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SUBSTANTIVE EVALUATION DISCUSSIONS ON THE SETTING-UP OF A MAIZE GERM PROCESSING PLANT FOR THE PRODUCTION OF EDIBLE OIL*

SI/ZAM/77/801

ZAMBIA

Terminal report

Prepared for the Government of Zambia
by the United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of M. Schneider, oilseed processing technologist

United Nations Industrial Development Organization
Vienna

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CONCLUSIONS:

1. After describing the principal theories of the dry and humid separation methods of the maize and maize germs, it results that the existing dry degermination installations can be maintained if they are in good shape, but new installations should follow using the humid method. All new maize mills with more than 100 tons capacity should have their own degerminator.

2. The present daily production of corn meal, only along the Copperbelt/Livingstone line of rail, is 3,000 tons/day. That quantity of maize degerminated would yield, even with a pessimistic calculation, 6,000 to 8,000tons of refined corn oil per year.

3. In order to save the proteins of the maize germs the de-oiled maize germs are to be re-cycled to the maize meal.

4. An analysis of the present crop of oilseeds and the possible future developments, shows that by 1990 some 50,000 tons of cooking oil could be produced if the necessary processing installations are provided.

5. To cope with the crop in the 1980's and the last decade of the century, a daily capacity of prepressing of about 550 tons, solvent extraction of 600 tons and refining of 200 tons will be necessary.

6. It is proposed to increase the daily capacity of prepressing of ROP Lusaka, to almost 300 tons, and instal at ROP Lusaka, one Solvent Extraction Plant with 200 tons capacity. ROP Lusaka would de-oil the sunflower, groundnut and cottonseed produced.

   One solvent-extraction plant and a small refinery should be installed in the region north of Lusaka, in Ndola or Kabwe, together with the existing mill, and another to the south of Lusaka, or around Lusaka, together with a maize mill or stock-feed production.

7. In order to partly overcome the present difficult situation in the supply of cooking oil, the prepressing capacity of ROP should be increased by new machinery for the seed cleaning and preparation and with one or two suitable prepresses. This would bring the capacity of the Zambian oil industry to over 10,000 tons of oil per year as against less than 5,000 tons at present, saving K six million in foreign exchange yearly.

8. The total capital investment for the maize germ project will be less than K two million in foreign exchange, and less than K three million in Zambian currency, saving K six million yearly in foreign currency.

9. The total investment for the maize germ project and the capacity increase of the Zambian vegetable oil industry will be less than K four million in foreign exchange and less than K five million in Zambian currency, thereby saving K fifty million yearly in foreign exchange if the national production of oil seeds should permit it.

Introduction:

As a result of the investigation into the oil processing situation in Zambia, especially within the Eastern Province, a recommendation was made and a preliminary report covering the extraction of oil from maize germs was prepared. UNIDO was approached with a view to providing an expert to participate in the discussions for the setting up of a maize germ processing plant for the production of edible oil. Reference is made in this context to the UNIDO project IS/ZAM/74/001.

The expert was expected to carry out the following duties:

- Review with the authorities, the recommendations made in the final report of the project ZAM/74/001 and supplement it with further details in the light of the present situation.
- Outline and explain the techno-economic, technological and other details involved in maize germ extraction operations.
- Advise the authorities on all questions relevant to the establishment of maize germ extraction facilities in Zambia.
- To make general assessment of the existing enterprise in this field and particularly of the Refined Oil Products of Zambia and National Milling Company.

The expert arrived in Zambia on the 5th December, 1977 and departed on the 20th December, 1977.

1. The Maize-oil in the maize and the separation of the maize germ:

The following table shows the components of the maize-kernel with the relative percentage fat content and weight comparisons in per cent:

	% of weight:	% of Fat:	% of Total Fat:
		- (approximates) -	
The Hull	6	1	1.3
The Bran (Aleuron)	7	7	10.6
The Endosperm	74	0.25	4.0
The Germ	11	35	83.5
The point of the Kernel	2	1.5	0.6
Total Fat:		44,75	

We can see that the maize oil is almost completely found in the germ and the bran. In older maize, or badly stored maize, some of the oil can migrate to the endosperm (meal). The yield of the maize oil extraction depends upon how neatly the germ and the bran are separated from the meal, and also for the production of breakfast meal with good colour and low fat content the yield again depends upon the method used in the separation process. There are two ways in which to carry out the separation of the fat-containing parts from the meal:-

The dry separation method, and
the humid separation method.

With the dry separation method, the maize is broken in a special degerminator where the germ breaks out of the whole kernal, but leaving the hull and bran partly attached to the meal. The broken kernals are then passed through separating tables where the hulls, brans, and germs, as they are freed from the kernals, are isolated. Obviously, the germ-part will contain meal and bran, and the meal will also contain particles of germ. The resultant fat-content of the meal, in spite of a careful process, will be around 1.2% or more, which shows that a very important part of the germ remained with the meal. There is another loss of fat through the hull and the bran giving a total yield of oil from the separated germ at 3 to 3.2% of the weight of the whole maize kernal. When maize with a lower fat content is used, the yield would be more than proportionally lower since the fat content in the endosperm remains constant while the deficit is found in the germ.

In Venezuela, about 2.0 to 2.2% of the maize is obtained as already refined oil after dry separation and solvent extraction. The germ is of such a physical character, however, that only minimal flaking is necessary before the extraction, with no pelletizing nee[illegible].

