENIZACION



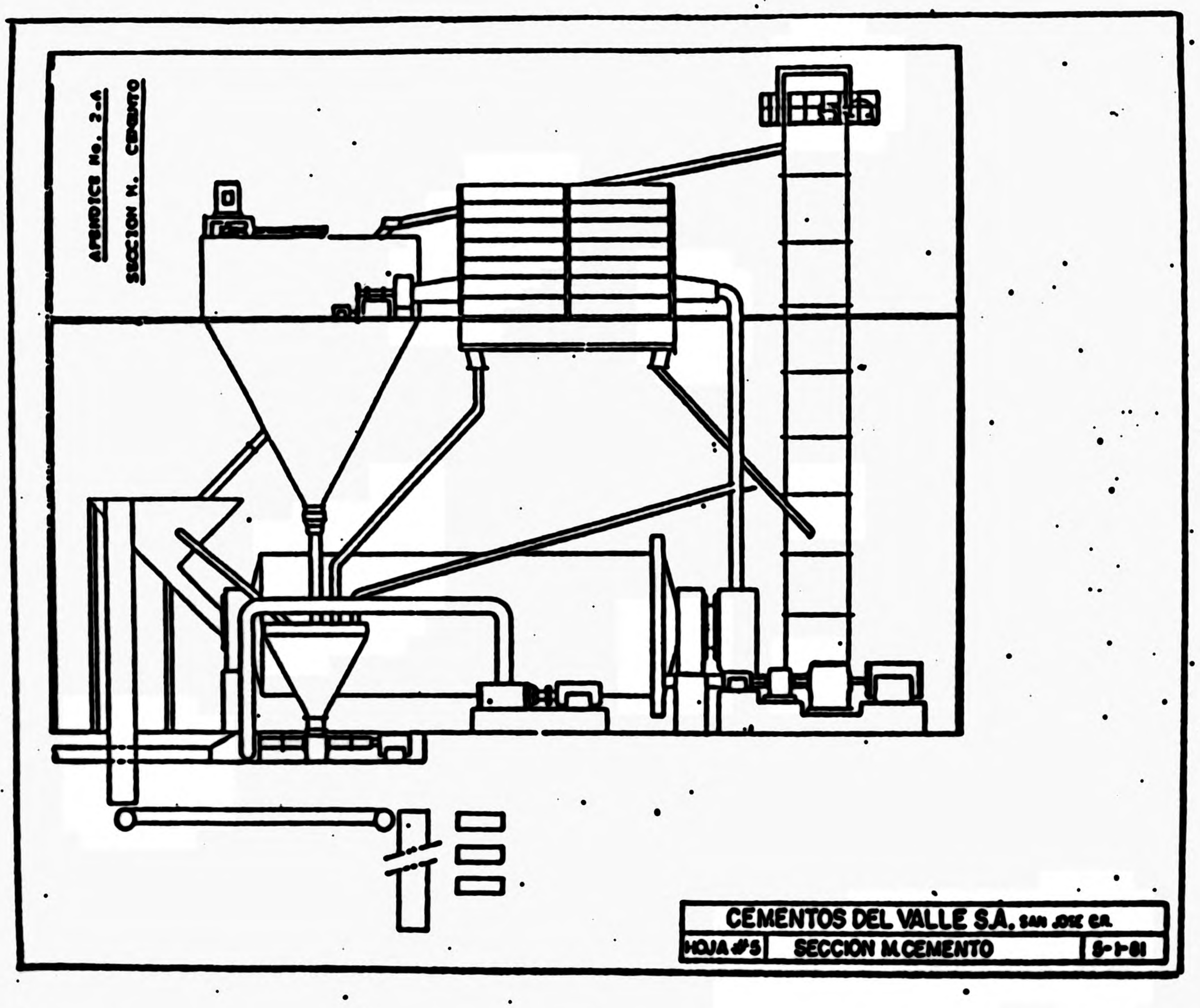
CEMENTOS DEL VALLE S.A. SAN JOSE C.R.		
HOJA #3	SECCION HOMOGENIZACION	5-1-81

APENDICE No. 2-5

SECCION COCCION

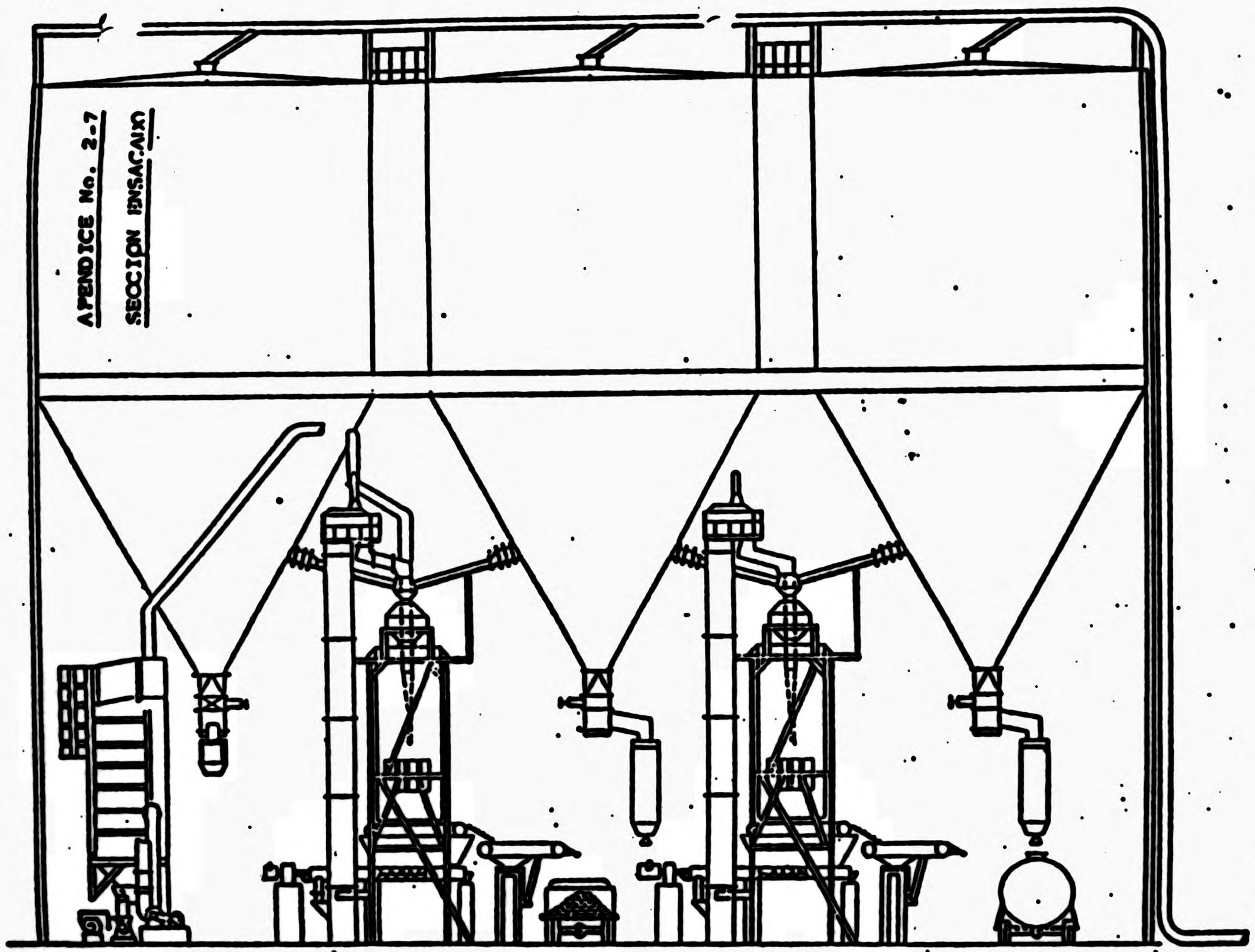


CEMENTOS DEL VALLE S.A. SAN JOSE CR.		
HOJA #4	SECCION COCCION	26-12-80


APENDICE No. 2-A
SECCION M. CEMENTO
CEMENTOS DEL VALLE S.A. SAN JOSE C.R.
HOJA #5
SECCIÓN M.CEMENTO
8-1-81

APENDICE No. 2-7

SECCION ENSACADO



CEMENTOS DEL VALLE S.A. SAN JOSE C.R.

