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1 - RECALL OF COMPLETED STUDIES

The successful results of forestry plantations completed in Madagascar, particularly in tropical resinous species, have brought forth the concern of their use for papermaking.

11 - POSSIBLE ERECTION OF A CELLULOSE MILL

111 - First studies

- a short document, written by C.T.F.T. in 1960, put the Madagascar Covernment in a position to consider two actions : papermaking or panel processing (fiber, fibraglos or particule board and panels).
- We may also indicate a doctorate degree thesis submitted in 1961 to the Paris Law and Economic Science Faculty, on the subject of "Reafforestation, preliminary condition for development in Madagascar". This thesis indicated more particularly the profitable influence, utilization of its reaffo-restration resources would have on the country's economy.
- In 1962, a first study was issued on the papermaking concern. This was "Perspectives d'Implantation d'une industrie de pâte à papier à Madagascar" (S.E.D.E.S. - C.T.F.T.). (1) Although written some time ago, the interest of this study resides in the survey, over a number of years, more specially of the woodpulp world market and of prospective Madagascar development schemes. The forward Madagascar paper consumption, indicated by S.E.D.E.S. (Société d'Etudes pour le Développement Economique et Social) has proved to be overestimated on a year 1970 level. On the contrary, development of world market is in accordance with the conclusions of the report.

Raw material study for papermaking has enabled checking Pinus Patula as adequate for woodpulp processing. The report concludes as to a study of productive potentiality of the Upper Matsiatra Pine plantations and to possible undertaking of a papermaking industry. The cost price estimate concludes to necessity of further studies.

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(1) The headlines in French referring to works mentioned in this chapter are translated in Appendix I, A.

112 - Possible choices

112.1 - Use of Pine

Among checked raw materials other than Pine, one may Eucalyptus, primitively planted for supplying the railroad with firewood. A further study, issued in 1963, had in view a decision to be taken on a possible choice. This was a work completed by O.C.C.R. (Office Central de Coopération et de Recherche) and titled "Implantation d'une industrie du papier et de la cellulose à Madagascar". This report presents for consideration four cellulose mill projects :

Project A - A non combined 60,000 ton bleached sulfate Pine patula pulp mill.

Project B - A combined mill, the same as the first one, but provided besides with a 15,000 ton (P. patula) grinding mill, and a papermaking unit, producing 30,000 ton of products in three stages (7,500 ton per annum, 15,000 ton per annum, and 30,000 per annum).

Project C - Same type of mill as project A, but producing 90,000 tons of bleached sulfate pulp. First of all, it was intended to use Eucalyptus, and replace it progressively by Pine in relation with plantation development.

Project D - The last project, exclusively directed towards sole Pinus patula groundwood pulp processing, included : a 70,000 ton per year capacity grinding mill ; a 30,000 ton per year papermaking unit (same as B and C) ; the necessary chemical woodpulp would be imported.

Although the financial outlook of project D were more profitable, the report unrecommended it, on account of the dullness in the world market for this pulp grade.

In fact, after analysis of the different projects, project B was recommended, thas is, a capacity of 200 tons per day of bleached sulfate chemical pulp.

Interest was also emphasized on adjoining a papermaking unit so as to improve the profitability. Mill was suggested near Fianarantsoa, and the completion by stages. The first stage would be the papermaking unit with a grinder installation ; chemical woodpulp would be subject to import. The papermaking would start up at 7,500 ton per annum, then go up to 15,000 ton per annum to finally reach 30,000 ton per annum.

The second stage was in relation with the woodpulp mill, which was to be erected after more definite studies, but before the papermaking unit had reached full capacity (30,000 ton per annum).

112.2 - Use of Eucalyptus

In 1963, S.E.D.E.S. completed a study on "Perspectives d'utilisation des Eucalyptus de la région Périnet-Moramanga pour la fabrication de pâte à papier". In this work, use of Eucalyptus was considered, as well as eventual marketing and site of mill at Périnet. Cost of woodpulp was also estimated as well as fabrication cost price and pulp marketing. From this date forward, says the report, Madagascar Government considered establishment of a papermaking industry as essential for development of the country.

However, the woodpulp mill for export project and the papermaking unit for a local market project were considered as two different concerns.

We note as regards to this, a Convention with Parsons and Whitemore firm for the erection of a papermaking mill at Ambohimanambola, near Tananarive, which became operative in 1966.

112.3 - Various notes

Between 1964-65, five notes were issued concerning the prospective woodpulp mill, and they gave way to controversy.

112.31 - Note by Mr. Labbé-Laurent, administrator delegate for Madagascar Papermaking (PAPMAD).

It put forth the question of proceeding with the Upper Matsiatra project. The writer objected :

- insufficiency of woodland (13,000 ha. in 1964)
- dubious character of adequate water supply
- insufficiency of roads for conveyance of the pulpwood and necessity of opening them
- no deep water harbour at Manakara (railroad terminus)
- necessity of erection of a hydro-electric power plant.

He concluded as to the discarding of the Upper Matsiatra project, as to the choice of a better site, to affore-station of at least 40,000 ha. Pine plantation at proximity of the most suitable site. The Moramanga area seemed the most favourable one.

112.32 - Notes controverting the preceding one

Two notes contended Mr. Labbé Laurent's assertions. The first one was written jointly by Estate, Agriculture and Forestry Departments, the second one by Mr. Perraudin, technical adviser to the Forestry and National Reafforestation Minister.

The data put forth in these two notes were the following :

- the preceding note overestimated the forestry potential involved and underestimated the difficulties as to finding adequate lands for reafforesting 40,000 ha. with the result that the erection of the projected mill could not possibly be operated before ten years time.
- as to Matsiatra, afforestation extension and proceding with complementary studies ought to settly the three first points put forth, which in any way would have to be settled somewhere else.
- the power station and the necessary road construction might be completed by an enlarged program of the Betsileo country development scheme.

112.33 - Notes of a more technical character

Two notes of a more technical character have been issued, one by the E.C. Public Works and Transport Ministry, the other by the Power Department.

The first one studies transport cost in the different possible eventualities :

- Matsiatra mill : conveyance by rail to Manakara with lighterage to ship, or construction of another harbour, or else, conveyance by another railroad (Fianarantsoa-Antsirabé) to be constructed up to Tamatave.
- Moramanga mill : wood supply from Matsiatra and export towards Tamatave or wood supply from new afforestrations (farseeing solution).

Conclusions of the note suggested two investment choices, one excluding the other :

- whether construction of a harbour in the Manakara region,
- or railroad construction Antsirabé-Fianarantsoa.

The second note recalled the hydro-electric power plant in the Fianarantsoa area.

112.34 - "Pine plantations and papermaking industry in Madagascar".

This study, financed by United Nations special funds, was completed in 1965 by Mr. Robbe in collaboration with Mr. Rouanet, Manager of C.T.F.T. in Madagascar.

This report stresses first of all practical answers to two following queries :

- Is there at the outcome, a woodpulp market ?
- Is Madagascar in a position to compete with other countries for supplying the consumption market or markets ?

Discarding the problem set by Upper Matsiatra reafforestation (out of the scope of the present study), the writers insist on reducing the cost of pulpwood delivered at mill through research of maximum unit potentiality and conveyance cost reduction.

Six areas for eventual reafforestation are then considered. The report concludes as to necessity for restricting plantations to one area only, for supplying one sole mill producing 100,000 tons of pulp.

At end of 1965, Mr. Labbé Laurent concluded in the same manner as to the policy for Madagascar to export woodpulp and to complete a combined unit producing unbleached kraft pulp (one part being bleached), the woodpulp required for local papermaking being provided in a wet state.

Establishment of this unit at Fianarantsoa seemed possible only by building the Antsirabé-Fianarantsoa railroad line, and by erection of a hydro-electric power plant ; these two realizations would come in with the industrial and agricultural development scheme for Madagascar.

113 - Combined study (S.E.D.E.S. - C.T.F.T.)

In 1966, was published the last of combined studies titled : "Perspectives d'industrialisation papetière à Madagascar", completed jointly by S.E.D.E.S. and C.T.F.T.

This report comprises following parts :

- a study of the pulp and paper world market,
- a prospect of local and regional consumption,
- a study of the available fibrous raw material in Madagascar,
- the methods of processing pulpwood into woodpulp,
- pulpwood cost price,
- the previsional accounts for operating the possible mills.

We have seen that the world market prospects were in accordance with 1970 figures, whereas those in relation with local market were rekoned too high, on account of lacking adequate statistics. Raw material for use was checked as to Pine and Eucalyptus.

As regards to Pine, the report points out that by planting 3,000 ha. yearly from 1967 onwards, 150 m3 per hectare, with a ground level logging, would be available towards 1983, which works out at 450,000 m3 per annum. Due account given to the standing timber presently disposable of 3,000,000 m3, a mill could be supplied 5 years earlier, i.e. in 1978, for a 100,000 pulp tons production.

Good paper characteristics have been obtained from laboratory and semi-industrial tests effected on Madagascar Pinewood (P. patula and P. kashya).

Price of barked A.D. pulpwood was valuated between FMG 3,900 and 4,950 per ton for 100,000 or 200,000 tons of pulp per year.

As to Perinet Eucalyptus, the price was put down for FMG 2,500 or 3,000 per ton of A.D. pulpwood.

The report concludes to the affect that a 60,000 pulp tons unit on a Pine basis would not yield satisfactory returns. On the other hand, with 100,000 Pine kraft pulp tons, a mill at Fianarantsoa might be considered, providing reafforestation be conducted at a fairly speedy rhythm. However, the gross returns ratio would still be faily low. The investment would then be : FMG 9 billions

If 100,000 bleached kraft Eucalyptus pulp tons were considered at Perinet, conditions would be more favourable and the returns ratio higher than at Fianarantsoa. However, it must be indicatad that other similar projects exist in other African countries restricted softwood pulp market.

12 - MADAGASCAR PINES

A number of studies deal with Pinewood plantations and the use of this pulpwood for papermaking.

121 - Resources in Pinewood

In 1966, C.T.F.T. issued a report titled : "Les plantations de Pins à Madagascar et au Cameroun". This report gathers data on cultivation methods, pulpwood yield, planted lands and available pulpwood resources.

122 - Plantation development scheme

Mr. Parrat, of C.T.F.T., has prepared a "Regional development plan in view of extending Pinus patula plantation in Upper Matsiatra".

This inquiry was to meet recommendations in preceeding reports urging extension of plantation. This document, completed in 1967, defines the areas to be planted and makes many suggestions for each of them.

123 - Utilisation of Pinus patula

123.1 - Logging and conveyance

The first study, completed in 1967 by C.T.F.T. is titled : "Etudes des problèmes d'exploitation et de transport dans les reboisements de la Haute Matsiatra".

The object ot this study was to describe logging methods for P. patula in the Finarantsoa region, and to assess pulpwood cost price delivered at the pulp mill at Forgeot. It deals successively with : the road system, logging methods, conveyance of pulpwood to mill and working expenses.

123.2 - Industrial and papermaking uses.

The second study, also completed in 1967, was titled : "Utilisation industrielle du Pinus patula". It also comprised a papermaking study and a technological study of Pinus patula.

As regards to papermaking out of this pulpwood, laboratory tests have proved the possibility of getting P. patula kraft pulp with a grade between Maritime Pine woodpulp and Spruce pulp. Mechanical or semi-chemical process proved to be not as interesting comparatively as kraft process.

Furthermore, unbleached and bleached wrapping paper has been manufactured, on a semi-industrial scale, out of kraft Pine patula woodpulp. These tests have proved satisfactory as regards the paper characteristics results, although they are slightly lower than Spruce paper.

As a conclusion, Madagascar P. patula has been acknowledged as suitable for treatment without any particular technical difficulty for kraft pulp fabrication of commercializable quality.

The technological study on P. patula, due to the corresponding C.T.F.T. division, deals with grades and technological properties of P. patula in various possible uses : building, packing cases, linings, etc...

124 - "Investment prospects for pulpwood production in Madagascar"

The above article, published in 1970 by Mr. Ramanantsoavina, Forestry and Estate Director for Madagascar, emits a clear view on the Madagascar papermaking problems in relation with forestry. After having stressed the world woodpulp demand development, in Europe as well as in Japan, and the powerful involvement of investments in the pulpwood industry,

the writer draws an allround inventory of Madagascar forestry resources, and recalls the two favourable projects which are in his view :

- the Upper Matsiatra project,
- the Upper Mangoro project.

Having already defined the aims of the Madagascar Government forestry policy, he shows his interest in the realisation in progress and in the projects in course of study.

Actual plantation schemes decided upon by Madagascar Government bears upon following surfaces : 3,000 ha. yearly between 1970 and 1974 in the Upper Matsiatra, 4,000 ha. yearly from 1970 onwards in the Upper Mangoro.

These plantations will enable Government to complete, in case of need, investments studied in Upper Matsiatra by availing of 35,000 ha. planted Pinus patula in 1974-1975.

Establishment of a second unit in Upper Mangoro would be operated towards 1985-1990, the unit capacity being about 200,000 tons per annum.

13 - PULP AND PAPER WORLD MARKET

131 - International studies

Various studies were completed before 1966 by international organisms. Among these, we may quote :

- "Comparaison géographique des coûts de production de la pâte à papier" (F.A.O. 1964)
- "Programming data and criteria for the pulp and paper industry" (O.N.U. 1964), in concern with different world paper projects.
- "Conférence internationale sur le commerce du bois en Afrique" (F.A.O. 1965)

132 - Combined study

The already quoted study : "Perspectives d'industrialisation papetière à Madagascar" (1966), completed by S.E.D.E.S. and C.T.F.T., comprised a very important first part titled :

"The world woodpulp and paper market".

The report on world market concluded in this manner :

" In all part of the world, the woodpulp, paper and board demand " will go on increasing at a rapid rhythm during the fifteen coming years. " In fact, only South America and U.S.S.R. have at their disposal enough " conventional pulpwood for papermaking. Western Europe will remain the " foremost importing area and it will essentially buy first long fiber " woodpulp, and secondly kraft paper and board. Its hardwood pulp imports " will remain restricted because Europe is in a position to produce " sufficient quantities on its own, on the spot..."

The woodpulp and paper market must be competitive, so the report concluded as to a quotation stabilization at a rather low level (this has been denied ir 1970).

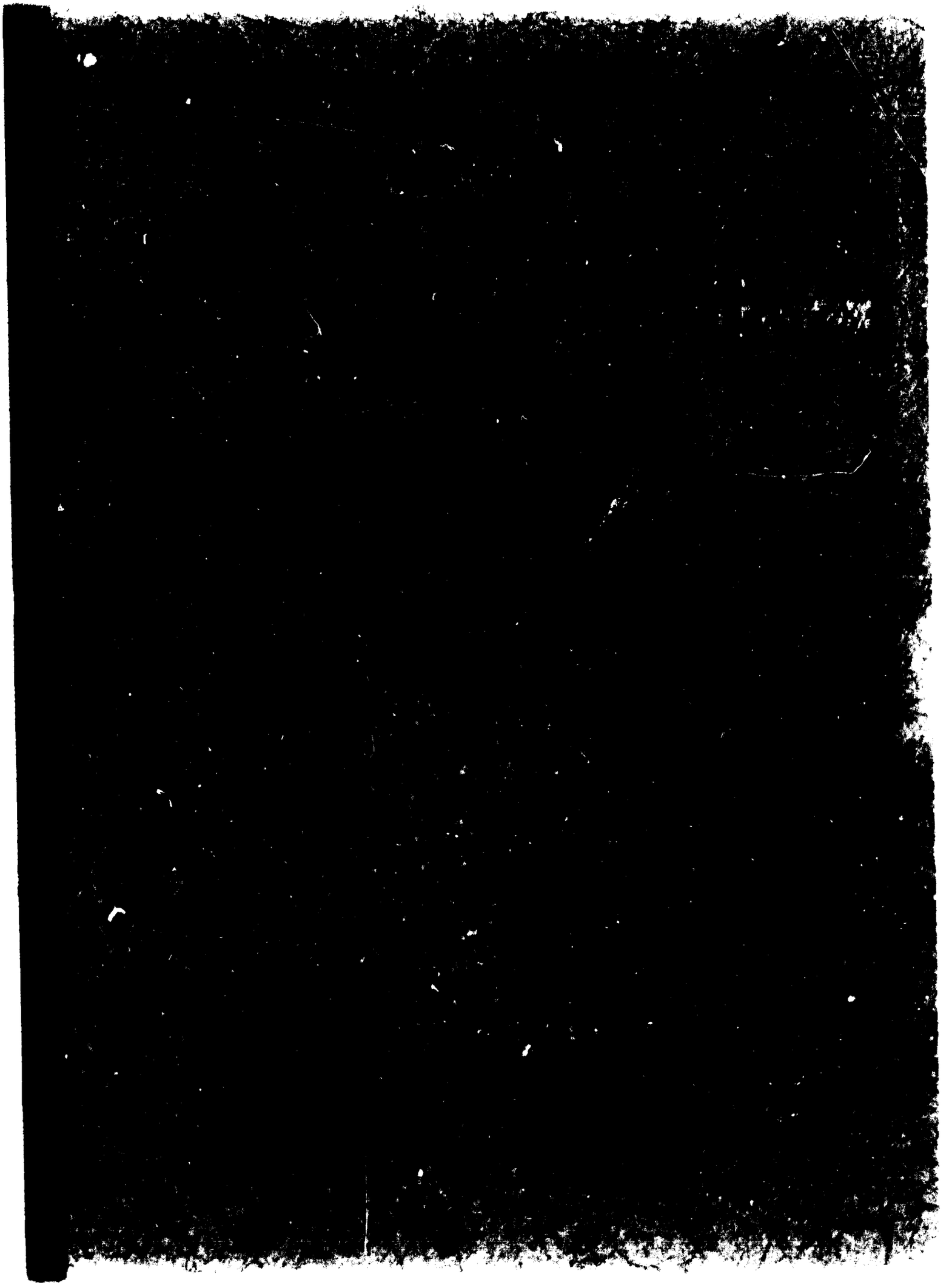
However, says the report, it seems possible for Madagascar to apply to a good use full grown Pines in spite of their remoteness from urban centres or ports. Interest of Pine for Madagascar is a provision of a long fiber woodpulp, whereas other African French-speaking countries "possess only primary forest products or Eucalyptus, the potentiality of which is more restricted".

14 - SISAL IN MADAGASCAR

Report related to in Appendix I.a have been summed up hereafter.

141 - Sisal plantations

Concentrated in the South East of Madagascar, Sisal plantations have undergone a speedy development from 1950 to 1960. There are also other plantations in the Morondava region, which correspond to a 1,000 to 2,000 ha. surface out of 19,400 planted hectares on the whole.



141.1 - Mandraré soils

Except at Morondava, the plantations are to be found on alluvial tracts of the Mandraré (50 km. long).

There are three types of soil :

- the reddish sands (advanced soils, ferruginous, tropical);
- the alluvions and colluvions (slightly or not advanced);
- the erosive or skeletal soil.

The alluvial soils are the more fertile. Generally speaking, the soils are of a good fertile quality.

141.2 - Pluviometry

At Amboasary, we check an average 510 to 520 mm. rainfall per annum, with extremes of respectively 250 and 730 mm. In Tanzania (Tanga), Kenya and Mozambique, we note 1,200 mm. per annum in the Sisal areas.

Rainfalls in Mandraré Valley are short, irregular and with heavy downpours. 70 % of the rainfalls occur between November and March (5 months) which is the intensive vegetation season, but 13 times out of one hundred, these months have less than 10 mm. rainfall. Outside these months, a monthly pluviometry of more than 100 mm. has been registered on several occasions. It rains an average of 60 days per annum.

Under local conditions, an essential minimum for the growth of Sisal is 400 to 500 mm. We may indicate three dry years : 1957, 1958, 1959 with 350 mm. The 1969-70 period was very rainy.

141.3 - Agronomical characteristics

The cyclical duration of the plant is normally eight years, with a 17 tons fiber yield per hectare in six cuttings in succession every ten months. On less rich soils, the cyclical duration may reach ten years with a 12 tons yield per hectare. The Mandraré average is between 13 and 14 tons per hectare with a nine year cycle, so, as an average : 1,5 ton of fibers per annum and per hectare.

The length of the leaves may reach 150 cm. on good soil. Weight of fiber per leaf varies between 13 and 20 g. with a 16 g. average.

Plant reproduction is effected by bulbils in 75 % of the cases and by suckers in 25 % of cases. The plant has to be hoed on the 1st, 2nd and sometimes the 3rd year after planting. Afterwards the plant is developed enough to find available dampness its own way.

Differently from other African producing countries, the sucker removing is operated every year. In the other countries, the suckers are removed during hoeing.

With an experience of only four cultivation cycles in the Mandaré Valley, evolution of soil richness is still unknown. Only a few poor soils are actually fertilized and defiberised waste is put on the nursery beds.

The vegetal diseases are scarce in prevailing drought conditions. "Sun scorch" and stem rotting only could rise problems.

141.4 - Agronomical researches

We recall excellent results owing to "Institut de Recherches du Coton et des Textiles Exotiques" (I.R.C.T.) in relation with Sisal development in the Mandraré Valley. The cultivation techniques having been studied, this Institude brought about improvements in close collaboration with all the cultivation concerns, with the result of the highest grade obtainable and excellent yields per hectare of Madagascar Sisal.

Other problems have already been settled or are in course of study, especially : chemical or genetical means of sucker growth prevention, possibility of fertilizing soils on long term, and liveatock fodder from defiberised waste, etc...

141.5 - Labour

Labour employed on the plantations and for Sisal harvesting comes from Antandroy, a South Eastern Madagascar tribe, the upkeep of whom depends upon the wages coming from the Sisal workings. This industrial

cultivation has modified the trend of these populations which, from nomads they were, are now sedentary. Sisal employs about 4 or 5,000 men and women workers (cultivation and fiber preparation) and provides for the living of about 25 to 30,000 persons. Its forward prospects are of great importance for Antandroy people and interests Government authorities to the highest degree.

142 - Sisal cultivation promotion

142.1 - French Government Aid

Sisal cultivation was promoted from 1953 to 1958 by "French textile promotion funds", who paid planters an extra price up to F CFA 10,000 per ton (£ 14 1/2) at the time of a fall in the quotations. The total amount paid was : F CFA 500 millions or nearly US$ 2 millions.

142.2 - Madagascar Government Aid

The slump being due more particularly to the discarding of reaper-binder machines (main outlet for Sisal cord) for combined harvesters, Madagascar Government adopted important steps to help the planters :

- the export tax on fiber was lowered and finally cancelled : first 7 % down to 2 % (1966) and afterwards 0 % (1968) ;
- middle term loan fscilities granted to three workings.

142.3 - Quota system

Quota system was also applied to assist Sisal workings, under care of F.A.O. Quota reserved for Madagascar was reckoned in 1968 on the 1964-65-66 export ratio. The same was applied on the 1965-66-67 period.

Madagascar complied with these quota distributions, but other producing countries (Tanzania in particular) did not, and the result was that in 1970, we note a further fall of fiber prices on the world market.

143 - Sisal fiber market

Apart from a low tonnage delivered at the cord mill (SIFOR), the capacity of which is lower than 600 tons of cord, string, bags, cloths, and carpets, Madagascar production is entirsly exported.

143.1 - Export volume

Export have regularly increased from 1953 (4,500 tons) to 1965 (28,600 tons). For the last four years, exports have been :

1966 : 23,000 tons
1967 : 20,300 tons
1968 : 25,700 tons
1969 : 24,700 tons

The quota aseigned in 1968 was 25,400 tons plus 100 tons alloted to SIFOR. In 1969, the Madagascar quota was 24,700 tons, and 100 tons were alloted to SIFOR. Furthermore, 200 tons wers alloted to Comore Islands. A suspension in Comore production is expected in 1970.

143.2 - Export valuation

In 1963-64, Sisal exports reached US$ 8 millions (FMG 2 billions) and corrsponded to 9 % of entire Madagascar exports. At the present time, the slump on world market has reduced this percentage to 2,4 % or 2,6 % of entire exports, with a gross valuation of nearly US$ 3 millions (FMG 830 millions) only.

143.3 - Cost price and world quotations

In 1968-69, the average Sisal coet price was somewhere near FMG 35,500 per ton at F.O.B. price per metrical ton, corresponding to F CFA 44,500 per ton C.I.F., i.e. £ 66.7 per ton C.I.F.

In fact, the C.I.F. price variegated following cultivation concerns and soils, between FMG 42,000 and 48,000 per ton, i.e. between £ 64 and 72.

Important endeavours have been undertaken by the planters. During our misaion, Sisal quotations established between : £ 58 and 60 per long ton (1,016 kg.).

These quotation show up reduced profits for planters, if not losses.

143.4 - Fiber grades

In decreasing grade order, we note : 1° - A° - 2° - 3L° - 3° - UG or R° (waste) - R2° or D° and tow.

Madagascar planters have made elaborate attempts so as to standardise grades for sales. At present time, 85 % of sales are made up of 3L (41 %) grade : UG (44 %) grade and tow (8 %). We also note 2 % of 2° grade, 3 % of 3° grade and 2 % of R2 or D grade.

The Tanzania sales, which roughly correspond to four times the Madagascar sales, grade in following manner : 8 % 1° grade, 3 % 2° grade, 48 % 3L° grade, 9 % 3° grade, 22 % UG and R° grade and 7 % tow. Grade concentration in Madagascar has enabled reducing cost price.

144 - Papermaking utilization

The C.T.F.T. export, Head of Cellulose Division, has written a report on Sisal papermaking utilization, after a visit to Brasilian and Angola mills. We sum up conclusions of this report.

144.1 - Technical utilization possibilities

Two fabrication techniques may be considered :

- a former method copying the process for rags : coarse fiber washing and rag breaking in a stock beater;
- a more recent method : previous fiber cutting, cooking, putting pulp through a disc crusher to complete fiber shortening.

Cooking properly speaking may take place in a rotary digester. No test has ever been made in a vertical digester.

Soda quantities may vary from 5 % (after previous water treatment) to 14 or 15 %. High alkaline quantities yield a better cooked pulp, easy for mechanical treatment and for bleaching.

Sisal unbleached pulp is adequate for wrappers or cement bag fabrication. Mixing with other shorter fiber is possible and is even recommended. Sisal proportion in the mix may vary between 30 and 70 %.

Sisal bleached pulp may be useful in a mixing with short fiber for printing writing paper. Sisal between 10 to 30 % then makes up a strong long fiber web.

Waste stuff is certainly responsible for many impurities. It may be used for cardboard under-layers and very coarse wrappers. It must be discarded for well finished paper.

144.2 - Economic aspect

Sisal is a very costly raw material for papermaking. Its use may be admitted when resinous pulpwood is scarce and has to be imported.

In Madagascar, where Sisal is in competition with resinous species, its sale price must be adjusted accordingly.

In the eventuality of paper made up of 50 % hardwood pulp and 50 % resinous pulp, with a paper yield of 45 % for Pine and 50 % for Eucalyptus, we get :

$$\frac{0,5 \times 100}{45} \times 5,500 + \frac{0,5 \times 100}{50} \times 3,200 = \boxed{\text{FMG } 9,350}$$

of raw material per paper ton. Pulpwood of full dryness price being as follows :

- Pine : FMG 5,500 per ton
- Eucalyptus : FMG 3,200 per ton

Supposing an equivalent paper fabrication with 35 % Sisal and 65 % Eucalyptus (Sisal paper yield = 70 %), Sisal cost would be X :

$$\frac{0,35 \times 100}{70} \times X + \frac{0,65 \times 100}{50} \times 3,200 = \text{FMG } 9,350$$

so : $X = \boxed{\text{FMG } 10,400}$

It may therefore be admitted that for Madagascar, O.D. Sisal cost, ought not to exceed FMG 10,000 per ton, so as to be competitive with resinous pulpwood. This is for "textile grade" or entirely purified waste stuff; waste stuff containing impurities ought to be commercialised at a lower price, taking into account cost of purifying if this can be done.

In Brazil and Angola, Sisal fiber for papermaking commercialises around FMG 2,000 and 2,500 per ton.

