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FEASIBILITY STUDY OF A MULTI-PURPOSE PESTICIDE PLANT IN NORTH-EAST BRAZIL[1]

by

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I - INTRODUCTION

Prognosticating that "the green revolution heralded a new and better era for the developing countries", but stating that in the latter "the use of pesticides has not increased at a rate commensurate with the increase of other physical inputs, leaving a vulnerable point in crop production," the UNIDO experts have given full justification for the timeliness of convening of this workshop on pesticides.

It was also very fitting to enumerate, in the draft aide-mémoire, the principal problems hindering the formulation and, even more so, the local manufacture of basic pesticides in developing countries.

Notwithstanding the abundance of certain raw materials and the expansion of its industries, Brazil is still facing - as a developing country - many of those problems related to the production of basic pesticides. The only sector in which difficulties are no longer being encountered is that of formulation.

At the seminar organized by UNIDO and held in Rio de Janeiro in November 1970 for the development of the fertilizer and pesticide industries in Latin America, I had the honour of presenting as Brazilian official lecturer on pesticides, an extensive paper in which I described the existing situation and future prospects of the Brazilian market in that sector. The characteristics described in that study have not changed in the subsequent 30 months, with the exception of the fact that, as a result of valid projections on production and demand of pesticides, development of this industry has considerably accelerated to keep in line with the so-called "Brazilian miracle".

The major subject of the present study is to examine the feasibility of establishing a multi-purpose plant for the production of basic pesticides in Brazil.

II - CURRENT SITUATION

Brazil has a population of 100 million inhabitants to feed, and an area of 8.5 million square kilometers. Yet of that area, only 330,000 km^2 is actually cultivated, amounting to only 4% of the total. Hence the immediate goal for heading off hunger in a population growing at a rate of nearly 3% a year is that of boosting agricultural productivity per unit area of farm land. For this purpose, about one million tons of fertilizers will be applied during the present year, and demand projections indicate that by 1980 consumption should attain a level of 2.4 million tons yearly.

But if natural enemies are not to jeopardize the sought-for increase in agricultural production, demand for pesticides will also have to rise substantially. Actually, the existing plants are indeed being expanded with every year that goes by. The HOECHST establishment in São Paulo, for instance, operating to peak capacity in 1967, produced that year 1,500 tons of 100% technical grade DDT. It has since been expanded to the point that in 1971 it made 6,000 tons; a further increase to 6,500 tons was recorded in 1972, and this year the plant is expected to manufacture 8,000 tons of technical grade DDT.

The point may be raised as to why we keep on using so much DDT. There are technical and economic reasons for this. In the Public Health field no insecticide has yet been obtained capable of fully substituting DDT, for purpose of erradication of malaria. Our choice therefore still is DDT on the walls rather than malaria in the population. In agriculture the same is true of our cotton plantations, on which it is impossible to do away with DDT, since it is the most efficient agent consistent with economy.

That is why, despite the fact that some non-polluting pesticides are already being produced in Brazil, such as methyl- and ethyl-parathion, we cannot however, in the near future, relinquish the organo-chlorinated pesticides, since to do away with them pure and simple would entail consequences far more serious than their pollutant action in itself. Besides this, such effects can be reduced to tolerable limits by the controlled use of the products.

III - THE MULTI-PURPOSE PLANT

As I indicated in detail in my 1970 paper, Brazil already is preparing the majority of the pesticide formulations it needs, the vehicles and diluting agents being readily obtainable in the country in satisfactory quality and quantities. The need is nevertheless felt for greater diversification in the manufacture of basic pesticides. Until recently this fact might have been accounted for by the economic infeasibility of such diversification, based on low domestic consumption and the high cost of the raw materials, or even lack of such raw materials.

Recently, however, a series of favourable circumstances came into existence in Brazil which to our mind permit the production of a number of different pesticides in a single polivalent plant that could operate economically and produce at prices that would be competitive even on the international market.

The whole thing started a number of years ago, when government incentives began to be granted for industrial projects established in certain areas of Brazil considered as being lacking in development. Thanks to this, the North East is today the region of the fastest rate of development in the entire country. Currently being installed there is the second largest petroleum chemicals center in Brazil, not to mention a whole series of other industries. Prominent amongst the major projects now being set up is that for SALGEMA CHEMICAL INDUSTRIES, a caustic soda and chlorine plant located in the State of Alagoas, over the largest bed of rock-salt discovered in the entire country up to the present time.