HOJA #6 | SECCION ENSACADO | 27-12-80

Appendix B 2:

FERTICA

....# 4

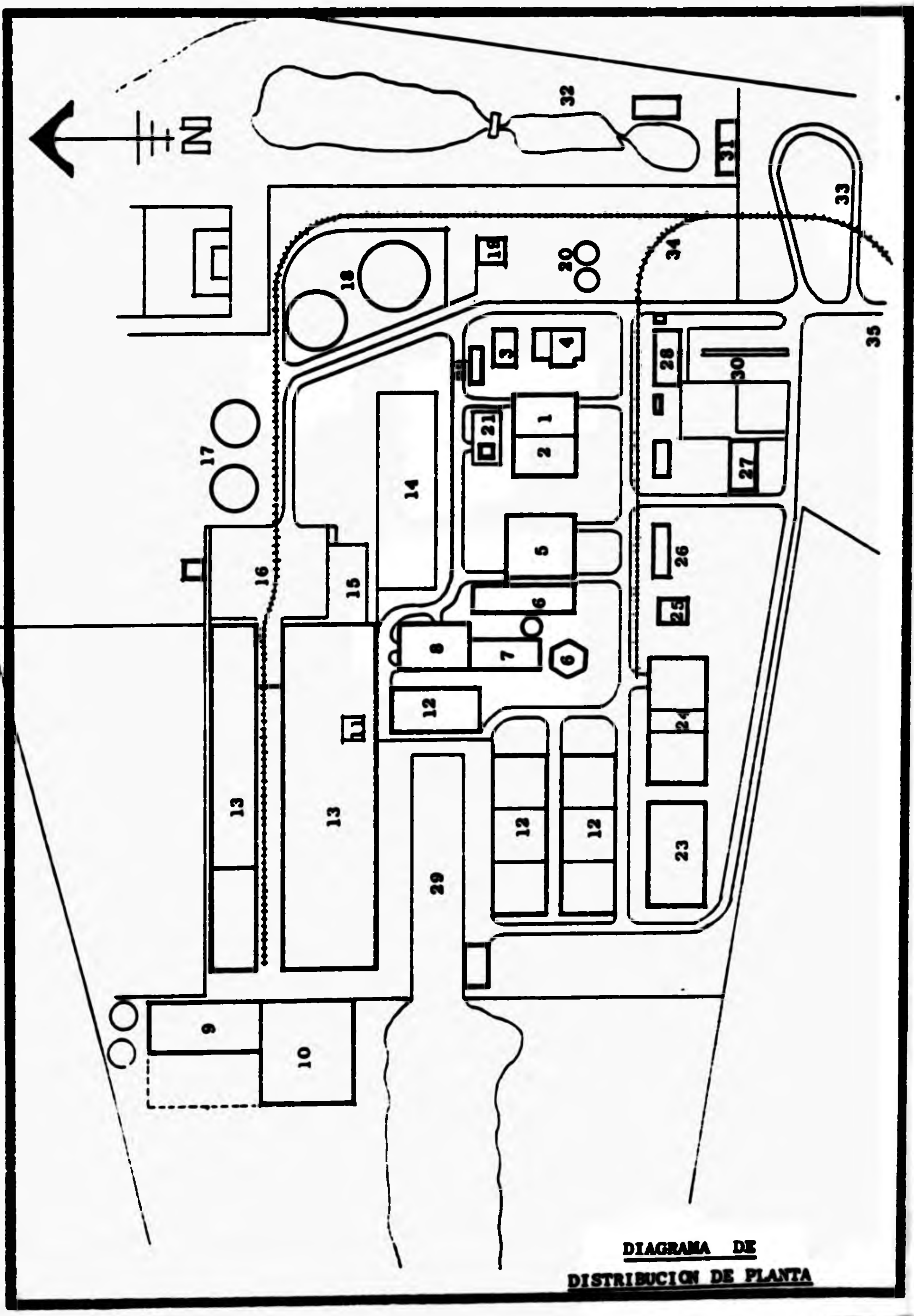


DIAGRAMA DE
DISTRIBUCION DE PLANTA

NOMENCLATURA

1.- Planta de Acido Nítrico # 1.
2.- Planta de Acido Nítrico # 2.
3.- Torre de Enfriamiento de Agua # 1.
4.- Torre de Enfriamiento de Agua # 2.
5.- Planta de Complejos.
6.- Planta de Nitrato de Amonio # 2.
7.- Planta de Sulfato de Amonio.
8.- Planta de Nitrato de Amonio # 1.
9.- Planta de Acido Sulfúrico.
10.- Silo Almacenamiento de Azufre.
11.- Planta Mezcladora.
12.- Bodegas de Materias Primas.
13.- Bodegas de Producto Terminado Ensacado.
14.- Silo de Almacenamiento de Producto Terminado a Granel.
15.- Bodega de Material de Empaque.
16.- Area de Despacho de Producto Terminado.
17.- Tanques de Almacenamiento de Acido Sulfúrico.
18.- Tanques de Almacenamiento de Amoníaco.
19.- Sistemas de Compresores de Amoníaco.
20.- Tanques de Almacenamiento de Agua.
21.- Sub-Estación Eléctrica Principal.
22.- Tanques de Almacenamiento de Amoníaco para Proceso (Tanques de "Quemado").
23.- Talleres de Mantenimiento.
24.- Bodega de Repuestos.
25.- Tanques de Almacenamiento de Bunker.
26.- Calderas, Unidades de Tratamiento de Agua y Compresores de Aire.
27.- Edificio de Servicios.
28.- Edificio Administrativo.
29.- Muelle y Canal de Navegación.
30.- Parqueo para Autos.
31.- Soda-Club.
32.- Area Recreativa (Piscina, lagos, canchas de Tenis, Basket Ball, Foot Ball, Soft Ball, etc.).
33.- Area Parqueo Camiones.
34.- Línea Ferrocarril.
35.- Carretera de entrada principal.