With the humid separation method, the maize is humidified and dampened which allows the maize to be dehulled and decortigated before - and in newer processes, together with - the degermination. The result is the meal has a better colour, a lower oil content, usually below 0.9%, and a higher yield of meal. The germ is more pulverised than in the dry process and therefore requires pelletizing before the solvent extraction. The yield of oil is somewhat higher, but in order to achieve a good crude-oil quality, the germ and the pellets have to be dried if they are to be stored before the extraction.

The germ from the dry process has also to be dried if the initial humidity of the maize is higher than about 8%.

Which of the two processes should be used?

The machinery for the dry process is cheaper, but requires more maintenance. The yield and quality of the breakfast meal is higher when the humid process is used but this is not of importance if the extracted germ is re-cycled to the meal.

It seems that the best way would be to maintain the existing dry degermination installations, but when new degerminators are required in existing mills, or for any new mills, the humid process should be applied, together with the necessary pelletizing equipment.

It should be decreed that all new maize mills of a minimum of 100 tons daily capacity should have their own degerminator.

2. Present Maize Mill Situation:

The main maize mills in Zambia are on the line of rail between Mufulira and Livingstone. The capacities of these operating mills are approximately 1,300 tons of mealie meal and 700 tons of breakfast meal daily output, which corresponds to the processing of approximately 2,500 tons of maize per day. In addition there is a daily output of 300 tons from Indeco projects and a further 300 tons daily, from private projects, giving a total output of more than 3,000 tons per day.

Taking a conservative yield of 8% germs with 20% oil content, giving 1.6% crude oil, from those mills on the Mufulira/Livingstone line of rail, 240 tons of germ could be extracted producing 48 tons of crude oil or approximately 40 tons of refined oil daily, giving a total of over 10,000 tons of refined oil per year. Taking into consideration that some of the present mills are old, others not yet completed, shortages of maize, break-downs in the older mills and the usual problems in the newer mills, it should still be possible to produce about 6,000 to 7,000 tons of refined oil yearly from maize germs in 2 to 3 years time.

One milling machinery producer has calculated very roughly that the cost of renewing and installing machinery for degerminators in the above mills, including necessary equipment to improve other parts of some mills, which are in very bad repair, would require a capital in foreign exchange of approximately K1.1 million. As with all mills, other expenses such as silos, structures, and conveyors, form a greater part of the total capital outlay than with other types of plants. One would, therefore, have to account for an additional cost of K2.0 million for eventual building, erection and set in operation. For planning, offering, buying constructing and erecting the machinery, two to three years should be allowed before completion. In the meantime some of the already produced germs with 20 to 25% oil content could be pressed - if the oil pressing capacity of the country is sufficient. The bottleneck is there and this bottleneck cannot be eliminated before the first solvent extraction plant is operative or the first new low-pressure presses are working. This is a question we will investigate in the following chapters.

In order to avoid delay, INDECO, as the parent body of Indeco Milling and National Milling, should instruct one or two of the milling machinery constructors to study the problem thoroughly, in respect of the situation of his mills, and to ask them to submit their offers quickly. Then arrangements should be made immediately to select the mills which are capable of producing the biggest quantity of germs in the shortest time and which are worthwhile up-grading.

3. <u>The Proteins of the Maize</u>:

It was frequently stated that as mealie-meal forms the staple diet of the major part of the population of the country, and if, through the process of degermination of the maize, the oil and protein content was lost, serious adverse effects may be caused to the consumers. It was previously explained in the first report of 1975, that, by re-cycling the solvent extracted germ meal to the mealie meal, the proteins would not be lost. The fat is lost as part of the mealie meal but this is in any case lost through natural degradation before the mealie meal arrives to the consumer. The re-cycling of the extracted germ meal is practiced in Venezuela and in other countries of Latin America. It is true that by re-cycling the extracted germ meal the degerminated meal will loose its white colour, but the process of re-cycling is meant only for the mealie meal and not for the breakfast meal. Later on, when there is sufficient soya bean grown in the country, one can consider the production of a mixture of extracted soya-meal and germ-meal as a special high-protein meal, which

would give a high nutritional value to the whole diet of the population.

4. The oil Seeds:

At present, Zambia is not producing enough oil seeds to meet the requirements but the growing of oilseeds is progressing very rapidly. In deciding what type and size of equipment to be purchased the agricultural situation in 10 to 15 years time has to be estimated. It appears that sunflower growing is proceeding well in the country and representatives of the FAO assume a crop of 40,000 tons already, for the first years of the eighties. If this does transpire we could expect roughly 60,000 tons of sunflower seed in 1990.

Referring to the study of Mr. P. Peotinoy and the expectations of Mr. H. Olf of the FAO, we can fairly estimate for 1990, the following crop production:-

Sunflower (unshelled)	60,000	tons per year
Groundnut (shelled)	30,000	"
Cottonseed (unshelled)	30,000	"
Soya bean	40,000	"
Maize Germs	60,000	"

These oilseeds will yield about 50,000 tons of oil per year which should be sufficient for the Zambian population of 1990, but further production will have to be achieved for the time thereafter. The resultant oil cake produced if combined with Alfalfa, Sorghum, etc., could meet the national need for stock feed, but again additional seed production will be necessary. If the agricultural sector meets the above figures and surpasses these estimates thereafter, more crushing capacity and more solvent extraction will be necessary, but provision can be made for this around 1985 when the more exact results are known. At that time new decisions will have to be made on what part of the country and in what size the new industries should be established. For the present we should base our calculations on the production figures given above.