At present, practically the whole output of caustic soda takes place in South East Brazil, in plants considered small by modern standards and which process sea salt brought from a considerable distance at high prices. This output covers only 40% of the demand in the domestic market, which today consumes 330,000 tons of caustic soda a year. But when the plant in the North East is completed next year, involving an aggregate investment of US$67 million, it will be in a position to produce every year 250,000 tons of caustic soda and 220,000 tons of chlorine. The whole of this caustic soda will be readily absorbed by the domestic market, displacing imported soda which comes in at a price so high that it cannot compete even with the existing plants in the South East of Brazil. As regards chlorine, however, there will be a substantial surplus available which is unlikely to be absorbed in full for the next few years. Besides this, the fact that "SALGEMA" is 2,000 kilometers away from major consuming centers (São Paulo) is an additional adverse factor in the light of the well-known difficulties of transportation of the product. The company, which belongs to Brazilian interests associated with Du Pont, intends to sell the chlorine at US$ 60.00 per ton. (1)

Our idea consists precisely of utilizing the chlorine referred to, as the main raw material for the manufacture of a number of basic pesticides, in a plant which could be located near to "SALGEMA", and could receive the gas over a pipe line.

We shall proceed to examine these pesticides that could be made by the polivalent plant in question.

IV - THE PROBLEM OF COFFEE RUST IN BRAZIL

Brazil is the major coffee producing country in the world, and had 2.27 billion trees planted as of 1971, according to a Brazilian Coffee Institute estimate. At the same time, unfortunately, the country was being scourged by a terrible plague, the fungus "Hemileia Vastatrix", commonly known as "coffee rust". Once the plant is attacked there is no known treatment that could save it. But there are fungicides capable of protecting those plants that have not yet been attacked. And as the fungus can travel at considerable distances, practically every coffee plant has to be protected.

The principal fungicides have been tried out by a number of groups of research workers belonging to both private industrial firms and official agencies, and in all tests the efficiency of products based on copper has been borne out. On the basis of tests going on for one and a half years the Brazilian Coffee Institute classified amongst the best products against coffee-rust the copper oxychloride (containing 35% of metallic copper), when applied at a rate of 6 kg. per hectare. (2)

Taking this concentration, and bearing in mind that the treatments will have to be given from once to five times a year, dependent on circumstances, it is estimated that average demand will amount to 24 kgs. of oxychloride per 1,000 coffee trees per year. Since oxychloride is not produced in Brazil, 12,000 tons of the salt were imported in 1972, a quantity sufficient for treating 500 million trees. But if oxychloride were to be produced in Brasil, a far higher percentage of the 2.27 billion trees could be treated with the product. Studies might accordingly be made for a capacity of some 20,000 tons a year, for the production of copper oxychloride in the polivalent plant suggested.

V - MANUFACTURE OF COPPER OXYCHLORIDE

Copper oxychloride or cupric oxychloride is a salt of varied composition, containing from 24 to 57% of metallic copper and whose formula might be expressed as $2\ CuO\ CuCl_2 \cdot 4\ H_2O$. For fungicidal purposes it is applied as a dust or spray.

There are a number of processes for manufacturing copper oxychloride, the commonest being by means of a reaction between cupric hydroxide and cupric chloride or hydrochloric acid. in solution.

The cupric chloride is obtained by treating cupric oxide by hydrochloric acid itself, which presents no problems of production when chlorine is available.

The cupric oxide may be obtained from scrap copper, which is abundant in the North East where it sells for US$ 0.50/kg. As a matter of fact, the North East is also the location of the largest known copper deposits in Brazil, estimated to amount to 48 million tons with a metal conent of 3%. The Federal government recently took over control of the concessionaries to the beds - located at 400 kms. from SALGEMA - with a view to speeding up operations.

As regards cupric hydroxide, finally, this is obtained by treating copper sulphate in solution with ammonia. The hydroxide is then precipitated by means of caustic soda. Ammonia, incidentally, is another item produced in the North East.

Local production of the copper sulphate is an easy matter. All that is needed besides the copper is sulphuric acid, also available in the region.

VI - CUPROUS OXIDE AS FUNGICIDE

The largest cocoa plantation in Brazil is located in the State of Bahia, also in the North East. But this plant is attacked by a fungus causing the so-called "brown rot", for whose control cuprous oxide is used. Brazilian consumption of this fungicide is not large.

Obviously there would be no justification for putting up a plant to produce this alone. But if the polivalent plant here studied were to produce cupric oxide as a raw material for the obtaining of copper oxychloride, it might be feasible to produce cuprous oxide too. Both oxides could be produced in the same kiln, inasmuch as the cupric oxide changes into cuprous oxide above 1,030°C. Marketing of this product, even if it failed to afford great profit, would provide growers with another specific non-imported fungicide, and this diversification might encourage higher consumption.

