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PROJECT FOR THE ESTABLISHMENT OF A VEGETABLE OIL HYDROGENATION PLANT *

prepared by

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(BOLIVIAN DEVELOPMENT CORPORATION)

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(DEPARTMENT OF ENTERPRISES AND PROJECTS)

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I. INTRODUCTION

1.1 Edible oil plant

The Villamontes Vegetable Oil Plant (Department of Tarija), began industrial production in November 1977, and processed some 4,000 tonnes of crude soya bean oil during its first stage of operations designed to test the performance of its various production departments.

At this time some 8,000 tonnes of various oil seeds (soya, cotton seeds and ground-nuts) are being processed with a view to testing the operation of the oil extraction units.

Both test operations (extraction and refining) show satisfactory results in relation to the plant's production capacity, which stands at 15,000 tonnes of vegetable oil per annum.

This initial output has been marketed under the trade mark "El Rey" in cylindrical containers of 1 litre and 5 litres capacity. This marketing experience has made us aware of the relatively slow growth of domestic demand for vegetable oils, and we do not feel that it will be possible, over the short term, to make use of the entire installed capacity of the Villamontes Plant. On the other hand, unless it can be operated at an optimum level of capacity utilization, there is a real risk of this plant's becoming uneconomical, thereby thwarting the efforts of the Bolivian Development Corporation and the Government in carrying out this major project in the south of the country, which, when completed, should have a very positive impact on the social conditions of that region.

Because of the presence of a number of different brands, competition in the domestic oil market is extremely keen, with the disadvantage that, forced as they are to cut back their scale of production, none of the country's plants are able to operate under economically acceptable conditions.

In the light of this situation, the Bolivian Development Corporation considers it expedient and necessary to convert its oil output into vegetable fat through a process of hydrogenation.

1.3 Hydrogenation plant

The volume of lard imported by the country - the total reached 15,170 tonnes in 1976 for a value of $US 8,533,190 - fully justifies the building of a plant of this kind for reasons which, as this study will demonstrate, are both economic and technical in nature.

In addition, the Villamontes Vegetable Oil Plant already offers all the industrial infrastructure facilities required for the units involved in the hydrogenation process.

Our estimates indicate that by allocating 12,000 tonnes of oil a year to the production of vegetable fat we shall be able to meet the total domestic demand for this product. The remaining margin as compared with the present observed demand for animal fat is regarded as a demand for animal fat (lard) which is non-substitutable in view of consumer habits.

II. MARKET STUDY

2.1 General considerations

In the community of Villamontes, Province of Gran Chaco, Department of Tarija, the Bolivian Development Corporation is currently operating a vegetable oil plant with the capacity to refine crude oil and directly process such vegetable seeds as soya, cotton seed, ground-nut, safflower and others.

As a very important by-product this plant will produce large quantities of oil-seed cake, which, because of its high protein content, is used as a basic ingredient in the production of balanced feeds for poultry and animals.

Another product derived from soya cake is soya flour, which when blended with wheat flour is used for human consumption.

The need for a study on the potential Bolivian market for vegetable-derived fats as substitutes for fats of animal origin that are now imported arises from the fact that the entire domestic demand for edible oil during 1977 was satisfied by domestically manufactured products, with the result

that the newly built plants, particularly the one at Villamontes, found themselves at a disadvantage in their efforts to market their products in competition with those of other, more favourably located plants.

Thus, the Villamontes Plant's current relatively small share of the domestic market and the pressing need to keep the plant operating at a high percentage of its installed capacity have made it necessary for the officials of the Bolivian Development Corporation to look for an alternative product line to allow operation under at least minimally favourable economic and financial conditions.

In the light of this situation and on the basis of the real potential of the domestic market for fats, the conclusion reached is that it would be feasible for the Villamontes Plant to diversify its production and hydrogenate its oil to produce vegetable fats as substitutes for the animal products which the country imports at this time. To make it possible to arrive at a thorough understanding of where the national vegetable-oil industry currently stands, the present study contains separate analyses of the possibilities of the domestic market for vegetable oils and oil-seed flours and cakes, and, finally, of the market for edible fats.

2.2 The national market for edible oils

Until the year 1976, despite some domestic production, most of the vegetable oil consumed by the Bolivian market was imported from abroad, since local industry was unable to satisfy the existing demand. However, the building and start-up of operations of two new plants, that of the Sociedad Aceitera del Oriente (SAO) at Santa Cruz and that of the Bolivian Development Corporation (CBF) at Villamontes, Tarija, have changed the situation with respect to the domestic supply to such a degree that since 1977 the Government has banned the import of edible oils on the grounds that domestic producers are able fully to meet the country's demand for these products.

2.2.1 Domestic demand

The statistical data that follow reveal the clear upward trend in the apparent domestic demand for vegetable oil.

Year	National production	Imports	Estimated contraband	Total demand
1965	196.0	4,103.1	1,515.6	5,814.7
1966	214.2	3,512.7	2,264.2	5,991.1
1967	448.1	6,411.8	-	6,859.9
1968	1,088.6	3,598.2	1,673.4	6,360.2
1969	2,352.5	2,973.8	1,240.8	6,567.1
1970	1,868.4	2,931.2	1,981.3	6,780.9
1971	1,112.0	3,250.0	2,671.1	7,033.1
1972	1,861.5	3,644.2	1,782.1	7,287.8
1973	1,375.9	4,296.7	1,887.0	7,559.6
1974	1,388.5	4,885.3	1,574.5	7,848.3
1975	2,326.5	4,512.6	1,787.5	8,626.6
1976	5,234.4	4,496.4	1,798.6	11,529.4

Source: National Institute of Statistics, Directorate-General for Domestic Commerce, Directorate-General for Supplies, Directorate of Industry.

Analysis of this table reveals the following facts about the Bolivian vegetable oil market:

(a) To a very large degree, the demand has been satisfied through imports and contraband;

(b) National consumption shows a clear upward trend which cannot be traced to trends in production as these have been too irregular.

2.2.2 Analysis of per capita consumption

On the basis of the figures for the apparent national consumption of edible oils in the last twelve years, the country's per capita consumption has been as follows:

National per capita consumption of oil

(in litres)

Year	National consumption	Population (thousands)	Per capita consumption
1965	6,466,068	3,524	1.83
1966	6,662,108	3,611	1.84
1967	7,628,208	3,699	2.06
1968	7,072,567	3,790	1.87
1969	7,302,556	3,884	1.88
1970	7,540,331	3,979	1.90
1971	7,820,870	4,077	1.92
1972	8,104,046	4,189	1.94
1973	8,406,218	4,295	1.96
1974	8,727,309	4,408	1.98
1975	9,592,828	4,525	2.12
1976	12,820,695	4,644	2.76

Source: National Institute of Statistics, Ministry of Planning and Co-ordination, Directorate-General for Domestic Commerce.

It is clear from this table that in the 12-year period covered per capita consumption rose from 1.83 litres in 1965 to 2.76 litres in 1976 - i.e. consumption increased at a cumulative annual rate of 3.82 per cent. It might be mentioned that Bolivian per capita consumption of oil is among the lowest in Latin America, region-wide consumption being in the neighbourhood of 8.5 litres.

If one compares domestic consumption with domestic production for this period, one finds that production has been unable to keep pace with the demand for oil, which is why the country has had to import and why, also, vegetable oil has been brought into the country in the form of contraband. In 1977, there was a marked change in the domestic supply/demand ratio as a result of

the addition to the domestic production capacity of the SAO plant at Santa Cruz and the CBF plant at Villamontes, the latter currently in a test operation phase. As a result of the addition of the output of these two new plants to the production capacity which existed prior to 1976, the Bolivian vegetable oil market can now be totally supplied by domestic industry, with the result that protectionist measures, including, since 1977, a ban on edible oil imports, are being instituted.

2.2.2 Regional demand

The largest amount of edible oil is consumed in the Department of La Paz, the principal reason being the size of that department's urban population. In order of importance, the next two departments are Cochabamba and Santa Cruz.

Apparent demand for edible oil in the Department of La Paz

Year	Consumption (tonnes)	Percentage of the domestic market
1966	3,017	50.4
1967	3,093	45.1
1968	3,192	50.2
1969	3,293	50.1
1970	3,398	50.1
1971	3,533	50.2
1972	3,674	50.4
1973	3,820	50.5
1974	3,973	50.6
1975	4,171	48.3

Source: Ministry of Industry, Commerce and Tourism, Directorate for Domestic Commerce

As indicated in this table, some 50 per cent of the country's apparent demand for edible oil is concentrated in the Department of La Paz. Accordingly, the marketing machinery to be set up must be geared primarily to satisfying this consumption area.

2.2.4 Analysis of supply

Installed oil plants

The installed extraction and refining capacity of each plant is indicated in the following table:

Installed capacity of the Bolivian vegetable oil industry
(in tonnes/day)

Plant	Extraction	Refining
Cooperativa Integral Guabirá 1/	100	-
Industrias del Aceite S.A.	80	25
Industrias Oleaginosas Ltda.	80	20
Compañía Oleaginosas Ltda.	20	10
Sociedad Aceitera del Oriente	200	40
Fábrica de Aceites Villamontes (CBF)	250	50
COMINGO	40	-
SOBOAVE 2/	200	25

Source: Ministry of Industry, Commerce and Tourism, Directorate of Industry

1/ Shut down.