5. Requirement of Industrial Capacity and Selection of the Site of the Plant:

The different types of oilseeds will have a somewhat different treatment. Sunflower will have to be de-shelled, loosing around 30% in weight, and the kernal (40% oil) passed through a prepressing stage yielding a cake with 18% oil, which is finally solvent extracted. Groundnut will have a similar process with the exception that it arrives are the factory already without the shells. Cotton seed has to be decorticated and as the kernal has a medium oil content of about 30% it can be either fully pressed giving a cake of 6% oil, or pre-pressed and solvent extracted leaving a meal of 1% oil. The treatment given will depend upon the

available capacities. Soya bean and maize germs with their 20% oil content, are solvent extracted directly.

Taking the above working scheme into consideration, Table 1 given below, helps to find the necessary industrial capacity. It can be seen that around 100 tons of full-pressing; 250 tons of pre-pressing and 600 tons of solvent extraction capacity will be required.

It would be possible to amass all the machinery in a super-plant, but this is not advisable since any failure in any part of the equipment would bring about a major crisis in the supply of oil to the country. In addition, the transportation costs would be unbearably high and the re-cycling process of the maize germs would be made practically impossible. It is more feasible to divide the installations between three different sites and dividing the oilseeds to be treated accordingly.

Oil production has two distinct phases. One is the crushing and crude oil production, the other is the refining. The situation of the sites for these two different production activities, should not be located together. Crushing should be either near to the seed growing area, or near where the stock feed will be consumed in order to economise as much as possible on transportation costs of the bulky oil seed and oil cake. Refining should take place near the cooking oil consumption areas, viz: the cities, since it is cheaper to transport crude oil in bulk, than refined oil in cans or bottles. In the present situation the selection of sites for the new plants has already been pre-determined - also taking account of the re-cycling of the de-oiled maize germs to the mealie-meal, Lusaka is both a cooking oil and stock feed consumption area and as ROP is already established in Lusaka, the most logical solution would be if ROP Lusaka, received one solvent extraction plant of a 200 tons capacity to de-oil the prepressed oilcakes of groundnut, sunflower and cottonseed. Two other plants could be located north and south of Lusaka, possibly in Ndola or Kabwe, and Chema, where a new mill is being built, respectively. These two plants would have their own small refinery and could produce also cooking oil for their respective consumption areas.

It is also possible to think of an independent company, either south of Lusaka or in the Copperbelt, which would receive maize germs from the mills for de-oiling, refining and selling the oil, and then returning the de-oiled germ meal to the mills, paying only the difference in weight. The same company could also receive soya bean from NamBoard, produce the oil and sell the soya bean meal to the mills. Which of these two ways is chosen would depend upon the economic policies of the country.

TABLE 1

Oilseed:	Unshelled: (tons/year)	Shelled: (tons/year)	Full-Pressing: -	Pre-Pressing: (tons/day)	Solvent Extraction: -	Yield on: Oil: (tons/day)	Yield on: Meal: (tons/day)	Yield on: Oil: (tons/year)	Yield on: Meal: (tons/year)
Sunflower	60,000	42,000		168	123	67	100	16,750	25,000
Groundnut		30,000		75	55	30	44	7,500	11,000
Cottonseed	30,000	21,000	84			24	60	6,000	15,000
Soya Bean		40,000			160	32	128	8,000	32,000
Maize Germs		60,000			240	48	190	12,000	47,000
TOTALS:			84	243	578	201	522	50,250	130,000

6. Medium Term Solution of the Oil Supply

To bring the above mentioned installations into operation, about two to three years would be required, but the present situation in respect of the country's oil supply is so critical that it is not feasible to wait for such a long time, and the best plan to improve the present production by 20% would be the following:-

ROP, Lusaka, is presently producing 4,000 to 5,000 tons of crude oil per year. To improve the capacity of ROP Lusaka, the following steps should be taken:

1. In view of the inefficiency of the existing sunflower seed dehulling equipment a new suitable dehulling unit with a daily capacity of 350 tons is to be imported and installed.

2. One seed cleaner - EMCEKA, Cologne, Germany - with a capacity of 15 to 20 tons per hour should be obtained. This machine is very effective and also much cheaper than other brands.

3. One destoner from Simon, Bauer, Bühler, or other brands, with a ten ton capacity should be obtained.

4. One prepress - MASIERO 2000, San Paolo, Brazil, with 5 stage cookers, should be obtained. For the past five years we have been using these very good and extremely economic presses for prepressing sesame seed and ground nut seed. For eventual final capacity however, two prepresses would be required and therefore it would be better to order the two machines at the same time. Delivery can take up to 4 to 5 months, pushing the company, especially when the second press is ordered at the same time.

5. Change the small, complicated and ineffective Niagara filtering press for two simple filter-presses with about 60 plates of 50' by 50' in size.

If the above mentioned items are installed, the capacity of ROP will increase from the present 70 tons to 120 tons of deshelled seeds daily, to give a yield of about 10,000 to 11,000 tons of oil in 250 days.

If the second press is installed, ROP Lusaka, could prepress in addition, abo 50 tons of deshelled seeds per day, sending the cake to ROP Ndola, for final pressing. This would also mean that no extra transport costs would be involved since the final pressed cake would remain in Ndola for stock feed and the oil obtained would be refined in Ndola and sold in the Copperbelt. This operation would yield a further 7,000 tons of oil per year.

Finally, by installing the old presses of ROP Lusaka in the Eastern Province or in ROP Ndola, or in some small private oil factory, a further 10 to 20 tons of seed could be crushed per day to produce, in addition, more than 1,000 tons of oil per year.

Taking everything into consideration it would be possible to produce in 1979 or perhaps in the second part of 1978 about 10,000 tons of oil per year over the present production figures, which will bring about a saving of around K6 million in foreign exchange to the country. This is a scheme which should be attacked immediately.