VII - BENZENE HEXACHLORIDE

We are by no means unaware of the restrictions placed on the use of persistent organo-chlorinated insecticides. But just as in the case of DDT there are situations in which we cannot dispense with BHC. In the Public Health sector, for instance, the combatting of the hemipterous insect - "bug" - transmitting Chagas disease has been made possible in Brazil only with the application of BHC in all houses in the endemic areas. The Ministry of Health, responsible for the insect control campaign, uses 570 tons of wettable BHC powder containing 30% of the gama-isomer every year for these applications. The product sells in Brazil for $US 0.40/kg., and is imported because the only BHC plant in operation in Brazil is not equipped nor in a position to produce a wettable powder in that concentration. There were two other plants making low concentration BHC, but they ceased operating several years ago. The lack of incentives to such activity was the fact that the whole of these old plants are located in the South East, where chlorine costs US$ 75.00 per ton on account of the high prices of salt, power, labour, and all other inputs in the region.

Brazilian farmers are using more and more BHC, and the local plant mentioned previously has been supplying a technical grade product with 16% of the gama isomer, of which it made 4,414 tons in 1971 and 5,825 tons in 1972.

The product is sold at US$ 0.17/kg. The output is insufficient to meet the demands of consumption, however. This is why imports are permitted on a contingent basis, meaning that they are authorized to the extent of a certain proportion of the domestic production, so as to avoid jeopardizing the latter. This is a salutory measure for protection and encouragement of local production, but it does reveal the tight situation in the consumer market.

The main crop grown in the North East is sugar cane, of which Brazil is today the world's largest producer. The plagues that attack the crop need to be combatted. Yet economic conditions prevailing in the region are such as to permit only a single application of insecticide a year. It is for that reason that they have resorted to BHC. It means a choice between protection of the cane by means of an inexpensive residually effective insecticide, or loss of the crop, bringing poverty for all those whose living depends on it.

It is our belief that the production of NHC in the North East based on cheaper chlorine and labor, availing of all of the government incentives for the region, will permit advantageously competitive prices all over the country. Besides this, the adoption of a more sophisticated technology will permit the obtaining of a more highly concentrated BHC, which will also meet the requirements of the public health campaigns.

The other necessary raw material, benzene, will not create any problems since in the plans for the establishment of the petroleum chemicals center in the North East the Government authorities decided to recommend that the new industries producing aromatics should be included.

As regards the main equipment, the reactor vessels ought to be designed so as to be able to operate with the utmost versatility. This ought not to prevent, however, the adoption of more specific equipment whenever technical or economic motives render this desirable. We would cite as an example a case that occurred with our own team, when it installed for the Ministry of Health in 1950 a BHC plant to operate by chemical catalysis at low temperatures. This process caused rapid wear of the lead lining of the chlorinating vessels, which weighed heavily in the capital cost. Then a cylindrical shaped wooden cask device was constructed, of a height three times the diameter, without any lining at all. After this system had been approved in tests, five of these low cost casks were used to replace the lead-lined iron vessels used previously. During the next four years during which the plant remained in operation the wooden reactor vessels did not require any substantial repairs whatever, and with their use it was possible to obtain in a half-hour period of chloration a BHC containing up to 50% of the gama isomer after evaporation of the stable solution removed from the decanting tanks.

VIII - TOXAPHENE

Toxaphene is another organo-chlorin ated insecticide still required by Brasil. In association with DDT it possesses a synergistic action which is highly efficient in combatting certain cotton insects. Brazilian imports of technical grade toxaphene 90% amounted to 3,079 tons in 1971 and 3,080 tons in 1972. There was no production in Brazil, but only formulation, and the 10% powder sold for US$ 0.30/kg.

It is our belief that annual domestic production at a rate of 5,000 tons of technical grade toxaphene could be readily placed on the domestic market in the various formulations. The only raw material required, camphene, would be eligible for a tariff redution or perhaps even exemption from duties. It would be chlorinated until it contained 67 to 69% of the halogen, in which state the mixture of isomers known as toxaphene would be obtained.

The very same equipment would be used to chlorinate a mixture of camphene and pinene, which gives another insecticide already marketed in some countries. Also from these components of terebentine it is possible to produce iso-bornil-thiociano-acetate, an insecticide with a powerful knock-down action.