144.3 - Other processes

Apart from the preceding standard processes, one may use other processes. Although experience in this regard has not yet been completed, they are worthy of notice :

- neutral sulfite process : this process yields very bright unbleached pulp;
- activated chlorate process : a scheme was set up in Tanzania for the use of this reagent; but nothing is known about the means by which it was to be operated;
- GOMEZ process : this process treats Abaca (Musa textilis or Manilla hemp). It uses the whole plant. Machines have been devised for cutting the plant into small pieces. These are crushed and treated for separating the parenchymatous part from the fibrous part. The latter is then conveyed to the pulp processing shop. The parenchymatous part is dried and ground into flour for livestock fodder or soil fertilizing or mill fuel.

The same kind of process could be devised for Sisal.

144.5 - Conclusion

Use of Sisal for papermaking is an economic concern. It incurs a sufficient market protection for the marketing of a 5 to 10,000 tons per annum production.

When other long fiber resources are available, such as resinous, cost of Sisal delivered at mill is an important restrictive concern.

Tests leading to further fabrication processes for getting better returns from Sisal fiber might possibly improve papermaking possibilities, in case standard processes were not profitable.

145 - Development scheme for the Mandraré region

A study on a development scheme for the Mandraré region was completed in 1969. The aim of this study was to cope with the deterioration of the Sisal situation, whether by exploiting bauxite mines, in view of industrial development prospects or by agricultural production improvement.

The Sisal Studies Commission had already considered in 1967, Sisal variation by combining fiber export and papermaking from this material, with alternative crop growing in Mandraré : fruit growing or other cultivations alternating with Sisal.

However, first conclusions led to the fact that different technical problems for Sisal papermaking had to be settled beforehand and that actual markets would not be appropriate for such an establishment from an economic point of view.

Irrigated cotton experimentation has been undertaken by I.R.C.T. Merinos sheep breeding had also been considered.

145.1 - Bauxite mining

The British mission scheme is based on exploitation of 2 millions yearly tons of bauxite. This would be conveyed to a deep water harbour north of Manantenina.

145.2 - Aluminia production

Bauxite production could be supplemented by 300,000 tons of Aluminia production instead of ore. This would be exported through Fort Dauphin or through a harbour to be set up at Ranofotsy.

145.3 - Aluminium smelting works

The third industrial development stage would be establishment of smelting works producing 200,000 tons of aluminium by means of an electric furnace. This would mean setting up a hydro-electric power plant on the Mananara river with a dam.

In fact, if aluminium smelting is to be undertaken, the dam on the Mananara river is necessary (400 to 600 M.W.). On the contrary, if production is restricted to Alumina only, a dam on the Mandraré river (at Amboetsy or Anadabolava) producing only 10 to 40 M.W. per year would be enough.

145.4 - Irrigated cultivation

The preceding industrialization projects as regards bauxite, the entire investments of which would be over 110 milliards FMG, would be associated with irrigated cultivation development of beans and cotton on the Mandraré sands and alluvions. In this case, irrigated cultivation would replace present dry Sisal cultivation. Exclusively agricultural investments comprising : main canal, secondary canals, soil preparation, construction, roads and experiments, would amount to a little over 6 milliards.

146 - Conclusion

The Mandraré area actually includes 19,400 hectares of Sisal plantations, the export of which is questionable on account of the slump on the world market. This slump is due to abandonment of Sisal cord for harvester machines, and to the increasing use of nylon thread and cables.

Mandraré Basin cultivation has already reached a high technical degree and no further improvement seems possible in this regard. The Madagascar State Aid to planters is not sufficient for covering production expenses. This cultivation, providing for the living of 30,000 persons in Antandroy area on distributed wages through Sisal industry, is an imperative concern and a solution should be found for promoting the economy of this area. Utilization of Sisal for papermaking is an answer, and substitution of irrigation (cotton, beans) for Sisal is another one.

2 - SURVEY OF THE WOODPULP AND PAPER MARKET

21 - LOCAL AND REGIONAL PROSPECTS

211 - Madagascar prospects

212 - Reunionese prospects

213 - Mauritian prospects

22 - EAST AFRICAN MARKET PROSPECTS

221 - General economic characteristics

222 - Survey and development projects of the paper concern in different countries

223 - Prospects of exporting paperpulp to East Africa

23 - MIDDLE EAST MARKET PROSPECTS

231 - United Arab Republic market

232 - Iraq market

233 - Iran market

234 - Israelian market

24 - INDIAN SUB-CONTINENT COUNTRIES MARKET

241 - General data

242 - Paper prospects

25 - PAPERPULP INTERNATIONAL MARKET

251 - General data

252 - Analysis of latest tendencies

253 - Paperpulp international quotations

26 - CONCLUSION

UNITED NATIONS INDUSTRIAL DEVELOPMENT

01473

FEASIBILITY OF A PULP AND PAPER INDUSTRY IN MADAGASCAR FROM A TECHNICAL AND ECONOMIC POINT OF VIEW

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July 1970

2 - SURVEY OF THE WOODPULP AND PAPER MARKET

21 - LOCAL AND REGIONAL PAPER PROSPECTS

211 - Malagasy prospects

The data gathered in March 1970 at Tananarive have enabled establiahing with accuracy following informations :

- pulp, paper, printed and non-printed cardboard imports and exports
- remarkable economic concourse
- basic up to date demographical data
- influence of different economic and social concerns interested in paper production and consumption.

The study was completed in two stages :

- regrouping general basic data and round figures
- inquiry through interviews with the various paper dealers and manufacturers.

211.1 - Analysis of the actual paper consumption

We have consigned in table liat 211.1a the data furnished by the National Institute of Statistics and Economic Research for Madagascar.

This table list classifies data following the usual statistic methods : (so called "Brussels method") : (1)

- paper pulp import (chapter 47)
- paper and non-printed board imports (chapter 48)
- printed paper imports (chapter 49)
- woodpulp and paper production figures (furnished by the Malagasy Paper Company
- paper exports
- allround printed and non-printed paper consumption in Madagascar

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(1) Madagascar, like the other OCAM African countries, have accepted the Brusaels statiatic schedule.

Table list 211.1a - ALLROUND PRINTED AND NON PRINTED PAPER CONSUMPTION (tons)

Imports	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969 11 months	1969 *
Non printed paper and boards (A)	4,052	4,882	5,373	5,143	5,860	7,206	6,760	7,823	9,216	5,155	6,331	5,140	5,603
Printed paper (B)	426	394	408	437	502	604	464	499	635	619	686	647	706
Total paper and paper articles (A + B)	4,478	5,276	5,781	5,580	6,362	7,810	7,264	8,322	9,851	5,774	7,017	5,787	6,309
Paperpulp (C)	-	-	-	-	-	-	2	-	696	1,919	2,459	2,134	2,326
General total (A + B + C)	4,478	5,276	5,781	5,580	6,362	7,810	7,266	8,322	10,647	7,693	9,476	7,921	8,625
Production (D)	-	-	-	-	-	-	-	-	-	3,800	4,700	5,700	6,213
Exportations (E)	-	-	-	-	-	-	30	10	85	380	725	-	
Consumption (A + B + D + E)	4,478	5,276	5,781	5,580	6,362	7,810	7,234	8,312	9,766	9,194	10,992	-	

* 1969 - 12 months - estimation

Source : INSRE - Tropical Markets

Table list 211.1b - IMPORT PROGRESS FROM 1958 TO 1969 (Tons)

Years	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Non printed paper and board imports	4,052	4,882	5,373	5,143	5,860	7,206	6,780	7,823	9,216	5,155	6,331	5,140
Progress index (100 = 1958)	100	120	132	126	144	177	167	193	227	127	156	
Printed paper imports	426	394	408	437	502	604	484	499	635	619	666	647
Progress index (100 = 1958)	100	92	95	102	117	141	113	117	149	145	161	
Total imports	4,478	5,276	5,781	5,580	6,362	7,810	7,266	8,322	10,647	7,693	9,476	7,921
Progress index (100 = 1958)	100	117	129	124	142	174	162	185	237	171	211	176
Duplicating paper and Stationary articles					45	79	82	78	46	62	71	
					146	163	186	155	112	103	104	
Paper and articles for packing					410	706	637	451	534	940	1 278	
Consumption (corrected) Cg MM3			5,178	5,545	5,907	6,564	7,135	7,785	8,437	8,757	9,650	
Progress index (100 = 1960)			100	107	114	127	137	150	162	169	186	

Source : INSEE - Tropical Markets

So as to enlighten the various tendencies of the different items, table list 211.1b mentions to increase incurred in the proposed grades. We have also added the part in concern with following items:

- duplicate paper
- stationary articles
- package paper and articles

The variable average on a three years period has furthermore been reckoned (formula Cg MM3) as regards to allround printed and non-printed consumption.

This method corrects the very strong influence of the casual annual variegations which come upon Malagasy consumption. When the Cg MM3 formula is applied, we find that the increase is very steady.

We also recall that the report "Paper industrialization prospects in Malagasy" had concluded as to a probable consumption between 22 and 24,000 tons of paper and cardboard in 1970, and as to 44 to 45,000 tons in 1975.

The 1970 consumption is very much lower and it has seemed adequate to start on entirely new prospects. This is possible, the present statistics data methods being sounder.

The detailed data actually available will be found in the two table lists : 211.1c and 211.1d.

Table list 211.1c shows the non printed paper consumption in Madagascar from 1958 to 1968; we have reckoned the variable three years average C MM3 formula and its progression rate, so as to discard impeding occasional variations for a middle term study.

Progression during the latest years shows as being very rapid, the annual average ratio being over 9 % per annum. It enlightens Malagasy development and the progress of its industrialization.

Table list 211.1c - NON PRINTED PAPER CONSUMPTION (tons)

	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968
Imports	4,052	4,882	5,373	5,143	5,860	7,206	6,780	7,823	9,216	5,155	6,331
Production										3,800	4,700
Exports							30	10	85	380	725
Consumption	4,052	4,882	5,373	5,143	5,860	7,206	6,750	7,813	9,131	8,575	10,306
Consumption CM3			4,769	5,132	5,458	6,069	6,605	7,256	7,898	8,506	9,337
Index			87		100		121		144	155	171

Source : INSRE

In table list 211.1d, we show the various statistics paragraphs of item 48 for 1968 and for the eleven first 1969 months.

The large number of paper uses and the variegation of paper articles appear distinctly in the diversity of the items.

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(1) CM3 : reckoning of mobile average over three years.

Table list 211,1d

		Quantities (tons)		Valuation (1000 FMG)	
		1968	1969 11 months	1968	1969 11 months
Mechanical paper	4801	2 366.4	1 029.4	118.7	57.5
Parchment board, paper	4803	103.6	58.6	17.4	11.3
Assembled board, paper	4804	87.9	36.0	7.5	3.0
Creped corrugated board, paper	4805	161.7	68.9	14.6	6.2
Cross-ruled board, paper	4806	1.8	0.9	0.9	0.6
Asphalte board,paper	4807	349.4	300.7	53.7	45.9
Paper pulp building panels	4808	3.1	2.8	1.2	11.1
Construction board	4809	1 199.0	1 648.0	40.9	57.3
Ready cut cigarette paper	4810	64.6	43.5	29.3	17.8
Tincture paper	4811	1.5	8.4	0.3	3.4
Floor covers	4812	257.6	258.9	22.3	20.8
Duplicator paper	4813	71.5	60.7	53.8	54.3
Stationary articles	4814	104.2	109.2	28.9	28.2
Ready cut board, paper	4815	114.2	247.3	26.6	49.4
Wrappers	4816	969.3	888.9	102.9	93.5
Office boards	4817	0.2	0.6	0.2	0.4
Copybooks - pocketbooks	4818	166.8	129.7	61.5	52.9
Labels	4819	49.1	29.3	29.3	24.4
Miscellaneous		153.6	196.1	54.2	45.4
TOTAL		6 330.7	5 140.3	665.9	582.1

Source : INSRE

However, we note that :

- the "mechanical paper" item does not permit to show the newsprint proportion
- the "asphalte board, paper" item includes very different sorts, such as carbone paper and asphalte board
- the "ready cut cigarette paper" item corresponds to nearly the whole actual cigarette paper, a small portion, only, being delivered in reels (mechanical paper)
- the "miscellaneous" item includes all sorts of articles, like statistics and perforated cards.

Table list 211.1e marks out evolution on a longer period following items : mechanical paper
copy books and pocket books
duplicator paper
stationary articles

Finally, the whole of so called "printing/writting papers" have been regrouped.

Table list 211.1e - Various paper grades of import into Malagasy (tons)

	1962	1963	1964	1965	1966	1967	1968	1969 11 months
Mechanical paper	1944 (161.0)	1863 (184.6)	1707 (170.9)		5209 (396.9)		2366.4 (118.7)	1029.4 (57.5)
with newsprint	1680 (130.7)	1521 (116.2)						
Copybooks, pocketbooks	875 (152.5)	1088 (172.6)	1229	1087	663	281	166 (61.6)	129.7 (52.9)
Duplicator paper	37 (29.8)	45 (31.3)		78	46	62 (52.4)	71 (51,8)	60.7 (54.3)
Stationary articles	146 (30.4)	163 (38.9)		155	112	103 (29.5)	104 (28.9)	109.2 (28.2)
Package paper and articles	410 (53.9	706 (70.8)	637	451	534	940	1278 (128.5)	
Printing/writing paper	1888	1794			4846		718.8	475

(...) : Value : (thousands of FMG)

Analysis of 211.1e table list figures stresses the major influence of the Malagasy Papeterie firm for providing the local market, and the fall of paper imports as to the items : copy books and pocket books - stationary articles and mechanical paper, which incur the hightest import recession.

The slow progression in package paper and articles is in relation with development of Madagascar cardboard package manufacturing : ELGE board mill (Tamatave) and ets BIAGGI.

It may be interesting to compare the two preceding table list with table list 11.A in the appendix, which relates to the whole of OCAM countries.

The special package articles concern is studied in table list 211.1f hereafter. This table list does not concentrate on all package manufactured in Malagasy, because small bags and light cardboards made by the Malagasy Papeterie firm are not mentioned.

Table list 211.1f - Malagasy package consumption (tons)

	1962	1963	1964	1965	1966	1967	1968	1969 (11 months)	1970
Paper and board imports 4804 + 4805)							249.6	107.9	
Package imports 4804 + 4805 + 4816	410	706	637	451	534	940	1278	993.8	
Board production (1)						500 (X)	1850	2500 (X)	3000 (X)
Paper and package paper and board consumption	410	706	637	451	534	1440 (X)	3128	3500 (X)	

(1) - Elgé board factory

(X) - Estimation

The very rapid progression of board packing is obvious in all the other OCAM countries. It is connected with the accelerated export development (bananas, tinned food) and with the modern agricultural and industrial production development.

Printed paper consumption is not easy to define because there is no reliable datum in Madagascar as to the production concerns. Inquiry through interviews has been the only way of getting, very approximately, the Malagasy printing production.

However, table list 211.1g concentrates on the printed paper imports (chapter 49 of Brussels schedule)

It is convenient to note that :

- book imports do not include those given free by various countries
- the newspaper and periodicals are practically not checked owing to airmail diapatch
- the advertisement, propaganda and suchlike prints are concentrated in various mixes chapters.

Table list 211.1g - Printed paper imports (tons)

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969 11 months
Entire printed articles	408	437	502	604	484	499	635	619	686	647
Books			277	370	239	264	368	384	406	380
Newspapers (1)			1	10	5	1	1	5	2	4
Various prints				159	166				206	209
Calendars			34	38	37	31	41	29	36	19

(1) - Statistics concerning newspapers, magazines and periodicals are false. Most of these imports come by airmail and are not checked.

Study, partly completed through interviews with publishers and graphic art professionals, has enabled to check the Malagasy allround printed articles production at about 1,200 / 1,300 tons per annum.

Consequently, the whole Malagasy printed articles consumption may correspond to 1,900 / 2,000 tons per annum.

211.2 - Assessment of future paper consumption

The report "Malagasy paper industrialisation prospects" has already stressed the inconvenience of long term assessments based on fragile data.

We shall also recall that all correct prospects are based on a definite and complete knowledge for former data; this is particularly imperative when one has to deal with correlation between economic phenomena.

To try and assess Malagasy 1975-1980 paper and card-board production, we had at hand the serials which have been made up. These serials are very short and some of the statistics among them seem to be vague. In this way, the figures we shall put forth are to be considered rough valuation only and as guide marks.

Economic aggregate generally known for explaining consumption phenomena is the Revenue. But we have been unable to get homogenous and complete composites of the Gross National Product.

So we have tentatively taken into account a very short and very indefinite check-list for Gross Interior Product (at market price) ; moreover, we have been brought to make use of the European Tananarive environment as to family consumption, so as to establish tentatively some kind of formula, in view of getting a G.I.P. on a steady franc ratio basis.

The actual results are deceptive over several tentative formulas (linear, logarithmical or semi-logarithmical) and finally the linear formula is the one which yields the highest probability ratio. This may be explained by the nearly linear bearing of the consumption curve.

This survey has been carried out jointly

by

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92 - COURBEVOIE

Table list 11b will be found herewith in appendice : it marks out G.I.P. evolution in current francs. Table list 11c also herewith shows a very slow G.I.P. constant franc progression over the very short period (1962-1968) taken into consideration.

These figures enable to apprize impossibility as to a basic valuation on G.I.P. progression. It seems much more probable that G.I.P. will progress until 1975, and afterwards up to 1980, at a much quicker rhythm.

In relation with actual evolution and doubt connected with rhythm of allround economic progression (The Malagasy Plan has not yet been issued), the most reliable definition for paper consumption is the one in relation with demographical criteria, the results of which are stated in table list 211.2a hereafter.

This table list shows the Malagasy non-printed paper consumption forward evolution in actual economic circumstances.

The resulting data is in concern with the consumption variable average (of non-printed paper), and are thus definitely low.

The assess will be a sure minimum :

- 1975 consumption will be over 13,000 tons
- 1980 consumption will be over 17,000 tons.

Table list 211, 2a - Connection between non printed paper consumption and demography

	1960	1962	1964	1965	1966	1967	1968	1970 -71	1975 -76	1980 -81	
Entire population (by thousands)	5298.2	5657.6	6104.0	6335.8	6562.0	6777.0	7011.6	7300	8165	9170	average 6249
MM3 consumption (tons)	4,769	5,452	6,605	7,256	7,896	8,506	9,337				
MM3 consumption per head (kg)	0.900	0.964	1.082	1.145	1.203	1.255	1.331				average 1.126
Y	-0.226	-0.162	-0.044	0.019	0.077	0.129	0.205				
X	-951	-592	-145	87	313	528	762				
Y^2	0.051	0.026	0.002	0.0004	0.006	0.016	0.042				0.143
X^2	904,401	350,464	21,025	7,569	97,969	278,784	580,644				2,240,856
X Y	214.9	95.9	6.4	1.7	23.1	68.1	156.2				566.3

Correlation coefficient very near 1.

$M = (2.528)(10^{-4})$

$Y - 1.126 = (X - 6,249)(2.528)(10^{-4})$

$Y = (2.548)(10^{-4} X - 0.453)$

If X = 7,300 Y = 1.392 in 1970 and Cmm3 = 10,161 tons
If X = 8,165 Y = 1.611 in 1975 and Cmm3 = 13,153 tons
If X = 9,170 Y = 1.865 in 1980 and Cmm3 = 17,102 tons

Assessment of printed paper consumption appears still more critical due to the complete lack of appropriate data.

The only possible assessment which could be reasonably made has been practised, due account given to information received during interviews.

The progression rate of Malagasy Publishing Graphic arts production industries being nearly the rate of non-printed paper consumption, we have assessed entire Malagasy paper production all in following a regular relation between printed and non-printed paper.

Printed paper consumption (import + production) ought to be approximately on the following levels :

- in 1975 2,700 tons per annum
- in 1980 3,500 tons per annum

The aggregate printed and non-printed gross consumption would therefore be :

- in 1975 15,700 tons per annum
- in 1980 20,500 tons per annum

Furthermore, it will be convenient to assess the extra requeremants which are already apparent (with more or less certainty) in the different spheres of the Malagasy economy and community.

We shall dintinguish <u>industrial</u> and <u>cultural</u> requirements :

<u>Industrial extra requirements</u>

The industrial extra requirements are linked with further inveatments or else accelerated snd important development of agricultural productions especially.

We will note :

- Cement production. There is a scheme for establishing in Malagasy a cement factory large enough to cover the whole Malsgasy market, and a fair export contingent.
- Flour production. There is also a flour mill scheme to supply the whole Malagasy market
- Banana production and export. This comes in with the actual ready export line.

The cement factory scheme forecasts that the Malagasy cement consumption, which was 138,645 tons in 1969 (of which 75,445 tons produced locally) will be 170 to 200,000 tons in 1975.

The whole of the Malagasy market will be supplied by a national production. Furthermore, the lime production at Antsirabe will go up from 5,000 to 10,000 tons.

The additional consumption of cement bags (400 grs. paper) will therefore be about 760 tons or 1,000 tons in 1975, i.e. 880 unbleached kraft paper tons.

The flour mill scheme is not as accurate, but it forecasts actual development of consumption (24,000 tons). Extra kraft paper consumption will therefore be 190 tons before 1975 and may reach 320 tons shortly after 1975.

The packing requirements for banana export depend upon Government export policy and upon banana world market tendency.

Banana production for export (15,000 tons) corresponded in 1968 to about 800 tons cardboard packages. This figure will probably nearly treble from now on to 1975.

The extra industrial requirements may be assessed 3,500 tons of paper and package cardboards. They might reach, and very likely exceed, 5,000 tons in 1980.

Extra cultural requirements

The schoolable population corresponds for the two sexes to 875,000 pupils in 1969 with a schoolable population of 1,700,000 children, so the schooling rate is near 53 %.

A future schoolable population of 1,875,000 is put forward for 1975-1976. If the schoolable population increases at the rate put forward by Malagasy National Education Board (10 % per annum), the schoolable population will be more than 1,600,000 pupils in 1975. The schooling rate would then be over 86 %.

In this case, the school book requirements would be considerably increased as well as the copy book, pocket books and other cultural utilities. The Malagasy schoolbook production problem would have to be settled imperatively, and cultural paper extra requirements will have to be defined. We are unable to assess this on account of no available data, but we may venture an approximate figure of 1,500 to 3,000 tons or even more in 1975. The 3,000 tons figure might be reached in 1980 at the latest.

Total consumption

Entire printed and non-printed paper consumption ought to settle into shape around the regrouped figures showing in the table list hereafter :

Table list 211,2b - Total consumption prospects (tons)

	1975 prospects low eventuality	1975 prospects high eventuality	1980 prospects low eventuality
Printed and non printed paper	13,000 2,700	13,000 2,700	17,000 3,500
Printed and non printed paper total	15,700	15,700	20,500
Industrial paper extra requirements	3,500	3,500	5,000
Cultural paper extra requirements	1,500 (1)	3,000 (1)	3,000 (1)
General total	20,700	22,200	28,500

(1) evaluation

211.3 - Malagasy Pine and Sisal pulp requirements

The Papeteries de Madagascar firm produces paper since 1966 and has the benfit of a fabrication monopoly in Madagascar; however, they still run against impediments in ther production development which has not been as fast as expected. In fact, Madagascar consumption is not very important and too variegated, so the firm has to comply with the situation by making many production articles in small numbers.

The Papeteries de Madagascar firm produce Pinus patula mechanical wood pulp, use waste paper, and import several pulp grades for their paper production.

With establishment of a pulp mill in Madagascar, woodpulp imports of corresponding grades would disappear.

One may try to define the chemical Pinus patula woodpulp or Sisal pulp proportion which could be used by Papeteries de Madagascar firm. Kraft Pinus patula woodpulp (bleached or unbleached) would be a convenient grade (it is intermediate between Scandinavian woodpulp and Landes Maritime Pine pulp, and Sisal pulp would have the same characteristics at least.

Papeteries de Madagascar firm have consumed in 1969 :

630 tons kraft bleached resinous woodpulp
118 tons kraft unbleached resinous woodpulp
1,100 tons bleached bisulfite hardwood pulp
650 tons unbleached bisulfite hardwood pulp

which totalize 2,500 tons of imported woodpulp.

An important portion of non printed paper imports could be replaced by Papeteries de Madagascar firm production, so in table list 211.3a, we shall try to assess the potential Papeteries de Madagascar firm's market and its forward evolution.

We have made a gross analysis. A detailed analysis would have required more time and more definite data; forward progression of paper requirements of this kind during further years has been taken into account.

Forward progression of Papeteries de Madagascar firm potential market has been made by reckoning the outcome of following statistical items :

- mechanical pulp
- corrugated cardboard paper, creped paper (Papeteries de Madagascar are studying a liner for Elgé board mill)
- cross-ruled cardboard paper
- duplicator paper
- stationary articles
- copy and pocket books
- labels
- wrappers (cement bags and board packages)

We note with interest reduction of this potential market between 1968 and 1969, due to Papeteries de Madagascar production development. We may expect progression of this evolution, but it would not be appropriate to forecast the rate of this progression.

However it is probable that in 1975, this market will be entirely under control and that the above statistical items will come in but for paper import, that the Papeteries de Madagascar will not process. These items will come in for a rough 500 tons.

Supposing a constant fabrication construing, we get the table list 211.3a previsions.

However, construing of fabrication modifications is probable and the various woodpulp grade requirements will be evolutive, according to development of Papeteries de Madagascar firm's fabrications ; so the mechanical pulp portion ought to lessen and the resinous chemical woodpulp portion ought to increase. The figures put forth ought thus to be depassed.

It may be added to these prospects, extra industrial requirements which will be in relation with the package article.

We have assessed them (Cf 211.2) for 3,500 tons in 1975 and 5,000 tons in 1980; we indicate that the unbleached resinous woodpulp portion which will come into the component will be high, without being able to give an exact figure.

The Papeteries de Madagascar firm's resinous woodpulp or Sisal pulp demande would be (not taking into account extra requirements) :

- 900 tons bleached pulp in 1975 and 1,200 tons in 1980
- 170 tons unbleached pulp in 1975 and 220 tons in 1980

Table list 211,3a - Papeteries de Madagascar firm production portion on the Malagasy market (tons)

	1968	1969	Prospect 1975	Prospect 1980
Non printed paper entire consumption	10,300	11,000 (x)	13,000	17,000
Papeteries de Madagascar firm entire production	4,700	5,700	8,000	10,500
Bleached resinous kraft pulp used by Papeteries Madagascar		630	875	1,160
Unbleached resinous kraft pulp used by Papeteries Madagascar		118	170	220
Bleached bisulfite pulp used by Papeteries Madagascar		1,100	1,600	2,000
Unbleached bisulfite pulp used by Papeteries Madagascar		650	910	1,200
Total of pulps imported by Papeteries Madagascar	2,450	2,500	3,555 soit 3,500	4,680 soit 4,600
Paper waste used by Papeteries Madagascar		1,000		
Mechanical pulp made by Papeteries Madagascar	1,780	2,000		
Non printed paper import portion which could be made by Papeteries Madagascar	4,000	3,100 (x)	500	700
Non printed paper total imports	6,300	5,600 (x)	5,000	6,500

(x) Provisional evaluation

211.4 - Sectoral analysis of the Market

The analytic method of tendencies applied for previsions in preceding paragraphs is a rough method. It is quick and essential for long term studies of continuous phenomena (consumption). This method however is not accurate and the impending results only correspond to a scale order of size which are useful for taking investment decisions.

Sectoral analysis, on the contrary, more complete, yields better short term results and enables defining discontinuous phenomena influence (starting up of production units).

Inquiry through interviews has been short and practically restricted to Tananarive (the Elgé board mill at Tamatave was also studied); this inquiry has enabled the particular outlining of the Malagasy market in 1969 - 1970.

The inquiry bears essentially on the paper and board utilization sectors :

- printing, publishing, graphic arts
- board and package fabrication
- industrial customers.

Printing, Publishing and Graphic arts :

The Industrial Development and Promotion Bureau has checked 36 firms in this sector (23 are in Tananarive). The entire turnover amounts to 645 millions FMG in 1966 and the business employed nearly 1,000 persons (in 1968 the turnover would have been 700 to 750 millions).