In a feasibility study by ROP, a project of winterizing of oil was mentioned. It must be noted here, that such a plant, at least for the next 10 to 15 years, will be certainly unnecessary in Zambia.

7. CAPITAL INVESTMENT

(a) Maize Germ Oil

It is difficult in only a few days to receive quotations for complete plants - one needs time to receive offers from different places and evaluate them carefully. However, it has been possible to obtain by telex some approximate prices which are good enough to make some estimated calculations on the capital investment and the profitability of the project.

As mentioned previously, for the degermination of maize and pelletizing of the germs, a foreign exchange investment of about K1.1 million would be involved taking into consideration also that this amount will include the modernization of several mills. To be on the safe side we will use this figure completely, for the maize oil production. Another K2.0 million will cost the Zambian Government for implements, etc., such as buildings, conveyors, erection, and so on. For solvent extraction, one 200 ton extraction plant and part of a second 200 ton plant will be used which cost K600,000 each plus Zambian costs of K700,000 each. Out of the total capacity of 400 tons per day, only 240 tons will serve for germs, with the remainder for soya bean (the price includes the necessary preparation for the soya bean) thus only 60% of the total of K2.6 million will be charged for the maize germ project. Therefore we can estimate that for the maize germ oil production, a foreign exchange investment of (K1.1 + K0.72 =) K1.82 million will have to be made with an additional K2.87 million for works in Zambia. The production of oil will be 12,000 tons of

maize oil yearly, which will replace the same amount of imported oil of inferior quality with a foreign exchange value of K7.2 million. From this amount the value of the imported solvent, hexane, (K1.2 million yearly) has to be subtracted, giving a saving of K6.0 million yearly as a result of the operation. The foreign exchange initial expense will be covered after only a four month operation!

The total cost of the operation, including the value of the raw material, solvent, steam, electricity, water, salaries, and 10% amortization, 10% on capital and 5% for repairs, would bring the cost of the oil produced to K0.51 per kilo, against a selling price of K1.1 per kilo. Allowing about 15% of the sales price for distribution costs, a net benefit remains of K0.42 per kilo of maize oil, or K5.0 million per year, against a total investment of K6.22 million, including the costs of degermination and solvent extraction. Even being very pessimistic and allowing for higher costs of production, in 1.5 years or, at the latest 2 year time, the whole investment will be paid back, amortizing the plant in a regular way.

In its own right, the maize germ project is very sound and would help, most effectively, to save foreign exchange. The condition for the success of the operation is however, dependent upon the right selection of the installations and the co-operation of the right constructors. This is also especially important in respect of the milling equipment and the solvent extraction plant. With regard to the solvent extraction plant, preference should be given to the type with the rolling band, which is made by one Belgian and one German company. The Rotocell type does not have such good results and is also much more expensive and more susceptible to failure in operation. There are some Italian extractors on the market but I would not recommend these. In our companies in Venezuela the Belgian and the German extractors have proven to be excellent and the best.

(b) ROP, Lusaka:

To increase and improve the crushing capacity of ROP Lusaka, it is necessary to instal a complete system of seed dehulling, cleaning, flaking, prepressing (18-20% oil content in the cake), as well as a solvent extraction plant with a 200 tons per day capacity for prepressed oil cake. The existing line for the endpressing (6-8% oil content in the cake) can be used for endpressing of the prepressed cake until the solvent extraction plant is in operation. Later it will be used to crush cottonseed. For the dehulling and the flaking equipment one could ask Swiss, English and German constructors to offer their prices for adequate machinery of a capacity of about 300 tons of seed daily. In Venezuela,

we are now using, for prepressing, already the third Brazilian made press with other very good results. The price of this press is about one-third of the price of/ presses of the same capacity from Europe or the USA, and I would recommend that two of these presses with a daily capacity of 160 to 200 tons of seed each, be purchased. The Brazilian presses are simpler and easier to work with than the European or American counterpart and the prices of spare parts are only a fracti of their competitors.

We can calculate approximately, that all the above mentioned machinery, including one prepress would cost in foreign exchange about K400,000. Erection will not be very expensive since the existing building is large enough, and this can be estimated at about K100,000. Again, as already explained, this is an investment which pays back in a very short time, since with the help of these machines, the present crushing capacity of ROP Lusaka, would be increased by at least 60 tons of seed per day, corresponding to 6,000 tons of oil or K3.6 million in foreign exchange per year.

ROP Lusaka, will also require a solvent extraction plant of 200 tons daily capacity to be able to increase the production even more, and be prepared to receive sunflower, groundnut, and cotton seeds by 1980 and beyond. This solvent extraction plant does not need any preparation if the appropriate type of installation is purchased. Such a plant will cost in foreign exchange about K800,000, since the extraction of oil from cake is somewhat more difficult than that of soya bean or pelletized maize germ. The corresponding work which would be paid for in Zambian currency (building, steam boiler, erection, etc.) would amount to an additional K800,000. The total investment would be K1.6 million. With the implementation of the prepressing section and the solvent extraction RO' Lusaka, would be able to produce a yearly 25,000 tons of oil, which means a foreign exchange saving of K15 million, if the corresponding seed is available

(c) New Oil Refinery:

With the enlargement of the crushing capacity, the 100 ton per day refinery of ROP would be just sufficient for the proper crude oil production. Since the soya bean and maize germ extraction will produce a further 80 tons of crude oil daily, at least one, or possibly two, 50 ton per day refineries should be installed, together with two solvent extraction plants. The value of each of these would amount to about K100,000 each in foreign exchange and K150,000 in Zambian currency, and should be ordered a year after the ordering of the solvent extraction plant.