IX - 2,4-DICHLOROPHENOXY-ACETIC ACID

The herbicides based on 2,4-D which are used in Brazil are all derived from the foreign market. 2,473 tons were imported in 1971, and 1,800 in 1972.

This reminds me of the fact that when I participated in the Training Program for Industrial Production of Pesticides sponsored by UNIDO, in 1970, one of the lecturers at the University of Syracuse, N.Y., was Dr. John Burton, who had much to say about this product. In dealing with the topic of "Pesticide Production Processes", he based his subject on a presentation of the smallest details of the manufacture of 2,4-D. He explained that in the USA plants making upwards of 2,270 tons of this herbicide a year (or 5 million pounds, as he put it), were profitable at that level.

It can be acceptable in the developing countries to operate plants at lower than optimal scales of production, even in the chemical industry. This would not be necessary in the case in point. The existing Brazilian market already consumes the quantity referred to above, which is why there would be grounds for designing for a higher installed capacity, say 5,000 tons a year. This would bring the capacity up to that suggested for toxaphene. The plant being a polivalent one, it would be economical if it could be designed for the various product outputs, in terms of the purpose and size of machinery and installations.

X - POSSIBILITIES FOR OTHER PESTICIDES

In the light of the consumer market already in existence, we feel that the pesticides discussed in this paper justify in themselves a project study for a polivalent plant for producing them in Brazil. Later we shall be going into the investments which would probably be required, and the whole of the assistance that might be forthcoming from the Brazilian government for such an undertaking.

We shall now briefly examine a few other pesticides whose lower consumption in the Brazilian market should not prevent their consideration for future production, or rather, for the utilization of idle equipment when inexpensive raw materials are available.

XI - TRICHLORFON

This is the di-methyl ester of 2,2,2-trichloro-1-hydroxy-ethyl phosphonate much used in the form of a sweet bait for flies, with great efficiency. It has the additional advantage of being an organo-phosphonate of low toxicity for warm-blooded animals (LD_{50} = 450 mg/kg), which permits its household use.

The entire Brazilian consumption comes from imports of the product of technical grade: 569 tons in 1971 and 440 tons in 1972.

A projected capacity for the production of 1,000 tons of trichlorfon a year would not be out of line, provided plans covered polivalent equipment whereby a part of the product would be transformed into two other insecticides mentioned next.

XII - DDVP

These initials stand for di-methyl, 2,2-dichloro vinyl phosphate, also known as dichlorvos. It is the insecticide most widely used in sprays and aerosols in Brazil. It was at one time produced domestically in small quantities, but nowadays the entire supply is imported: 108 tons came in during 1971, and 100 in 1972.

DDVP may be obtained by means of dehydrochlorination of trichlorfon.

XIII - NALED

Imports of this product, in technical grade, amounted to only 18 tons in Brazil in 1971 and 20 tons in 1972. Production in Brazil would be aimed merely at increasing the consumption of trichlorfon as a raw material, since naled is produced by treating DDVP with bromine, and should find some special uses.

Use of bromine as a raw material would be a new problem to be solved. It might therefore be worthwhile to use bromine for the halogenation of more than a single product, as we shall now postulate.

XIV - METHYL BROMIDE

Much used for the fumigation of plants, stored grains and against rats, though its main application in Brazil is for combatting ants, the worst agricultural pest in the country. Methyl bromide is not manufactured in Brazil, and imports have fluctuated considerably, though the figures recorded for the past two years were 732 tons in 1971 and 718 in 1972.

It might therefore be the second product to be derived from bromine. The other raw material required is methanol, the largest Brazilian factory of which is currently under construction in the North East, and is due to have an initial production of 60,000 tons in 1974.

XV - DIBROMOCHLOROPROPANE

Brazil uses practically no nematocides, as in 1970 only 10,350 kg of dibromochloropropane were imported, and 9,050 (for a value of US$ 10,000) in 1972. Hence production of this item in the polivalent plant would be justified only as a form of promotional diversification, if the equipment and bromine were available.

As regards bromine as a raw material, there has already been production in the country on a small scale, by a firm that purifies sea salt. We believe higher domestic consumption of bromine would provide incentives to intensified local extraction.

XVI - CYCLODIENES, CARBAMATES, ETC.

Many other pesticides might also be considered for future production, such as, for instance, the cyclodienes, synthesized by the chlorination of cyclopentadiene, the first fraction from distillation of the aromatics obtained in the coking plants of the steel industry. In Brazil this raw material is currently discarded due to lack of available consumers.

The carbamates might also be considered in future, since Brazil is now importing 500 to 600 tons of carbaryl a year.