However, these concerns are of very irregular importance and the following distinctions are to be made :

- the public sector includes two organisms :
  - . the National State Printing Plant
  - . the National Geographical Institute.

- the private sector is divided as follows :

  . five firms, established at Tananarive, have a 50 to 100 millions FMG turnover, and employ more than 50 persons ; together they make more than 67 % of the whole turnover. The first three make 50 % of the whole turnover by themselves;

  . nine firms have a turnover of between FMG 12 to 25 millions; they make 23 % of the whole turnover (four are established in the provinces);

  . the other firms are of a negligeable importance.

The Plan Commissariate forecasts (the school books not taken into account) a 5 % production increase per annum and about FMG 1 milliard gross turnover; parallely, printed articles import would attain a cost of FMG 1,1 milliard in the case the school book problem were not settled.

The National State Printing Plant is definitely the most important in Madagascar. It produces essentially for Government offices and administrations and has used following quantities of paper during latter years :

	1967	1968	1969
Paper	494 tons	328 tons	403 tons
Board	7 tons	7,3 tons	8,5 tons

The year 1967 was exceptional and many forms of administrative print were turned out; there was also an important stock of kraft papers for binding tax lists. The year 1968, on the contrary, was marked by very many book printings and by a reduction of the 1967 stocks.

The greater portion of the sales was operated by Papeteries de Madagascar firm, which had supplied 353 tons paper grades in 1969.

The National Geographical Institude prints maps and scientific documents on very special paper grades which are provided after control by the Paris Geographical Institute. These papers are processed from resinous chemical pulp with a low quantity of titanium dioxide. These papers must be resisting folding and wear of folding, of high tensile strength, of good tearing resistance, non porous, white, clean and void of plush. The consomption is 7 tons per annum.

TABLE OF CONTENTS

The five most important firms have a progression rate very much above the other sectoral concerns, some firms progressing slowly or at the same production level. In this relation, the three foremost printing firms have used together in 1969 a 500 tons paper bulk and have progressed more than 50 tons between 1968 and 1969. One firm has progressed more than 100 tons in two years time.

Prospects of these firms are promising ; various extension or further production unit schemes are in course of study or fitting up. Furthermore, some kind of specialization is taking shape between different firms. Acquisition of export markets also seems to be going well.

Firms of lesser importance are still undergoing the results of the indirect effect and registered stock desequilibrium owing to lack of sufficient financial means, at the time of production starting up of the Papeteries de Madagascar firm. However, constant demand progression will enable them more promising prospects.

The cardboard manufacturing sector

This production sector is still of a limited importance and there are only three firms in existence in Madagascar. But board is useful for packing a large number of goods several of which are industrial and its growing demand is connected with production development, like banans packing, tinned food and bottle casing.

Elgé board manufacture at Tamatave started up in 1967 by producing 500 tons of corrugated a year at the time. Now it makes different sorts of package (light board is made by Papeteries de Madsgascar and thick fiberboard is imported). This firm produced 1,850 tons in 1968 and will make about 3,000 tons in 1970; its production capacity is much larger.

Production growth is remarkable, something like 20 % a year. It will go on, but the rhythm will break before 1975, and the Tamatave mill will then be over 5,000 tons a year.

Two other firms are established at Tananarive. They are smaller : they produce about 350 tons wrappers from board coming from Elgé manufacture. Their growth is also fast and connected with the use of casing development.

Industrial customers

Inquiry through interviews took place with widely different people and concerned a part of the Malagasy paper and package market.

The visited firms belonged to the following business :

- Tobacco and matches
- Soap making
- Ready-made dresses
- Boots and shoes
- Distribution of goods

Between 1960 and 1968 the secondary sector has progressed (Gross Interior Product percentage) from 9,7 % to 14,8 % with a 12,7 % annual growth. This gross tendency for industrial development has resulted in a marked progress of the studied firms during latter years.

However, a general remark becomes apparent after the interviews : the progression rate of exchange between industries is much faster than the final individual consumption rate. Firm managers opinions differ appreciably according to the market they trade on, and the final purpose of thsir goods (goods for industriai consumption and export have much better prospects than those for the local market).

However, it is to be considered that the probable rise in wages will lessen this discrepancy by stimulating the local market, which progression has been impeded by a low rise in wages related with monetary circulation. We also note that, in spite of the temporary less favourable prospects, firms of all sectors have gone on investing and developing their production capacity.

The sectoral "Tobacco and matches" firms are divided into three groups :

- match factory
- tobacco for smoking fabrication
- tobacco for chewing or snuff fabrication

The only match factory develops rapidly and has just started a new light board model made by Papeteries de Madagascar.

Cigarette making is done essentially through ready cut paper imported from France. This production is growing fast.

Chewing tobacco making is latent and could only develop if Government took steps to reduce clandestine consumption.

Soap and detersive sector :

A modern soap mill has been erected in Madagascar lately. Production increases and ought to diversify rapidly. The mill will shortly start making detersive powder. This will call forth an important wrapper demand.

Ready-made clothes firms :

Here the managers opinions is often unfavourable, the local market progressing very slowly. Previsions are difficult to make, because the market is split up into a lot of small markets. There are some very encouraging signs of export business, and some firms have been studying frest investment possibilities. Clothing firms use two board types :

- a grey light board, 500 gr/m2, for shirts and shirt boxes,
- corrugated board for packing.

Boot and shoe business :

This sector includes a large firm surpassing all the small artisanal shops.

Boot and shoe board packing development will progress at a moderate rate over the 1969 figures : about 435,000 boxes and 16,000 boards; still, plastic bags are much in favour and will progress more steadily.

Distribution sector :

This sector comprises two sorts of establishments :

- a modern "de luxe" sector, and large surface store especially for European customers.
- a traditional sector of small shops, essentially for Malagasy provincial and suburbs customers.

The modern sector's expansion, although being rather low, is much faster than the traditional sector. It concerns mostly paper bags.

The small shops use very small quantities for wrapping : this is newspaper processed locally. Each shop may use about 5 to 10 paper reams yearly.

211.5 - Prices on the Malagasy market

211.51 - Price of imported pulp and paper Import

Import prices essentially concern :

- various paper pulp grades
- different types of paper

After an increase at the end of 1969, the Scandinavian unbleached kraft paper pulp price was : FMG 53,000 C.I.F.; in March 1970, another rise of about Swedish Crowns 25.- was expected.

The prices for imported paper are as follows :

Liner :

- USA origin - US$ 191 per ton CIF Tamatave, since 1.1.1970
- South African origin : US$ 230 per ton CIF Tamatave (semi-chemical bagasse or Eucalyptus waterproof liner).

Corrugated paper :

- South African origin : US$ 191 per ton CIF Tamatave (Piet Retief or SAPPI)

Freight :

Importance of freight cost is stressed by following figures :

- Freight USA-Tamatave US$ 58.50 per ton (about F CFA 17,000)
- Freight South Africa-Tamatave US$ 17.85 per ton (about FMG 5,000)
- Freight Tamatave-Fort Dauphin FMG 5,000 per ton

The paper product imports (non printed) are submitted to 30 % customs duty rate. We note that school books have been free of customs duty up to now.

211.52 - Wholesale price of paper on the Malagasy market

INSRE has established two statistics series for wholesale prices :

- printing paper
- binding board

They are in the table list hereafter :

Table list 211.5a - Evolution of wholesale paper price in Madagascar

	1964	1965	1966	1967	1968
Printing paper (100 kg)	12,620	12,676	13,365	12,928	12,991
Binding board (100 kg)	9,855	9,884	10,218	10,443	10,647

In march 1970, AFNOR 21 paper - 76 x 112 - 64 gr/m2 was sold 120 FMG per Kg whereas in 1965, the price was 90 FMG per Kg and in 1960, 105 FMG per Kg.

- Offset paper was sold from 280 to 300 FMG per Kg
- Bible paper 40 grs/m2, was 120 FMG per Kg
- Corrugated board 740 gr/m2 costed 88 FMG/m2

It is instructive to compare these progressions with retail price progression at consumption level, in European environment or in Malagasy environment or with average annual wages :

Table list 211.5b - Price index

	1964	1965	1966	1967	1968	
Retail price index European consumption	108,1	111,0	114,1	117,2	120,4	100 = march 1962
Retail price index Malagasy consumption	100,8	105,2	108,4	109,3	110,3	100 = janv. 1964
Annual average wages 1,000 FMG	89,1	93,5	92,2	96,6		
Monetary circulation billions FMG	39,9	40,3	41,5	42,3		

Retail price index at European consumption level was 140,9 value march 1970, where as retail price index at Malagasy level was index 119,5.

212 - Reunionese prospects

Reunion island, which is a french department, is not far from Madagascar. A community in language and a same currency are favourable circumstances for trading, as well as for coordinating necessary means in view of economic development of interest for the two countries.

So the Reunionese paper market appears as being complementary to the Malagasy market, all the more because gross consumption of most diverse goods is developing and extending fast in Reunion Island.

The Reunionese capital economic resource is sugar cane, and use of its sub-product, i.e. bagasse, offers Reunionese paper prospects an asset which deserves due consideration.

212.1 - Analysis of actual consumption

The report "Paper industrialization prospects in Madagascar" valuated Reunionese paper consumption for about 1,000 tons and forecast that this consumption would not exceed 4,000 tons before 1975. Figures in Table list 212.1a a show that higher estimates are more appropriate.

Non printed paper imports have gone up from 2,917 tons in 1965 to 3,983 tons in 1968, which corresponds to an important progress of nearly 11 % per annum.

One must take due notice of the imports of kraft paper and packing articles which are due to further industrial development and to production and export diversification. A cement factory will be erected shortly at Pointe des Galets, and will turn out 250,000 yearly tons of cement.

This market might be of interest for Malagasy production due account given to proximity of Madagascar and remoteness of other paper production supplies.

Table list 212.1a - Paper articles imports and exports in Reunion Island (tons and 1,000 FMG)

	1965		1966		1967		1968	
	Quantities	Value	Quantities	Value	Quantities	Value	Quantities	Value
Chapter 48 Paper and boards, cellulose pulp, paper, board works	2,917	6,252	3,151	6,530	3,266	7,044	3,983	9,401
4801 Mechanical made paper and board in reels or sheets	662	905	746	1,029	677	992	886	1,370
4801.05 - Newsprint	23	29	4	4	2	4	103	106
4801.28 - Roller formed	7	10					32	62
4801.32 - Other kraft paper and board formed in continuous (less than 25 g/m2)							6	8
4801.33 - Ibid (from 25 to 224 g/m2 excluded)	26	43					22	54
4801.34 - Ibid (from 224 g/m2 and over)	2	2					2	2
4803 Parchment paper, boards and imitations in reels or sheets	51	96						
4805 Corrugated paper, board, crepe, glossy, crimped...		4						
4816 Paper or board wrappers							614	1,463
Chapter 48 - Exports		338		114	82	63	125	101
Chapter 49 - Library articles, graphical art products	274	3,687	285	3,826	241	3,407	354	5,604
Chapter 49 - Exports	1	8		2		15		1

212.2 - Further requirements previsions

Reunionese consumption - comparatively low - will probably go on developing at a steady rhythm during the next year. This consumption ought to attain 6,000 tons in 1975 and 10,000 tons after 1980.

It is essential to stress hereafter Reunionese paper possibilities and industrial development projects which are of interest in this regard.

In 1970 Reunion Island disposes of 70,000 tons of A.D. bagasse. The more and more wide use of fuel for steam and power production in the sugar industry sets the problem of utilization of this sub-product.

The Bourbon sugar factory has therefore erected in 1966, at La Mare sugar factory, a production unit for bagasse particle boards exported to France and commercialized by Linex Co.

In March 1970, a study was in course of completion by French engineering firms in view of establishing an integrated paper production unit producing paper pulp out of bagasse. This pulp would be manufactured into corrugated paper (for corrugated board-middle) and exportsd in reels on the European markets.

The studied project forecast three possible production capacities : 40,000, 60,000, 90,000 tons, the returns study enabling choice of the most profitable solution.

Other former schemes have probably been abandoned : they suggested production of furfural and glycerin from bagasse.

213 - Mauritian prospects

Mauritius Island, independant since 1968, is not so maintainous and more populated (700,000 inhabitants) than Reunion Island. Population density is very high : 442 inhabitants per Km2.

As in Reunion Island, sugar cane is the major agricultural activity (90 % of lands and 96 % of agricultural production value) with 600,000 tons per year. Other cultivations develop rapidly : tea, tobacco...

Industrial activity is growing and is apparent in many parts. Port-Louis traffic (1,000,000 tons) is definitely above Tamatave traffic on another hand. Intricate labour concerns have been set (80,000 unemployed people).

However, solutions seem to be in view, and are in connexion with industrial development and probable setting up of a free port and a free zone, where many industries with fair labour employment, would be erected, and producing for export especially towards Australia and New Zealand.

213.1 - Analysis of actual consumption

The schooling rate is very high in Mauritius Island : 90 %, and this explains a comparatively high paper and cardboard consumption.

Total paper, cardboard, printed and non printed, figures show in two table lists 213.1a (bulk) and 213.1b (detail) :

Table list 213.1a - Paper and cardboard imports in Mauritius (tons)

	1965	1966	1967	1968
Non printed paper and board	4,586	4,036	4,279	3,782
Printed paper and board	158	119	172	294
Total imports	4,744	4,155	4,451	4,076

Table list 213.1b

Item No.	Description	QUANTITY (tons)			
		1965	1966	1967	1968
Paper and paperboard					
641.01.0	Newsprint paper, when proved to the satisfaction of the Comptroller of Customs to have been imported solely for the printing of news-papers	697.2	625.0	556.5	599.3
641-02.0	Printing and wrinting papers in rolls and sheets other than newsprint	418.9	441.4	779.1	511.2
641-03.0	Common packing and wrapping paper	47.6	75.2	63.3	71.5
641-04.0	Paperboard (cardboard) including corrugated cardboard but not including building board	321.7	243.2	168.4	338.2
641-05.0	Building board of paper or of pulp, not impregrated	628.5	638.5	491.3	356.8
641-06.0	Paper and paperboard, bituminised or asphalted; including reinforced and coated with graphite in imitation of slate	24.3	21.7	6.7	7.7
641-07.0	Paper and paperboard coated, impregnated, vulcanised, etc... other than bituminised or asphalted	140.3	51.0	116.9	35.6
641-08.0	Wall paper, including lincrusta	0.5	0.9	0.1	1.6
641-11.0	Cigarette paper	32.0	22.3	33.3	35.5
641-12.0	Blotting paper, filter paper and blocks	3.0	0.8	0.7	2.3
641-19.1	Tissue or muslin paper	10.3	10.0	10.9	13.8
641-19.2	Paper and paperboard n.e.s.	25.5	18.3	23.2	36.2

Table list 213.1b (following)

Item No	Description	QUANTITY (tons)			
		1965	1966	1967	1968
Articles made of pulp, of paper, and of paperboard.					
642-01.1	Paper bags, board boxes and other containers of paper or cardboard	302.8	209.2	307.9	258.1
642-01.2	Paper bags when proved to the satisfaction of the Comptroller of Customs to have been imported exclusively for the purpose of bagging cement from a bulk cement installation	1,558.2	1,319.4	1,241.1	1,003,8
642-02.1	Paper stationery, cards, post-cards and similar items printed, decorated or embossed for correspondance, in boxes, packets, etc.	10.9	12.3	36.5	78.9
642-02.2	Paper stationery, cards and similar items plain, in boxes, packets, etc...	38.9	41.3	53.3	49.9
642-03.1	Registers and ledgers, account adress, memorandum, note, order and recept forms, books or pads file covers and files other than box files, stationery in the form of bounds books, of paper or paper board	38.8	39.6	64.4	63.9
642-03.2	Exercise and copy books	60.0	40.2	28.5	12.2
643-03.3	Albums and diaries of paper and cardboard	6.4	7.0	9.8	8.6
642-09.1	Cigarette papers cut to seze for cigarettes	0.3	0.4	2.0	0.4
642-09.2	Articles of pulp, of paper and of paperboard, n.e.s.	230.3	218.0	284.3	306.7
Printed matter					
892-01.0	Books and pamphlets, printed	62.9	35.5	101.0	228.0
892-02.0	Newspaper and periodicals	84.9	82.8	71.1	66.2

It is to be noted that 1968 was a deficient year for Mauritian economy ; 1969 wes marked by a definite minimum 5 % progression; in march last, 1970 seemed to be even more promising.

The two peper and board firms, Packing Industries and M.S.M., forecast more then 20 % annual progression, their latter years progression having been about 15 %.

213.2 - Further requirements previsions

Mauritius is a market of interest for Madegascar, and quite near : consumption is alreedy important and it will grow very much in the near future. Industrial projects, still in course of study, ought to stimulate eppreciably board end package consumption up to 10 % yearly.

Furthermore, developing exports will require more and more board packings, especially for export of following goods :

beer, cigarettes, clothings, tinned food, flowers, fruit

(in 1969 : export value of 144,000 rupees)

Acquisition of Mauritian paper market entails e policy : at present time, Malagasy exports to Mauritius are taxes 15 % whereas South African exports enter free of duty. This is probably connected with the low rate of Malegasy imports of Mauritian goods.

Mauritius, like Reunion Island, disposes of important quantities of bagesse, but it seems that technical conditions in Mauritius ere far from favourable (weter concern) and that a study of possibility of erecting a bagasse pulpmill in Mauritius has been abendoned.

We note existence, at Port Louis, of a bagasse particle board factory.

On the whole, it seems that Mauritius paper end board consumption ought to be very much over 6,000 tons a year in 1975, espacially if the scheme for erection of a fertiliser fabrication unit (paper bags) were completed with a 100,000 yearly tons output.

22 - GENERAL REVIEW OF PROSPECTS OF THE EAST AFRICAN MARKET

East Africa groups the following countries :

- Burundi
- Ethiopia
- Kenya
- Malawi
- Uganda
- Rwanda
- Somaliland
- Tanzania
- Zambia

This an aggregate of States of diverse importance which are in a rather similar economic development situation. Entire population exceeds 65 millions inhabitants.

We also indicate that Kenya, Uganda and Tangania are associated in a Customs Union : East African Union.

221 - General economic characteristics

It is of interest to compare paper and cardboard consumption per head in the different countries. Table list 221.a classifies data already far back (1965 and 1967) but gives an idea of evolution and gross development level of the countries.

- If Ethiopia is the more populated country, it is the State where the standard of living is the lowest;
- The East African States aggregate : Kenya, Uganda, Tanzania, have similar standard of living; population varies from 7 to 11 millions inhabitants;
- Rwanda and Burundi are very populated (very high density) but poor;
- Somaliland, with a very dry climate, is underpopulated and poor. Its development is questionable;
- On the contrary, Zambia has an income per head far superior on account of its important mining resources.

Table list 221.a - Analysis of paper consumption per head in East Africa

	Population 1965 in million inhabitants	G. I. P. 1965 estimate in $ per head	Newsprint consumption per head in Kg				Printing/writing paper consumption per head in Kg				Other papers and boards consumption per head in Kg				TOTAL Total consumption of papers and boards per head			
			1955	1960	1965	1967	1955	1960	1965	1967	1955	1960	1965	1967	1955	1960	1965	1967
Ethiopia	22.6	45			0.05	0.01	0.01	0.02	0.06	0.09	0.02	0.02	0.1	0.1	0.03	0.04	0.2	0.2
Kenya	9.4	81	0.2	0.4	0.3	0.4	0.4	0.6	0.7	0.7	0.6	1.0	2.8	3.5	1.2	2.0	3.8	4.6
Malawi	4.0	86			0.03	0.02			0.3	0.4			0.1	0.2			0.4	0.7
Rwanda	3.1												0.2	0.2			0.2	0.2
Somaliland	2.5	56	0.1	0.05		0.04	0.05				0.2	0.1		0.3	0.2	0.3	0.5	0.5
Tanzania	11.5	66	0.02	0.04	0.06	0.09	0.08	0.08	0.2	0.2	0.07	0.07	0.1	0.2	0.2	0.2	0.4	0.5
Uganda	7.6	67	0.04	0.06	0.1	0.1	0.06	0.08	0.2	0.3	0.07	0.05	0.2	0.4	0.2	0.2	0.5	0.8
Zambia	3.7	171			0.3	0.6			0.7	0.7			1.0	0.9			2.0	2.2
Total Burundi and Rwanda excluded	61.3	71																1.1

Source : F. A. O.

It should be noted that in 1967, for these countries, the comparison generally estsblished between the Gross Interior Product (G.I.P.) level and the paper consumption per head has not been entirely checked.

In fact, the paper consumption per inhabitant is the hightest in Kenya, whereas the income is maximum in Zambia. This unusual fact is probably the consequence of the most drastic change of the social structure which modern economy brought into Kenya and therefore of the higher cultural level.

In 1968, different origins of information gave following consumption per head :

- Burundi	0.9 kg
- Ethiopia	0,5 kg
- Kenya	4.3 kg
- Malawi	0.8 kg
- Rwanda	0.5 kg
- Somaliland	0.8 kg
- Tanzania	1.3 kg
- Uganda	1.3 kg
- Zambia	5.5 kg

Very quick paper consumption growth in Zambia is thus stressed.

It is of interest to note that average consumption per head is near Madagascar's, the entire market being ten times the Malagasy market for a ten times more numerous population.

Table list 221.b gives the entire non printed paper consumption in the different studied countries.

The 1968 consumption structure undoubtbly differs very much from the figures that will characterize 1969-1970 period, because of production unit erection in Ethiopia and Kenya (see 222.2 and 222.3).

Table list 221.b - Paper consumption in the various countries studied (short tons)

	Population (1,000)	Cosumption per head £	Number of units		Production		Imports		Exports		Consumption	N o t a
			Pulp	Paper	Paper and board (x)	Waste paper (x)	Pulp	Paper, beard	Pulp	Paper, beard		
Malawi	4,347	1.9						4,900			4,900	A pulpmill scheme for 1975
Somaliland	2,600	1.8						2,340			2,340	
Tanzania	12,600	2.9						18,400			18,400	Sisal pulpmill scheme (100,000 yearly tons)
Zambia	4,000	12.3						14,000			14,000	
Ethiopia	23,457	1		2	650			12,000			12,650	A papermill has just started up (5/10,000 T/year)
Kenya	10,209	9.5		1	3,500	3,000	900	45,000			48,500	Integrated pulp/papermill for 45,000 T/year in 1972
Uganda	7,900	2.8		1				11,000			11,000	Paperbag unit for T : 6,000/year from 1970
Total East Africa except Rwanda - Burundi	65,103	1.76			4,150	3,000	900	107,640			111,790	

(x) - 1968 production

222 - Situation and paper development projects in the various countries

The states of the considered area have generally drawn schemes in regard with economic and social development : five-year plans, short term schemes and diverse projects. Different types of projects have been put to study, more especially in the forestry matter or in the paper industry concern. We shall review this situation in each country so as to be able to valuate market which Madagascar might acquire for an eventual paper pulp production.

222.1 - BURUNDI

Burundi is a small state in which the population is very dense but which does not possess enough economic resources for considering maintenance of a paper industry.

Reforestation is projected in an erosion prevention scheme, especially on the line of watershed between the two Nile and Congo great fluvial basins.

We note that paper and board imports (non printed) have amounted to :

3,300 short tons in 1967
3,400 short tons in 1968

originating essentially from South Africa.

222.2 - ETHIOPIA

Ethiopia is the most populated country of the group, but it is also the one where the standard of living is the lowest and where development is the slowest.

The paper market is of about the same importance as at Madagascar (for a 23 million inhabitants population). It is sufficiently important for three paper mills of different capacities to be established there.

The most important is also the more recent : the Ethiopian Pulp and Paper is a Parsons and Whittmore sub-company. It processes paper from imported pulp but will soon be using bagasse from the Wonji sugar factory.

This paper mill, very similar in its planning and its production characteristics, to the one established at Tananarive by Papeteries de Madagascar, started up during 1969. It is meant to produce at least 25 daily tons of papers of all sorts. Its production will probably reach 9 or 10,000 tons per annum.

The African Match and Paper factory erected at Asmara could process about 15,000 yearly tons cardboard and paper wrappers from Doum fiber and waste paper. Its actual production is about 650 tons cardboard.

Paper imports have amounted to 12,000 short tons en 1968, which puts consumption at 12,650 short tons.

222.3 - KENYA

Kenya is the state in which the traditional society has been overturned to the utmost and where sociological conditions of economic progress are the best.

We recall Kenya previsional evolution as it is described in the second five year development plan for 1970-1974.

The aims of this plan are based on four conditions which ought to enable its completion :

- a world economy in continuous expansion, without any fall in exports of countries in course of development,
- a constant expansive demand and opening of new markets,
- an intensification of economic cooperation within the East African community,
- adequate technical and financial assistance.

The first aim is in concern with production increase which must attain 6.7 % per annum. The monetary economy share ought to be in 1974 : about 83 % of Gross National Product, with more than £K 500 millions.

The added value of manufacturing industry ought to grow to nearly 9 % per annum. In particular, paper pulp and paper industry will develop appreciably. Investments to be completed in this relation between 1967 and 1973 will amount to £K 12,500,000 (to which will be added £K 1,800,000 in printing and publishing).

The Kenya paper projects are in relation with important wood supplies :

- 133,000 ha. forestry plantations in 1965, of which more than 50 % planted in resinous species;
- further plantations are in course of completion and it is estimated that planted lands will attain 142,000 ha. in 1980;
- there are more than 100,000 ha. bamboo plantations.

A small paper mill exists at present in Kenya (Kenya Paper Mill Co.). It produced in 1968 : 3,500 tons of paper and board packages. Its requirements are :

. 3,000 tons waste paper
. 900 tons imported pulp

Production of this mill ought to reach nearly 5,000 tons in 1974.

Investments prevised in the plan are in relation with erection of a pulp and paper mill at Broderick Falls. This scheme seems to be in a good way. The mill would start up production in 1972. Construction would start in April 1970. Final capacity would be 45,000 tons of pulp per annum. Entire investment is about £K 13 millions. This mill ought to supply all Kenya paper requirements.

Kenya paper and board consumption was, in 1968, about 48,500 short tons of which 3,500 were produced on the spot; imports come essentially from the United States, Great Britain and Scandinavia.

222.4 - MALAWI

Malawi is a preeent developing, with the help of F.A.O., an important paper reforestation scheme of £ 2 millions for reforestation of Vijya plateau.

Correspondingly, detailed studies of an integrated resinous kraft pulp and paper mill will be probably completed in 1970, and the mill of which production would start up at 150 tons daily, would begin working in 1975. Capacity would be brought up to 300 tons daily in 1980.

A paper project is now being studied by a South African financial concern : it previses use of waste paper in a firet stage.

In 1968, Malawi consumption was 4,900 short tons of paper and cardboard. If the above project came into being Malawi would became an exporting country for paper and perhaps for pulp.

222.5 - UGANDA

The second Uganda five year plan for 1966 - 1971 had three essential aims :

- production increase,
- production diversification,
- social and economic rights.

Thie proposes that income per capita should increase by 25 % and that the share of this income in national economy should proceed from 76 % in 1966 to 79 % in 1971 and then 86 % in 1981. The Groes National Product amounted to £ 290,000,000 in 1968.

In the paper industry relation, the plan prevised eetabliement at Jinja, by Madhavani concern, of a bag factory with use of imported kraft paper. Two further stages were considered : erection of a pulp mill and of a paper mill.

At preeent time, a paper mill has been added to the bag factory and the production is 20 daily tons of kraft paper bag (8,000,000 bags a year).

FOREWORD

This study was carried out according to a contract entared into between Unitad Nations Industrial Devalopment Organisation (U.N.I.D.O.) and Centra Technique Forestier Tropical (C.T.F.T.). The part of the study relating to engineering wae committed to Société de Conetructions Industriellas, de Réalisations de Montage et d'Assistance Technique (C.I.R.M.A.), acting as sub-contractor for C.T.F.T.

The contract was signed on January 30th 1970 end was completad by an amendment countareigned on May 11th 1970 by the General Manager of C.T.F.T.