2/ Has not begun operations.

Extraction capacity refers to the volume of oil-seeds that can be processed by each plant; refining capacity refers to the volume of refined oil produced by each plant.

Location of the plants

Cooperativa Integral Guabirá

This plant is located in the Department of Santa Cruz (on the Okinawa Road, 4 km from Montero). Its sole activity consists in the extraction of vegetable oil from cotton seeds and soya beans. The extraction system is based on the use of discontinuous solvents, permitting a higher oil recovery rate.

This facility is currently not in operation.

Industrias del Aceite S.A.

This company has two plants - an extraction plant located at Santa Cruz and a refining plant located at Cochabamba. The raw material processed at this time at Santa Cruz includes soya and cotton seeds.

The firm markets its refined oil throughout the country under the "FINO" trade mark.

Industrias Oleaginosas Limitada

The plant, which is located in the Department of Santa Cruz, is engaged in the extraction and refining of edible vegetable oils. Its extraction plant will process mainly soya and ground-nuts.

Compañía Oleaginosas Limitada

The principal activity of the plant, which is located in the city of Cochabamba (8 km on the road towards Quillacollo), is the press-extraction and refining of vegetable oils. The extraction plant will process soya and cotton seeds. The refined oil produced at this plant is sold in the country under the "MANISOL" trade mark.

Sociedad Aceitera del Oriente

The plant is located in the Department of Santa Cruz. Extraction is based on a solvent process.

This company markets its product under the "SAO" trademark.

Fábrica de Aceites Villamontes

At the present time this plant, which is located at Villamontes (Department of Tarija), is in an experimental phase and is producing refined oil. Once the extraction plant has begun operations, in addition to edible oil it will produce oil-meal and oilcake for use in the manufacture of balanced feeds.

Marketing of the refined oil began towards the end of 1977, under the "ELREY" trade mark.

COMINCO Limitada

The plant is located in the Department of Santa Cruz. Cotton seed is the principal raw material used in the extraction operation.

SOBOAVE Limitada

The plant is located in the city of Santa Cruz and has thus far not begun production. Crude oil extraction will be based on the processing of oil-seeds, mainly soya and cotton seeds.

2.2.5 Share of edible oil in the country's total consumption of oils and fats

Within the total demand for fats and oils, oils account for a smaller share than edible fats, lard being the most important item in the latter category.

The principal reason for the lower demand for oil than for fats is price, a factor which also explains why oil is in demand mainly in the urban and industrial centres, where per capita income is highest.

2.2.6 Oil demand projections

In the following analysis an effort is made to quantify the probable levels of domestic oil consumption in the years immediately ahead. The analysis is based on an extrapolation of the historically recorded trend in the apparent demand for oil. As recorded during the period 1965-1976, this demand shows an average annual growth rate in the order of 6.45 per cent for the period as a whole, a figure which may be taken to represent the expansion of domestic demand.

The following table summarizes the projected data as calculated according to the method described above.

Projections of the domestic demand for oil (in litres)

Year	Consumption
1977	13,647,630
1978	14,527,902
1979	15,464,952
1980	16,462,441
1981	17,524,268
1982	18,654,583
1983	19,857,804
1984	21,138,632
1985	22,502,073
1986	23,953,457
1987	25,498,455

2.3 The external oil market

2.3.1 The Andean subregional market

The Andean countries offer the best potential markets for the export of the surplus that may arise in the Bolivian vegetable oil industry, although it should be noted that within this group Bolivia's best market prospects lie in Peru and Chile. Colombia is nearing the point of self-sufficiency, Ecuador shows no evidence of any major increases in consumption and is engaged in a number of agro-industry projects which will provide substitutes for imports, while the possibilities offered by Venezuela as a purchaser of Bolivian surpluses is hardly encouraging in view of the fact that, as a result of projects now in progress there, that country is expected to become itself an exporter of edible vegetable oils.

The following table conveys a general idea of the volume of edible oil imported by the countries of the Andean Group (excluding Bolivia) during the period 1967-1971.

Edible oil imports in the Andean Group (in tonnes)

Year	Colombia	Ecuador	Peru	Venezuela	Total
19[illegible]	[illegible],239	13,030	20,830	[illegible]0,180	83,160
19[illegible]	[illegible],100	14,200	47,310	36,990	145,[illegible]70
19[illegible]	[illegible],600	14,830	35,386	[illegible]0,540	116,066
19[illegible]6	1,670	14,230	55,060	[illegible]2,870	127,810
1971	80	17,990	46,830	[illegible]2,380	147,[illegible]0

•3.2 The Chilean oil market

As we noted earlier, the best potential export market for Bolivian vegetable oil products is in Chile, both because of the nearness of that country and its absorptive capacity.

In a study prepared by the Export Promotion Division of the Central Bank, consumption during the period 1971-1975 was found to have increased irregularly, while production tended to decrease, requiring the offsetting of this shortfall by imports. The following table illustrates this situation.

Chile: production, imports and consumption of edible oils (in tonnes)

Year	Production	Imports	Consumption
19[illegible]	50,350	[illegible],976	58,326
1[illegible]3	55,963	10,388	66,351
19[illegible]4	67,640	[illegible],264	78,904
19[illegible]0	70,956	[illegible],103	79,060
19[illegible]1	71,014	10,052	81,066
19[illegible]2	71,500	12,[illegible]59	83,859
19[illegible]3	72,588	3,900	76,508
19[illegible]4	69,640	14,800	84,440
19[illegible]5	63,300	1/	-

Source: Estudio del Mercado Chileno. Central Bank of Bolivia, Export Promotion Division.

1/ Data on imports for 1975 are available only in terms of value ($US [illegible], 90,263), with no distinction made between refined [illegible].

The figures given in the table above refer to purified or refined soya bean, cotton-seed and ground-nut oil.

In the import area, crude oil imports moved upward during the period 1971-1974, mainly because there was a shortage of domestic raw material to satisfy the requirements of the oil industry. Imports fell off during 1975, the principal reason being the greater output of oil-seeds during the 1974-1975 season in comparison with preceding periods. In addition, the drop observed in the demand for oil resulted in a decrease in the volume of oil imported in 1975 as a proportion of that year's oil demand to 55 per cent.

The following table indicates Chile's imports of crude oil for the years 1971-1975.

Chile: imports of crude oils

Year	Crude oil imported (in tonnes)	Percentage of total oil consumption
1971	40,456 1/	53.9
1972	44,336	58.6
1973	59,426 2/	77.4
1974	58,930	76.9
1975	37,545	54.8

Source: Estudio del Mercado Chileno. Central Bank of Bolivia, Export Promotion Division.

1/ This figure includes 1,800 tonnes of soya bean oil imported in 1971.

2/ This figure includes 2,850 tonnes of oil contained in the soya beans imported towards the end of 1972 and processed by the associated companies in 1973.

2.4 The domestic lard market

2.4.1 Apparent demand

Lard is the item accounting for the largest share of total demand for oils and fats. The basic factor is price: the major demand for oil is found in the country's urban and industrial centres where per capita income is highest, while the heaviest consumption of lard is found in rural communities where income levels are lower.

The entire domestic demand for lard is met through imports from various countries. From the following table, showing the quantities imported and the countries of origin it will be seen that Argentina and the Netherlands are the two countries which contribute most towards satisfying the demand for lard in our country.

Domestic production is negligible since at the present time there is only one enterprise, CONALDE, which turns out lard - in very small quantities due to the limited size of its production plant.

Bolivia: imported lard and other forms of pressed or rendered pig fat

Country of origin	Kilograms	Value in $US (CIF, border)
1970		
Totals	12,492,854	3,893,349
Argentina	6,260,841	1,903,303
Austria	17,950	4,992
Chile	23,544	5,666
Netherlands	5,815,846	1,936,057
Peru	371,760	41,648
United Kingdom	2,463	1,315
United States	450	368
1971		
Totals	14,933,671	4,897,544
Argentina	7,162,504	2,238,983
Chile	117,884	32,369
Federal Republic of Germany	97,200	31,670
Netherlands	7,393,285	2,546,624
Peru	36,787	4,692
Spain	50,915	17,404
United Kingdom	75,096	25,802

(Cont'd)...

Country of origin	Kilograms	Value in $US (CIF, border)
1972		
Totals	17,045,842	5,367,842
1973		
Totals	14,605,516	4,625,551
Argentina	9,340,388	2,957,462
Chile	237	148
Peru	1,097,701	317,896
Other countries	4,167,190	1,350,045
1974		
Totals	13,913,390	9,333,418
1975		
Totals	15,913,482	8,808,863
1976		
Totals	15,170,165	8,533,190

Source: Ministry of Industry, Commerce and Tourism, Directorate for Domestic Commerce

2.4.2 Lard consumption in the total consumption of edible fats and oils

It will be evident from the following table that the proportion of lard consumption in the total consumption of edible fats and oils is quite high, given that during the statistical period 1970-1976 this item accounted for an average of 65 per cent of the total. The annual cumulative rate of growth is 3.37 per cent.