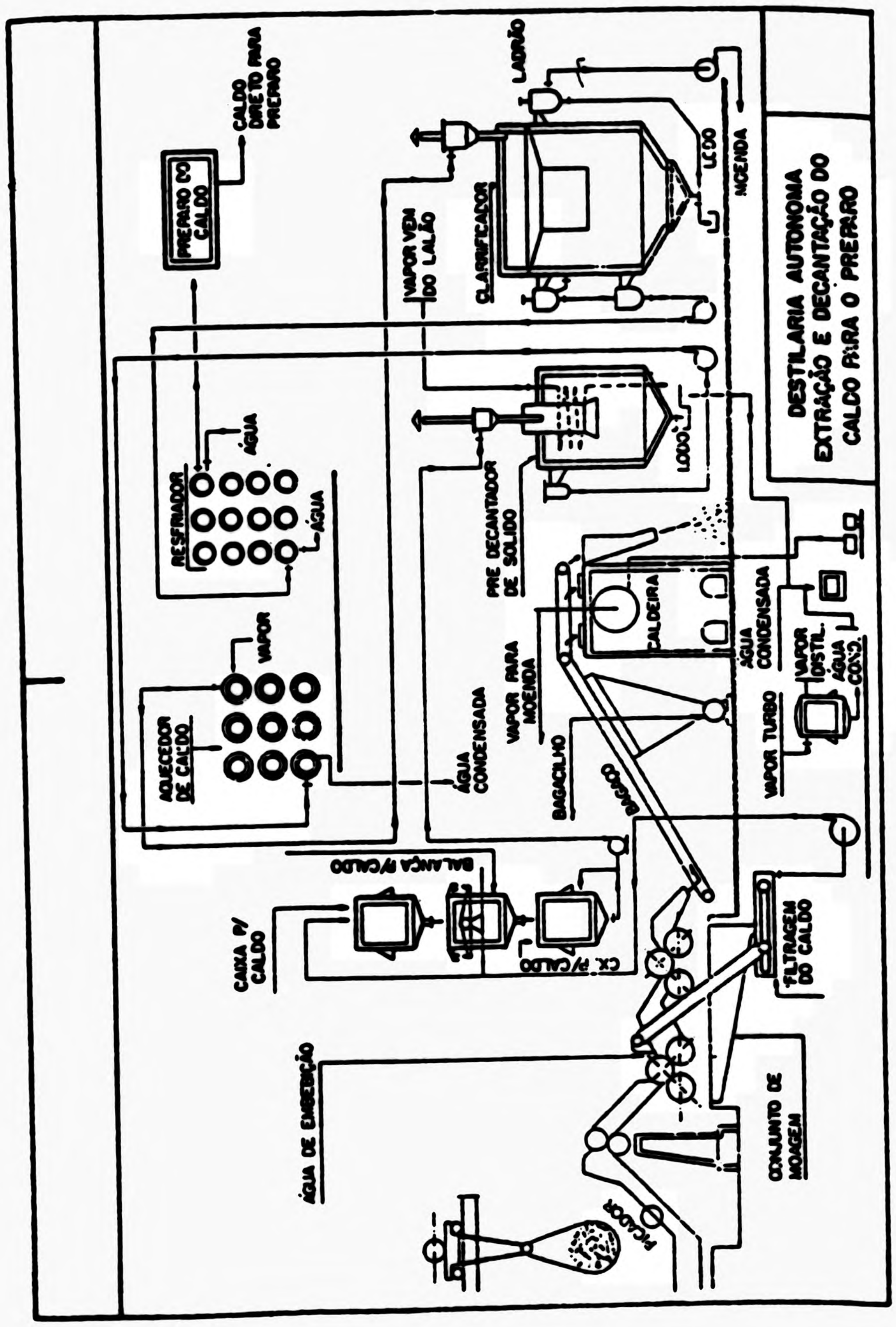
Appendix B 4:

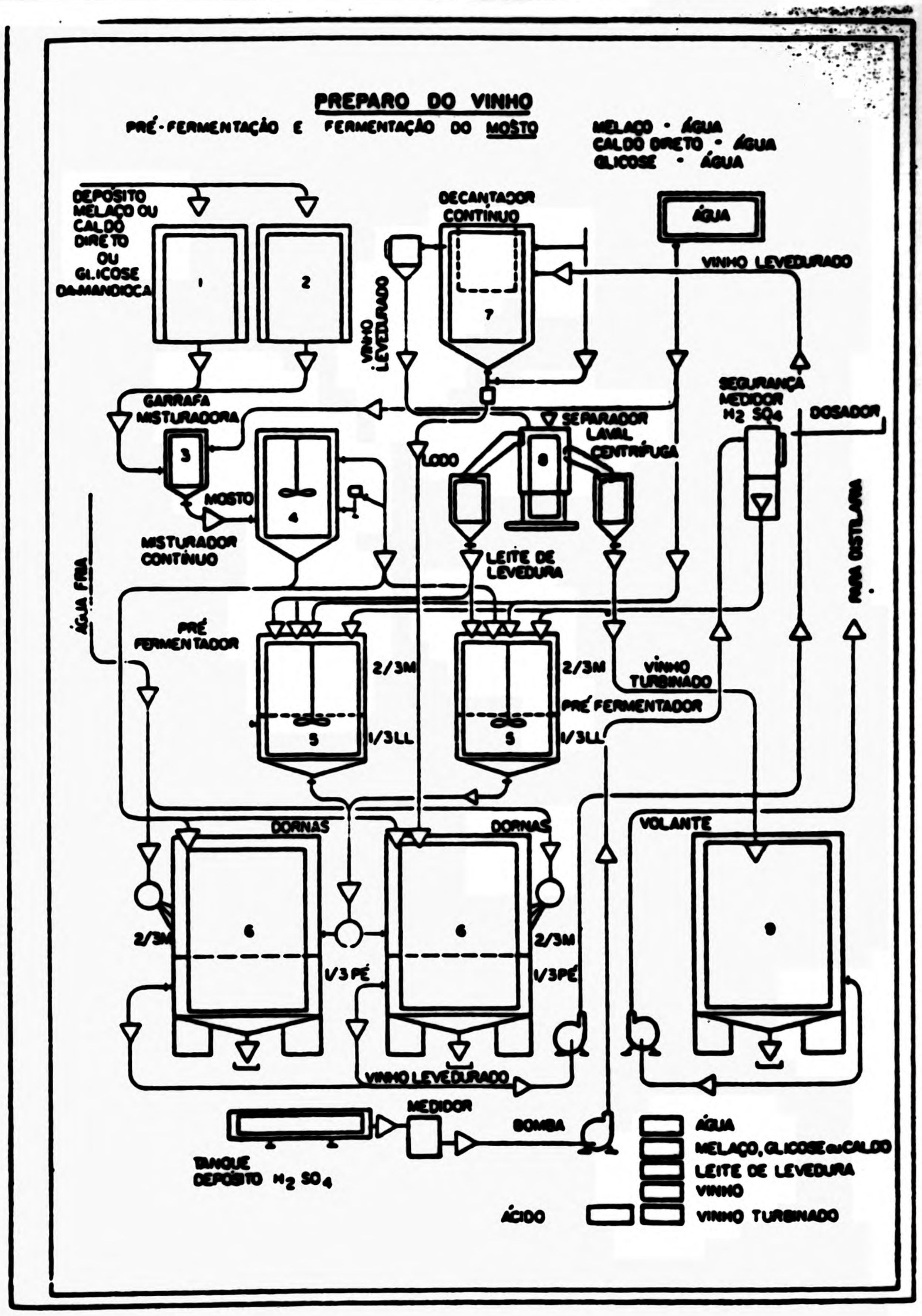
CATSA

Appendix B 4:

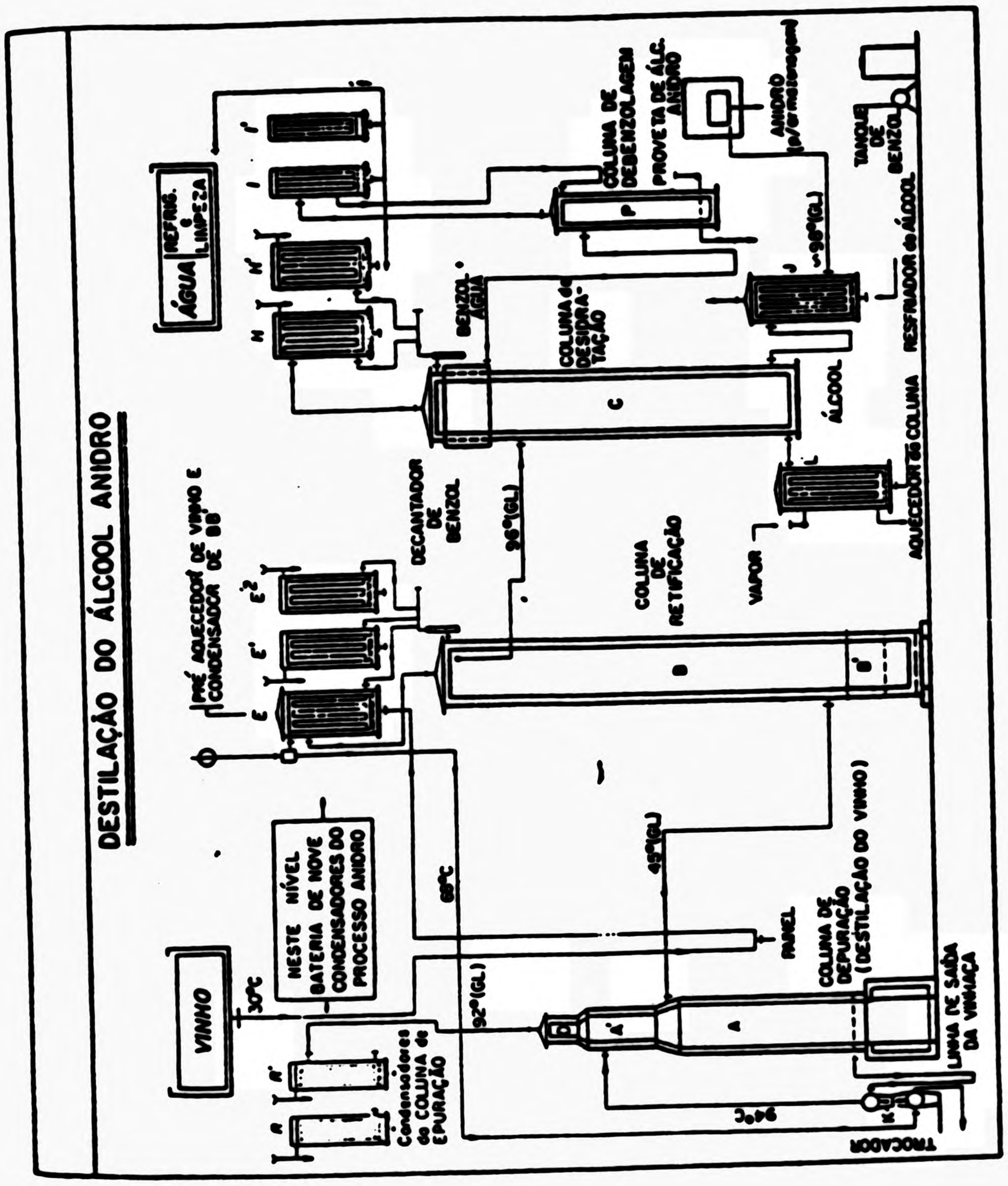
CATSA

DESENHO 2


DESTILARIA AUTONOMA
EXTRAÇÃO E DECANTAÇÃO DO CALDO PARA O PREPARO
PREPARO DO CALDO
CALDO DIRETO PARA PREPARO
LADRÃO
LODO
MOENDA
CLARIFICADOR
RESFRIADOR
ÁGUA
PRE DECANTADOR DE SOLIDO
CALDEIRA
ÁGUA CONDENSADA
VAPOR PARA MOENDA
AQUECEDOR DE CALDO
VAPOR
BAGACILHO
BAGAÇO
VAPOR TURBO
CAIXA P/ CALDO
BALANÇA P/CALDO
CX. P/CALDO
FILTRAGEM DO CALDO
ÁGUA DE EMBEBIÇÃO
CONJUNTO DE MOAGEM
PICADOR


PREPARO DO VINHO
PRÉ-FERMENTAÇÃO E FERMENTAÇÃO DO MOSTO
MELAÇO - ÁGUA
CALDO DIRETO - ÁGUA
GLICOSE - ÁGUA
DEPÓSITO MELAÇO OU CALDO DIRETO OU GLICOSE DA MANDIOCA
DECANTADOR CONTÍNUO
ÁGUA
VINHO LEVEDURADO
GARRAFA MISTURADORA
SEPARADOR LAVAL CENTRÍFUGA
SEGURANÇA MEDIDOR H_2SO_4
DOSADOR
LODO
MOSTO
MISTURADOR CONTÍNUO
LEITE DE LEVEDURA
PARA DESTILARIA
ÁGUA FRIA
PRÉ FERMENTADOR
2/3M
1/3LL
VINHO TURBINADO
PRÉ FERMENTADOR
DORNAS
VOLANTE
2/3M
1/3 PÉ
VINHO LEVEDURADO
MEDIDOR
BOMBA
TANQUE DEPÓSITO H_2SO_4
ÁGUA
MELAÇO, GLICOSE ou CALDO
LEITE DE LEVEDURA
VINHO
ÁCIDO
VINHO TURBINADO