The plan of the study comprised recalling previous reports on the papermaking industry in Madagascar, pulp and paper market prospect in the neighbouring countrias, technicel and economic feasibility of a Sisal pulp mill arection in the Fort Dauphin region and of a Pine woodpulp mill erection near Fianarantsoa.

The experte were in Madagascar during the months of March and April.

Mr. Uhart wee there from March 5th to April 4th for the raw material and market study ; Mr. Bertrand from March 5th to March 28th for the Madagascar, Mauritany and Reunion market study ; Mr. Gokeleere from March 18 th to April 15 th for the engineering study.

The two former experts completed their study in the Middle East from May 15th to 29th.

Mr. Petroff, Head of the Cellulose Department, carried out laboratory paper teste at Nogent-sur-Marna from end of March until beginning of June.

The two first chapters of the study are devoted to a detailed account of previous studies and the pulp and paper middle term markat prospects. The following chaptar deals with possibilities ed to potentiality and price of existing raw matarial and previsions as to plantatione to be eet up.

Extension of the mill will be done by estsblishment of a pulp production unit with use of straw of bagasse and finally another paper machine will be set up.

Uganda does not seem to have considered a reforestation scheme for groundwood. There seems to be another project prepared by a Japanese concern for erection of a paper pulp mill on the Nile, but at present time this project has been put aside.

In 1968 Uganda consumed 11,000 short tons non-printed paper and board.

222.6 - RWANDA

Rwanda is independant since 1962, but the first five years plan could only be set up in 1967.

This plan sets up a priority investment scheme which was divided in the following way :

- production 44 %
- economic infrastructure 30 %
- social and administrative infrastructure 26 %.

Prevised Gross Interior Product was 5 %.

With UNIDO Aid, Rwanda is studying various projects of which an integrated paper mill which would process pulp and then paper from papyrus. These projects would not come into being before 1975-1980.

Rwanda paper consumption amounted to 1,650 short tons in 1968.

222.7 - SOMALILAND

Somaliland is abarren country, poor and sparsely populated.

In 1968 paper consumption was 2,340 tons and there is no progress.

Paper prospects of Somaliland are remote and it will import no paper pulp for the next years.

222.8 - TANZANIA

Tanzania is a country poorer and more agricultural than Kenya but it may be compared with the latter as to its economic and social situation (tribal society regression).

The second Tranzanian plan covers the years 1969 to 1974. It is expecting a Gross National Product of 6.5 % which would proceed from Tanzanian shillings 6,150 millions (1 shilling T = FF. 0.69) to 8,445 millions in 1974. Industrial development will essentially bear upon the small industries.

However, the paper connexion is in concern with a large scheme. These Tanzanian schemes essentially bear upon use of Sisal. There is a small paper pulp mill for Sisal at Tangani.

A French firm has studied a Sisal paper pulp project with establishment at Tanga.

This project, the realisation of which could begin rapidly, is awaiting final Tanzanian Government agreement. The forecast production would be 100,000 tons per year of pulp.

In 1968, Tanzanian consumed 13,400 short tons non-printed paper and board. Coming into being of above project would definitely make Tanzania a paper pulp export country on world market in competition with Madagascar.

222.9 - ZAMBIA

Zambia, like Malawi, has some common features with Southern African states such as South Africa, Rhodesia or Mozambic, or even with former Katanga.

In this way, Zambia possesses important mining resources already exploited on a large scale, and the production often being treated locally. Thus, 85 % of copper production is exported in the form of electrolytic copper. The other exploited ores are :

- zinc, lead, cassiarite, manganese, cobalt.

In all metallurgic spheres, Zambia is in a leading position, principally on account of its mining industries. In this way, the Zambian Gross Interior Product per capita is more than double the one of the other studied countries, the industrial population being very high for a whole population comparatively low, with 3.7 millions inhabitants.

Although paper consumption per capita is high, Zambia paper projects are restrained and directed towards long term. The forestry potential in 1980 will be sufficient (taking into account completed plantations) for establishment of a pulp and paper integrated unit.

At the present moment, the only project in course of completion is a bag and paper and board package factory; this project, of a total $ 1.4 million value, started in april 1969.

In 1968, Zambia consumed 14,000 short tons of paper.

223 - Prospects of exporting paper pulp to East Africa

For a survey of paper pulp imports by the above studied countries, one must valuate :

- forward consumption level
- paper production level
- pulp production level

The paper and board consumptions which are prevised during the F.A.O. Cairo Conference in 1965 are already remote, but with due account to actual figures, one may believe that forward needs will approach these :

Table list 223.a - Paper and board consumption previsions (per thousands tons)

	1975	1980
North Africa	905	1,324
West Africa	237	376
Central Africa	69	102
East Africa	342	526
South Africa	866	1,145
Total	2,419	3,473

F.A.O. Cairo Conference 1965

Indeed, according to an estimate completed in 1969 by the Pulp and Paper International Magazine, annual consumption progress per capita in Africa is around 1 pound i.e. 0.454 Kg.

These two above estimates enable to valuate paper consumption in the studied East African countries at about :

- 250 - 290,000 tons in 1975, and nearly
- 450,000 tons in 1980

Progress will not be regular according to the various considered countries. The more forward countries such as Zambia, Kenya or even Tanzania and Uganda will advance faster than the others; progression will be helped forward in the countries where paper producing units will be set up.

According to above estimates, country after country, it seems that forward paper production in studied countries will be the following in 1975 (it would be useless to rely upon present data and projects, for a 1980 production estimate).

Ethiopia	12,500
Kenya	50,000
Malawi	45,000
Uganda	12,000
Total	119,500 i.e. 120,000 tons

East Africa will therefore incur a gross paper deficiency of about 290 - 120 = 170 thousand tons.

It is herefore to be presumed that between 1975 and 1980, many paper and pulp unit schemes (generally integrated) will come into being and will use all available raw materials : resinous, bamboo, straw, bagasse, papyrus, etc...

On the other hand, in 1975, pulp production will be in excess : the Ethiopian, Kenyan, Malawian and Ugandan integrated pulp and paper units will produce their own necessary pulp, and Tanzania will perhaps produce 100,000 tons of Sisal pulp.

It may therefore be expected that until 1976-1977, East Africa will be exporting paper pulp (see 222.8) and importing paper, and that this trend will be on the reverse in the later years of 1976-80, East Africa becoming slightly importing pulp and then more appreciably pulp together with paper.

A Malagasy resinous pulp production would therefore find outlets in East Africa around 1980, as the requirements could only be covered up to 75 %.

23 - MIDDLE EAST MARKETS

The experts studied the Middle East following markets : United Arab Republic, Iraq, Iran and Israel, by way of direct relations with the administrative authorities and the industrial managers of above studied countries.

231 - United Arab Republic market

231.1 - General situation

In 1970, the United Arab Republic has a population of 32 millions inhabitants, which increases at a 2.7 % yearly rate, whereas the Gross National Product, which is actually $ 160, increases yearly by 2.6 %. The state of war which exists in United Arab Republic does not help the country's development.

Presuming a rapid decline of the existing tension, one may deem that in 1980, the population will be 42 millions inhabitants and that G.N.P. settles at about $ 210.

231.2 - Market situation

United Arab Republic paper product consumption is supplied by import and by local industry production. This consumption is about 7 yearly kilos per capita.

Table list 231.2a defines imported bulks in 1967 and 1968 in metric tons :

Table list 231.2a - United Arab Republic paper product imports (metric tons)

Imported products	1967	1968
Paper making material	42,021	70,683
Newsprint	46,285	20,890
Printing/writing paper	13,272	4,824
Wrapping/packing paper	14,761	17,111
Cigarette paper	596	1,152
Board	21,621	19,342
Parchment paper	941	1,688
Light weight paper (30 gr/m2)	196	463
Blotting and filter	6	18
Total paper products	97,678	65,488

National production coming from about a dozen of converting units is :

Table list 231.2b - United Arab Republic paper production (metric tons)

Materials	1966	1967	1968
Printing/writing paper	25,214	28,432	32,741
Wrapping/packing paper	60,839	59,394	69,282
Kraft paper	24,169	3,942(1)	13,976
Total	110,222	91,768	115,999

(1) The production fall registered in 1967 is due to closing down of Suez kraft mill following bombing. It is to be removed to Cairo or Alexandria.

Present consumption, on the 1968 tonnage basis then establishes at

(metric tons and %)

Newsprint	21,000	11.6 %
Printing/writing	38,000	20.9 %
Wrapping/packing and kraft	100,000	55.2 %
Board	20,000	11.0 %
Miscellaneous	2,000	1.3 %
Total	181,000	100.0 %

231.3 - Forward requirements previsions

Previsions have been made for 1980, presuming same consumption per capita, ascribed to the future prevised population. The same percentages by kinds of products have been retained. From which we get following tonnages.

(metric tons)

Newsprint	35,000
Printing/Writing	64,000
Wrapping/packing and kraft	168,000
Board	33,000
Miscellaneous	4,000
Total	304,000

If we take into account present production and mill schemes forwarded in 3rd five year plan (1971-1975), we get following prospects :

(metric tons)

	Production	Scheme	Total
Newsprint	-	100,000	100,000
Printing/writing	33,000	18,000	51,000
Wrapping/packing and kraft	83,000	31,500	114,500
Corrugated board	-	25,000	25,000
Total			290,500

If the plan is completed in 1975, production ought therefore to attain 290,000 tons. The deficiency in relation with requirements is apparent for printing-writing paper, wrappers, kraft, and board.

The projected mills are :

- one 100,000 tons newsprint mill for bagasse processing
- one 7,000 yearly tons rice straw pulp unit (bleached chemical pulp - Pulp unit in National Paper Co - Alexandrie)
- one chemical pulp unit (30,000 tons) for printing-writing paper (bagasse and rice straw)
- an increase in a mill capacity (RATKA) from 4,000 to 22,000 tons for printing-writing paper
- one fine wrapper unit (24,000 tons) at Alexandrie, by using imported kraft pulp and sulfite or soda pulp from bagasse or rice straw
- one paper, board and fine wrapper mill (7,500 tons)
- one corrugated board mill (25,000 tons)
- one mixed wrapping paper unit (paper, board, aluminium, cellophane) (750 yearly tons)

On the whole, in the 3rd Plan, 3 pulp mills and 5 manufacturing units are prevised.

231.4 - Malagasy potential exports

For production prevised in 1975, United Arab Republic will have to import long fiber pulp. For 140,000 tons wrappers and board, 100,000 tons imported pulp may be forecast, and for 51,000 tons printing/writing paper long fiber pulp import may be estimated at 10,000 tons.

Madagascar could therefore find an outlet on the Egyptian market for following quantities :

- Pinus patuls pulp	: 25 to 40,000 tons (bleached and unbleached)
- Sisal pulp	: 5 to 10,000 tons (bleached)

The first grade would be for wrapping paper and board; the second grade would be intended for printing/writing paper.

231.5 - Commercialisation process

United Arab Republic is a socialistic economy country, and has only state concerns. So, to get into this market, one has to participate in Government tenders, the notices of which are published in the M.O.C.I. (International Commerce Monitor). This may be consulted by referring to the commercial adviser of Tananarive French Embassy. Furthermore, for a tender to be accepted an offer at equal quality is not sufficient : one has to be politically introduced and agreeable in the country. It would be desirable for Madagascar to be represented by a Bureau or a Malagasy commercial adviser who might be introduced to important personalities. (1)

Above remarks are also valid for Iraq market that we will now study.

232 - Iraq market

232.1 - General situation

Iraq population : 8,500,000 inhabitants a present, ought to rise to 11,200,000 inhabitants in 1980, thus an increase of 2.8 % every year.

The Gross National Product is $ 230 per capita; it ought to attain $ 280 in 1980, which is a yearly 1.9 % increase.

232.2 - Market situation

Iraq possesses no pulp processing, nor basic paper product fabrication units. There are only converting or conditioning units which use imported gooda : board casing, paper bag, paper and cigarette box, enveloppe, block and copybook works.

Following Table list gives 1967 and 1968 Iraq imports.

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(1) The United Arab Republic paper industries heads have permitted us to publish their names, they are :
Mr. Abdel EL MASRI, Middle East Paper Co. - 37, rue Kasr El Nil, Cairo
Mr. Ibrahim EL DESSOUKI, Managing Director and Chairman of Egyptian kraft Paper Co. - 26, Sherif Street, Cairo.

The test outcomes are specified as well as the necessary complementary research.

In the two further chapters, technical and economic circumstances for the erection of a Sisal pulp mill and a Pine woodpulp mill are dealt with. In particular, location factors for the first, and fabrication process for the second, have been surveyed. The returns reckoning has been established for the two projects.

The study closes on a summing up of the results and suggestions for appropriate complementary research.

The experts would like to express their thanks to the Malagasy authorities and the United Nations representatives in Tananarive for their kind assistance during their mission.

Table list 232.2 - Iraq paper product imports

(metric tons)

Products	1967	1968
Newsprint	1,376	875
Printing/writing	7,458	8,974
Wrapping/packing paper	11,741	17,198
Corrugated board	416	570
Plain board	6,190	5,920
Other papers	3,269	4,201
Total	30,450	37,733

Consumption is actually 4 Kg per capita and per annum of miscellaneous paper products. We may note absence of pulp imports.

232.3 - Forward requirements previsions

With preceding consumption, and relating it to forward population, the 1980 requirements would amount to :

about 45,000 yearly tons

Iraq Government has anticipated erection of a producing 40,000 tons/year of various paper products mill in the Bassorah area (32 Kms from Bagdad). Investment would be 20 millions Dinars ($ 60 millions); it would use straw or marsh reed and imported pulp. Full capacity production would be :

Solid fiberboard	6,600 tons		
Plain board	1,500 tons		
Corrugated board	1,800 tons		
Flat cardboard	3,600 tons	=	13,500 tons
Cement bags and misc.			14,100 tons
Printing paper	3,600 tons		
Writing paper	6,600 tons	=	10,200 tons
	Total		37,800 tons

Presumably, this mill would pratically cover forward Iraq requirements. It would only have to import special grade products, such as newsprint, cigarette and filter paper etc...

Forward long fiber pulp mill requirements ought to mark out for between 50 and 70 % of requirements, so, between :

20 and 28,000 tons softwood or Sisel pulp.

232.4 - Madagascar potential exports

Subject to remarks in § 241.5 for U.A.R., which are also valid for Iraq, Madagascar ought to be in a position to export from 1975 onwards :

8 to 12,000 tons unbleached or bleached Pinepulp
2 to 5,000 tons bleached Sisel pulp (1)

233. Iran market

233.1 - General situation

Iran enjoys actually a particular bright economic activity in comparison with neighbouring countries. Its population is 29 millions inhabitants, and it will rise to 33,200,000 in 1980 (growth rate 2.9 %). The G.N.P. increases by 10 to 12 % every year. From $ 350 in 1970 it will rise to $ 900 in 1980.

Furthermore, the course of action of the Shah against analphabetism induces increased requirements prevision for printing and writing peper. The Natural Resource Ministry experts forecast a peper and board consumption increase of 10 to 15 % per annum until 1975, and over 15 % after 1975.

233.2 - Market situation

Iran did not possess a pulp mill up to 1970. Firms, principally artisanal in character, process imported wrapping paper and board.

The concerned imports are :

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(1) The personality it would be useful to contact for starting a commercial course is : Mr Gabriel ZEBOUNI, Iraq Manufacturing and Trading Co - South Gate , Bahgdad.

Table list 233.2 - Iran paper product imports

(metric tons)

Iran year	1346 March 21 1967-March 20 1968	1347 March 21 1968-March 20 1969
Waste paper	-	491
Paper pulp	-	25
Diverse boards	2,584	5,834
Wrapping/packing	31,840	40,570
Printing/writing	8,344	9,513
Other papers	45,983	61,710
including newsprint	7,694	8,725
Total	88,751	118,143
in round figures	90,000 tons	120,000 tons (1)

A non restrictive list of foremost Iran paper importers will be found in Appendix.

The local processing units produce actually 58,000 tons of board boxes or cases; moreover, cement bag requirements are 13 to 14 tons of bags (34 to 40 millions bags). Apart from many artisans who produce an average yearly 200 tons, there are about a dozen converting shops.

The actual consumption per capita is about 5 yearly Kilos.

233.3 - Forward requirements previsions

With a 14 % average increase rate per annum, the forward consumption in 1980 would be 445,000 tons divided as follows :

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(1) ETEBARATE Bank statistics put forth respectively : 94,000 and 137,000 tons by counting printed papers : stencils, carbon, envelopes, etc...

Table list 233.3 - Iran forward requirements

(metric tons)

Products	1970 consumption	1980 consumption
Boards	64,000	130,000
Wrapping/packing	41,000	100,000
Newsprint	9,000	30,000
Printing/writing and miscellaneous	10,000	185,000
Total	124,000 tons	445,000 tons

A high progression of printing/writing paper during this period is to be noted.

The Iran further establishment projects are limited to a mill which has just been completed, at APTA-BE, near AHWAZ (60 Kms) in the South of the country. Of a printing/writing paper 30,000 to 40,000 tons capacity, this mill will use as raw material sugar : cane bagasse, and imported : pulp. Its forward requirements as to pulp may be valuated between 1/3 and 1/2 of entire requirements, so :

10,000 to 20,000 tons of Pinewood or Sisal bleached pulp.

233.4 - Potential Madagascar exports

Due account to the proximity of the future mill to the Korramshar or Abadan ports, it seems possible to sell Malagasy pulp at a competitive price. We shall mark out possible tonnages to be sold as :

10,000 to 20,000 tons of bleached Pinewood or Sisal Pulp.

233.5 - Commercialization process

Reverse of the two preceding countries, Iran has a liberal economic regime, and trading proceeds without administrative tenders and on an absolute liberty footing.

If Madagascar had disposed now of a pulp production, starting up in 1970 of the Aphta-Be mill might have resulted in the beginning of commercial exchanges with Iran during the present year. (1)

234 - Israelian market

231.1 - General data

Israelian economy is characterized by a rapid growth since the creation of Israel State, with from time to time a brief halt. In 1969, Gross National Product reached million £ 11,934 which is 4.5 times more than in 1950 in actual figures; it corresponds to a 9 % yearly growth. This rate is high, even compared with the United States (3.3 %), Federal Germany (5.5 %) or Japan (9.6 %). Income per capita has been £.I. 4,500 i.e. US$ 1,500, doubling in absolute value since 1950.

This swift economic expansion is due especially to manpower and capital growth. But the fundamental economic problems, eluded after the 1967 outbread, are still existing. They are :

- immigration decline
- dwindling of the monetary assignments from Diaspora (these assignments, very often without counterpart up to 70 % of the whole, fall off in spite of the abrupt and short rise in 1967).
- weight of war economy (nearly 40 % of State expenses of Israel are assigned to Defence and Police).

It must be expected that resort to foreign loans will devalop, and that the foreign debt reference will be an ever increasing burden for the payment balance in spite of the commercial balance deficient reduction. Israelian economic progression rate will therefore have to be restricted.

Paper product consumption is important; this is due to the high average standard of living.

Climatic and ecologic conditions are not propitious for groundwood production : afforestation is costly and unproductive on account of the dry climate, and is linked with erosion prevention only. Israel will be a permanent pulp and paper importer.

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(1) It would be advisable, for promoting pulp sales to Iran, to contact :

Mr. Louis GEMAYEL - Cartonnerie Mimosa - Teheran
P.O.B. 134 - TEHERAN (Iran)

Imports items are specified in Table list 234.1a :

Table list 234.1a - Israelian pulp and paper imports

	1968		1969	
	Quantities (tons)	Value (1,000 $)	Quantities (tons)	Value (1,000 $)
Chapter 47 : Paperpulp				
Mechanical pulp	1,735	227	25,836	3,431
Soda or sulfate pulp	115	14	168	26
Sulfite pulp	387	70	544	94
Vegetable pulp	52,329	6,446	28,383	3,694
Waste paper	1,316	97	1,721	194
Pulp total	55,882	6,854	56,652	7,439
Chapter 48 : Boardpaper				
Newsprint	11,924	1,811	21,237	3,124
Printing/writingpaper	980	232	2,385	595
Kraft paper	17,566	2,865	19,201	3,263
Cigarette paper	116	123	144	153
Filter paper-board	22	36	16	33
Condenser tissue	15	40	17	46
Wrapping cellulose	447	173	167	96
Fruit wrapper	253	89	-	9
Paper/board in rolls	48,984	8,303	34,337	6,112
Parchment paper	1,119	408	2,618	472
Glazed paper	173	71	129	56
Paper wrappers	139	144	213	225
Paper articles	-	3	-	11
Writing board-paper	-	154	-	207
Ready cut boardpaper	44	109	44	193
Paper reels	426	392	462	390
Perforated cards	3	28	5	35
Measuring paper	24	114	84	187
Cigarette filter	224	408	216	343
Spindles, reels	7	13	23	29
Board egg boxes	5	10	115	50
Filter paper	5	11	1	3
Paper lamp shades	8	13	-	-
Non checked articles	-	578	-	413
Various articles	-	21	-	29
Total paper	82,479	20,872	81,414	24,128

Ref. : Israel statistic yearbook 1969

On another hand, it must be noted that Israelian exports indicated in Statistic chapter 47, bear solely on waste paper : 3,323 tons in 1969. Table list 234.1b gives the total non-printed paper and board production in Israel.

Table list 234.1b - Israel non printed paper and board production

(metric tons)

	1958	1960	1963	1964	1965	1966	1967	1968
Newsprint	4,629	5,803	8,075	7,211	8,483	11,963	14,770	13,250
Printing/writing	9,047	12,446	15,353	18,874	18,796	20,431	23,966	26,637
Other papers	4,811	7,973	9,425	12,619	13,401	12,975	14,791	20,278
Board	3,485	4,866	8,084	8,727	8,763	8,303	9,750	12,938
Total	22,972	31,088	40,937	47,431	49,443	53,672	63,277	73,103

Growth of this production is remarkable by its regularity and its rapidity. It enlightens Israel industrialization policy.

Table list 234.1c gives the 1967 and 1968 total paper consumption according to other statistic data (Pulp and Paper International) with appreciably different figures.

Table list 234.1c - Israel paper and board consumption (short tons)

	Production	Imports	Exports	Consumption
Year 1967	69,335	65,036	9,370	125,001
Year 1968	80,799	98,105	7,275	171,629

Israel is in a very good position for using imported papers; graphic art and packing industries are many and diversified. There now exists an important paper mill which processes about sixty thousand tons of imported pulp. This paper mill, the American Israel Paper Mill, is established at Hadera, between Haifa and Tel Aviv, and is restricted in its production capacity only through lack of sufficient water.

However, there is a development project consisting of fitting up an extra paper machine which would increase production capacity by about 60,000 tons before 1975. This investment will be made possible by adjoining a waste water purifying unit, which would reduce water needs by 50 %.

The board factories of lesser importance make 5,000 yearly tons of board each, essentially from waste paper. In 1969 the entire board production was 14,000 tons, the most of it being corrugated board. At Jerusalem, Commerce and Industry Ministry, the production capacity is estimated at about 18,000 tons.

234.2 - 1975-1980 prospects

It is not easy matter to valuate non-printed paper and board gross consumption in Israel between 1975 and 1980. Consumption per capita will increase very much, but its progression is in strict relation with the standard of living and manufacturing industry development; a detailed study would be the only way to clear up this point. Influence of immigration, in relation with political local and world circumstances, is difficult to appraise.

For these two reasons, a forward consumption prevision may only be an indication. The Jerusalem Commerce and Industry Ministry indicates a possible increase average of 7 to 10 % per annum.

As for the forward paper pulp requirements they are relatively easy to estimate :

- there are definite projects
- possibilities are restricted by peremptory technical concerns.

From now on to 1975, the American Israel Paper Mill production increase is the only one in view and when in operation the entire Israel production will then be between 100 and 130,000 tons of paper and board. Any other investment would require further water supply, which is subject to new techniques particularly in relation with the removal of salt from sea water.

Israel will obviously be compelled to increase its paper imports to cover its needs, its production being limited.

With this outlook in view, we come to valuate forward American Israel Paper Mill requirements in coniferous or Sisal kraft pulp. Its actual requirements are about 25,000 tons and are divided according to grade, as follows :

Between 1975 and 1980, the American Israel Paper Mill will want about 40 to 50,000 tons long fiber kraft pulp, the greater part of which might be provided by Madagascar : as an example, about 40,000 tons of Pine patula pulp and 5 to 10,000 tons of Sisal pulp.

It must be stressed that all Israelian personalities visited, whether belonging to administrative service or private firms, have shown great interest in Madagascar paper projects and attached much importance in exchange developments between Israel and Madagascar.

234.3 - Export costs to Israel

Paper pulp entries into Israel are free of custom duty and imports are now absolutely free. Export costs will therefore concern sole transport costs.

Port tariffs in Ierael are uniform : Haifa port on the Mediterranean and Eilat on the Red Sea, apply the same tariffs. Every Israelian importer pays a 2 % ad valorem port tax for imported goods.

Ex-wharf cost (generally included in maritime transport cost) is :

I.£ 6.- so about $ 2.- in the case of direct delivery
I.£ 11.- " $ 3.5 in the case of delivery from warehouse.

The Zim Co tariffs presently applied for maritime paper pulp imports principally originating from Finland and the United States were, before June 1st, 1970 : $ 21 per m3 for Finland, therefore between $ 16 and 18 per ton according to denaity of the various grades of pulp (0.7 to 0.8 ton/m3).

On June 1st, 1970, there was a 10 % rise, which brings transport cost (freight, shipment, ex-wharf) up to $ 18 to 20 per ton.

The American Israel Paper Mill is at Hadera, at about 45 kms, from Haifa, so the pulp is conveyed from port to mill by rail, although sometimes by trucks. The conveyance cost is :

- by rail : I.£ 5.80 per ton, but $ 1 only in large quantities
- by trucks : I.£ 6.30 per ton, for a minimum of 10 tons.

Under above conditions, should Madagascar pulp be competitive, it must be delivered at American Israel Pulp Mill at equal or lower price as to equal grade Scandinavian pulp. The entire conveyance cost between Tamatave and mill must therefore be lower than Scandinavian pulp freight.

Freight between Tamatave and Eilat would be about $ 10 to 13 and may be less for large quantities. It seems as though the rough $ 8 margin left by maritime transport would be enough to pay for road conveyance between Eilat and the American Israel pulp mill.

Road conveyance on about 400 kms might be changed before 1980 for rail conveyance if the actually studied railroad line between Eilat and Dimona were completed.

234.4 - Export possibilities to Europe by Israelian overland transit

Suez canal being out of use since June 1967, world trade transits by the Cape; Israel State has just built a road for transfer of goods overland from Eilat on the Red Sea to Ashdod on the Mediterranean. This conveyance utility relays the Eilat-Ashkelon pipe line for oil product transit. Products are immediately unloaded and transferred at Ashdod or Eilat.

This transport cost is appreciably reduced by very competitive tariffs conceded by Israel.

As regards to this utility, Malagasy Tamatave freight would get to Europe at following costs :

1 - RECALL OF COMPLETED STUDIES

11 - POSSIBLE ERECTION OF A CELLULOSE MILL

111 - First studies

112 - Possible choices

113 - Combined studies

12 - MADAGASCAR PINES

121 - Resources in pinewood (1966)

122 - Plantation development

123 - Utilisation of Pinus patula

124 - Investment prospects for pulpwood production in Madagascar.

13 - WOODPULP AND PAPER WORLD MARKET

131 - International studies

132 - Combined study

14 - MADAGASCAR SISAL

141 - Sisal plantations

142 - Sisal cultivation promotion

143 - The fiber market

144 - Papermaking utilisation

145 - Development scheme for the mandrare area.

- Tamatave - Mediterranean port (Genoa, Marseilles...) about $ 40 per ton.
- Tamatave - North European port (Rotterdam, Hamburg...) about $ 47 per ton.

These costs are too high and this method is not feasible. As a fact, paper pulp material is more or less a raw material. Its conveyance has a very notable influence on its price; all export costs must therefore be reduced to a strict minimum; so it is quite obvious that this transport method, convenient for fashioned products, must be abandonned, and that paper pulp material export to Europe will have to transit by the Cape.