Bolivia: share of lard in the consumption of oils and fats (in tonnes)

Year	Total consumption of oils and fats	Consumption of lard and other imported pig fats	Percentage of lard in total consumption
1970	19,274	12,493	64.82
1971	21,967	14,934	67.98
1972	24,333	17,046	70.05
1973	22,165	14,605	65.89
1974	21,761	13,913	63.94
1975	24,540	15,913	64.85
1976	26,699	15,170	56.82

Source: Ministry of Industry, Commerce and Tourism.

Note: As no numerical data are available regarding domestic production, the Ministry of Industry, Commerce and Tourism, for statistical purposes, considers the total consumption of lard and other pig fats to be equal to the volume imported during the period in question.

2.4.3 Projection of lard and fat consumption

On the basis of the annual growth rate for the period 1970-1976 it is possible to extrapolate the consumption estimates indicated in the following table.

Year	Consumption (tonnes)
1978	16,210
1979	16,756
1980	17,321
1981	17,904
1982	18,508
1983	19,131
1984	19,776
1985	20,443
1986	21,132
1987	21,845
1988	22,580

2.4.4 The future supply of vegetable fat

The oil hydrogenation plant which is to be built at Villamontes will have a production capacity of 4,125 tonnes/year, assuming it operates on the basis of a single shift per day.

In estimating the degree to which the plant will be able to cover the requirements of the domestic market, the guiding assumption is that only 70 per cent of the projected consumption of lard and fats can be substituted by vegetable fat for the reason that there are applications for which this latter product cannot be used. On the basis of the planned production programme the plant will cover only 41 per cent of the projected consumption in 1979 and 99 per cent in 1980, after which its share will drop to 76 per cent in 1988.

Bolivia: future supply and demand in respect of vegetable fat (in tonnes)

Year	Output of CBF plant	Domestic demand	
		Only 70 per cent of projected consumption	Unmet demand
1979	4,800	11,730	6,930
1980	12,000	12,125	125
1981	12,000	12,533	533
1982	12,000	12,956	956
1983	12,000	13,392	1,392
1984	12,000	13,843	1,843
1985	12,000	14,310	2,310
1986	12,000	14,792	2,792
1987	12,000	15,292	3,292
1988	12,000	15,806	3,806

2.5 Price analysis

2.5.1 Oil prices

The following table indicates the movement of vegetable oil prices during the period from 1965 to 1977.

Movement of average prices for imported oil

(in current Bolivian pesos per litre)

Year	Imported oil (Bolivian pesos)	Price index (1965=100)	Domestic oil (Bolivian pesos)	Price index (1965=100)
1965	7.00	100	7.00	100
1966	7.00	100	7.00	100
1967	7.50	107	7.00	100
1968	7.80	111	7.76	111
1969	7.00	100	7.27	104
1970	7.21	103	7.91	113
1971	7.38	105	7.25	104
1972	7.38	105	8.65	124
1973	9.29	133	11.57	165
1974	24.27	347	19.70	281
1975	23.65	338	23.65	338
1976 1/	23.20	331	23.75	339
1977 2/	-	-	22.98	328

Source: National Institute of Statistics, Ministry of Industry, Commerce and Tourism.

1/ The 1976 per-litre price fluctuated between 20 and 33.60 Bolivian pesos.

2/ The per-litre price for the first quarter fluctuated between 20 and 23 Bolivian pesos throughout the entire country with the exception of the Department of Beni, where the price was 27.50 Bolivian pesos.

As can be seen from the table above, prices remained fairly constant during the period from 1965 to 1972, but rose in 1973 (as a result of the devaluation) and even more in 1974 because of government economic measures resulting in shortages and, hence, hoarding and speculation. An additional contributing factor was higher prices in the exporting markets, especially Argentina. The table shows that there was a price increase from 9.29 to 24.27 Bolivian pesos between the years 1973 and 1974, i.e. an increase of 161 per cent. There was a slight rise during the period 1975-1977 due to the elimination of taxes on oil trading.

Following the analysis carried out in July 1977, the Ministry of Industry, Commerce and Tourism decided to put into effect the following schedule of official wholesale and retail prices for edible oil.

Current edible oil prices (in Bolivian pesos)

	Wholesale	Retail
200-litre barrel	3,900.00	20.00 per litre
5-litre tin	110.00	112.00
4.75-litre tin	107.00	109.00
1.5-litre tin	37.00	35.50
0.9-litre tin	22.00	23.00
1-litre bottle	24.40	23.50

In addition, prices of 1.50 and 5.00 Bolivian pesos per litre were set for the sale of packaged cotton-seed cake and soya cake, respectively.

2.5.2 Lard prices

The trend in prices for this product has been upward, sometimes gradually and other times sharply, varying from department to department. For example, in the Department of La Paz there was an increase in price of 15.40 per cent during the period 1970-1974; there was an increase of 15.33 per cent in the Department of Cochabamba, an increase of 16.33 per cent in the Department of Tarija and an increase of 15.81 per cent in the Department of Beni. From these figures it is clear that the price increases have varied according to the specific zones involved, this being a reflection of the importance of the transport cost factor, as will be evident in the following table.

Consumer prices of Argentine lard

(Annual average per kilogram in each department)

(in Bolivian pesos per kg)

City	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
La Paz	5.40	5.00	5.20	5.34	5.30	5.93	8.36	20.74	20.08	20.00
Cochabamba	6.00	5.00	4.75	5.67	6.00	6.42	-	21.00	20.00	20.00
Oruro	5.89	5.00	6.00	6.00	6.00	6.25	12.84	21.68	22.06	20.00
Potosí	5.11	5.00	-	5.30	5.80	5.80	-	19.00	-	-
Chuquisaca	5.97	5.00	5.00	5.61	6.00	6.25	8.53	21.88	19.42	18.17
Tarija	6.00	5.00	5.00	6.00	6.10	6.19	-	22.63	19.70	20.75
Santa Cruz	6.00	6.00	6.00	6.23	6.00	6.37	9.13	23.68	20.00	-
Beni	7.00	7.00	-	6.69	7.20	7.25	10.15	22.54	23.00	22.70
Pando	9.00	9.00	8.00	10.00	-	9.00	-	-	-	-

Source: Ministry of Industry, Commerce and Tourism

7.' The domestic oilcake market

The plants that produce balanced and concentrated animal feeds are the consumers of oilcakes, a by-product of the Villamontes Vegetable Oil Plant. These feed plants are located for the most part in the Departments of Cochabamba and Santa Cruz.

Bolivia: plants producing balanced and concentrated animal feeds

Plant	Location
IMBA	Cochabamba
Nutrinal	Santa Cruz
Gra e y Cía	Cochabamba
Avi ola Chulumani	La Paz
Molino San Sebastián	Cochabamba
Sin Par Mix	Santa Cruz
Molinos Santa Pilar	Cochabamba
Molinos Kavir	Cochabamba
PIL- Cochabamba	Cochabamba

Source: [illegible], UAI, [illegible].

The country's demand for soya cake will be determined by the total installed capacity of the above plants plus any future expansion they may undergo.

Bolivia: installed and projected capacity of plants producing balanced animal feeds (in tonnes)

Plant	Total capacity	Expansion	Total
IMBA	14,400	19,200	33,600
Nutrinal	12,000	24,000	36,000
Grace y Cía	14,400	-	14,400
Avícola Chulumani	14,400	-	14,400
Molinos San Sebastian	12,000	-	12,000
CICO	6,000	-	6,000
Sin Han Mix	4,500	4,500	9,000
Molinos El Pilar	6,600	-	6,600
Molinos Oscar Navia	3,300	-	3,300
PIL-Cochabamba	2,500	-	2,500
Coop. SCZ	-	31,680	31,680
Totals	90,000	79,380	169,480

Source: Estudio de Prefactibilidad Alimentos Balanceados, ISAP, 1975.

Soya cake accounts for 10 per cent of the formulation of balanced animal feeds, so that a figure of 16,948 tonnes may be taken as the future annual consumption of this product.

2.7 Domestic soya-flour market

The rising demand for wheat flour in our country, which is not a producer of this cereal grain, has led to studies on the possibility of producing compound flours by mixing wheat flour with the flour of other cereals, including soya. This results in an increase in the nutritional value of foods prepared from wheat flour, such as bread, food pastes, biscuits, cakes, etc.

The following table indicates the demand for wheat flour on a department-by-department basis.