The total investment for the maize germ project, the extension of ROP and the new refineries would amount to a total of K3.7 million in foreign exchange and K4.6 million in Zambian currency, or a total of K6.72 million.

Recapitulating, the amounts cover the following:-

	Foreign Exchange	Zambian Currency
	(millions of Kwacha)	
Degermination and Repair of the Maize Mills.	1.1	2.0
2 Solvent Extraction Plants for soya bean and maize germs	1.2	1.4
2 Oil Refineries	0.2	0.3
Extension of ROP	0.4	0.1
Solvent Extraction ROP	0.8	0.8
Totals:	3.7	4.6

GRAND TOTAL: K8.3 million

Successful termination of that investment would allow the country to produce more than 50,000 tons of edible oil per year and 130,000 oil-meal for stock feed, if sufficient oil seeds are produced from the agricultural sector. The foreign exchange value of the oil and the oil meal is K30 million, and K20 million respectively, giving a total of K50 million.

8. WORKING CAPITAL

One of the new solvent extraction and refinery units, will require about 40 to 60 operators, with 15 to 20 administration staff, as well as the managerial staff. This means a yearly salary bill of about K1.8 million or K150,000 per month. Possibly, three months' salaries, as part of the working capital would be sufficient. Without taking into consideration the value of raw material, semi-finished and finished products, there would not be very much more working capital necessary. The amount required for raw material and semi-finished material depends upon the credit policies of NamBoard and that required for the finished products, upon the commercial habits of the country. To arrive at a more definite figure for working capital, these factors have to be investigated.

Supplement

POSSIBLE SUPPLIERS OF EQUIPMENT

Introduction

In continuation to the study effectuated in Zambia in December 1977 here follows a list of possible su pliers of equipment for the Project of one or two Maize Germ Oil Factiries as well as for the extension of the capacities of the Refined Oil Products Factory in Lusaka Zambia.

This additional study was accomplished during 7 days in the time between 25 December 1977 and 7 January 1978.

The factory will require an experienced works manager, with his substitute, and the different mechanics and electricians. The other operators will have to be trained. The Belgian constructor of the solvent extraction equipment offers schooling and training possibilities for a limited number of future engineers and foremen. After a few of the engineers have been trained, they may be allowed to visit our factories in Venezuela to see how we produce the maize meal, maize-oil, the refining and the stock feed. Also it may be very helpful in the meantime, before ordering the machinery, if some of the leading engineers of the existing INDECO enterprises made a visit to our factories.

Conclusions:

The following suppliers of equipment and constructors are proposed to be asked to submit quotations for the proviewed equipment:

Maize Degermination

BUEHLER BROTHERS Uzwil, Switzerland
SIMON ROSEDOWNS, Old Foundry, Cannon Street, Hull, England
Telex: 52226

Seed Cleaning and Preparation for the Prepressing, complet.

H. Bauermeister, Masch. Fabrik GmbH
2 Hamburg 5o. Po.Box 5o16o, Telex: o2 13 452
Buehler Brothers, Uzwil, Switzerland
Extraction De Smet, Anvers, Belgique, B-252o Edegem,
Telex: 31824 Anvers
Lurgi GmbH, D-6ooo Frankfurt am Main 2, Germany
Gervinusstrasse 17/19 Telex: 41236 -o
Simon Rosedowns, Hull England

Seed cleaning only:

EHCEKA Gompper KG. 5 Köln 91, P.O.Box 95o 18o
Telex: o8873416

Destoner:

Sutton, Steele & Steele, Inc.
1o31 South Haskell Ave. Dallas, 23, Texas, USA
Fred Forsberg & Sons, Inc.
Thief River Falls, Minnesota, USA
Oliver Manufacturing Co. , Inc.
Rocky Ford, Colorado, 81o67, USA

Desintegrator

Wc. Cantrell Co.
P.O.Box 11216, Forth Worth, Texas 761o9, USA

Decorticator for Ground Nut

Louis Samat
P.O.Box 13oo5, Marseille 399.35X, France, Telex:44o193
Cabel: SAMELA MARSEILLE

Masiero Industrial S.p.A, Sao Paolo, Bresil
Av. Ipiranga 919 - 15 Andar - Sala 1507
Telex: 112 43 25

Prepressing Equipment

Anderson Ibec
19699 Progress Drive, Strangsville Ohio, 44136
Telex: 98-0259

French Oil Mill Machinery Co.
Piqua, Ohio 45356

Fried. Krupp, Hamburg-Harburg, Harburger Eisenwerke
Hamburg-Harburg P.O.Box 105, Cabel: KOEBER HAMBURG

Masiero Industrial S.A., Sao Paolo, Bresil
Av. Ipiranga 919 - 15 Andar - Sala 1507
Telex: 112 43 25

Fritz Müller Pressenfabrik
73 Esslingen- Neckar, Postfach 310

Simon-Rosedawns, Hull England

SPEICHIM, (Presse Olier),
106 Rue dAmsterdam, Paris 9,

Solvent Extraction Plants

Anderson Ibec
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1. Maize Degermination

For the maize degermination there are two companies, who know the mills in Zambia and who are represented there. These are Bühler Brothers, Switzerland and Simen Rose-dawns, England. These two companies are very well known by Indeco, by ROP and by the maize mills and need no introduction. As I found out during my stay in Lusaka Mr. Haas from Bühler Brothers knows the characteristics of the Zambian maize mills, their equipment and their technical situation. Mr. Haas will make a study and will offer the neccssary machinery for the degermination of the maize produced in the mills along the railroad between the Zaire frontier and Livingstone. I had during my stay in Switzerland an interview with Dir. J. Amman, the manager of the milling machine section of Bühler Brothers, and as a result of this interview we found that because of the lesser amount of capital involved, and also because of the higher value of the maize oil obtained from the germs, the germs now will have a higher valuethan actually, the dry degermination method should be preferred and not the wet or semi-wet process, despite of the lower yield obtained on breakfast meal. In the case of meali meal there is no loss in meal produced, as the extracted germs will be recycled to the meali meal.