24 - INDIAN SUB-CONTINENT COUNTRIES MARKET

241 - General data

The indian sub-continent includes three countries :

- Indian Union
- Pakistan
- Ceylon

These three countries are very densely populated; the entire sub-continent population is more than 657 millions inhabitants. They have not yet reached generalized forward movement stage of their economy and the average standard of living of the population is very low. One may therefore understand that paper consumption per capita is very low.

In 1967 :

- Indian Union used 1.5 kg per capita
- Pakistan " 1.2 kg " "
- Ceylon " 3.6 kg " "

(Ref. : F.A.O.)

In 1968 :

- Indian Union used 1.5 kg per capita
- Pakistan " 1.1 kg " "
- Ceylon " 3.1 kg " "

(Ref. : Pulp and Paper International)

These figures are to be put in relation with Gross Interior Product which as shows Table list 241.a drawn from F.A.O. publications, indicates the sub-continent paper consumption characteristics.

The gross consumption figures are in Table list 241.b. They give an idea of present demand importance. Consumption per capita, very low, progresses very slowly but birth rate is so striking that gross consumption has increased since 1950 at an average annual rhythm of 10 %.

Table list 241.a - Indian sub-continent paper consumption per capita

		Indian Union	Pakistan	Ceylon
Population 1965 (millions)		483.0	113.1	11.2
G.I.P. per capita ($)		83	82	134
Newsprint consumption per capita in Kg.	1955	0.2	0.07	1.1
	1960	0.2	0.2	1.0
	1965	0.3	0.3	1.3
	1967	0.2	0.3	1.4
Printing/writing paper consumption per capita in Kg.	1955	0.3	0.2	0.7
	1960	0.5	0.3	1.2
	1965	0.7	0.4	1.1
	1967	0.7	0.4	1.1
Other paper and board consumptions per capita in Kg.	1955	0.3	0.2	0.6
	1960	0.5	0.3	0.
	1965	0.5	0.3	1.0
	1967	0.6	0.5	1.1
Gross paper and board consumption per capita in Kg.	1955	0.8	0.5	2.4
	1960	1.2	0.8	2.9
	1965	1.5	1.0	3.4
	1967	1.5	1.2	3.6

Ref. : F.A.O. (1969 forestry product review)

Table list 241.b - Paper and board trade and consumption in the Indian sub-continent in 1968

(short tons)

		Indian Union	Pakistan	Ceylon
Number of pulpmills		41	11	1
Number of papermills		40	10	1
Production of paper pulp	Chemical	706,574	28,000	
	Mechanical	27,557	42,500	
	Others	93,693	25,000	4,731
	Total	827,826	95,000	4,731
Production of paper and board		734,132	134,000	9,478
Waste paper		60,625	14,200	790
Imports	Pulp	58,422	19,000	3,800
	Paper	160,936	17,000	32,250
Exports	Pulp			
	Paper	36,927	8,000	
Consumption		918,766	157,200	42,518
Entire consumption of the three studied countries				1,118,484

241.1 - Indian Union

At the preeent time, Indian papermaking industry is in a position to provide for nearly the whole commercialized paper except newsprint.

In this way, India provides by its own means, for :

- 98 % printing/writing paper requirements;
- 90 % wrapping paper requirements;
- 95 % board requirements;
- 60 % special grade requirements.

But whereas the economic planification scheme has forecast 300,000 tons newsprint consumption for 1970, 450,000 tons for 1975-76 and 600,000 tons for 1980-81, 1968 production only emounts to 30,000 tons. It was believed that it could be brought up to 75,000 tons in 1969 by the starting up of a new machine.

Newsprint, made in the only mill erected by means of public financial means, is the Indian paper induetry's weakeet point.

241.2 - Pakistan

As in India, production increases rapidly. Many new unit establishment projects have been made, and ought to be completed in the next year.

A unit producing 24,000 tons per annum of paper and board started up in Lahore in 1969. The other projects preeently studied and being completed, correspond to a gross production capacity of 60,000 yearly tons. Another pulp mill ie also in course of etudy for producing 30,000 yearly pulp tons; this unit would be fitted up into an intograted paper making unit shortly.

241.3 - Ceylon

Ceylon production is also far from meeting consumption needs. Development projects bearing on present production, and establishment of another unit are in course of study.

242 - Indian sub-continent paper prospects

Indian sub-continent gross production will be for many coming years lower than consumption, and the three countries will have to consider very important investments to follow consumption development.

Indian Union might develop in spite of its deficit a paper export scheme, but this concern will be of inferior importance.

Indian sub-continent countries will definitely not export pulp material. It is more probable that paper supplies will be inadequate and that paper or even pulp imports will increase.

25 - PAPER PULP INTERNATIONAL MARKET

251 - General data

During recent years, progression of paper pulp consumption on the world market has been more pronounced : 50 million tons in 1956, 60 million tons in 1960, 94 million tons in 1968. F.A.O. forecasts nearly 200 million tons for 1980. For each one of the chief geographical areas, the greater part of the fabrication is consumed on the spot; however, a more and more important part, about 10 to 15 % of gross production, is commercialized over wide distances and is what is called the "International Market". One part of the fabrications represents pulp sold to manufacturing firms mostly situated in places where forestry resources are deficient. These pulp exports consisted formerly of coniferous pulp essentially. Since several years, hardwood pulp is also commercialized on a more and more large scale and the tonnages exported by producing countries is increasing rapidly.

The foremost exporting areas at the present time are Canada and Scandinavia, but we may also note coming on the market of other export countries, such as Portugal and Morocco who produce a very good Eucalyptus woodpulp.

Long term world consumption prospects forecast a very important pulp deficiency for Wertern Europe in spite of Scandinavian potential. Indeed, countries such as Canada or U.R.S.S. which possess a considerable forestry potential would be in a position to supply the necessary complementary pulp. But it is to be noted that Canada is already exploiting intensively the Canadian Pacific coast, and futur mills will soon have to get their supplies from remote areas inside the country, which increase production costs.

As to U.R.S.S., supplies are already coming from far reachable forestry areas; on the other hand internal demande is very high, and it is not likely that large quantities of pulp will be available in this country for supplying the international market during the coming years.

Therefore, export possibilities are apparent for other countries possessing natural ou artificial forestry resources, espacially those countries which are in a position to supply coastal mills in pulpwood of a good quality at a fair price. One may indicate, for an example, establisment of the swedish Billerud firm in Portugal, or the Norwegian Borgaard in Brazil.

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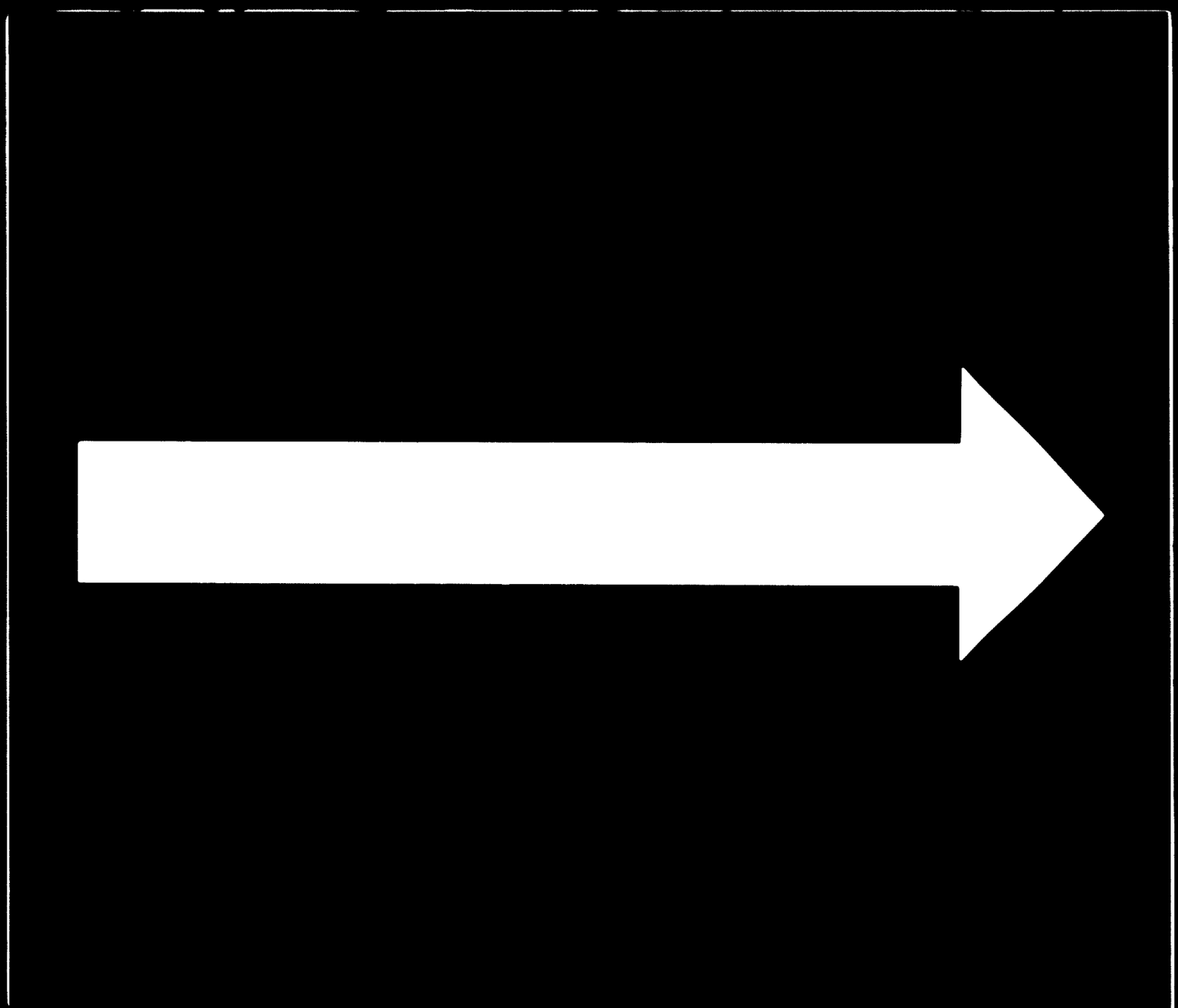

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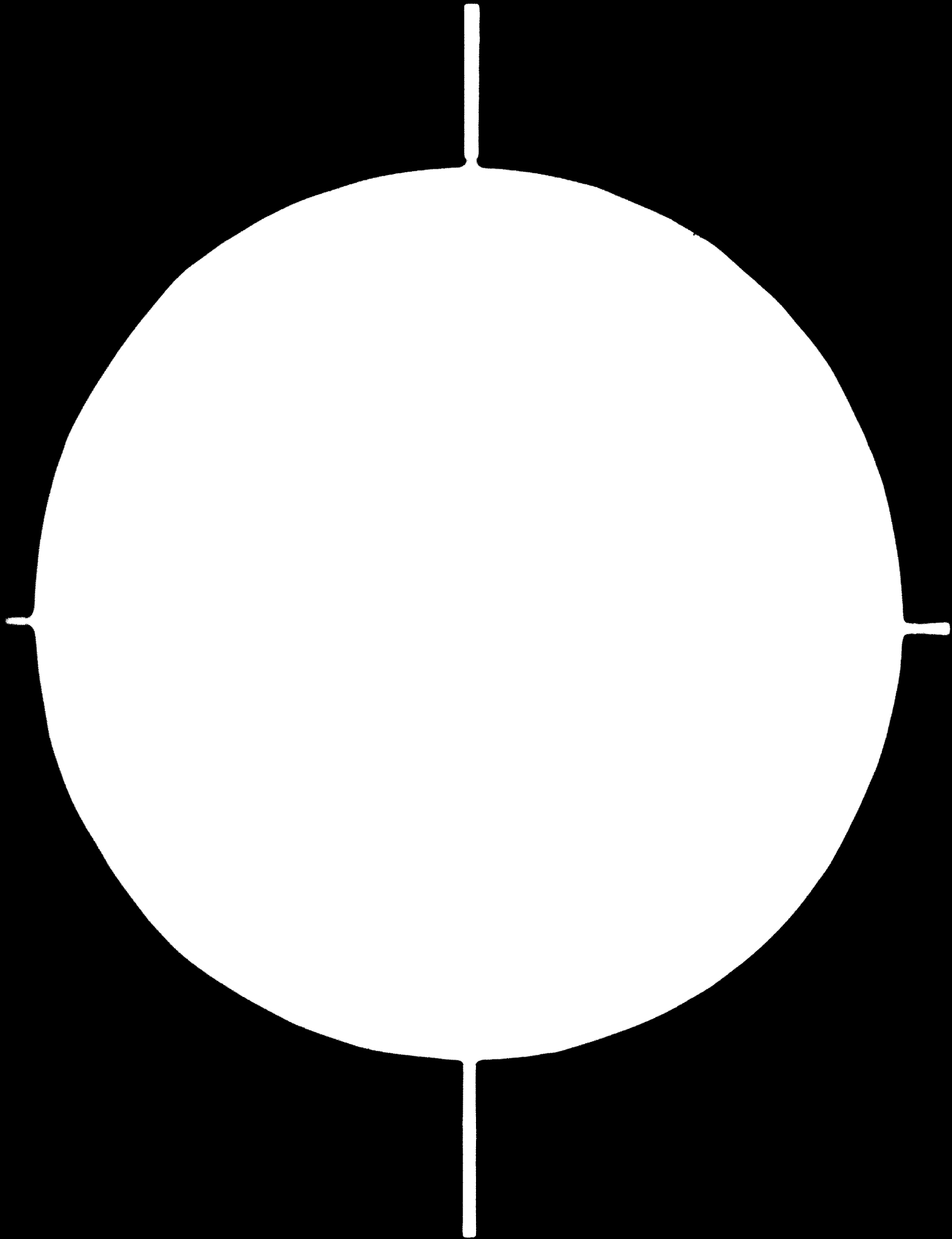


3 - SISAL, RAW MATERIAL FOR PAPERMAKING

31 - SUPPLYING POSSIBILITIES OF THE FORECAST MILL

Utilization of Sisal for papermaking sets the problem of the nature of the raw materiel to be delivered at mill.

Present fiber production leaves various impurities or ingredients which still contain fiber mixed with cell debris (parenchyma, wax, mineral salts, etc...). One may be guided to make use of these impurities and ingredients for papermaking.

Furthermore the plantations having come to the end of their vegetation, still possess stems containing and appreciable quantity of fiber. This matter will also be useful to the forecast mill. At the present time, these stems and various debris (scapes) are buried in the ground by ploughing, before replantation, where they serve as a fertilizer. Use of stems for papermaking will have as a result, the necessity of finding another method for preventing impoverishment of the soil.

Lastly, another way of supplying the mill could be closely set plantations exclusively reserved to this effect. Cutting would take place every five years once and for all, and leaves and stems would be worked at the same time.

We shall study one after the other these different raw material possibilities.

311 - Defibering waste

When they come out of the grinders, the commercially serviceable fibers are torn off the leaves and put out to dry in the sun. The other ingredients containing small fibers and debris of every description are washed away/ in a canalization to a decanting vat or more generally conveyed to storage yards before being buried in the ground or burnt. This waste is used in a small way as a fertilizer in the nurseries, and may be generally considered as worthless in present circumstances.

This recoverable fibrous matter corresponds at present to 20 to 30 % of the whole commercially serviceable fiber (25,000 tons) so a potentiality of 5,000 to 7,500 tons of available dry material every year. If we allow for a 50 % average yield between fiber weight and pulp weight, this raw material would enable processing 2,500 to 3,750 tons of pulp every year.

312 - Tow and flume tow

After the defibering process, the Sisal planters recover, apart, the commercially serviceable long fibers, two lower by-products : "Tow" and "Flume Tow" which are in the waste. But the commercial quantities of these two products are very small, and correspond to 2 or 3 % for the whole volume only.

The planters of the region agree on providing the vorecast mill with the whole of this material. In present production conditions, non commercially serviceable Tow is thrown away. It corresponds however as a fibrous matter to 8 % of the whole commercialized material, so to a potentiality of :

2,000 tons of dry fiber per annum,

and with a 50 % pu'p yield to :

1,000 complementary tons of pulp per annum.

313 - Stems after their cyclical vegetation

The average duration of a plantation is 8 to 10 years and the leaves are cut from the 3rd or 4th year onwards until the 8th or 10th. The land is then replanted and the stems are buried in the ground. There are 2,500 standing stems per Hectare which weigh an average of 10 Kgs each. They contain 50 to 60 % serviceable fibers.

12,5 to 15 tons of dry fibers

may be recovered per Hectare.

As for the whole region 2,000 Hectares are replanted every year, utilization of stems for papermaking will yield :

25,000 to 30,000 dry tons of fibers which will enable to get :

12,500 to 15,000 tons of pulp, with a pulp yield of 50 %

In this way, while proceeding with long fiber selling without complementary plantations or better still without increasing planted surfaces, one may consider in the region a yearly pulp production of :

minimum 2,500 + 1,000 + 12,500 = 16,000 tons
maximum 3,750 + 1,100 + 15,000 = 19,850 tons.

Presuming a 240 day-operation per year, on account of restriction of water supply, the yearly 15,000 tons capacity plant would be provided every day with :

- defibering waste : 10.4 pulp tons or 20.8 dry fiber tons
- tow and flume tow : 4.2 pulp tons or 8.4 dry fiber tons
- stems : 52 pulp tons or 104 dry fiber tons

per day of operation.

314 - Closely set plantations for purpose of papermaking

If mill capacity is to be brought up to say : 100,000 tons per annum, special plantation workings will have to be forecast to this effect, so 10,000 stems per Hectare, to be cut all in one, every 5 years. According to Chief of the Research Station (IRCT) a test bearing on 10,000 plants put in red sands will enable a fifth year harvest of : 800 tons leaves and 400 tons stems per Hectare of green matter. Being aware of the fact that there are 5 % dry fiber in relation with entire green matter, one hectare ought to yield :

60 tons dry fiber every 5 years

which, with a 70 % pulp yield, would enable process of :

42 tons pulp per Hectare.

Another assessment of closely set plantation pulp yield may be made out of a whole plant sample treated in a laboratory. After cutting, defibering and pressing the material, they obtained a weight corresponding to 18 % of the green weight. The pulp yield from this dry material was 33 %, from which following reckoning :

1,200 tons (green matter) x 18 % x 33 % = 71.28 tons
in round figures **72 tons of pulp**

For more security, a 42 tons of pulp yield per Hectare every 5 years on closely set plantations has been held for good for further developments.

So as to supply a 100,000 tons of pulp mill,

$$\frac{100{,}000\ T \times 5\ Ha}{60\ T \times 70\ \%} = \underline{12{,}000\ Ha} \text{ in 5 years}$$

will be necessary.

If a 20 to 30,000 tons of pulp per annum mill is to supplied, preceding resources corresponding, as an example, to 16,000 tons of pulp might be completed by closely set plantations. It will be necessary for 30,000 tons per annum, to have an availability of :

$$\frac{(30{,}000 - 16{,}000) \times 5\ Ha}{60\ T \times 70\ \%} = \underline{1{,}710\ Ha} \text{ in 5 years.}$$

Consequently, Malagasy Government would have several possible choices for supplying a Sisal mill.

By utilisation of defibering waste, Tow and Flume Tow, it would be possible to produce 16 to 20,000 tons of pulp per annum, due account for 25,000 tons of presently commercially serviceable fiber being made.

It would be possible to process 20 to 30,000 yearly tons of pulp by completing preceding resources by close plantations, for paper-making purpose, on a 342 Ha working per annum or 1,710 Ha on a 5 years basis.

Lastly, a 100,000 yearly pulp tons factory capacity could be supplied with 12,000 Ha close plantations every 5 years, so, 2,400 worked Hectares every year.

The entire combination of raw material resources would allow for getting 116 to 120,000 tons of yearly capacity.

32 - VARIOUS PROBLEMS TO BE SOLVED

We must now survey circumstances in which the mill will be supplied following different origins of raw material considered in § 31.

321 - Defibering waste

Coming out of the grinders, the recoverable material has the form of an aqueous mixture containing floating debris which must be prepared quickly to avoid putrefaction.

By perfecting a method, it ought to be possible to find an appropriate treatment comprising draining, drying and pressing the material coming out of the machine. It seems to be essential to convey to mill a dry material, in which the fibers will sort easily from parenchyma of other debris. The presence of fines is, as a matter of fact, a concern in Sisal pulp processing. It would be advisable to discard them as much as possible by this treatment.

This would be effected by means of a decanting or recovery tank fitted with screens of filters, where the recovered material would gather. This would then be set apart mechanically or manually (spades or wooden forks), dried (artificially or in the sun), and pressed several times in a continuous press. These two latter operations could be repeated following necessary degree of dryness.

In this way, each defibering plant will be completed by following devices, after the tests have been successful :

- 1 decanting tank
- 1 mechanical or manuel device for recovery
- 1 or 2 continuous presses
- 1 drying yard or 1 artificial drier
- Necessary labour or man power (1).

---

(1) It was decided that baling would take place with the machines that all the Mandrare planters possess for treating commercially serviceable fibers.

322 - Tow and flume tow

This material is of no particular matter of concern, except gathering, pressing and baling. With the adequate equipment existing in most workings, it seems that this preparation will not create any obstacle, although a special press might be necessary. The operations would be :

- gathering (manuel or by vacuum)
- pressing (same press as for fiber)
- baling (with existing apparatus).

323 - Utilisation of stems after their cyclical vegetation

Here, the problem is to perfect a mechanical harvesting device, manual harvesting being excluded (slow, and risks of wounds), and a mechanical loading of the trucks or cars for conveyance to the factory. A bulldozer fitted with a triangular shovel dredger could be deviced for cutting the stems at ground level and laying them in lines on the ground. Two lines will be cut together. Tests will prove whether the ready cut stems can be crushed without domage to the tractor caterpillar bands, or whether they will have to be pushed aside to allow the tractor to pass.

After sun drying, the duration of which is to define, the stems will be gathered by a mechanical loader and put on trucks or cars. Conveyance will be made directly to the mill.

For supplying a 16,000 yearly pulp ton mill, so 52.9 tons of pulp of this origin daily, corresponding to 104 dry fiber tons, $\frac{104\ T}{12.5}$ = 8.33 Ha plantations at their cyclical term will have to be harvested daily. This operation ought to be possible with two bulldozers (one as stand by) fitted with a cutting blade and with three mechanical loading shovels (one as stand by) for the entire Mandrare workings.

Pneumatic wheel tractors, with necessary trailers, will also have to be previsied for daily conveyance to mill of :

$$\frac{1,800 \text{ tons}}{20 \text{ tons}} = 90 \text{ trailer conveyance, so 15 tractors}$$

and 30 trailers (3 conveyances daily).

324 - Closely set plantations

If mill capacity is to be increased to over 20,000 yearly tons, special plantations will have to be created for supply of the necessary raw material. These plantations would be of high density (10,000 plants per Hectare) and worked once and for all in the 5th year. According to Mandrare planters the average cost per hectare planted would be FMG 40,000.

Several problems must be considered in this respect. First, the choice of the lands. It appears that this will be easily solved and that 12,000 Ha will be found easily, apart from existing plantations, whether on alluvions or on red sand. Then, the new plantations will have to be divided between the existing working concerns. It may be suggested that each concern create these plantations for papermaking at a prorata of presently planted surface, or that this dividing be effected by the planters Syndicate among its members.

One unconditional restraint is that the plantations must be established near the projected site for the future mill, that is at Amboassary or at proximity. In the returns reckoning, this distance was put down for about 25 kms.

Lastly, another problem of importance is in relation with landed property. The lands to be alloted to the planters will be raised on the Antandroy tribe traditional lands where they take their zebus to graze. Although full support of Malagasy authorities is assured, negociations will have to take place with local population representatives for their acceptation. As an offset, the planters could plan pasturages to serve as fodder reserves for the herds during drought periods.

325 - Agricultural and cultivation improvements

Utilization for papermaking of the stems at their cyclical term set the problem of the soil fertility maintenance, these stems being usually ploughed into the soil. I.R.C.T. will have to find the most economical method (cover plant, green fertilizer, fallow or artificial fertilisers, or organic compound matter) for soil impoverishment prevention.

Relating to new plantations for papermaking purpose, it would be advisable as well, to perfect kinds possessing the very best paper yields and to define the best cultivation methods (soil workings, fertilisers, nursery workings, maintenance, etc...). It seems as though this research survey ought to extend over several years, and be directed together with tests and technological researches which will be mentioned further on.

If decision were taken by Malagasy Government to establish a Sisal pulp mill, it would be essential to maintain the I.R.C.T. station at Mandrare, and to grant all financial means to enable it to proceed with its researches.

33 - PRICE OF RAW MATERIAL DELIVERED AT MILL

Following reckonings correspond to an estimate, which it will be necessary to check or eventually cancel during perfecting of working methods and raw material preparation.

The writer has depended upon investigation with the planters, and, for ameliorations, upon his personal experience. The suggested prices approach the most likely, due account being given to our present information.

Have been considered one after the other, price of raw material for a 16,000 yearly tons mill, and for 30,000 tons and a 100,000 yearly tons mills.

331 - 16,000 yearly tons mill

Supplying this mill would take place from following elements :

. defibering waste	: 2,500 yearly pulp tons	or	10.4 daily tons
. tow and flume tow	: 1,000 yearly pulp tons	or	4.2 daily tons
. stems at end of cycle	: 12,500 yearly pulp tons	or	52 daily tons
total	16,000 yearly tons	or	66.6 daily tons

presuming 240 production day per annum.

331.1 - Defibering waste

For a daily 10.4 pulp tons production corresponding to 20.8 dry fiber tons, the price may be established thus :

- Labour costs (wages + taxes)	: 30 MD x FMG 300	= FMG 9,000
- Equipment amortalization (11 plants at 5 millions over 10 years and 240 days per annum)	: $\frac{11 \times 5,000,000}{240 \times 10}$	= FMG 22,916
- Power or fuel		= FMG 5,000
- Conveyance of raw material to mill (supposed water content : 20 %)	: 25 T x F 6 x 25 km	= FMG 3,750
	Total	= FMG 40,666

so a cost price per ton of dry fiber of :

$$\frac{40,666}{20.8} = \text{FMG } 1,955 \text{ per ton.}$$

To this amount must be added : overhead costs, unforseen expenses, and profit for planter, estimated at 30 % of preceding price, by equal parts, so : 587.

As total, we get : 2,542.

Cost price delivered at factory will be in round figures : FMG 2,600 per ton of dry fiber, which leaves to the planter a profit per ton of : FMG 250

331.2 - Tow and flume tow

The cost may be reckoned as follows for a daily 4.2 T pulp production, corresponding to 8.4 T of dry fibers :

- Labour espences	: 15 MD x 300	= FMG 4,500
- Amortalization of presses (11.3 million shops, for 240 days, over 10 years	: $\frac{11 \times 3,000,000}{240 \times 10}$	= FMG 13,750
- Conveyance to mill (a 10 % water content is supposed)	: 9.2 T x F 6 x 25 km	= FMG 1,380
	Total	= FMG 20,030

so a cost price of : FMG 2,384 per ton
By adding 30 % like above : FMG 715
We get to : FMG 3,099 per ton
in rounds figures : FMG 3,300 per ton of dry fibers delivered at mill, profit for planter being : FMG 430.

331.3 - Stems after cyclical term

The daily production will amount to 52 tons of pulp, corresponding to 104 tons of dry fibers. The cost may be reckoned as follows :

Knowing that one Hectare can produce 12.5 T fibers, the cutting must be : $\frac{104}{12.5}$ = 8.33 Ha daily, so :

Cutting of 8.33 Ha, with D7 tractor	: 2 H x 8.33 x FMG 5,000	= FMG 83,300
Mechanical shovel loading	: 3 H x 8.33 x FMG 2,000	= FMG 49,980
Transport to mill of a green damp matter, containing 10 % of dry fibers, so 104 x 10 = 1,040 tons	: 1,040 T x F 6 x 25 km	= FMG 156,000
	which reckons	= FMG 289,280

Export pulp quotations follow supply and demand principale with its fluctuations. Towards 1966-67, quotations were relatively low on account of simultaneous establishment of several Canadian production units on the Pacific coast, but recently the market has recovered to a certain extent. Hardwood bleached chemical pulp quotation which fell to less than 32,000 F. CFA per ton in 1967 has risen to more than 40,000 F. CFA at the end of 1969 and there are no indications as to another slump for the years to come. Although evolution of quotations may not really be defined for pulp on a very long term basis, prospects for 1980 and after, are bright.