Bolivia: demand for wheat flour according to department (in tonnes)

Department	1975	1976	1977 */
La Paz	61,500	63,340	65,240
Cochabamba	20,400	21,010	21,640
Oruro	29,800	30,690	31,610
Santa Cruz	17,000	17,510	25,180
Potosí	8,900	9,170	9,440
Chuquisaca	4,000	4,120	4,680
Tarija	2,600	2,600	3,310
Beni-Pando	3,300	3,400	3,500
Bolivian Mining Corporation	10,000	10,380	10,300
Armed Forces	5,000	5,150	5,150
Total	162,500	167,370	180,050

*/ Projected data.

Source: Ministry of Industry, Commerce and Tourism. Plan Operativo 1977.

On the basis of this table and the population statistics obtained through the 1976 census, the following figures have been calculated for the per capita consumption of wheat flour:

Bolivia: per capita consumption of wheat flour (in kg/year)

Year	Consumption
1975	35.3
1976	35.6
1977	37.5

Source: A CBF internal study.

By applying the equation y = 1.10 x + 33.93 and the estimated population data for the next few years to an extrapolation of the per capita consumption of wheat flour, one arrives at the following table indicating the projected domestic demand for this product.

Bolivia: projected demand for wheat flour

Year	Per capita consumption (kg/year)	Population	Total demand (tonnes/year)
1975	35.3	4,524,774	159,725
1976	35.6	4,644,228	165,335
1977	37.5	4,765,442	178,704
1978	38.3	4,829,820	187,280
1979	39.43	5,017,445	197,838
1980	40.53	5,148,776	208,680
1981	41.63	5,290,882	220,259
1982	42.73	5,436,911	232,319
1983	43.53	5,586,969	243,201
1984	44.93	5,741,170	257,951
1985	46.03	5,899,205	271,540
1986	47.13	6,077,951	286,454
1987	48.23	6,262,113	302,022
1988	49.33	6,451,856	318,270

Source: Diagnóstico Industria Alimenticia, Ministry of Industry, Commerce and Tourism. CBF internal study.

In countries where there is a tradition of using soya flour in combination with wheat flour good results have been obtained by adding the former in proportions of up to 15 per cent. On the basis of the experience of these same countries, the following table has been prepared showing the estimated requirement for soya flour over the next few years.

Bolivia: estimated demand for soya flour (tonnes)

Year	Total flour demand	Wheat flour	Soya flour
1978	187,280	159,335	27,945
1979	197,838	167,416	30,422
1980	208,680	175,768	32,912
1981	220,259	184,402	35,857
1982	232,319	193,325	38,994
1983	243,201	202,546	40,655
1984	257,951	212,072	45,879
1985	271,540	221,914	49,626
1986	286,454	232,078	54,376
1987	302,022	242,578	59,444
1988	318,270	253,420	64,850

Source: CBF internal study.

In addition to increasing the nutritional value of the derivative products, the addition of soya flour to wheat flour is to the country's financial advantage in that it makes it possible to save the foreign exchange that would otherwise have gone to pay for the imported wheat for which the soya flour is used as a substitute.

III. SIZE AND LOCATION

3.1 Production capacity

The hydrogenation of vegetable oils consists in the addition of hydrogen to the non-saturated molecular bonds of the oil. This operation requires the use of the following equipment:

- A hydrogenation unit;
- A hydrogen-production and gas-handling unit;
- A post-refining unit.

It is believed, on the basis of the market study, that it will be possible to process 12,000 tonnes of vegetable fat a year from 1980 onwards. In line with this target, consideration has been given to the offer of the (name withheld by UNIDO) , which includes the equipment mentioned above and would provide a production capacity of 16.5 tonnes per eight hour period, i.e. an annual production capacity of 12,000 tonnes, assuming operation 250 days of the year.

3.1.2 Gradual build-up to full-capacity operation

Allowing for the starting up of operations and for performance testing, during its first year the plant will operate at 80 per cent of its installed capacity, moving to full capacity with the beginning of the second year.

3.1.3 Factors which affect size

Obviously, it was the market study that was the decisive factor in selecting the production capacity for this plant, a capacity which at the same time represents the minimum economic size for an edible-fat production facility.

In addition, the individual capacities of the equipment units mentioned in 3.1 above are directly related to the capacity of the different operations of the vegetable oil refinery now in existence at Villamontes.

3.2 Location

The hydrogenation plant will be built at Villamontes in the Department of Tarija, because of the advantages of this area, as described below.

3.2.1 Existing infrastructure

Villamontes is the largest community in the Chaco and an important commercial centre. The region is now regarded as a noteworthy development area because of such current local projects as the CBF-built vegetable oil plant, the Pilcomayo River Irrigation Programme - which is now in the construction and experimentation phase - and the agricultural development of the zone, with respect particularly to the cultivation of oil-seeds, an initiative of the private growers of the area.

Villamontes is linked by rail to Santa Cruz in the north and Argentina in the south. There are also motor roads offering access from this locality to Santa Cruz in the north and to the Department of Chuquisaca and other areas of the Department of Tarija in the west, and ultimately to the entire country.

3.2.2 Raw material supplies

A point of particular importance is that, in selecting the site for the hydrogenation plant, consideration was given to the desirability of ensuring a direct supply channel for the raw material, which in this case consists of the refined oil produced by the vegetable oil plant. The siting of the plant somewhere else would have required the transport of large quantities of oil by means of high-capacity tank vehicles or other means, none of which are currently available for this kind of transport assignment. The handling and shipping of the finished product will obviously be simpler, as this is solid and will be broken down into portions.

3.2.3 Services

In order to ensure the proper operation of the Villamontes Vegetable Oil Plant a number of services have had to be provided which it will now be possible to use in the hydrogenation process. These include the following:

- Electric power. The vegetable oil plant obtains its electric power from three generators providing a total installed capacity of 2,400 kW. In view of this plant's requirements, there will be sufficient energy to meet the needs of the hydrogenation plant as well.
- Production and generation of steam. The oil plant also has a steam boiler with a capacity of 10 tonnes/hour at a pressure of 12 kg/cm^2, which can be used as a source of steam for the two facilities.
- Mention should also be made of the drinking-water, compressed-air, sewerage and other systems which are already in place and are the property of the oil plant and whose adaptation to the hydrogenation process will require only a modest investment.
- Gas supply. A consideration of great importance is the gas supply for the generation of hydrogen. The State-owned petroleum enterprise (Yacimientos Petrolíferos Fiscales Bolivianos) has built, expressly for the Villamontes Vegetable Oil Plant, a branch of the gas pipeline with its related pressure-reduction, monitoring and other systems, which, as it is being used at considerably less than its full capacity, can provide natural gas to the new facility for the production of hydrogen in the amounts required.

- Packaging plant. The oil plant has its own factory for tin-plate containers, whose plate cutting and shaping machinery will be used for the packaging of the finished hydrogenated products.
- Marketing. It will be possible to utilize the same marketing channels now used for the sale of edible oil.

3.3 Distribution channels

The product will be marketed in tin-plate containers weighing 17 kg (net weight) and identical in their characteristics to the containers used for the packaging of lard.

As the melting point of the vegetable fat product will lie above 45°C, there will be no need for refrigeration in transport or storage to preserve the fat in its solid state.

It is considered that, as the product in question is solid, the problems currently encountered in transporting oil will not arise - i.e. it will be possible to send the vegetable butter by road or rail from Villamontes to its final destination.

IV. TECHNICAL ASPECTS

4.1 Production process

The hydrogenation of fatty oils involves an industrial process, particularly in the manufacture of vegetable cooking-fat, margarine and high-fat-content soaps.

In addition to transforming the oils into solid fats, hydrogenation improves the colour and eliminates the objectionable odour and taste of the unrefined oil. The degree of hydrogenation and the direction of the reaction are determined by the temperature, pressure, catalyst, mixing efficiency and the purity of the oil and hydrogen.

In addition to the hydrogenation unit known as a "converter", a hydrogenation plant consists of equipment for the following processes:

- Refining of the oil;
- Generation and storage of the hydrogen;
- Deodorization and filtration of the hardened oil.

The refining operations will be performed using the equipment currently installed at the Villamontes Plant. The hydrogen will be produced using natural gas supplied by Yacimientos Petrolíferos Fiscales Bolivianos through the gas pipeline through which the vegetable oil plant is now supplied with gas for the generation of electric power and steam and for other uses.