DESENHO 4


DESTILAÇÃO DO ÁLCOOL ANIDRO
VINHO
NESTE NÍVEL BATERIA DE NOVE CONDENSADORES DO PROCESSO ANIDRO
PRÉ AQUECEDOR DE VINHO E CONDENSADOR DE BB
DECANTADOR DE BENZOL
ÁGUA
REFRIG. E LIMPEZA
COLUNA DE DESIDRATAÇÃO
COLUNA DE DEBENZOLAGEM
PROVETA DE ÁLC. ANIDRO
TANQUE DE BENZOL
RESFRIADOR de ÁLCOOL
ÁLCOOL
AQUECEDOR de COLUNA
VAPOR
COLUNA DE RETIFICAÇÃO
PAINEL
COLUNA DE DEPURAÇÃO (DESTILAÇÃO DO VINHO)
LINHA DE SAÍDA DA VINHAÇA
TROCADOR
Condensadores da COLUNA de EPURAÇÃO
BENZOL
ÁGUA

Appendix B 3:

ALUNASA

A L U N A S A

Juanilama (Esparza) - Costa Rica

- **Main Equipment**

  1) Melting and Holding Furnaces
  2) Continuous Casting Line
  3) Cold Mill
  4) Annealing and Homogening Furnaces
  5) Foil Mill
  6) Foil Separator
  7) Coil Slitting Line
  8) Tube Welding Line
  9) Foil Slitter
  10) Foil Embossing Machine
  11) Household Foil Rewinding Machine
  12) Disk Production Line
  13) Slug Production Line

- **Plant Area** : 100.000 m^2
- **Covered Area** : 18.000 m^2
- **Start-up** : 1981
- **Possible Marketing Plan**

1)	Foil	7 microns (min)	
		100 microns (max)	3.600 TM PY
2)	Sheet	0,0165" x 48"	9.000 TM PY
			12.600 TM PY

A L U N A S A

Juanilama (Esparza) - Costa Rica

. **Main Equipment**

1) Melting and Holding Furnaces
2) Continuous Casting Line
3) Cold Mill
4) Annealing and Homogening Furnaces
5) Foil Mill
6) Foil Separator
7) Coil Slitting Line
8) Tube Welding Line
9) Foil Slitter
10) Foil Embossing Machine
11) Household Foil Rewinding Machine
12) Disk Production Line
13) Slug Production Line

. **Plant Area** : 100.000 m^2

. **Covered Area** : 18.000 m^2

. **Start-up** : 1981

. **Possible Marketing Plan**

1)	Foil	7 microns (min)	
		100 microns (max)	3.600 TM PY
2)	Sheet	0,0165" x 48"	9.000 TM PY
			12.600 TM PY

A L U N A S A

Equipment Data

EQUIPMENT LIST	ORDER REC'D	DEL. MADE	EQUIPMENT MISC. DATA
COIL SLITTING LINE	–	–	(1) slitter 0,3÷3 mm. gauge 1650 mm. wide 100 mpm speed
TUBE WELDING LINE	–	–	(1) 14-100 mm. o.d. 80 mpm speed 3÷7 meters tube length
FOIL SLITTER	–	–	(1) 1400 mm. wide 0,030÷0,3 mm. gauge (1) 1400 mm. wide 0,007÷0,050 gauge
FOIL EMBOSSING MACHINE	–	–	(1) 1400 mm. wide 0,06 mm. gauge 260 mpm speed
HOUSEHOLD FOIL REWINDING MACHINE			(1) 300 and 450 mm. rolls width 0,014 mm. gauge 10 to 48 meters roll length
DISKS PRODUCTION LINE	–	–	(1) disks press 500 mm. o.d. max. 2,5 mm. gauge max. (1) disks annealing
SLUGS PRODUCTION LINE			(1) slugs press 250 mm. width max. 8 mm. max. gauge (1) slugs annealer (1) slugs polishing tumbler
FITTING PRODUCTION DEPARTMENT			Chill casting foundry capacity 500 tons/year
TUBE AND FITTING WELDING DEPT.			Mig and Tig automatic welding machines. Cutting and preparation machines.
MISC. EQUIPMENT	Production auxiliary equipments utilities distribution nets buildings steel frame