252 - Latest tendency analysis

252.1 - Pulp production capacities

F.A.O. estimates in relation with world production capacities and with increase of these capacities are summed up in following Table lists :

Table list 252.1a - Estimate of world nominal capacity of pulp production

(million yearly tons)

Years	1963	1966	1969	1970	1971	1972	1973
Chemical woodpulp	45.4	56.0	66.7	68.8	71.1	73.0	75.7
Other paperpulps	32.1	36.5	42.1	44.0	45.5	46.9	48.1
Dissolving pulp	4.6	5.1	5.3	5.5	5.7	5.9	6.2
Pulp, total	82.1	97.6	114.1	118.3	122.3	125.8	130.0

Table list 252.1b - Production capacity annual increase (%)

Years	1963 to 1966	1966 to 1969	1969 to 1970	1970 to 1971	1971 to 1972	1972 to 1973
Chemical woodpulp	7.2	5.9	3.2	3.3	2.7	3.6
Dissolving pulp	3.2	2.0	3.1	4.2	3.5	4.3
Total paperpulp	6.1	5.6	3.7	3.4	2.8	3.3
Total pulp (paper and dissolving)	5.9	5.4	3.6	3.4	2.9	3.3

Taking into account overheads, profit and unforeseen expenses (30 %) we come to :

1 ton dry fiber cost price :

$\frac{289,280}{104}$ = FMG 2,782

30 % = 835

Cost price delivered at mill FMG 3,617

in round figures FMG 4,000 per ton dry fiber

planter's profit being FMG 660

The raw material average price for a 16,000 pulp tons unit is therefore :

FMG 497,800 daily for 133.2 tons dry fiber delivered or US dollar $ 1,794 at mill so :

FMG 3,737 per fiber ton - $ 13.46
and
FMG 7,474 per pulp ton - $ 26.92

332 - 30,000 or 100,000 tons per annum mill

We have made good the careful $ 314 estimate of 60 tons dry fiber per Hectare every 5 years estimate, corresponding to a 42 tons pulp production (yield 70 %), the entire green matter weight being, 1,200 tons per Hectare. The cost establishes as follows :

332.1 - Standing plant value

At FMG 40,000 per Hectare plantation cost, the plant value when five years old, at a 8 % rate, will be :

$40,000\ (1,08)^5$ = FMG 58,750

by adding 30 % to thia cost = FMG 17,625

FMG 76,375

in round figures FMG 80,000, so FMG 1,333 per dry fiber ton.

This price includes cost price and a FMG 140 per ton profit.

332.2 - Working costs per hectare

They comprise harvesting and foliage manual loading, workings and mechanical loading of stems, so :

- Labour (manual working)	: 60 MD x F 300	= FMG 18,000
- Manual loading	: 40 MD x F 300	= FMG 12,000
- Mechanical stem harvesting	: 2 H x 5,000	= FMG 10,000
- Mechanical loading	: 4 H x 2,000	= FMG 8,000
- 1,200 T green matter conveyance	: 1,200 T x F 6 x 25 km	= FMG 180,000
		FMG 228,000

so, a dry fiber cost price per ton :

FMG 3,800 to which will be added 30 %

so FMG 1,140

total FMG 4,940.

In round figures the price, delivered at mill, is : FMG 5,000

per dry fiber ton, and a profit for the planter of : FMG 440

or else

FMG 7,143 per pulp ton

332.3 - Raw material daily cost

332.31 - 30,000 yearly tons mill

We have seen that the 30,000 yearly pulp tons mill will be supplied for 16,000 tons as to preceding reckoning, and for 14,000 tons by plantations for papermaking purpose. The dayly cost establishes as follow in this case :

$\frac{16,000\ T}{240}$ = 66,6 T x 7,474		= FMG 437,768
and $\frac{14,000\ T}{240}$ = 58.4 T x 7,143		= FMG 417,151
so, on the whole, for 125 pulp tons		FMG 914,919
in round figures		FMG 915,000 or $ 3,297

Complementary plantation working represent a dsily harvest of :

$$\frac{58,4\ T}{42\ T} = \boxed{1.5\ Ha}$$

332.32 - 100,000 yearly tons mill

For a large capacity mill (100,000 T) operative during 240 days a year, so a 417 daily tons production, the raw materiel supply will be effected by the sole plantations.

The daily cost will be equal to :

417 T x 7,143 = FMG 2,980,000 or $ 10,740

The raw material will be obtained by harvesting of :

$\frac{417}{42}$ ≈ 10 Ha daily.

333 - Raw material annual cost

Relating to a yearly 240 days production, the raw material cost will be :

- for a 16,000 yearly tons mill :

  497,800 x 240 = FMG 119,472,000

  in round figures FMG 120 millions or $ 433,000

- for a 30,000 yearly tons mill :

  915,000 x 240 = FMG 219,600,000

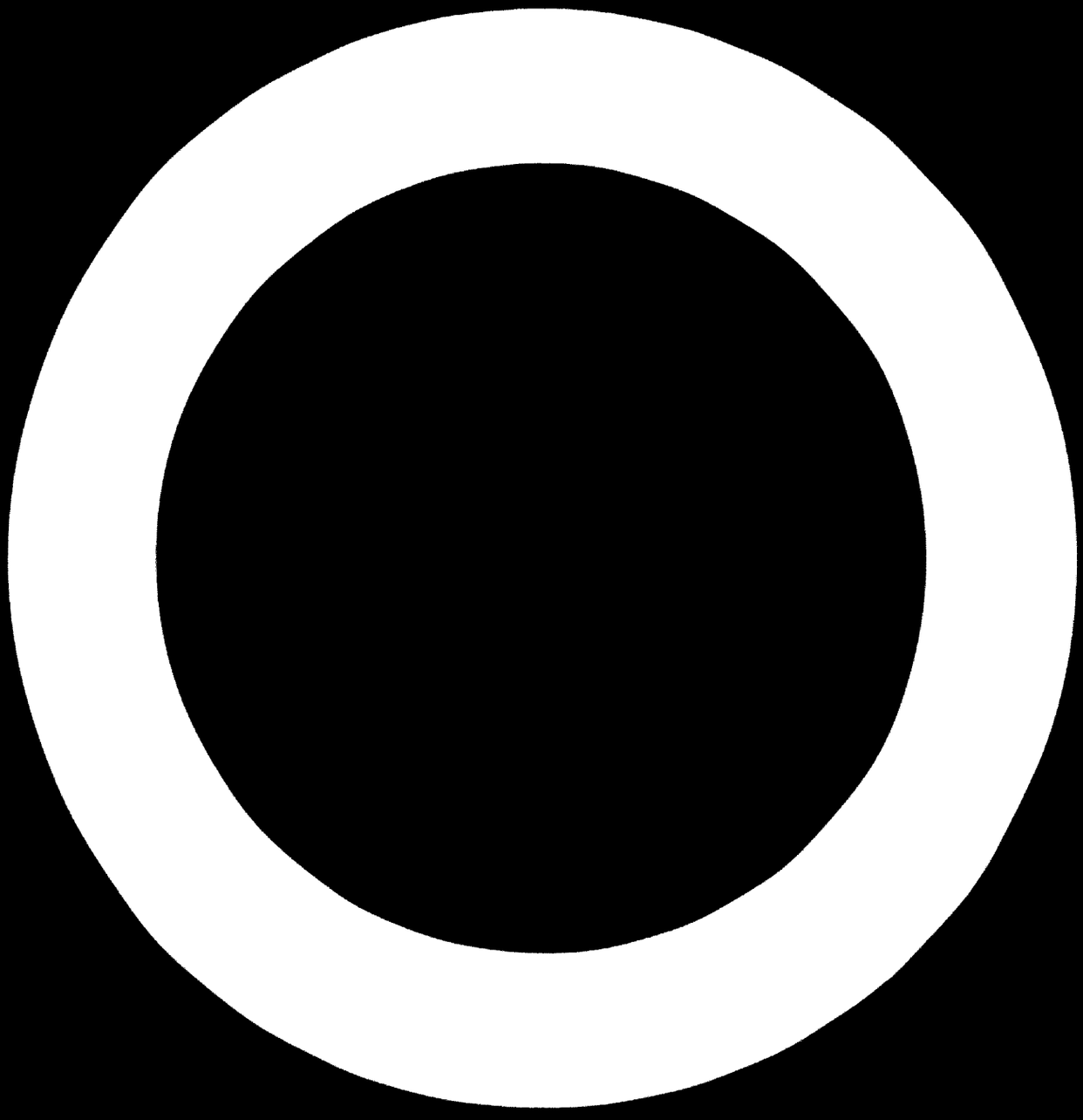
  in round figures FMG 220 millions or $ 793,000

- for a 100,000 yearly tons mill :

  2,980,000 x 240 = FMG 715,200,000

  in round figures FMG 715 millions or $ 2,580,000.

If we compare preceding estimates, one may note that, per produced pulp ton, cost of raw material from closely set plantations, is more profitable than cost of raw materials from other origins (various debris).



Net profit is valuated at FMG 660 per dry fiber ton, so FMG 1,320 per pulp ton, so :

Total profit : 1,320 x 12,500 T = FMG 16,5 millions.

The net return ratio is thus :

$$\frac{16,5}{155} = \boxed{10,64\ \%}$$

The average net return ratio for the whole of the plantation of the region is :

$$\frac{(2,500 \times 2.27) + (1,000 \times 2.61) + (12,500 \times 10,64)}{100 \times 16,000} = \boxed{8,83\ \%}$$

This operation appears as being definitely profitable for the working which, if the mill be erected, would be able to commercialize presently worthless ingredients or of a minimum worth.

342 - Case of the 30,000 tons mill

Investments concerning preparation of various wastes and those necessary for complementary plantations are to be forecast, that is to say :

- Preparation of various wastes (see § 341)

  55 + 33 + 155 — FMG 243 millions

- Completing plantations over 5 years

  1,710 Ha x 40,000 FMG — FMG 68,4 millions

- Buying of working equipment

  1 tractor D7 with bulldoser
  1 mechanical shovel } FMG 25 millions

- Buying of conveyance equipment

  10 tractors
  20 trailers } FMG 70 millions

  on the whole — FMG 406.4 millions

Annual profits are :

- for various wastes : 1.25 + 0.86 + 16.50 = FMG 18.61 millions
- for close plantations : FMG 629 x 14,000 T = FMG 8.806

so — FMG 27.4 millions

which is a return rate of :

$$\frac{27.4}{406.4} = \boxed{6.74\ \%}$$

This ratio, lower than the preceding, is still very profitable.

343 - Case of the 100,000 tons mill

In the eventuality of close plantations (10,000 plants per Ha), the investment forecast would be :

- plantations (5 years) : 12,000 Ha x FMG 40,000		FMG 480 millions
- working equipment :		
4 bulldozers D7 6 mechanical shovels		FMG 100 millions
- conveyance means :		
75 tractors		FMG 225 millions
150 trailers		FMG 300 millions
	Total	FMG 1,105 millions
	or	$ 3,982,000

The reckoned profit is FMG 440 per fiber ton or $\frac{440}{0.70}$ = FMG 629 per pulp ton; total profit is then :

629 x 100,000 tons = FMG 62.9 millions.

The net return ratio amounts to :

$$\frac{62.9}{1,105} = \boxed{5.69\ \%}$$

This ratio is quite appropriate for an agricultural plantation.

344 - Complementary labour

Erection of a Sisal pulpmill will bring about complementary labour employment.

344.1 - 16,000 tons mill

344.11 - Defibering waste

The complementary labour for raw material preparation is : 30.25 man-days (MD) for a 10.4 tons daily production. For 2,500 tons, necessary labour will be :

$$\frac{30.25 \times 2,500\ T}{10.4\ T} = 7,500\ MD$$ or 31 workers working 240 days a year.

344.12 - Tow and flume tow

For 4.2 T daily pulp preparation, labour will be : 15.25 MD so for 1,000 T pulp :

$$\frac{15.25 \times 1{,}000\ T}{4.2} = 3{,}631$$

so, for 240 days a year : $\frac{3{,}631}{240}$ = 15 workers

344.13 - Stems after cyclical term

For mechanical workings, the reckon is : 22 MD for a 52 T daily production which needs for 240 days a year : 22 workers.

On the whole, for gross investments of : FMG 243 millions, or $ 876,000 one may previse : 68 new permanent posts, so an employment ratio of : 0.3 per invested million.

344.2 - 30,000 tons mill

We shall add to preceding results the necessary complementary labour for plantation and for working of 342 Ha per annum.

The plantation will need :

$$\frac{70\ MD \times 342}{300} = 80 \text{ permanent workers}.$$

For harvesting and foliage loading, it will be needed :

$$\frac{80\ MD \times 342}{300} = 114 \text{ permanent workers}.$$

Workings and mechanical loading will need :

$\frac{12\ H \times 342}{8\ H \times 240}$ = so 3 workers. However we shall put them to 4, considering 2 chauffeurs or machine helpers per engine.

For conveyance, we shall take on :

$$\frac{40 \times 2\ H \times 342}{8\ H \times 240} = 15 \text{ workers (chauffeurs)}$$

so as to total : 68 + 80 + 114 + 4 + 15 = 281 new posts.

The employment ratio for 406.4 millions investments will be :

$\frac{281}{406.4}$ = 0.69 for 1 invested million

344.3 - 100,000 tons mill

Here, we must consider necessary labour for :

- plantation
- harvest and loading of foliage
- cutting and mechanical loading of stems.

Plantation requirements

2,400 Ha yearly closely set plantations are reckoned; the labour will be : 70 MD per planted Ha, so yearly :

$$\frac{70 \text{ MD} \times 2{,}400 \text{ Ha}}{300 \text{ D}} = \frac{168{,}000}{300} = 560 \text{ workers}$$

Others needs

Harvest and loading of leaves will need 80 MD per Hectare, so :

$$\frac{80 \text{ MD} \times 2{,}400}{240 \text{ D}} = 800 \text{ workers}.$$

Cutting and mechanical loading of stems will need :
(6 H x 2) chauffeurs and chauffeur helps per Ha, so yearly :

$$\frac{(2 \times 6 \text{ H} \times 2{,}400 \text{ Ha})}{8 \times 240 \text{ D}} = \frac{120}{8} = 15 \text{ workers}$$

Conveyance will need : 40 conveyances of 2 H per Ha and daily, so :

$$\frac{40 \times 2 \text{ H} \times 2{,}400 \text{ Ha}}{8 \times 240 \text{ D}} = 100 \text{ workers}$$

Supplying a 100,000 yearly tons mill require FMG 1,105 million or $ 3,982,000 investment and will bring about :

560 + 800 + 15 + 100 = 1,475 posts for permanent workers,

so, a labour ratio of :

$$\frac{1{,}475}{1{,}105} = 1{,}33 \text{ per million invested}.$$

345 - Conclusion

We have summed up in the following Table list, different items in relation with raw material supply of a mill of a different production capacity.

Table list 345 - Raw material supply of a Sisal mill

Annual capacity (ton)		16 to 20,000 T	20 to 30,000 T	100,000 T
Average price of one ton dry fibers	FMG	3,737	4,326	5,000
	$ US	13,46	15,58	18,00
Average price of raw material per pulp ton	FMG	7,474	7,319	7,143
	$ US	26.92	26.37	25.74
Complementary investment				
Millions	FMG	243	406.4	1,015
US dollar	$	880	1,465	3,982
New permanent employments		68	281	1,475
Employment coefficient		0.3	0.69	1.33
Net return ratio for the planter		8.83 %	6.74 %	5.59 %

We note that the dry fiber cost per ton delivered at mill increases slightly following capacity, whereas the pulp ton cost decreases slightly. Is also decreasing, following capacity, the net return ratio for the planter. On counterpart, investment amount, number of new employment posts and the employment ratio cariegats at the same time as mill capacity.

35 - LABORATORY PAPER STUDY FOR DEFINING SISAL UTILIZATION POSSIBILITIES FOR PAPERMAKING

The object of studies effected in laboratory from Sisal is :

- to sort out the different types of available raw materials
- to define the grade of the main types of pulp and paper which may be achieved : alkaline chemical pulp or unbleached or bleached neutral sulfite pulp and semi-chemical pulp
- to define the operative obstacles resulting from the presence of non fibrous small particles in the raw material
- to direct a forward research course in view of perfecting an industrial treatment.

351 - Sampling

One must distinguish on one hand the textile fibers which form a good raw material but the cost of which is prohibitive for papermaking, and the different types of fibrous debris, considered as a textile fiber by-product, therefore of a much lower cost. These debris, or waste, contain more or less large quantities of parenchymatous cells and various ingredients, called "fines". These fines are useless from a papermaking point of view.

Lastly, one may consider eventuality of utilization of the "whole plant" that is to say a mixing of textile fibers and waste. One may indeed admit that cost of the entire crushed plant would not be prohibitive. It must however be noted that the entirely crushed plant, is most perishable on account of many fermentations which develop very rapidly. This may lead to a storage problem.

351.1 - Samples at hand

The six following samples, all originating from Madagascar, were received in view of tests :

Textile fibers :

- Commercially serviceable long textile fibers (GALLOIS firm).
  They are in the form of light colored tow. They include no impurities.

252.2 - Paper and board production capacities

Similarly, paper and board production capacities and capacity annual increase of percentages for the same periods were :

Table list 252.2 - Paper and board production capacity and percentage increase

Years	1963 to 1966	1966 to 1969	1969 to 1970	1970 to 1971	1971 to 1972	1972 to 1973
Paper-board production capacity (millions of tons)	96.3 to 114.1	114.1 to 133.3	133.3 to 139.6	139.6 to 145.6	145.6 to 150.8	150.8 to 155.6
Annual percentage increase	5.8	5.3	4.7	4.3	3.5	3.2

Whereas, between 1963 and 1969, paperpulp production capacity was inclined to increase faster than paper and board, the reverse is expacted from 1969 onwards.

252.3 - Comparison between pulp and paper production capacities

Evolution of relation between pulp production capacity and paper-board production capacity, reckoned by F.A.O. inquiries, are :

Table list 252.3 (1)

Years	1960	1963	1966	1967	1968	1969	1970	1971	1972	1973
Relation (percentage)	79.8	80.5	81.1	82.6	81.9	81.6	80.8	80.1	79.5	79.6

(1) Differences between percentages indicated and 100 % correspond to pulp excess but also waste paper contribution and mineral fillings and various products.

Waste :

- Flume tow.- They are fairly clean fibers with hardly any small ingredients.
- "Stork" debris, taken out of the sewer canalization of a Stork defibrator (DE HEAULME firm). These debris also contain few small ingredients.
- ASG3 debris.- The sole indication for this waste, of non specified origin, is the mention "on red sands". These debris contain a lot of fines.
- ARL65 debris.- The only indication for this waste, of non defined origin, is "on alluvions". These debris also contain a lot of fines.

Whole plant :

This raw material (DE HEAULME firm) corresponds to whole plant with leaves (72 leaves weighing 43 Kg), stems, hearts and 27 small white leaves (23 kg), for a total of 66 Kg of green plants. These plants were cut, washed, pressed at 300 Kg so as to discard the juice, dried in a drying device, and impregrated with boric acid to prevent fermentation. (Dry weight : 12 Kg; dry/green relation : 18 %). This raw material arrived in a good state of preservation. It is very heterogeneous and corresponds to a mixing of fibers, "fines", and particles comparable to wood.

351.2 - Constituent mixing

The tests were effected, following the case, on preceding samples one after the other, or on a mixing made up of Flume tow, Stork waste, ASG3 waste and ASG65 waste. It is indeed probable that, from a practical point of view, one waste type would not be used alone, but a mixing of different wastes.

351.3 - Complementary treatment

The textile fibers and the waste were cut very short, about 2 cm long. A similar process would probably have been industrially possible by means of a straw chopper type of cutting machine. The whole plant was already cut, so there was no special treatment in this regard.

One may note that the digester filling ratio whith these various raw materials was low. The charge, in dry weight for a specified volume, is about half the weight of medium density hardwood chips.

352 - Chemical composition of the samples

It was proceeded to analysis of the main chemical components of the 5 samples. For the ASG3 and ARL65 wastes, two portions were made up and analysed separately : the fibrous parts and the "fines", proportions of these two lots being approximately 50 - 50. The checked results are given in following Table list :

Raw material	Alc-benz. % extract	Water extr. %	Net soda extract %	Lignin %	Pentasanes %	Cellulose %	Ash % 425°C	Result
Textile Tow	1	0.9	13	10.8	20.5	58	1	92.1
Whole green plant	9	16.5	14.5	13.6	15.5	30.7	13.2	98 5
Defibering waste "Stork"	6.6	6.4	22.2	14	19.4	44.1	6	96.5
ASG3 waste								
Fibers	6.1	10.3	12.6	14	20	44.6	6	101*
Fines	14.5	19	33.4	22	9.1	21.7	14.4	100.7*
Average	10.3	14.6	23	18	14.5	33.1	10.2	
ARL65 waste								
Fibers	7.6	8	16.5	12	19.5	45	7.3	99.4
Fines	14.4	23.4	26.4	18.9	10.9	21.7	13.3	103.1*
Average	11	15.7	21.4	15.5	15.2	33.3	10.3	
Flume tow waste	3.2	5.4	13,3	13.4	20.7	49.6	4.4	96.7

*: The result is too high. This comes partly from important ash quantity in the raw material. One part of this ash, seemingly soluble in water, is twice counted for in the result.

In Sisal ash, the silica ratio was determined. For various samples, following percentages were checked (expressed as % of dry matter)

Tow	:	0.01 %
Whole green plant	:	0.18 %
"Stork" waste	:	0.1 %
ASG3 waste		
(Fiber	:	0.12 %
(Fines	:	1.4 %
(Average	:	0.76 %
ARL65 waste		
(Fiber	:	0.2 %
(Fines	:	1.- %
(Average	:	0.6 %
"Flume tow" waste	:	0.05 %

Analysis of results

First of all, we note that each sample has a very different composition from the others. These differences are very pronounced especially as to alcohol-benzine extract, water extract, cellulose and ash.

If in each case, we reckon the addition S = lignin + alcohol-benzine extract + water extract (this addition indicates more or less easy cooking of a raw material), we may sort out samples in following manner :

1 - Textile tow (S = 12.7)
2 - Flume tow waste (S = 22)
3 - "Stork" waste (S = 27)
4 - Whole plant (S = 39)
5 - ASG3 and ARL65 waste which are very similar (S = 42.9 and 42.2)

One may therefore presume that tow will be an easy cooking raw material with a good yield, and that ASG3 and ARL65 waste will be, on the contrary, the samples of the lesser interest of the studied lot, especially the fines of this waste.

As regards to silica, the quantities are low for tow and are not very high for the purified wastes. On counterpart, in the whole plant and especially in the fines, there were fairly high percentages of silica which would seemingly bring about disturbances during recovery of the black liquor if this were looked upon.

353 - Micrometrical characteristics of the fibers

Fiber sizes were measured from kraft pulp, bleached by ClO_2Na, corresponding to a mixing of Flume tow, Stork waste, A863 waste, AR165 waste. This is therefore not to do with textile fibers which are probably a little longer, but with waste fibers which will more probably be considered for a small mill supply.

The following results were registered :

Fiber length in microns	:	$L = 2{,}185 \pm 700$
Fiber width in microns	:	$W = 20.1 \pm 6$
Fiber cavity in microns	:	$C = 8.6 \pm 6$
Wall thickness in microns	:	$2W = 11.3 \pm 3$
Flexibility coefficient	:	$C/1\% = 40 \pm 2$
Felting power	:	$L/1 = 146$

These fibers are long and narrow, so of a high feutrant power, which supposes a good tearing resistance for paper.

The walls are fairly thick, so the flexibility coefficient is relatively medium. The breaking length of paper would thersfore probably not be extremely high. It is more likely that it would be in a line between 5,000 and 10,000 m.

However, these results are satisfactory on the whole and one may expect on one hand, a good deportment of the wet sheet at machine head and at the first press, and on the other, paper possessing higher mechanical characteristics than paper that would be made out of a hardwood pulp.

354 - Kraft cooking of the samples

354.1 - Case of uncleaned samples

The different samples were treated by the kraft process as they were received, that is to say without cleaning of fines before the cook. During this part of the study, we suppose as having been solved the problem of partial elimination of the fines which are in the pulp after cooking. Effectively, the fines of the uncleaned waste are to be found in the pulp. These fines may be partly discarded by a pressure spray washing on a sieve with wide mesh openings.

This technique, which is not to be directly transposed on the industrial scale, is essential in a laboratory for going on with the treatment (refining, papermaking), otherwise one would have to work on extremely slow stock at the start, which would be pure non sense. We shall come back in paragraph 357, on this very important problem of the fines, on their incidence as to drainage, on discarding possibilities. For the time being, the object in view is only to compare the grades of the raw materials without taking into account draining problems.

The different samples were treated in 2 litre-cases under following conditions :

Soda : 18, 24 or 26 % in relation with dry matter

Sulphur : 1.8, 2.4 or 2.6 % in relation with dry matter (1)

Liquor/dry matter relation : 6/1

Duration and temperature of the cook : 1 h 30 from 20 to 160° C
+ 2 h at 160° C

Results of the cook are indicated in following Table list :

Sample	NaOH + S	Gross pulp yield	Graded pulp yield	Remnant NaOH in the cook g/l	MnO_4K	Unbleached pulp photovolt
Textile fibers	18 - 1.8	71.8	71.8	4	7.6	45
Flume tow	18 - 1.8	59.2	54.1	4	10.5	35
Stork waste	24 - 2.4	54.4	49.7	4.4	10	31
ASG3 waste	24 - 2.4	38.5	37.2	5.3	14.7	21
ARL65 waste	24 - 2.4	35.1	33.8	3.2	15.6	21
Whole plant	26 - 2.6	36.9	33.8	5.6	15.5	25

After Jokro refining, following characteristics were obtained at 40° SR :

---

(1) We recall that soda + sulphur is equivalent to soda + sulphide with following correspondence :

NaOH	+ S	= NaOH	+ Sna_2
18	1.8	13.5	2.92
24	2.4	18.0	3.90
26	2.6	19.5	4.21

Sample	Breaking length	Bursting	Tearing	Porosity	Folding T = 1Kg	Bulk	Stretch	Time to get 40°SR
Textile fiber	8,100	65	245	13	1,500	1.5	4.1	80'
Flume tow	7,400	53	190	18	400	1.5	4.1	65'
Stork waste	7,000	56	185	8	700	1.6	4.0	14'
ASG3 waste	5,000-5,500	30-33	130-145	2	90-110	1.8-1.9	2.8-3.2	2'
ARL65 waste	5,400	36	135	2	120	1.85	3	1'
Whole plant	6,200	43	180	6	180	1.8	3.8	5'

The whole of preceding results show that the best raw materiel is textile fiber; then come a second group with Flume tow and Stork waste. Lastly we grade ASG3, ARL65 waste, and the whole plant.

In spite of squirt screening of pulp, we have proof of presence of residuous fines, in Flume tow pulp and Stork pulp in small quantities, and in larger quantities in the other wastes and in the whole plant (refining time and porosity are decreasing).

We also indicate presence in the paper of many dark spots, especially in the case of paper processed with non refined pulp. The number of these spots, practically non existant in "textile" paper, increases in "Flume tow and Stork" paper, and becomes very important in "ASG3" "ARL65" "Whole plant" paper. These spots probably come from remnant fines aggregates which more or less dissolve during refining. A part of these spots are eliminated by centricleaners, but there still remains an appreciable quantity in the pulp. As indicated before, we shall come back on this fines problem in § 357.

We shall keep in mind that this first test series show that the samples are very irregular as regards quality. However, concerning paper physical characteristics, and solely from this point of view, the grades found in ASG3 and ARL65 wastes (unfavourable cases) are not lower than those of a beech chemical pulp. One may even note that tearing strenght is definitely better.