The hydrogenation process is carried out in closed tanks in which the oil is mixed with the catalyst and hydrogen is injected. The process takes place as follows:

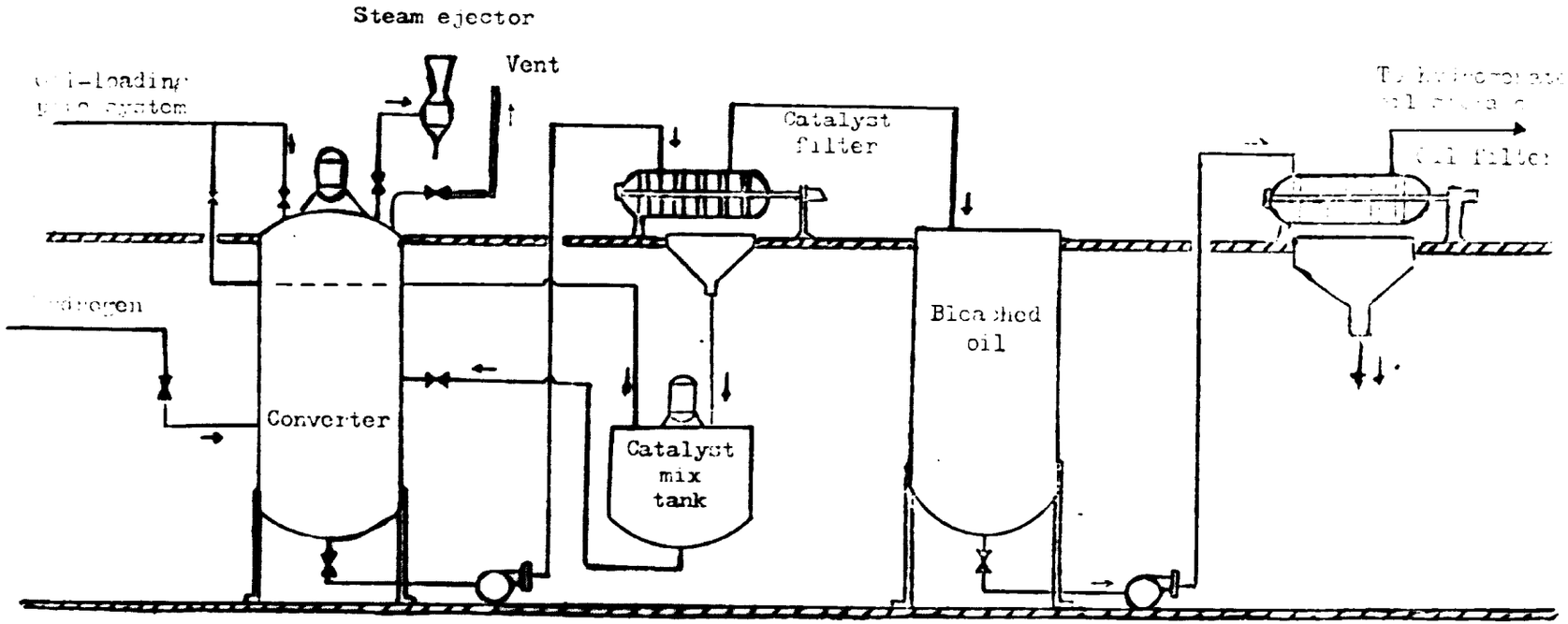
The oil and catalyst are pumped into the reactor and steam is injected into the heat-exchanger. The latter consists of an internal pipe coil which heats the mixture to a temperature of approximately 100°C in order to produce the reaction with the hydrogen. Since hydrogenation is an exothermic reaction, there is no need for continued heating. The temperature is regulated by allowing cold water to circulate through the internal piping. The most suitable final temperature is 175°C and the pressure 30 lbs. The attainment of the hydrogenation point is determined according to the iodine number or the melting point, after which the injection of hydrogen is discontinued and cooling is brought about through the circulation of cold water through the coil. Cooling continues until the oil is brought down to a temperature at which it will not turn dark on contact with the air, but still remains sufficiently liquid for the subsequent filtration operation in which the catalyst is recovered. Finally the filtered fat is subjected to a vacuum deodorization process.

Diagram 3-1 shows a flowchart of the hydrogenation process.

Diagram 3-2 indicates the interrelationship between the hydrogenation process and the refining process currently carried out at the Villamontes Plant.

4.2 Physical means of production

OPERATIONAL DIAGRAM OF THE HYDROGENATION PLANT



FLOWCHART

Relation of Villamontes Plant processes and hydrogenation plant

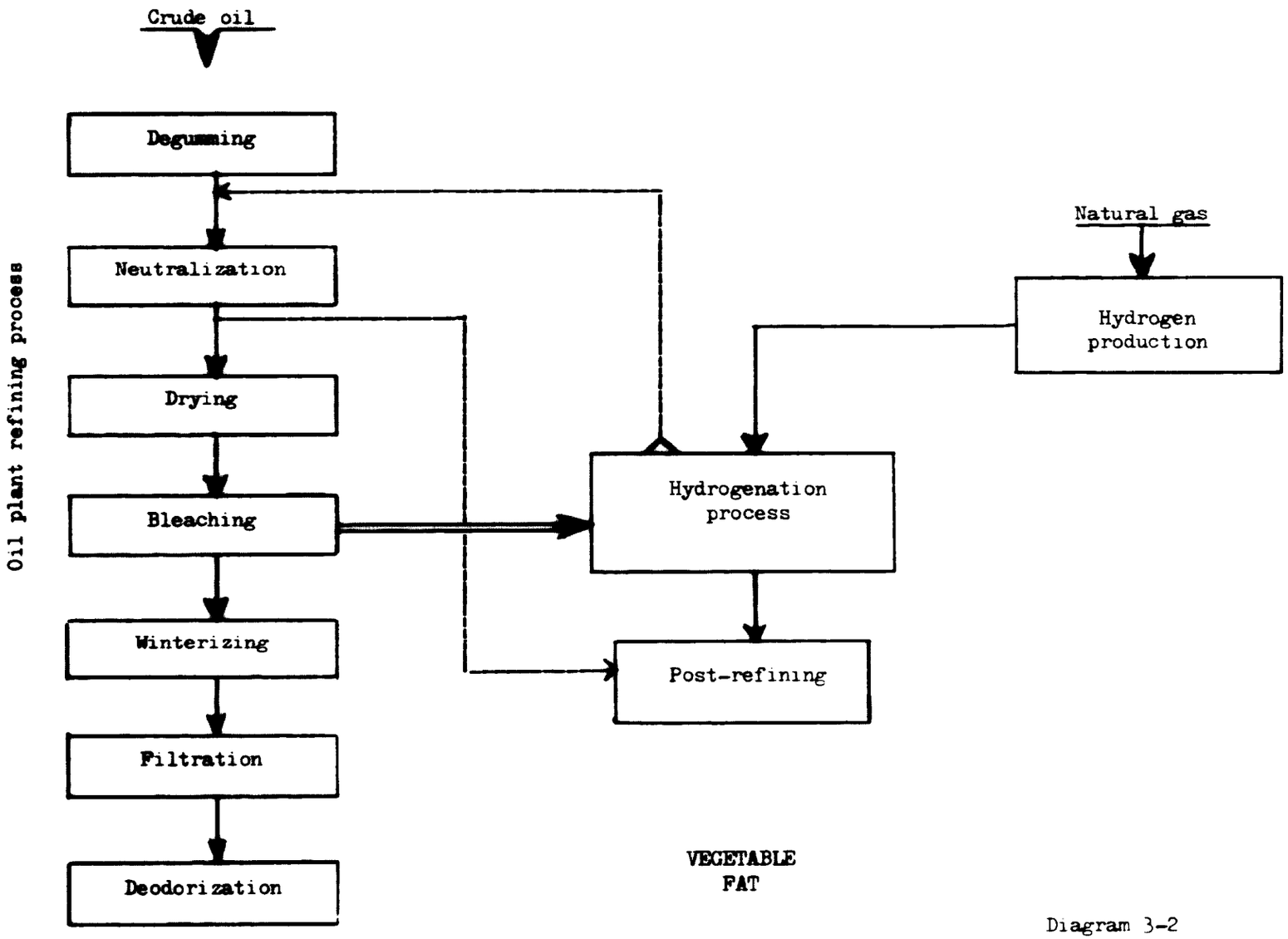


Diagram 3-2

4.2.1 Land

The grounds of the present vegetable oil plant, which cover an area of 11 hectares, are available for the erection of the hydrogenation plant.

4.2.2 Buildings

An area of 400 m^2 has been considered for the erection of the building to house the hydrogenation equipment and the storage areas for the processed vegetable fat. The hydrogen production plant, on the other hand, will be set up in the open air next to the hydrogenation equipment.

4.2.3 Machinery and equipment

The complete equipment will consist of:

- Hydrogenation unit;
- Post-refining unit;
- Hydrogen-production and gas-handling unit;
- Auxiliary services.

Operating conditions:

- Ambient temperature: 0 to 40° C
- Altitude: Up to 500 metres above sea level
- Electric power: 380 V, 3 HP, 50 Hz
- Steam: 150 psig

4.2.4 Hydrogenation unit specifications

The hydrogenation plant consists mainly of a stainless steel tank designed for vacuum operations, in which the heating, drying, hardening and cooling operations are carried out. Plant operations are relatively simple and require only a minimum of manpower.

The equipment of the hydrogenation plant consists of:

- A pump for feeding in the semi-refined oil;
- A stainless steel converter with pipe coil, agitator and monitoring instruments;
- Two catalyst storage tanks (one for new and one for used catalyst);

- A steam injection system;
- A centrifugal pump for discharging the hardened oil;
- A filter press for filtering the hardened oil;
- An instrument control panel for in-process monitoring of the operations;
- Piping, valves and fittings;
- A vegetable fat tank.