There are other vonstructors of maize mill beside of Bühler and Simon-Rosedo ns, but they are not so familiar with the Zambian situation, as the mentioned companies. Therefore in my opinion only Bühler and Simon should be asked to quote the degermination equipment.

2. ROP-Capacity extension.

To achieve a higher capacity in the ROP plant three investment has to be made:

a. Seed cleaning and preparation for Sunflower and Groundnut.
b. Prepressing equipment.
c. Solvent extraction.
d. Technical assistence for 3 to 4 years.

a, Seed cleaning and Preparation.

The list of the constructors of the seed cleaning machinery are given in the part: conclusions. General enterprises, able to deliver the complete equipment are the follows:

H. Bauermeister
Bühler Brothers
Extraction De Smet
Lurgi GmbH
Rose-Dawns
(See the adrcsses on the page with the vonclusions.)

The machinery of Bühler Brothers are known as the heaviest and most sophisticated, and also the most expensiv. The advantage is not only the lon er life of the machincry, but also the high degree of cleaning, which gives a better press cake, and the very good prepared cake with open cells facilitating the prepressing and solvent extraction operation. The total yield on oil is also higher by about o,5 %, which corroponds to about loo to 15o tons

of oil per year. This higher yield has to be balanced against the higher price of the machinery.

The rolls of Bauermeister are usually smaller in diameter having a higher revolution rate per minute. The diameter and the revolutions can be discussed with the constructor. The cleaning part is not made be Bauermeister, but they have a long experience with seed preparation.

Simon-Rosedownsas milling machinery constructors are producing the whole line. Their equipment is generally good. Details, price and delivery time should be compared with other suppliers.

De Smet and Lurgi are supplying the seed cleaning if the solvent extraction is ordered with them De Smet has his own design not very different from other constructors, They are cheaper than Bühler, but do not obtain theit quality. Anyhow, they are more than good enough for the work to be done, and one have to appreciate their experience of many installations in now some 3c years in this field.

Lurgi is buying the seed preparation, and one would have to discuss the supplier with them if the order for the solvent extraction is placed, in order to maintain the responsability in one place. Generally spoken the seed cleaning equipment and the prepress can be ordered separately, but always in concordence with the supplier of the solvent extraction plant.

Bühler and DeSmet are using a decorticator for sunflower which was developed in the USSR, having the biggest experience with that seed. As the decorticator is only a part of the whole equipment it should be ordered together with the seed cleaning plant.

Masiero, Sao Paolo is constructing also decoticators, especially for groundnut, and also rollers, but their engineering staff is not so much experienced to plan a complete installation, than the above mentioned companies. Their prices are however very low and it might be interesting to ask to include the rollers as part of thecomplete plant of other companies.

Seed Cleaners.

We had in Venezuela very good results with the cleaners of EICHA-Gompper, Köln using it for small seeds, like sesmi seed. We used it also for groundnut. The cleaner is small and therefore inexpensive, having a high capacity due to the special type of vibratory movement.

For the destoner, the following companies are specialized:
Suttny, Steele snnd Steele
Forsberg
Oliver

Buhler and DeSmet are using their own design, which is chosed [illegible] that of Forsberg, putting the air through the carpet of [illegible] by applying vacuum on the upper side, instead of positiv pressure in the downside. This constructions avoids the formation of dust in the cleaning section, and I would recommend to use that type of destoner.

Even it is not previewed by ROP to decoticate groundnut in Lusaka, it might interest you that the French company Louis Dumat, Marseille is specialized in constructing decorticators for groundnut in very different sizes, movible and immovible, and delivered a great number of them to many African countries. One or other of their machinery could be of interest for the Zambian groundnut producing areas in the Eastern Province, as well for the reception centers, as for the villages.

Masiero, Sao Paolo, Bresil developed also a simple equipment for groundnut decortication, which is in extended use in Bresil.

b. Prepressing equipment.

The following is a list of well known constructors of prepresses for oil seeds. Their adress can be find on the page of the conclusions. There are other constructors as well, but possibly with less experiende and from only local importance, as for example in India. I would recommend to consider the followin suppliers to be sure to receive machinery which are reliable having adaquate service, performance and spare parts. The proposed suppliers are:

Anderson Ibec
French oil mill
Krupp
Masiero
Fr.Müller
Simon Rosedawns
Speichim (Olier)

For the endpressing of seeds the Expeller of Anderson the machinery of French, Krupp, Müller, Rosedawn, Speichim are very well known and give excellent results, their construction is adaquate in every detail, and their material is of the highest quality as it has to be for the very hard work they have to do.