In the case of textile fiber (the most favourable case), the grades may be compared with spruce kraft pulp.

354.2 - Case of dry-cleaned samples

By just a beating of the dry raw material on a sieve with wide mesh openings, an important part of the small particles may be eliminated in some cases up to 50 % and more (taken from the bottom of the bags for example).

To get a comparison, the three following raw material have been tested :

- Stork waste partly dry cleaned by beating
- ASG3 waste " " " "
- ARL65 waste " " " "

The rest of the treatment is to compare with n° 354.1. Washing by pressure squirt in particular, has been used for pulp.

Following Table lists enable to compare the two types of results :

Sample	Raw pulp yield	Graded pulp yield	Remnant NaOH in the cook g/l	MnO_4K index	Unbleached pulp photovolt
Cleaned Stork waste	50.1	49.8	4.4	12	30
Uncleaned " "	50.4	49.7	4.4	10	31
Cleaned ASG3 waste	50.7	50	5.6	14.9	30
Uncleaned " "	38.5	37.2	5.3	14.7	21
Cleaned ARL65 waste	45.6	44.7	4.4	12.4	30
Uncleaned " "	35.1	33.8	3.2	15.6	21

Sample	Breaking length	Bursting	Tearing	Porosity	Folding T = 1 Kg	Bulk	Stretch	Time to get 40° SR
Screened Stork waste	7,100	59	180	6	650	1.6	4	10
Unecreened " "	7,000	56	185	8	700	1.6	4.0	14
Screened ASG3 waste	7,000	55	175	9	500	1.7	3.8	9
Unscreened " "	5,000-5,500	30-33	130-145	2	90-110	1.8 - 1.9	2.8 - 3.2	2
Screened ARL65 waete	7,200	56	175	8	500	1.6	4	10
Unscreened " "	5,400	36	135	2	120	1.85	3	1

Analysis of these Table lists allow for two important remarks :

- Differences between dry screened Stork waste and unscreened one are not eignificant. This confirms that Stork waste contains relatively few fines.

- The differences between ASG3 or ARL65 dry screened and unscreened waste are highly significant. They bear on pulp yield, pulp colour, mechanical resistance, refining time. They confirm importance of fines in these wastes.

Generally speaking, we may infer that when Sisal wastes contain important quantities of fines, a dry cleaning through a simple whipping ameliorates the reeults. This cleaning is however not sufficient from the pulp drainage and cleaniness point of view; we shall come back on this in 357.

354.3 - Confirmation cooking in digester

A confirmation cooking has been made in a 45 litre digester, so starting from a much more important raw material quantity than in the preceding cooking in a case.

The composition of the waste mixing which was used for this cook was :

Flume tow : 25 % (unscreened)
Stork waste : 25 % (unscreened)
ASG3 waste : 25 % (partly dry screened)
AR165 waste : 25 % (" " ")

A such mixing is more representative than would be only one waste type alone.

The cooking conditions corresponded to NaOH = 24 % S = 2.4 %, liquor/dry matter ratio : 6/1 - temperature : 2 Hr from 20 to 170° C + 1.30 H at 170° C.

The results were :

Raw pulp yield %	Graded pulp yield %	Remnant NaOH G/l	MnO_4K index	Photovolt
53.0	52.3	6.0	10.1	36

The pulp containing many small particle aggregates, a trial was made for eliminating them by passing them through a Lamort centricleaner. This operation succeeded in eliminating a large part of the aggregates but not altogether. On the other hand, a fairly large fraction of good fibers went with the aggregates, thus yielding a lower refuse pulp grade than would have been otherwise.

The screened part and the part corresponding to the refuse pulp were beated in the Jokro, processed in sheets and analyzed.

The results were as follows :

Kind of pulp	Breaking length	Bursting	Tearing	Porosity	Folding T = 1kg	Bulk	Stretch	Time to get 40° SR
Screened pulp	7,400	54	190	11	600	1.55	4.2	9'
Refuse pulp	6,200	47	180	12	250	1.60	4.0	7'

Results in relation with beated pulp in the form of a diagram, will be found in paragraph 354 (see further on diagrams 354 B, C, D).

We see that according to proceeding figures, screened pulp has satisfactory mechanical characteristics, but paper corresponding to the unbeated pulp still contains some dark impurities.

Refuse pulp, although less resisting than screened pulp, still possesses satisfactory qualities, but the look of the paper is most unpleasant on account of very many dark spots, particularly for paper processed from unbeated pulp.

On the whole, above results fairly well confirm remarks made during cook tests in cases.

354.4 - Bleaching of Sisal pulp

We have reserved for bleaching tests, the preceding pulp cooked in a digester with 24 % NaOH and 2.4 % sulphur at 170°C during 1.30 H. Two fractions having been made, one fraction, screened, containing few fines and the other made up of refuse, the two fractions were tested comparatively. The hardness of these two fractions were very similar (MnO_4K of screened pulp : 9.7 to 10.4 and MnO_4K of the refuse pulp : 10.5 to 11.2). The unbleached were about the same, but the refuse pulp had many dark spots.

354.41 - Types of bleaching tested

Several types of bleaching were experimented :

- a ClO_2Na excess treatment to find out the P.D. of unbleached pulp
- a 4 stages bleaching two of which with ClONa
- a more elaborate bleaching in 5 stages two of which with ClO_2
- a series of brightenings in one stage with increasing quantities of ClONa
- a series of brightenings in one stage with increasing quantities of peroxide.

Indeed, this relation is not a sufficient basis for valuation of balance between paper and board production on one side, and pulp production on the other, but its evolution is certainly worthy of notice. The indicated relations for 1972 and 73 could evidently be modified if new investments were decided upon from two or three years now on.

As regards chemical woodpulp in particular, their part of paper pulp total capacity production has gone up from about 58.6 % in 1963 to about 61.3 % in 1969, which is an appreciable increase. However, for 1969-73, the forecast is for a same expansion rate as for all the other various pulp grades.

252.4 - Situation in Europe

If we would now compare paper-board and pulp production in Europe (Scandinavia included), during the last ten years and the coming ten years, we may draw the following Table list :

Table list 252.4a - Pulp and paper european consumption

(in million tons)

Years	1960	1970	1975	1980
Paper, board total production	22.1	38.1	49.4	63.4
Corresponding chemical pulp consumption	9.7	19.1	26.1	35.2
Chemical pulp production	9.4	18.1	23.9	31.7
Difference	-0.3	-1.0	-2.2	-3.5

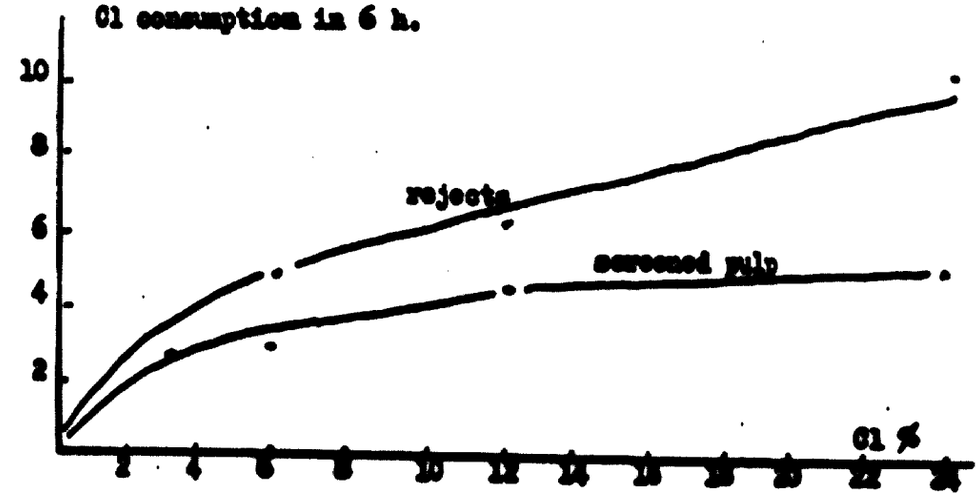
It therefore appears that in 1980, Europe, Scandinavia included, will have to import 3.5 million tons of pulp.

Up to the present time, Canada was the chief complementary pulp supplier for Europe. Between 1965 and 1968, fourteen units of an average 200,000 yearly tons capacity have started up in Canada, from which fact a world pulp surplus production occured in 1967-68. From now on to 1973, only three units are expected to start in British Columbia.

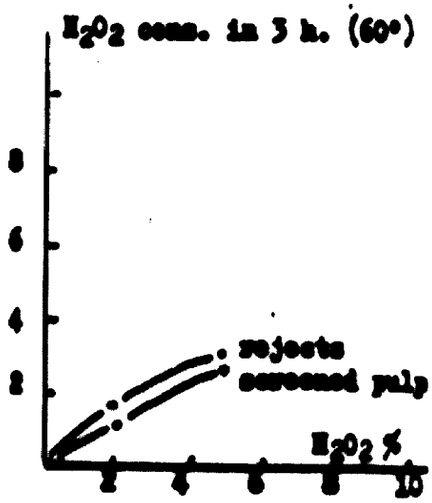
Pâte de Sisal = Sisal pulp

Chart 354 A

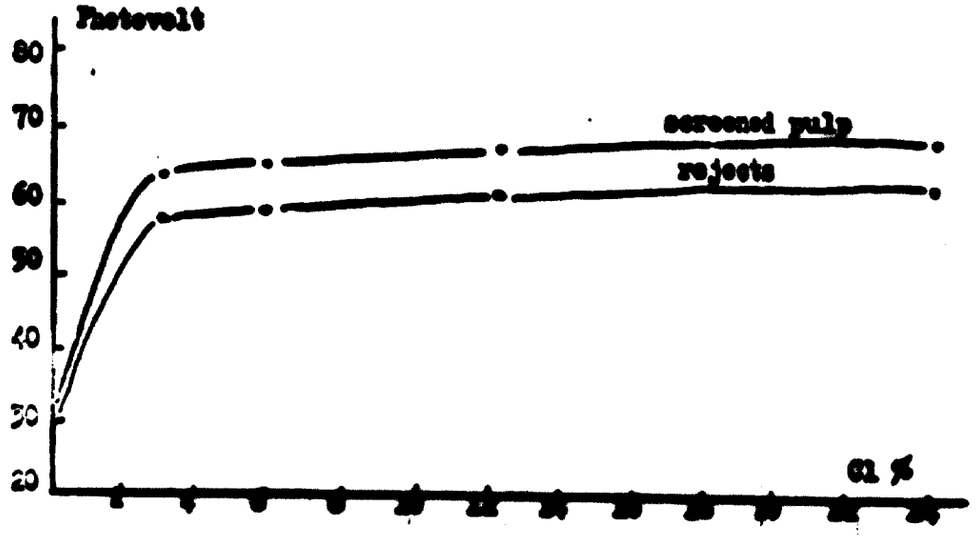
Cl consumption in 6 h.



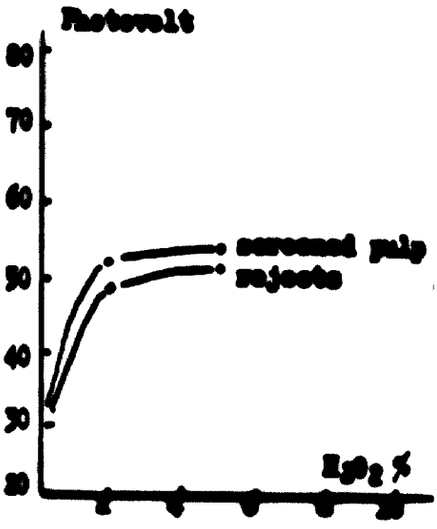
H_2O_2 cons. in 3 h. (60°)



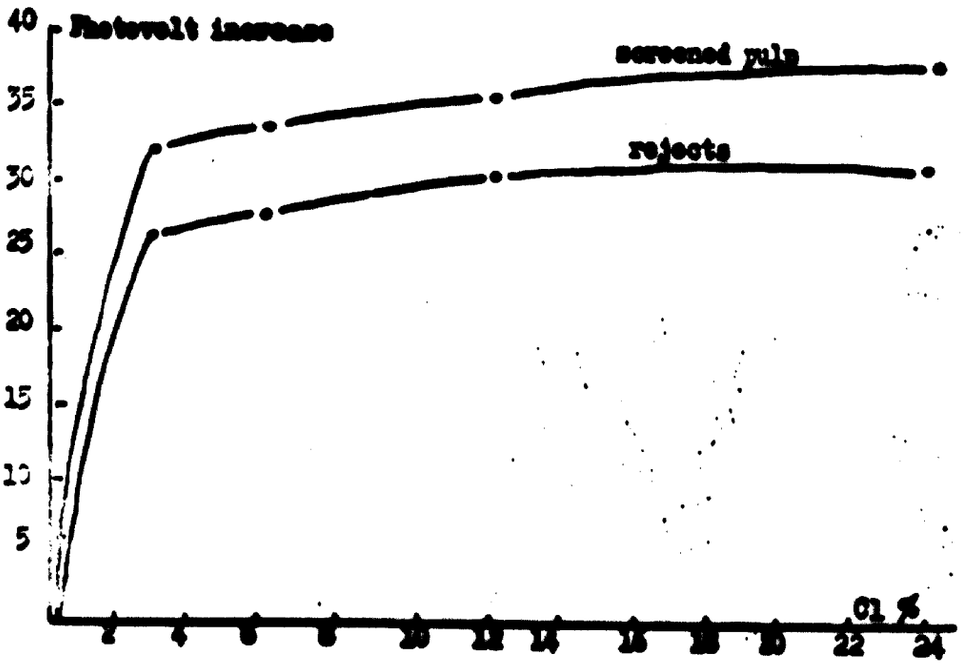
Photovolt



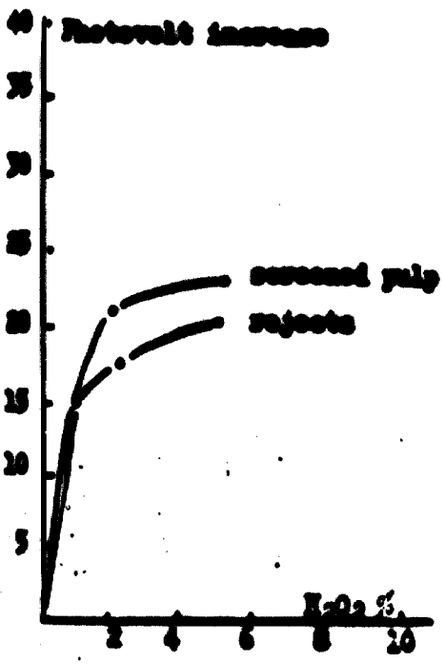
Photovolt



Photovolt increase



Photovolt increase



Unbleached

Bleached ClO^{2}

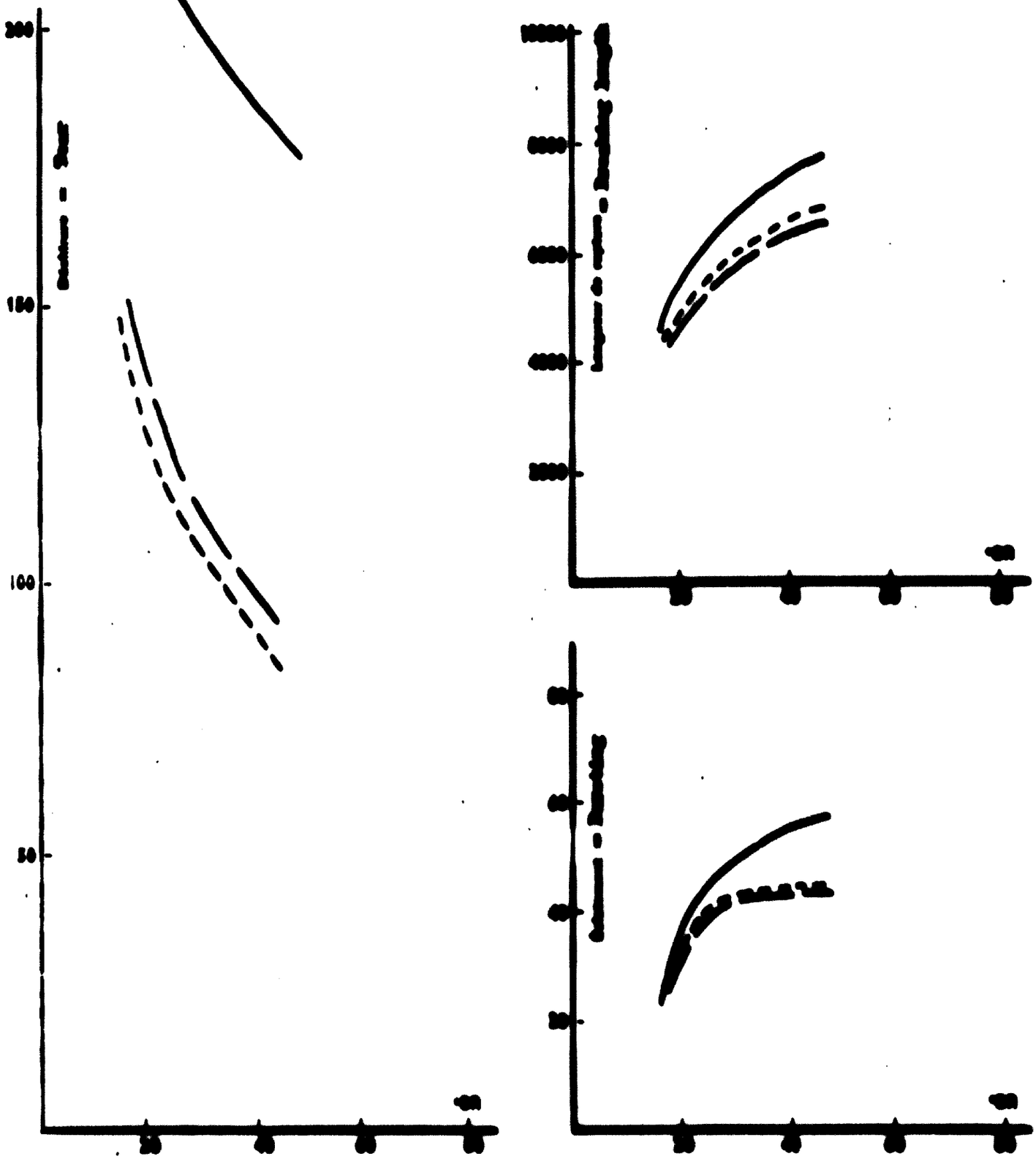
Bleached ClO^{2}

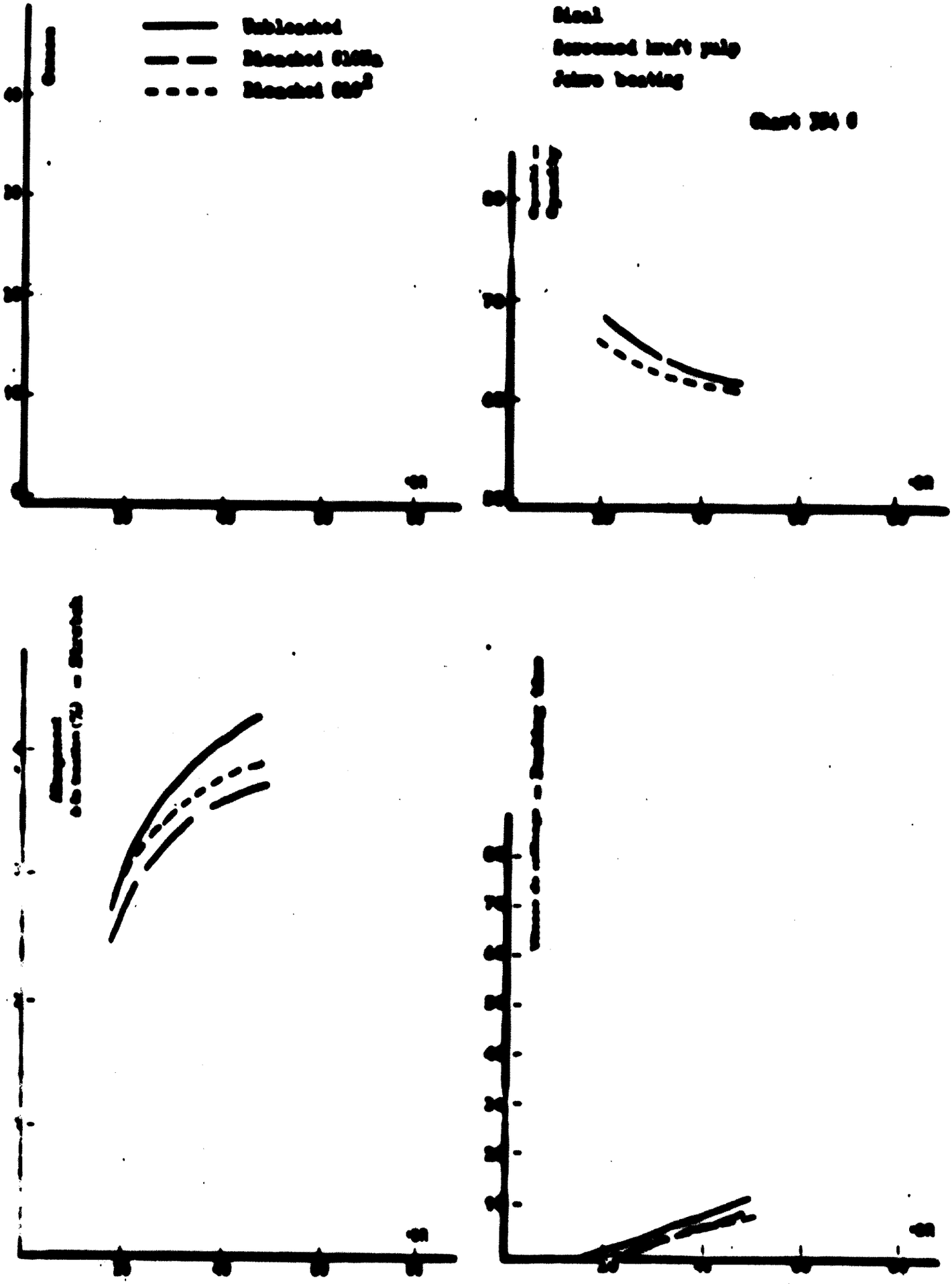
Kraft

Screened kraft pulp

Jahns beating

Chart 304 B



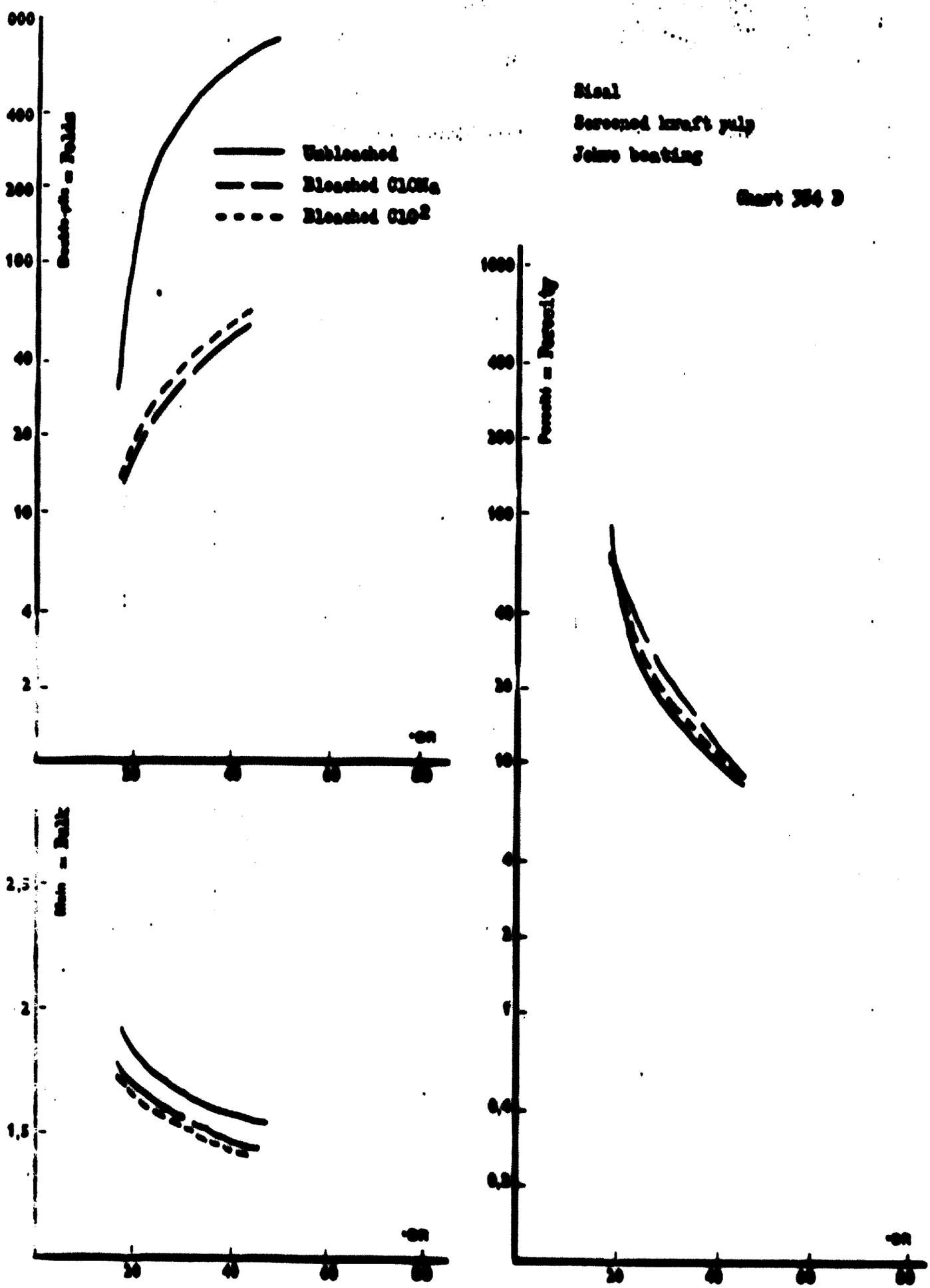


Sisal

Screened kraft pulp

Jokro beating

Chart 354 B



The results are put forth in following Table lists :

Bleaching results with ClO_2Na when hot

Pulp	ClO_2na int %	Time	Temperature	Photovolt	Stability %	P.D.
Screened	50	1/2 H	80°	80	88.5	1,070
Refuse	50	1/2 H	80°	80	88.5	1,050

Results of 4-stage bleaching (Cl - NaOH - 2 ClOna)

Pulp	Chlorosodation		Hypochloritation		Cl total cons.%	Bleach yield %	Photovolt	Stability	Cu index	P.D.
	Cl cons. %	NaOH cons.%	Cl int %	Cl cons %						
Screened	4.8	1.65	1.5+0.5	0.7+0.1	5.6	93.50	76.50	88	1.25	495
Refuse	5.5	I.8	1.5+0.5	0.8+0.15	6.45	87.5	73.5	85	I.25	455

Results of 5 - stage bleaching (Cl - NaOH - H_2O_2 - ClO_2 - H_2O_2 - ClO_2)

Pulp	Reagents consumed during bleaching				Bleach yield	Photovolt	Stability	Cu index	P.D.
	Cl cons. %	NaOH cons.%	ClO_2 cons. %	H_2O_2 cons. %					
Screened	4.8	I.8	0.85 + 0.45	0.40 + 0.25	92	86	87	I.3	505
Refuse	5.5	2.65	0.9 + 0.45	0.45 + 0.25	88	83	84.5	I.3	470

Brightening results with ClONa in one stage

Pulp	Cl int. %	NaOH int. %	Cl cons. %	Time	Temperature °C	Photovolt	Gain in brightness
Screened	3	0.5	2.5	6 h	30°	63.5	+ 32
	6	1	2.6	"	"	64.5	+ 33
	12	2	4.4	"	"	67.5	+ 36
	24	2.5	4.9	"	"	69	+ 38
Refuse	3	0.5	2.9	6 h	30°	57	+ 26
	6	1	4.7	"	"	58.5	+ 27
	12	2	5.9	"	"	6I.5	+ 30.5
	24	2.5	10.1	"	"	62	+ 31

Brightening results with H_2O_2 in one stage

Pulp	H_2O_2 int. %	NaOH int. %	SO_3Na_2 int.%	H_2O_2 % cons.	Time	Temperature °C	Photovolt	Gain in brightness
Screened	1	0.5	3 % in	0.25	3 h	60°	45.5	+ 14
	3	1	volume	0.95	"	"	52.5	+ 21
	5	2	(d=1.45	2.65	"	"	54.5	+ 23
Refuse	1	0.5	3 % in	0.25	3 h	60°	45.5	+ 14.5
	3	1	volume	1.45	"	"	48.5	+ 14.5
	5	2	d=1.45	2.9	"	"	51.5	+ 20.5

The photovolts were measured on thick 250 to 300 g/m2 pads. The figures registered in the Table lists are an average quoting of each side of the sheet. We note that with pulp including fines, the quotings differ from on side to the other, the upper side being generally a little brighter than the lower side where the fines collect. In the case of Sisal pulp these differences between the 2 sides are of about 1 or 2 points for screened pulp and a little higher for refuse pulp (about 3 to 4 points).