4.2.5 Hydrogen production equipment

- Gas desulphurizing unit;
- Catalytic reforming oven;
- Separator.

4.3 Operational requirements

- Hydrogenation unit (per tonne of processed oil):
  - Steam: 207 kg
  - Water: 0.25 m^3
  - Installed power: 53.0 HP
  - Power consumption: 8.50 kWh
- Post-refining unit (per tonne of processed oil):
  - Steam, vacuum system: 12 kg
  - Water, vacuum system: 0.16 m^3
  - Steam, heating process: 108 kg
  - Water, cooling process: 0.046 m^3
  - Installed power: 64.5 HP
  - Power consumption: 4.80 kWh
- Hydrogen production unit:

The hydrogen consumption depends on the type of raw material used and the desired degree of saturation. Different raw materials, whether vegetable or fish oils, have a different iodine number (i.e. the number of grams of iodine absorbed under precisely defined conditions by 100 grams of fat), which indicates the average degree of saturation. The oils likely to be hydrogenated in the plant have the following iodine numbers:

- Soya oil: 130
- Cotton-seed oil: 105
- Ground-nut oil: 93

For fats the numbers are:

- Lard (United States): 68
- Lard (Argentina): 60

Accordingly, when the iodine number of the oils is lowered by hydrogenation of their molecules, they become solid fats, and the new iodine number must be such as to convert the fat into a product whose melting point is higher than the average ambient temperature so as to prevent it from returning to the liquid state.

In conclusion, soya and cotton-seed oil must be hydrogenated until their iodine number becomes similar to that of lard, with a melting point of 60° C.

On the assumption that the hydrogenation plant will process soya oil only, hydrogen consumption has been calculated as follows:

- Iodine number of the oil: 130
- Iodine number of the fat: 80
- Difference 50

Since for every point by which the iodine number is lowered an additional one m^3 of hydrogen is consumed, for a tonne of processed soya oil we would have:

50 m^3 of hydrogen per tonne of oil.

For the planned output of 12,000 tonnes of oil per year the annual consumption of hydrogen will be 600,000 m^3.

This amount of hydrogen will be produced by the fractionation of natural gas with the injection of steam. This process will consume the following quantities of gas, water and electric power:

- Natural gas: 162,000 m^3/year
- Cooling water: 27,600 m^3/year
- Process water: 1,240 m^3/year
- Electric power: 32,800 kWh/year

V. CALCULATION OF INVESTMENT COSTS

The total investment required for this project amounts to $US 2,312,900, broken down as follows.

5.1 Fixed capital

Machinery and equipment	
This includes the erection of a complete plant for the hydrogenation of the oil, including the hydrogen production equipment and storage tank. CIF Puerto.	$US 1,500,000
Cost of transport to Villamontes	
Freight and insurance from Puerto to Villamontes, Tarija.	150,000
Installation costs	
Investment required to meet all the costs of installing the machinery and equipment, including the purchase of any additional facilities for the plant.	198,000
Civil engineering	
Construction of the building to house the production equipment; built-up area of approximately 600 m^2 (including shed).	72,000
Total fixed capital	$US 1,920,000

5.2 Deferred assets

Interest during installation	
Amount corresponding to the financing cost of the external loan during the period when the plant is being put up.	$US 170,000

5.3 Current assets

Working capital

The working capital regarded as part of the project investment does not include the purchase cost of the semi-refined oil, as this raw material will be supplied directly by the Villamontes Vegetable Oil Plant.

For the calculation of the remainder of the intermediate inputs we shall assume a stock on hand for three months' operation:

- Steam, water, electricity and gas	$US 6,000
- Catalyst	45,000
- Packaging	160,000
- Wages and salaries	5,900
- Lubricants and miscellaneous costs	2,500
- Contingencies (2%)	3,500
Total	222,900

5.4 Summary of investments

Fixed capital	$US 1,920,000
Deferred assets	170,000
Current assets	222,900
Total investment	2,312,900

5.5 Financing of the total investment

The financing of the project is based on securing an external loan and on a contribution of capital from the Bolivian Development Corporation.

External loan: amount and conditions

The total loan amounts to $US 1.7 million, to be granted under the following conditions:

- Annual rate of interest: 10%
- Grace period: One year
- Full term: 11 years
- Repayment of capital: In equal half-yearly instalments.

A table showing how the loan is to be repaid is given at the end of this chapter.

The purpose of this loan will be to cover the following investment costs:

- Machinery and equipment, CIF Puerto	$US 1,500,000
- Installation costs	198,000
- Costs of transport to Villamontes	2,000
Total	$US 1,700,000

Capital contribution of BDC

The Bolivian Development Corporation will contribute $US 612,900, with this amount to be used to finance the following project investment costs:

- Cost of transporting machinery from Puerto to Villamontes	$US 148,000
- Civil engineering	72,000
- Interest during installation	170,000
- Working capital	222,900
Total	$US 612,900

External loan

Amount: $US 1.7 million
Interest rate: 10 per cent per annum
Grace period: One year
Full term: 11 years

Six-month period	Principal	Interest	Repayment
0	1,700,000		-
1	1,700,000	85,000	-
2	1,700,000	85,000	-
3	1,615,000	85,000	85,000
4	1,530,000	80,750	85,000
5	1,445,000	76,500	85,000
6	1,360,000	72,250	85,000

(Cont'd) ...

Six-month period	Principal	Interest	Repayment
7	1,275,000	68,000	85,000
8	1,190,000	63,750	85,000
9	1,105,000	59,500	85,000
10	1,020,000	55,250	85,000
11	935,000	51,000	85,000
12	850,000	46,750	85,000
13	765,000	42,500	85,000
14	680,000	38,250	85,000
15	595,000	34,000	85,000
16	510,000	29,750	85,000
17	425,000	25,500	85,000
18	340,000	21,250	85,000
19	255,000	17,000	85,000
20	170,000	12,750	85,000
21	85,000	8,500	85,000
22	-	4,250	85,000

VI. ECONOMIC AND FINANCIAL STUDY

6.1 Income

The income will be produced by the sales of the vegetable fat to be manufactured.

The sales price, ex works, will be $US 995 per tonne.

Over and above this price it is estimated that the cost of transport from Villamontes to La Paz will be $US 40 per tonne. Considering further a distributor's profit of $US 30 per tonne and handling costs of $US 5 per tonne, we arrive at a final price per tonne of $US 1,070.

6.2 Production cost

6.2.1 Variable costs

Raw material

Semi-refined vegetable oil

Year	Tonnes	$US/tonne	Total cost ($US)
1979	4,800	840	4,032,000
1980	12,000	840	10,080,000

It is estimated that the semi-refined vegetable oil will be available at a cost of $US 840/tonne, the difference being attributable to the cost of the deodorization required to produce a refined oil (see annex).

Steam

	1979	1980
Hydrogenation unit (tonnes/year)	993.6	2,484
Post-refining unit (tonnes/year)	576.0	1,440
Total	1,569.6	3,924

Cost of steam

Year	$US/tonne	Total cost ($US)
1979	3.50	5,500
1980	3.50	13,735

Water

	1979	1980
Hydrogenation unit (m^3/year)	1,200	3,000
Post-refining unit (m^3/year)	990	2,470
Hydrogen production unit (m^3/year)	11,500	28,840
Total	13,690	34,310

Cost of water

Year	Bolivian pesos/m^3	Total cost (Bolivian pesos)
1979	0.75	10,268
1980	0.75	25,733

Electric power

	1979	1980
Hydrogenation unit (kWh/year)	40,800	102,000
Post-refining unit (kWh/year)	23,040	57,600
Hydrogen production unit (kWh/year)	13,120	32,800
Total	76,960	192,400

Cost of electric power

Year	$US/kWh	Total cost ($US)
1979	0.025	1,925
1980	0.025	4,180

Natural gas (for the hydrogen production unit)

Year	m^3/year	$US/1,000 cubic feet	Total cost ($US)
1979	64,000	0.625	1,430
1980	162,000	0.625	3,575

Catalyst

The consumption rate of catalyst being 3 kg per tonne of soya oil, 26,000 kg of nickel oxide will be required for the planned 12,000 tonnes of oil.

Year	Kg/year	$US/kg	Total cost ($US)
1979	14,400	5	72,000
1980	36,000	5	180,000

Packaging

The entire output will be marketed in tin containers of 17 kg capacity.

Year	Containers/ year	$US/ container	Total cost ($US)
1979	300,000	0.85	255,000
1980	750,000	0.85	637,500

Lubricants

The annual cost of lubricants has been estimated at $US 2,500 for the first year and $US 5,000 beginning with the second year.

Spare parts and accessories

The estimated costs under this heading, beginning with the third year, amount to $US 40,000 per year.

Wages and salaries

Job category	Number	Monthly remuneration ($US)	Total cost ($US)
Supervisors	3	250	9,000
Workers	6	100	7,200
Warehousemen	10	60	7,200
Total			23,400

Social benefits

The cost of social benefits has been put at 60 per cent of wages and salaries.

Contingencies

A figure of 2 per cent of the total variable cost has been adopted for contingencies.