To prepress oilseeds for the solvent extraction there is not so much need of strength as the seed is pressed down to only 18 to 20% oil content, and not to 4 to 8% as in the final pressing. Therefore the press can be simpler, the question of construction material is not so decisiv. The constructors of final presses are producing also prepresses, but they are usually made to a much higher standard, than it is needed for the work. Masiero is constructing a very simple press, which would difficultly arrive to an oil-cake-content of 15 to 16%, but it forms easily a cake with 18 to 20% oil, exactly what is needed. His construction material is not the highest quality of steel, the axes are rather thick walled tubes, than a solid cylinder, but agail this is more than good enough to

for what is expected from it. Because of the simpler construction and by using lighter materials the price of the Nasiero press is much lower, some times only half or one third of other presses. We bought in Venezuela already the third press of the type 2000 which can crush 150 to 200 tons per 24 hours on seeds, and we are very satisfied with it. Therefore I would recommend to ask quotation for that prepress and considering it in the expansion of the ROP plant. I would propose, in the case of a visit of a Zambian delegation to Venezuela to extend the tour to Sao Paolo also, as some times it is possible to achieve better prices, payment conditions and delivery times by personal contact.

c. Solvent Extraction plant

There are quite a number of companies who are building continuous solvent extraction plants but using only four principles The first and oldest of these prinicipals is the use of baskets. The cake is filled in the baskets, which are linked to a chain. The chain is moved in a horizontal way in the form of a loop. On the upper part of the loop the cake in the basket is washed with hexane of gradually lower oil concentration to yield a countercurrent process of washing out the oil from the cake. In the dawn part of the loop the irrigation of the cake is continued but finally the basket is reversed and the desolventized deoiled cake falls out of the basket, and is transported out of the extractor. The desolventizing of the cake is executed with the help of heat and direct steam in a similar, but not identic way in the different plants. The miscella (oil containing solvent) is evaporated, and condensed and than reused. The solvent recovery is also similar but nit identic in the different systems. The basket type extractors are built by Bernardini and Giannazza and also by Crown in a new form. In Israel H.L.S. is building a basket extractor which is similar to the others. I do not recommend the basket type extractor, as they are relatively complicated in their movements, the area of the cake which is irrigated by the solvent is small, the reversing of the heavy basket gives problems and the transporting chain is under higher stress than it would be necessary of the transportation systems of the other processes. The performance in the practice is not so good as of the other type of plants.

I would definitely not recommend the direct extraction of Bernardini, which uses a pre-extractor followed by an extruder working with solvented cake and a final extractor. The cake in this extractor is too much mistreted and the result is a powder which is difficult to extract completly, or to less than 1 % oil content.

Around 1947 DeSmet introduced his belt extractor which in 30 years had been with a lot of smaller, but important changes improved. It is the simplest way of extraction allowing an easy adaptation to the material to be handled by changing the velocity of the belt and the height of the cake layer.

The cake is moved in the belt, but remains motionless, and will therefore not disintegrate. Important for the performance of the extractor is an as big area of the belt as possible and a long, - 2 to 3 hours - extraction time, and finally the number washing stages. This three parameters has to be discussed extensively, decided, and confirmed before ordering of the plant. For the economic performance of the solvent extraction the steam and solvent consumption are extremly important. The steam is expensive in Zambia and the Hexane has to be imported. Therefore the desolventizer and the solvent recovery has to be examined as much as the extractor itself. These parts of the plant are often similar in the different systems, but small differences, - sometime gadgets, - also differences in heat exchange areas, size of the recovery system and method used could save very much money in short time. Therefore the decisive parameters of the desolventizing and recovering system has to be discussed with the supplier.

The Lurgi extractor is similar to DeSmet, and the engineering of the whole plant is also of veri high degree. In effect if the decision is to be made between thie two constructors, the decisive factor would be the size of the extracting areas and volumes the heat exchange areas, desolventizing areas, price, payment conditions and delivery time, and not the difference of the system.

DeSmet and Lurgi plants are manufactured also in India by now independent companies, who worked before under license. I have seen several of these plants in India, which gave reasonably good results. Certainly beeing deprived of the newer development of the European mothercompanies the Indian plants are loosing some of the advantages of the newer plants. There is also not always easy to find all of the parts of the equipment with the required quality in India, therefore in my opinion the difference in price must be very important, to buy such a plant from India.

Blow Knox developed the Rotocell plant, which in some way is a variant of the belt extractor. This plant works well for easy to extract seeds, like soybean, but his performance is not so good as that of the belt extractors, especially when the percolation characteristics of the cake are somewhat defective. The belt extractor is much less sensitiv for failures of the seed preparation and the prepress operation. The possible cause is the form of the extraction-cells of the roatting extractor, and that the irrigating areas are usually smaller, as the construction is more expensive. Krupp and Rosedawns are licensees of Blow Knox, but they improved in some details the desolventizing and solvent recovery, letting the extracot itself basically unchanged.

In the Rotocell the body of the extractor remain fixed and only the bottom of perforated plate is moving. In the French extractor the whole body included the bottom is fixed and only the addition of the solvent is moving from one cell to the other. Speichim is building the French extractor in Licence for Europe.

Klöckner (Extraktionstechnik) finally lets move the body. All these apparatuses are variants of the original Rotocell with all his characteristics, as it was mentioned above.

The Filtrex process of Wuster and Sanger did not had succes It is also a dirct extraction process, but which depands too much o on the perfect preparation. It uses a horizontally rotating filt er, where the cake of only 5 to lo cm height is intensely washed with the solvent. The cake was before during about 15 to 3o minutes in cintast with the solvent in a mixer. The problem is, that if the cake is to fine it pasues the filter, if it is too curse the solvent is not able to enter and dissolve th oil.