We suggest, finally, that attention be paid to an insecticide that exists in native form in the North and North East of Brazil and that we saw being formulated in the United States, where it is recommended as a non-polluting pesticide. All that has to be done is to grind the roots of plants of sp. Lonchocarpus, known as timbó, which contain as their active principle rotenoids having insecticidal activity. In Brazil timbó is used also for consortiated planting, interspersed with crops, which stimulates growing of the product. The extraction of the rotenoids requires a simple technology only.

In any case, whatever pesticides are considered for production by the polivalent plant proposed here, it is obvious that they will have to be studied from the point of view of possible involvement of any patents that may be in force.

XVII - FORMULATIONS

No matter which pesticides be selected for initial production in the polivalent plant, we feel the undertaking will be the more profitable the higher the quantity of those pesticides formulated by the firm itself. This has, indeed, been the trend in the US pesticide factories in the last few years.

In the case of highly diluted formulations these would be prepared within the plant or in association with it only when intended for consumption in the North East itself, to the extent that it may be transported and still be sold at prices competitive with those offered by the local formulators.

Both the necessary diluents and the vehicles for distribution are readily obtainable in the region.

The plant might in the future build a second formulation facility, say in São Paulo, for direct coverage of the requirements of the consumer market in the Center-South of the country.

The firm could meanwhile sell the balance of its technical grade output to other formulators who might be interested in it, in Brazil and abroad, availing itself of the export incentives provided by the Brazilian government.

XVIII - INVESTMENTS AND INCENTIVES

In an initial feasibility study such as this, it is not possible to specify the investment required for a polivalent plant, in the light of the number of variables still to be determined. I remember visiting a pesticide plant in the south of the United States, belonging to a European group that had invested there a sum of US$ 100 million. On the other hand, I saw others that were far less expensive, such as a formulation facility that could not have entailed an outlay of more than US$ 250,000. And in the Midwest I actually saw a pilot plant for pesticides that had cost US$ 800,000!

As all those who are familiar with chemical industrial projects are well aware, only after specifying and sizing the equipment required for the manufacture of a given product, with the degree of vertical integration required and in the quantities designed, is it possible to have an idea of the amount of investment needed.

It is, however, possible to give an outline of the kind of investment currently being made in chemical industries in the Brazilian North East. You may remember that we have referred to the sum of US$ 67 million involved in the caustic soda plant. There is also a petroleum chemicals center being set up at a cost of US$ 120 million. And around the latter a start is being made for the establishment of 23 chemical products plants that are going to consume petrochemical raw materials, representing an aggregate investments of US$ 670 million[3], corresponding to a mean investment of US$ 29 million per plant.

To suggest such a level of investment for a pesticide factory in a developing country might appear an exaggeration. But it should be borne in mind that what is aimed at is a polivalent plant. Strictly speaking, what is involved would be a number of plants forming an industrial complex.

Besides this, a substantial portion of the required investments might be obtained from third parties, in line with one or other of the incentives the Brazilian government grants to those industries prepared to locate in the North East. More specifically, up to 65% of the investment might be financed by official Brazilian banks and another 25% would be obtainable from other firms that invest in the North East, a percentage of which is deductible from income tax liabilities as permitted by law (art. 34/18).

The Brazilian government permits import, free from customs duties, of all such equipment that cannot be manufactured in the country. That imported equipment could be brought in as part of the foreign investment or with external financing, for which the official Brazilian banks would grant credit guarantees.

For equipment manufactured in the country the Brazilian government is prepared to extend financing to the manufacturers.

The Brazilian legislation furthermore permits the transfer of complete plants to Brasil, provided they are willing to export a considerable portion of their output (decree law 1236 of 28-8-72).

As regards raw materials not available in the country, the government permits import with customs duties exemption.

With reference to the products output by the proposed new plant, the government would establish a customs duty on similar imported items, with a view to protecting those made in Brazil.

Profits obtained by the company from such a plant situated in the North East would also be income-tax free for ten years.

And for a plant for formulations to be set up in the South, instead of exemption from income tax there would be a reduction of the latter, calculated in accordance with a favourable write-off rate.

Other incentives might also be granted by the State and Municipal governments, with reference to the building lots required and the infrastructure, meaning water supply, drainage and sewage networks, etc.

XIX - CONCLUSION

Our objective in presenting this study, undoubtedly open to criticism, has been merely to arouse the attention of interested groups to the immense possibilities of development of the basic pesticides industry in a country that covers half a continent and that in the past four years has been maintaining a G.N.P. growth rate of ten per cent a year!

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