6.2.2 Fixed costs

Insurance

Insurance has been set at 1.5 per cent of the total value of the fixed capital.

Year	$US
1979	14,400
1980	28,800

Administrative overheads

It is expected that these expenses will cover such things as travel, travel allowances, work clothing, stationery, etc.

Year	$US
1979	2,500
1980	5,000

Depreciation

Assets	Total value	Residual value	Depreciable value	Annual rate	Annual depreciation
Machinery and equipment	1,650,000	165,000	1,485,000	10%	148,500
Installation costs	198,000	19,800	178,200	10%	17,820
Civil engineering	72,000	7,200	64,800	5%	3,240
Interest during installation	170,000	-	170,000	20%	34,000
Total					203,560

Depreciation from year 1 to year 5 $US 203,560

Depreciation from year 6 to year 10 $US 200,320

Interest on the external loan

In accordance with the repayment schedule, the financing cost will be as follows:

Year	$US
1979	85,000
1980	157,250
1981	140,250
1982	123,250
1983	106,250
1984	89,250
1985	72,250
1986	55,250
1987	38,250
1988	21,250

Contingencies

Contingency provisions equal 2 per cent of overheads.

6.3 Break-even analysis

The basis of calculation is the year 1980.

$$BEP = \frac{FC}{1 - \frac{VC}{I}}$$

where: BEP = break-even point
FC = fixed costs
VC = variable costs
I = income

$$BEP = \frac{393,910}{1 - \frac{11,178,955}{11,940,000}}$$

BEP = $US 6,174,138

BEP = 52% capacity

6.4 Cash flow

It will be evident from the table below that the project has sufficient capacity to meet the financial obligations imposed by the external loan. The cash flow analysis indicates that the required investment can be recovered between the sixth and seventh year of operation, after the financial obligations have been satisfied.

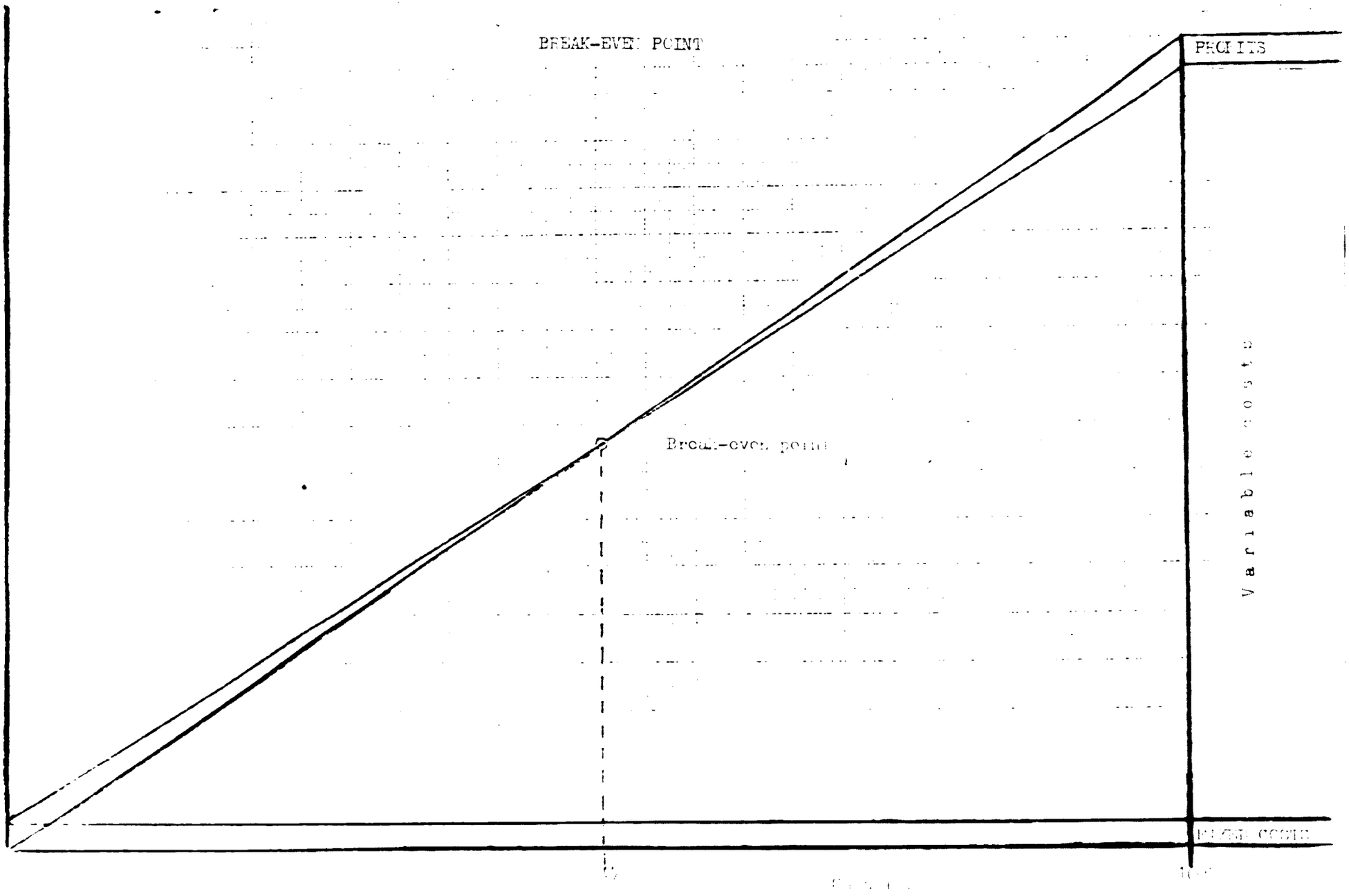
($US)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
INCOME										
Sales of vegetable fat (tonnes)	4.800	12.000	12.000	12.000	12.000	12.000	12.000	12.000	12.000	12.000
Price, ex works ($US/tonne)	995	995	995	995	995	995	995	995	995	995
Sales ($US)	4.776.000	11.940.000	11.940.000	11.940.000	11.940.000	11.940.000	11.940.000	11.940.000	11.940.000	11.940.000
PRODUCTION COST										
1. Variable costs										
Raw material (semi-refined oil)	4.032.000	10.080.000	10.080.000	10.080.000	10.080.000	10.080.000	10.080.000	10.080.000	10.080.000	10.080.000
Steam	5.500	13.735	13.735	13.735	13.735	13.735	13.735	13.735	13.735	13.735
Water	515	1.290	1.290	1.290	1.290	1.290	1.290	1.290	1.290	1.290
Electric power	1.925	4.810	4.810	4.810	4.810	4.810	4.810	4.810	4.810	4.810
Gas	1.430	3.575	3.575	3.575	3.575	3.575	3.575	3.575	3.575	3.575
Catalyst	72.000	180.000	180.000	180.000	180.000	180.000	180.000	180.000	180.000	180.000
Packaging (1/-kg containers)	255.000	637.500	637.500	637.500	637.500	637.500	637.500	637.500	637.500	637.500
Lubricants	2.500	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000
Spare parts and accessories	-.-	-.-	40.000	40.000	40.000	40.000	40.000	40.000	40.000	40.000
Wages and salaries	11.700	23.400	23.400	23.400	23.400	23.400	23.400	23.400	23.400	23.400
Social benefits	7.020	14.040	14.040	14.040	14.040	14.040	14.040	14.040	14.040	14.040
Variable cost contingencies (2%)	86.442	215.605	215.605	216.605	216.605	216.605	216.605	216.605	216.605	216.605
Subtotal	4.476.032	11.178.955	11.219.955	11.219.955	11.219.955	11.219.955	11.219.955	11.219.955	11.219.955	11.219.955
2. Fixed costs										
Insurance	14.400	28.800	28.800	28.800	28.800	28.800	28.800	28.800	28.800	28.800
Administrative overheads	2.500	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000	5.000
Depreciation	101.780	203.560	203.560	203.560	203.560	200.320	200.320	200.320	200.320	200.320
Interest on external loan	85.000	157.250	140.250	123.250	106.250	89.250	72.250	55.250	38.250	21.250
Fixed cost contingencies (2%)	50	100	100	100	100	100	100	100	100	100
Subtotal	203.730	394.910	377.710	360.710	343.710	323.470	306.470	289.470	272.470	255.470
3. Total cost	4.679.762	11.573.865	11.597.665	11.580.665	11.563.665	11.543.425	11.526.425	11.509.425	11.492.425	11.475.425
PROFITS										
Gross annual profits	96.238	367.135	342.335	359.335	376.335	396.575	413.575	430.575	447.575	464.575