In my opinion, and it seems, that this is also the opinion of the majority of the oil industry, the system preferred is the belt system represented by DeSmet and Lurgi. A big majority of the solvent extraction market is divided by this two companies as well as total installed capacity, as number of plants installed.

d. Technical Assistence

Interviewing DeSmet about the possibility of long term tec technical assistence, which would consist in sending one of their engineers for about 4 years to Zambia, I was told, that they are used to it, and in this moment they would have 3 men available. This engineer would function as production manager or something similar in ROP. Also Lurgi could accept such an arrangement, but with much more difficulties, as they are working on a very big number of fields, not only on oil, and their own needs are therefore much higher. Anyway, the question of the technical assistenca should be a theme of discussion during the negoatiations regarding of the purchasing of the plant.

Maize Oil Production

The preparation of the germs from the dry degermination is simple. It needs only heated rolls. Soybean needs a little better preparation, but not very much more than rollers, which would be bigger than that for the maize germs. The installation has to be previewed for soybean, and will serve also for maize germs. The possible suppliers are the same as mantioned in the ROP-Extension.

The solvent extraction is not particular, only that the capacities for soybean, maize germs one part and groundnut and sunflower other part are different. The cakes needs about 20% bigger extractors than the soybean and maize germs.

If two or three extraction plants can be ordered together, a an essential price advantage could be achieved, if the extractors are the same. In calculating the capacities, irrigation areas solvent recovery, etc. this is something which should be kept in mind.

As previewed in Lusaka I am awaiting now the visit of two or three gentlemen from Zambia to show them the maize mills and solve solvent extraction plants and discussing with them the whole project

whole project here. Once the quotation asked by the Zambian authorities and factories arrived, I could be at disposal to help to order the most appropriate plant, helping in discussion the mentioned parameters, prices, conditions, garanties and contracts.

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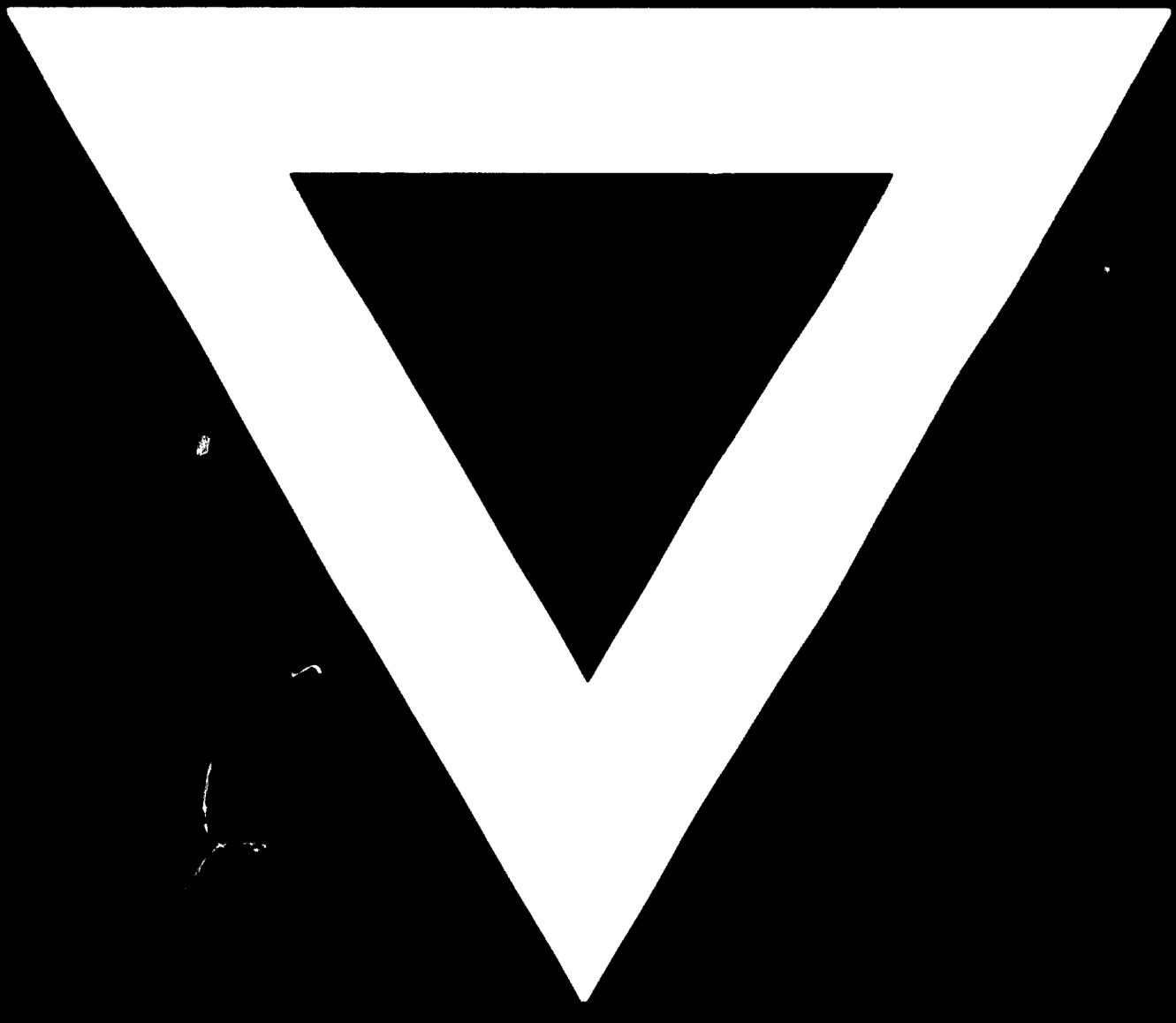

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