CASH FLOW

(US$)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
SOURCES										
Depreciation	101.760	203.560	203.560	203.560	203.560	200.320	200.320	200.320	200.320	200.320
Gross profit	96.238	367.135	342.335	359.335	376.335	396.575	413.575	430.575	447.575	464.575
TOTAL SOURCES	198.118	570.695	545.895	562.895	579.895	596.895	613.895	630.895	647.895	664.895
USES										
Repayment of external loan	85.000	170.000	170.000	170.000	170.000	170.000	170.000	170.000	170.000	170.000
CASH ON HAND										
Annual	113.118	400.595	375.895	392.895	409.895	426.895	443.835	460.895	477.895	494.895
Cumulative	113.118	513.813	889.708	1.292.613	1.692.498	2.119.393	2.563.288	3.024.193	2.502.078	3.999.973


BREAK-EVEN POINT
PROFITS
Break-even point
Variable costs

VII. PROJECT EVALUATION

7.1 Calculation of the internal rate of return (IRR)

Period	Cash flow of the project ($US)	Discounted cash flow	
		20%	15%
0-1	2,312,900	-2,114,222-	-2,155,629-
1-2	198,118	150,926	160,772
2-3	570,695	362,277	402,739
3-4	545,895	288,778	334,961
4-5	562,895	248,124	300,361
5-6	579,895	213,053	269,071
6-7	596,895	182,710	240,847
7-8	613,895	156,605	215,354
8-9	630,895	134,128	192,486
9-10	647,895	114,807	171,887
10-12	664,895	98,139	153,391
12-13	220,800	27,158	44,292

$$IRR = 15 + \frac{327,532}{464,449} \times 5$$

IRR = 18.5%

7.2 Benefit to the Villamontes Vegetable Oil Plant

Base year: 1980

Current situation

Because of the current situation on the international vegetable oil market, the Villamontes Vegetable Oil Plant will be able to produce no more than 5,000 tonnes a year. With production at this level, the plant will have an unused capacity of 10,000 tonnes/year, which means barely 33 per cent utilization of capacity. As a result, the enterprise's financial position would be extremely precarious, as indicated by the following figures:

Income	
Sale of 5,000 tonnes of vegetable oil	$US 5,004,000
Sale of 25,000 tonnes of oilcake	$US 5,650,000
Total	$US 10,654,000
Operating costs	
Variable costs	$US 9,200,000
Fixed costs	$US 3,284,000
Total	$US 12,484,000
Total losses	$US 1,830,000

Situation with hydrogenation operation added

The hydrogenation plant would enable the Villamontes Vegetable Oil Plant to operate at 100 per cent of its installed capacity; only 3,000 tonnes of its oil output would be sold on the domestic market, while the remaining 12,000 tonnes would be hydrogenated. Under these conditions, the profit and loss account of the Villamontes plant would appear as follows:

Income	
Sale of 3,000 tonnes of oil (domestic market)	$US 3,002,400
Sale of 12,000 tonnes of oil for the hydrogenation process	$US 10,080,000
Sale of 78,500 tonnes of oilcake	$US 15,815,000
Total	$US 28,897,400
Operating costs	
Variable costs	$US 23,783,236
Fixed costs	$US 3,284,389
Total	$US 29,067,625
Loss	$US 170,225
Profits	
The estimated profit realized by the hydrogenation plant for the base year is:	$US 367,135
NET PROFIT FOR THE OIL AND HYDROGENATION PLANTS	$US 196,910

This analysis points to the conclusion that were the Villamontes Vegetable Oil Plant to continue operating under the present conditions, it would, because of the limited size of the domestic market, show an annual loss of approximately $US 1.8 million.

The hydrogenation plant will make it possible to reduce this figure to only $US 170,000. In addition, through the combined operations of the vegetable oil and hydrogenation plants it will be possible to realize an annual profit of $US 196,000. This makes clear the need to build the hydrogenation plant at Villamontes.

ANNEX

COST OF PRODUCING 15,000 TONNES OF SOYA BEAN OIL

	$US
1. Variable costs	
Extraction plant	
Soya raw material: 95,670 tonnes at $US 250/tonne	23,917,500
Chemical products	392,008
Wages and salaries	71,508
Social benefits (60%)	42,904
Contingencies (2%)	500,000
Total cost of extraction	24,923,920
Refining plant	
Chemical products	185,259
Packaging for oilcake	550,000
Wages and salaries	64,563
Social benefits (60%)	38,721
Contingencies (2%)	20,800
Total cost of refining	859,316
Total variable costs	25,783,236
2. Fixed costs	
Wages and salaries	87,024
Social benefits (60%)	52,214
Insurance	70,000
Fuel and lubricants	45,000
Advertising costs	12,000
Administrative overheads	7,500
Contingencies (2%)	5,500
Total fixed costs	279,238
Total cost of production (excluding financing costs and depreciation)	26,062,474

	$US
3. Financing costs (in 1979)	
Interest on internal loan	1,243,813
Interest on external loan	570,569
Total financing costs	1,814,382
Total cost of production (including financing cost)	27,376,856
4. Depreciation (in 1979)	1,190,769
TOTAL COST OF PRODUCTION	29,067,625
5. Less income from oilcake	
Export of 63,500 tonnes of oilcake at $US 190/tonne	12,065,000
Sale to the domestic market of 15,000 tonnes of oilcake at $US 250/tonne	3,750,000
Total income from oilcake	15,815,000
NET COST OF PRODUCTION	13,252,625
Net cost per tonne of vegetable oil	883.50
Net cost for litre of vegetable oil	15.77

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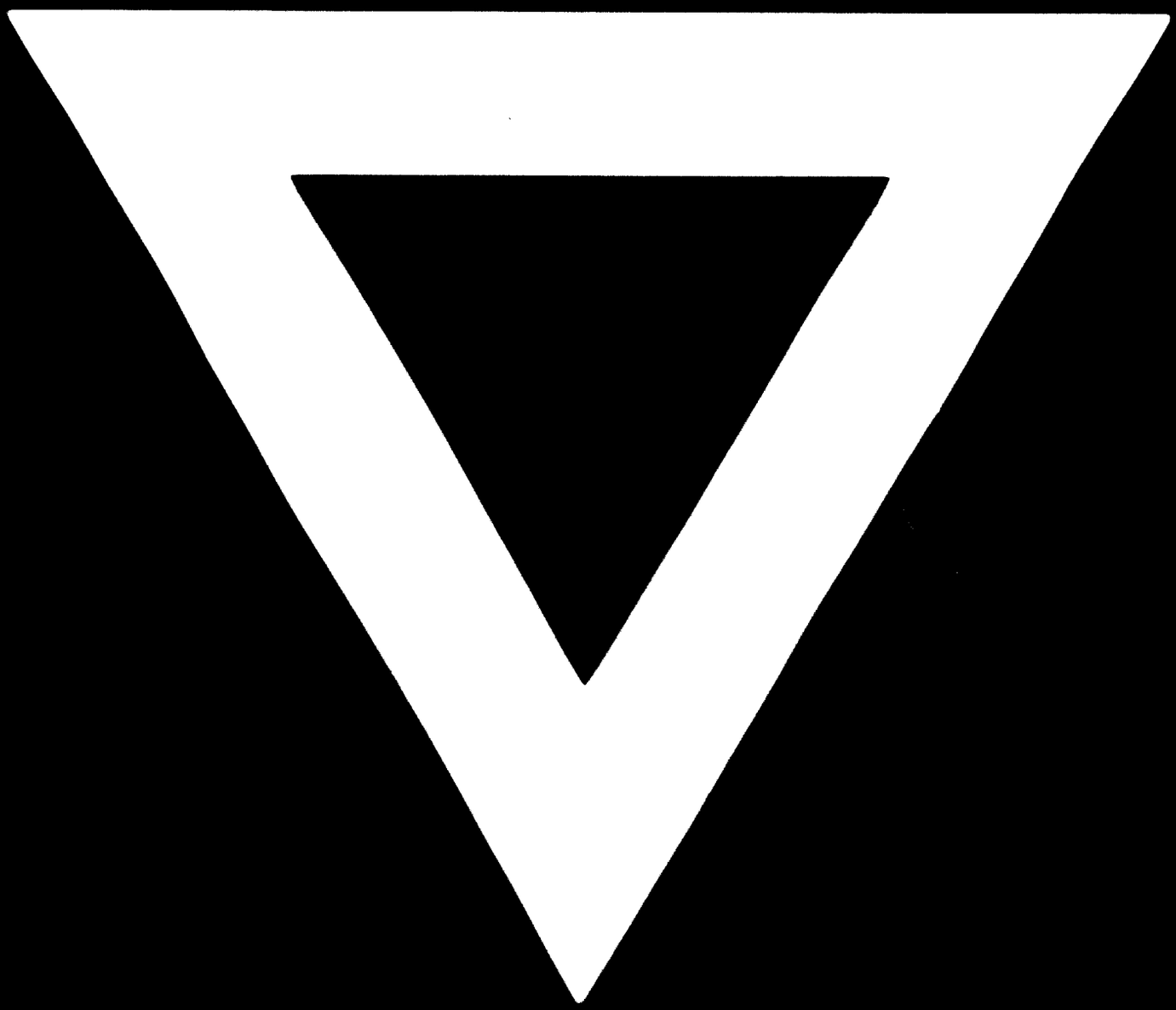

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