Moreover it must be noted that after 60 to 80 g/m2 streeting the photovolt values are definitely better than those registered on thick pads. This is due to elimination of one part of the fines which go through the machine wire.

354.42 - Analysis of bleaching results

Multistage bleaching :

a) - A four stage bleaching, two of which with hypochlorite, gives pulps of a very medium brightness (76.5 to 73.5) definitely lower than those registered for hardwood pulp which vary following species from 80 to 82 for the same kind of treatment and this in spite of the fact that the chlorine expenditure is high for this pulp type. Bleach stability is medium. Copper index and polymerisation degree of bleached pulp are not very good, and indicate that the pulp has incurred some kind of

degradation probably due to consumed chlorine excess. We also note that the refuse does not bleach as well as screened pulp, which is normal; yellow spots are to be detected in this refuse pulp, which correspond to dark spots visible in unbleached pulp.

b) - With 5 - stage bleaching, two of which with chlorine dioxide we get a better brightness (86 and 83 photovolt for both pulps). But here once more, brightness is lower than those registered for hardwood pulp which are around 90 - 92 for the same bleaching process. In the same way, the pulp show degradation, the P.D. and copper index being hardly more favorable than those with hypochlorite treatment. This degradation therefore comes from chlorosodation. Differences between refuse and fiber bleach are also of about 3 points. However, it seems that visual impression of black or yellow spots lessens by applying chlorine dioxide and this is of interest from this point of view.

<u>One-stage bleaching</u> (see chart 354 A)

The result of these tests is that hydrogen peroxide treatment seems to yield lower results than hypochlorite. With 3 % active chlorine one may get a 63.5 photovolt on screened pulp and 57 on refuse pulp. But these pulps, especially the second, have brown or yellow spots which perhaps might be eliminated when refined. In any case, oxidizing reagent increased quantity does not very much embetter brightness. One-stage bleaching may be considered but for semi-bleached pulp only.

354.43 - Bleached pulp mechanical characteristics

Bleached pulps were refined in Jokro, sheeted in Rapid-Köthen and analysed. Charts N° 354 B, C, D, give the entire results for different beating degrees.

Sheet characteristics are as follows for 40° SR (we recall, as reference, unbleached pulp characteristics) :

Paper characteristics (Flume tow/waste mixing)

Grade of pulp	Breaking length	Bursting	Tearing	Porosity	Fold T • 1 K	Bulk	Stretch	Time to get 40° SR
Screened pulp								
Unbleached	7,400	54	190	11	600	1.55	4.2	9'
4-stage Bleaching ($ClONa$)	6,300	43	100	12	40	1.50	3.6	7'
4-stage bleaching (ClO_2)	6,400	45	90	12	40	1.40	3.9	7'
Refuse pulp								
Unbleached	6,200	47	180	12	250	1.60	4.0	7'
4-stage bleaching ($ClONa$)	5,400	45	100	13	20	1.55	3.2	5'
4-stage bleaching (ClO_2)	6,100	48	85	11	20	1.45	3.5	5'

We note that bleached pulp mechanical resistance characteristics are appreciably lower than for unbleached pulp, especially as to tearing and folding; this confirms unfavourable phisico-chemical characteristics precedingly indicated (P.D., copper index).

In a bleached form, Sisal pulp is appreciably lower in grade than a good Spruce pulp. It is equal with a hardwood pulp with a higher tearing index.

We may conclude from these results that Sisal pulp bleaching is not very easy, and needs perfecting if a good quality product is required.

355 - Cooking of samples with neutral sulfite

The six samples, non-dry screened, were treated by sodium neutral sulfite under following circumstances :

SO_3Na_2 : 18 or 24 % (on dry matter)

CO_3Na_2 : 6 or 8 % (on dry matter)

Liquor/dry matter ratio : 6/1.

Time and temperature : 2 h from 20° to 170° C + 3 h at 170° C.

The resulting pulp, although possessing a low permanganate index, were badly defibrated. They were put through a 12-inch Sprout-Waldron to open them better.

The results were as follows :

Samples	SO_3Na_2	Pulp yield	Remnant SO_3Na_2	MnO_4K Index	Photovolt
Textile fibers	18 %	76	18.9	15.0	72.5
Flume tow	"	69	9.5	14.5	67
Stork waste	"	60	3.7	I5.5	60
ASG3 waste	"	53	5.0	I5.4	40
ARL65 waste	"	50	4.4	I3.0	38.5
Whole plant	"	50	3.2	I9.8	39.5
Textile fibers	24 %	76	27.1	13	73
Flume tow	"	67	16.4	13.2	67.5
Stork waste	"	59	I6.4	I3.8	6I.5
ASG3 waste	"	52	I7.6	I3.4	43.5
ARL65 waste	"	49	9.4	I2.3	40.5
Whole plant	"	48	I7.0	I9.7	40.5

Samples	SO_3Na_2 %	Breaking length	Bursting	Tearing	Porosity	Fold T - 1 Kg	Bulk	Stretch	Time to get 40° SR (1)
Textile fibers	18 %	8,200	64	210	-	900	1.5	3.8	-
Flume tow	"	7,200	62	230	9	900	1.5	3.6	25
Stork waste	"	6,500	48	205		400	1.9	3.8	15
ASG3 waste	"	5,200	38	160	7	150	2.2	3.1	4
ARL65 waste	"	4,700	32	130	7	100	2.0	3.0	4
Whole plant	"	5,400	41	160	9	200	1.9	3.0	3
Textile fibers	24 %	9,500	67	215	-	1,200	1.5	4.1	-
Flume tow	"	8,300	63	235	12	1,000	1.6	3.8	18
Stork waste	"	7,200	52	235	14	500	1.9	4.1	5
ASG3 waste	"	5,900	42	160	10	200	2.2	3.8	2
ARL65 waste	"	5,200	38	130	10	100	2.2	3.5	2
Whole plant	"	5,800	41	172	9	300	1.9	3.2	3

(1) Reference only, on account of possible pre-refining by putting through Sprout-Waldron

Analysis of above results allows for following remarks :

By referring to the permanganate index, we note that a 18 % sulfite quantity is sufficient for Sisal waste cooks. Lesser quantities may even be considered for textile fibers. Yields are higher than kraft pulp yields. Color is also brighter, and textile fibers even yield directly a pulp very much approaching a bleached pulp. One must however note in this regard a very important point : the fibers become very bright after a sulfite cook, whereas the fines remain dark, in such a way that there is a very distinct marking, like a "peppering" of the sheets of paper especially with ASG3, ARL65 waste, and the whole plant.

For this reason sulfite treatment is unadvisable, except if the elimination of the fines problem were perfectly solved.

As regards to pulp characteristics, we come to figures fairly similar to the kraft pulp figures except for porosity and bulk, which are higher. This is sometimes noticed for the unbleached neutral sulfite pulps, the fibers of which are not so plastic as the kraft pulp fibers.

The grade range of the samples remains unchanged.

356 - Various treatments

356.1 - High yield soda pulp

Some Sisal waste cookings were made with restricted quantities of soda : 6 and 10 % in relation with dry raw material. The other cooking conditions were the same as those described in 354.1

The resulting pulp was refined in a 12-inch Sprout-Waldron unit. Pressure spray washing of pulp was applied.

The pulp yield were :

Samples	6 % NaOH	10 % NaOH
Stork waste	57.4	56.5
ASG3 waste	41.9	40.6

A steady pulp demand is therefore to be expected on the world market from now on to 1973 and probably afterwards.

253 - Paper pulp international quotation

Pulp quotations have incurred several rises during 1969 and the 1970 first three months. These may be followed by other rises.

Following prices are for 1,000 kg 90 % dryness pulp - 88° GE brightness for the bleached pulps - C.I.F. Rouen, Calais, Antwerp or Rotterdam. For St-Louis-du-Rhône, these figures are to be raised by about 20 FF (1,000 F. MG) per ton. Discount 1.5 % for cash payment .

Table list 253.a

Year	1.4.1969			1.1.1970			10.4.1970		
Currency	Swed Crns	Francs Fr	Francs MG	Swed Crns	Francs Fr	Francs MG	Swed Crns	Francs Fr	Francs MG
Softwood bleached soda	820	820.25	44,012	885	950.05	47,502	925	993.00	49,650
Hardwood bleached soda	760	815.85	40,792	840	901.75	45,087	890	955.40	47,770
Softwood unbleached soda	635	681.65	34,082	715	767.55	38,377	770	826.60	41,330
Softwood bleached bisulfite	805	864.15	43,207	880	944.70	47,235	925	993.00	49,650
Hardwood bleached bisulfite	745	799.75	39,987	625	885.65	44,282	875	939.30	46,965
Softwood unbleached bisulfite	690	740.70	37,035	770	826.60	41,330	830	891.00	44,550

The difference between quotations for 1969 and for January 1970 come from an increase in pulp quotations as well as from French franc devaluation in August 1969.

We note that yields are not very high for this kind of treatment and that the differences are not very marked between 6 and 10 % soda. Soda quantities would therefore have to be appreciably lower than 6 % to increase the yield.

Pulp, even after having gone through Sprout-Waldron, have may dark spots which stand out like small hard bodies in the paper, which would only be presentable for coarse boards and papers.

The Schopper degree of pulp varien from 40 to 60.

The paper characteristics were about the same for both waste types, at least by extrapolating results at same °SR. Here are, as an exemple, the values corresponding to 50°SR.

NaOH %	Breaking length	Bursting	Porosity	Folding	Bulk	Tearing	Stretch %	Concora 112g/m2	Concora 135 g/m2
6	5,000	23	3	100	2.2	150	3.1	11.5	18
10	5,500	26	3 to 5	150	2.1	160	3.0	12.5	18.5

These characteristics are on the whole adequate for ordinary board and paper. The Concora index however, in case of corrugated medium, is not very high, since a 135 gr paper to be considered to get a crushing strength in accordance with the generally admitted standards.

From above results, it seems as though further tests should be made with a lower reagent quantity in the cooking. A better pulp yield with still sufficient characteristics is not to be excluded.

356.2 - Sisal kraft treatment with hot water

The chemical analysis has revealed that Sisal waste extract by boiling water is important. From which the idea of treating Sisal with hot water so as to make easier a further soda cooking. A test such as this one was made on a Sisal "whole plant" sample.

Extraction by water was made by boiling for 20 minutes. The soda cooking is the same that described in 354.1, but with 18 % soda instead of 26. Here are compared results :

Samples	NaOH %	Graded pulp yield	Remnant NaOH g/l.	MnO_4K Index	Photovolt
Without water treatment	26	33.8	5.6	15.5	25
With water treatment	18	23.4	4.4	14.4	26

Samples	Breaking length	Bursting	Tearing	Porosity	Folding	Bulk	Stretch	Time to get 40°SR
Without water treatment	6,200	43	180	6	180	1.8	3.2	5'
With water treatment	6,500	52	170	15	250	1.7	3.9	19'

These results show that it has been possible to cook a same Sisal quantity with less soda, but the pulp yield is much lower. In fact, the soda quantity per pulp ton is the same in the two cases. Pulp processed with water treatment is perhaps of a higher quality and a little more clear of impurities, but the differences, as far as they are significant, are not sufficient to account for an operative method as such, implying a complementary treatment.

357 - Problems relating to fines

We have pointed out the unfavourable influence of fines. It is essential to stress this influence before considering means for reducing it.

Sisal is not the only plant yielding fines. Sugar cane bagasse, as an example, has some as well. In this case, fines essentially come from the pith cells. They are partly discarded by dry beating of Bagasde in drums provided with round openings of a few mm to 1 cm size. The fines are discharged through the openings.

As regards Sisal, the fines originate seemingly from the destruction of sclerenchyma and parenchyma tissues which envelop the fibrous tissue embodied in the leaf. In a wet state, the fines stick strongly to Sisal waste. In a dry state, a large part may be discarded by beating, as for Bagasse. In laboratory the quantity is rather important. Experience as to industrial devices planned for Bagasse would be instructive from this point of view.

It must also be noted that this often concerns fine aggregates and not fines in a dust state. These aggregates, when cooked, under the mechanical action on the pulp (circulation, refining) may immediately disaggregate in very fine particles, or partly subsist, leaving intact the ultra-fine particle potential.

Fines proportion in the samples at hand is a very variable datum which depends upon : kind of sample, raw material previous manipulation, the way the sample was taken from the bags (fines have a tendency of progressing from top to bottom through gravity). Preparation of a homogeneous sample is therefore difficult.

357.1 - Fines value proper

We have seen that chemical composition of fines was very unfavourable (see n° 352).

Fines alone have been treated by kraft process : fines ASG3, fines ARL65.

The following Table list enables a comparison of results with those of the same ASG3 and ARL65 wastes partly screened by whipping (cookings similar to those described in 354.1 ; 24 % soda).

Samples	Pulp yield	Remnant NaOH g/l	MnO_4K Index	Photovolt
100 % ASG3 Fines	34.3	5.2	31.6	13.5
100 % ARL65 Fines	19.6	1.8	29.8	13.5
Screened ASG3	50.7	5.6	14.9	30
Screened ARL65	45.6	4.4	12.4	30

We note the bad results from fines. We also remark that the collected fines are of irregular quality (34.3 yield for ASG3, 19.6 for ARL65). Fines pulp give a very indifferent paper quality :

Samples	Breaking length	Bursting	Tearing	Porosity	°SR	Refining time
100 % ASG3 Fines	2,370	3.6	25	0.5	75.5	1'
100 % ARL65 Fines	2,140	8.3	29	0.5	61	1'
Screened ASG3	7,000	55	175	8	40	9'
Screened ARL65	7,200	56	175	2	40	10'

357.2 - Influence of Fines on pulp drainage rate

We have already pointed out the unfavourable influence of "fines" on the drainage rate. If, after cooking, we recover a Sisal pulp containing fines on a sieve with fine mesh, the sieve get clogged and pulp washing is practically impossible. This fact appears even in the case of wider mesh openings : clogging is only a little longer to start.

During preceding tests, a pressure spray washing method was put in use which permanently prevents clogging, eliminates a part of fines, and helps pulp washing.

A series of tests were effected, so as to compare cooking results and freeness value, on one side on pulp not washed by pressure spray (this washing lasts a very long time, but the fines are preserved) and on the other side, on pulp washed by a pressure spray. In each case, the samples are not screened.

Samples	Pulp the fines of which have been kept in the sample. (No spray wash)			Pulp the fines of which have been partly eliminated (Spray wash)		
	°SR	MnO_4K Index	Pulp yield	°SR	MnO_4K Index	Pulp yield
Textile fiber	14	8.7	70	14	7.6	70
Flume tow	19.5	11.6	66	14	10.5	59.2
Stork waste	27	14.4	54.9	14.5	10	50.4
ASG3 waste	34.5	21.9	46.5	23 (1)	14.7	38.5
ARL65 waste	40	23.4	45.2	24 (1)	15.6	35.1
Entire plant	31	22.4	43.4	24 (1)	15.5	36.9

(1) The figures may be lowered by lengthening treatment.

These results point out, textile fibers apart, pressure spray washing influence on the freeness value of the pulp, on the yields and the loss of fines, on the permanganate index. Only the textile fibers, practically without fines, yield similar results.

357.3 - Screening pulp on calibrated sereen plates

Fractionizing by Lorentzen screen puts into evidence importance of fines retention according to the operative method applied :

Samples	Washing with pressure spray	Retention of the pulp on screen plate → 18 to 100				
		18	40	60	80	100
Textile fiber	with	72.5	90.9	94.3	97.2	97.7
	without	71.5	88.9	93.7	95.7	96.6
Flume tow	with	55.7	89.0	92.5	93.0	95.8
	without	50.9	84.6	89.7	90.2	90.7
Stork waste	with	24.0	82.7	87.5	89.4	89.9
	without	18.3	70.0	77.0	79.8	80.3
ASG3 waste	with	13.2	63.8	69.5	74.6	75.1
	without	12.2	48.8	57.1	62.9	63.8
ARL65 waste	with	3.7	56.7	65.6	74.6	75.1
	without	2.9	45.5	54.1	59.3	59.8
Whole plant	with	32.9	68.6	73.4	74.4	76.3
	without	25.8	54.1	56.7	58.8	66.0

These results show that, except for textile fibers, the spray washing carries off from 5 to 10 % of fines which might get through a n° 100 screen (100 meshes per linear inch). These results also stress the lower long fiber proportion in Stork, ASG3, ARL65 and whole plant wastes.

If we take as independant variable, for the different tested pulp samples, the fines percentage measured by the lost pulp quantity on screen n° 100 (complement at 100 of preceding Table list values for the screen n° 100), we remark a good correlation between this variable and following characteristics : °SR of pulp, pulp yield, dryness of drained pulp and paper mechanical characteristics.

The "fines" proportion is therefore really the principal agent directly or indirectly linked with the paper quality of the samples.

338 - Conclusion relating to the paper studies on Sisal samples

As a conclusion, it appears that the received Sisal samples for papermaking tests are of an irregular quality.

Only the textile fibers, well screened, are of a good quality and do not bring about any operative troubles from a laboratory point of view. Furthermore, this type of fiber is well known and is already successfully industrially processed in some mills.

The other samples at hand, of a lower paper quality, are distinct from textile fibers by the presence of a more or less quantity of ingredients introducing fines in the pulp. The selection of samples containing the lowest fine content is advisable.

Whatever the samples, fines discarding is necessary. A first operation in a dry state may be considered; it is generally insufficient and a second screening of the pulp must be made.

Whatever the sample, the kraft process is the one that yields the best results. The neutral sulfite process brings about pulp and paper of a much more unpleasant appearance. Pulp bleaching is not as easy as woodpulp bleaching, at least when high brightness is looked upon.

As regards corrugation medium, a moderate chemical treatment may be considered, under the condition of a complementary defiberising in a disc machine. However the pulp yield is not very propitious.

4 - SISAL PULP MILL

41 - TECHNICAL ASPECT

411 - Products in demand

412 - Industriel applications

413 - Capacity of mill

42 - SITE OF MILL

421 - Raw material supplies

422 - Facilities for the other materials

423 - Water supply

424 - Power supply

425 - Conveyance facilities

426 - Labour availabilities

427 - Effluent water treatment and draining

428 - Consumption center vicinity

429 - Conveniences of chosen site

43 - ECONOMIC INFLUENCE

431 - Necessary labour

432 - Investment

433 - Production cost factors

434 - Pulp ton production cost

435 - Sale price ex-mill

436 - Projected mill economic feasibility

437 - Economic conclusion

44 - CONCLUSION AND RECOMMENDATIONS

441 - Conclusion

442 - Complementary studies and tests

4 - SISAL PULP MILL

This chapter deals with erection feasibility of a pulp mill utilising Sisal as raw material.

41 - TECHNICAL ASPECT

411 - Products in demand

Sisal pulp is a long fiber pulp, of a good or medium strength, which ought to find outlets, especially for export (see chapter 2) to Middle East countries or to Europe, in the unbleached sulfate grade. In this state, it could be used in mixings with bagasse pulp, rice stalks or bamboo pulp and hardwood pulp for wrapping paper, cement bags or board cases (liner or corrugating medium) fabrication.

It could also find outlets in the bleached or semi-bleached sulfate grade for the making, with short fiber pulp (bagasse, straw or hardwood) of printing/writing paper or high quality bags.

On account of local geographical conditions and conveyance cost influence, it would be appropriate to process an elaborate product such as a bleached or semi-bleached sulfate pulp rather than an unbleached pulp.

412 - Industrial applications

Laboratory tests have shown that the best results come from alkaline chemical pulp.

We may hold for good as posaible processes, subjects to solving the technological problems brought about during tests :

- production of sulfate pulp with bleaching in five stages;
- production of sulfate pulp with semi-bleaching in one stage.

412.1 - Sulfate pulp with 5 stage bleaching

This pulp would have a brightness of about 85 photovolts, which, although lowar than the brightness of the best commercially serviceable pulps, has many outlets.

The general diagram is shown hereafter :

412.11 - Raw material preparation

Fibrous matter available would be :

- wet defiberised waste
- dry fabrication waste
- harvast leavas for papermaking purpose
- plant stems.

The wet waste would be conveyed to a drier, the devica of which is to be designed (drum or "apron") and then directad to straw choppers which would cut the fiber into required sizes.

The dry waste would be brought directly to the straw choppers. The green leaves coming from the plantations for papermaking purpose would be defiberised in the mill. It would be advisable to study the different availabla types of defibrators on the market. Those in use in textile works do not seem adequate for papermaking fiber, and requir a too great water supply. Afterwards, the fiber would be directed to th drier and then to the straw choppers.

The stems or stalks would be crushed and the resulting chips would be graded according to size, for the cooking. It is presumed that these stems would be cut when dry. Experimentation ought to define the best kind of crusher, in relation with cutting method and dryness degrae.

Coming out of the straw-chopper and the crusher, the fiber would be conveyed by pneumatic conveyor to a screening plant similar to those in use for bagasse.

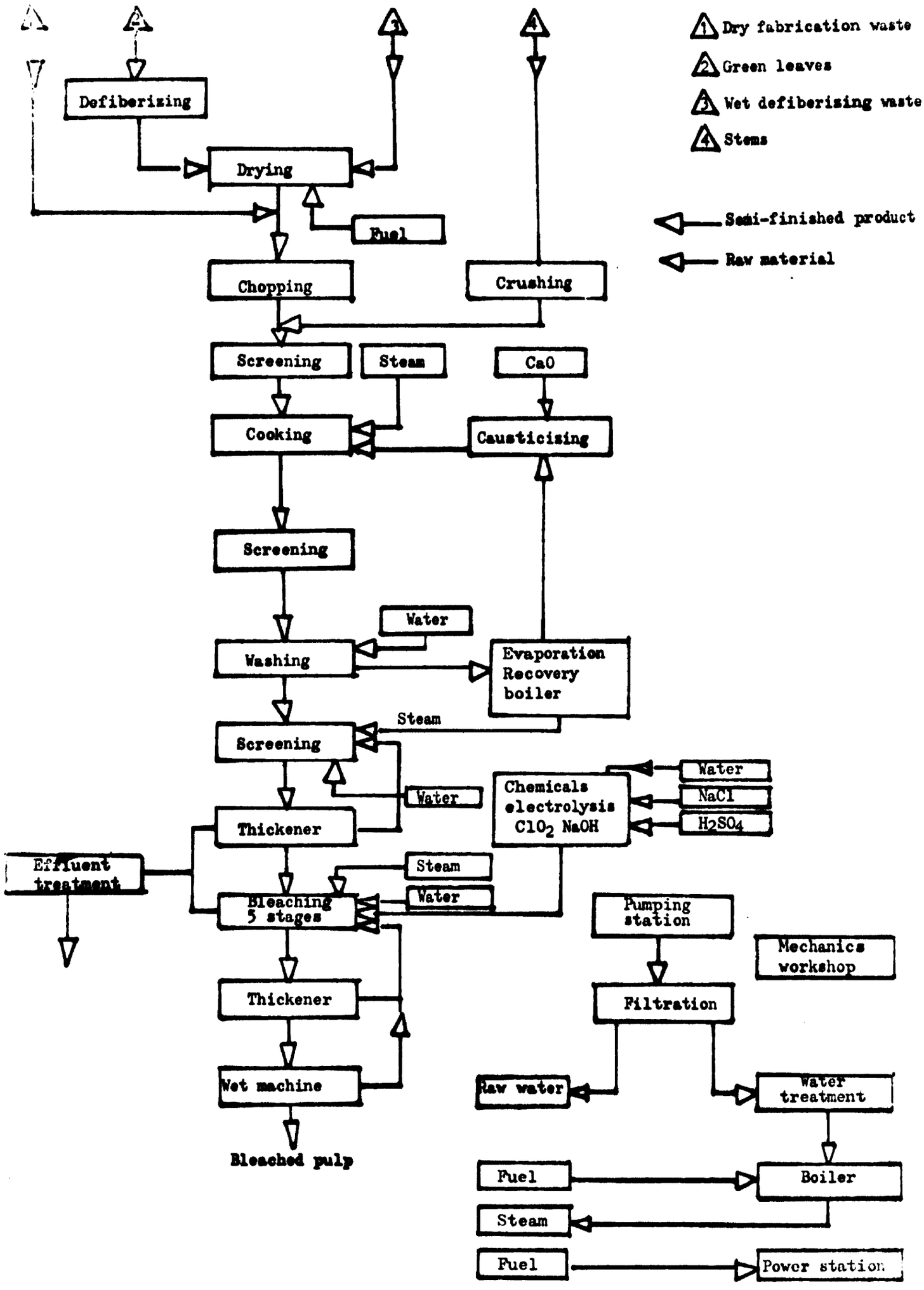
All these handlings should contribute to elimination of a great part of the fines, the influence of which is detrimental to the appearance of the pulp and its treatment, as we have already seen. We may point out that these various plants would be provided with a recovery device for the fines which will be burnt afterwards.

254 - Conclusion for the international market

Above information shows that the pulp market is extending rapidly. Pulp quotations have gone through important rises during 1969 and the first months of 1970. They are at a level high enough to ensure fair returns to the production units.

Long term previsions are not an easy matter, but the demand progression rate seems to be wide and regular, already reducing available stocks. Prospects therefore seem in favour of other production unit establishments, especially in developing countries such as Madagascar.

BLEACHED PULP MILL



412.12 - Cooking and washing

The cooking would be done in rotary digesters, similar to those in use in papermaking industry. At thie stage, there is no problem as regards to fabrication.

The cooked pulp would be blown out into a blow-tank, from where it would go to a screening station before washing. This screening station would be especially designed for Sisal pulp since the cleaning device should be selected in view of completing riddance of the fines, preventing at the same time, loss of a too high quantity of fiber in the rejecte.

Washing could take place in a conventional rotary filter. The washed pulp will have to go through a further cleaning in centri-cleaners before being conveyed to bleaching or to wet machine.

412.13 - Bleaching

The following stages will be used :

$$Cl - NaOH - ClO_2 - NaOH - ClO_2$$

Each treatment will be processed in a retention tower followed by a washing filter with ordinary equipment for this kind of plant.

At this stage, subject to finding an answer to raw material problems or previous screening problems, there should be no particular problem.

412.14 - Comments

The benefit of the process briefly described in this para-graph is to produce a high grade pulp but it has the inconvenience of needing high investment and of getting a low return.

412.2 - Semi-bleached sulfate pulp

The produced pulp would have a brightness of about 67 photovolts, which is acceptable for this pulp grade. A general diagram is enclosed hereafter :

The technique used for preparation of raw material, the cooking, the screening and the washing would be the same as in paragraph 412.1; afterwards, the pulp would be brightened by a one-stage bleaching with sodium hypochlorite (ClONa).

This process has the benefit of lower investment, yielding however a commercially serviceable pulp. Later on, the mill could be provided, in case of need, with a more elaborate bleaching plant. This would enable an investment in two stage.

413 - Capacity of mill

On account of restricted water supply availabilities (see 433 and following), the mill would be operative 240 days a year only.

The presumed capacity will be mainly in relation with raw material supply.

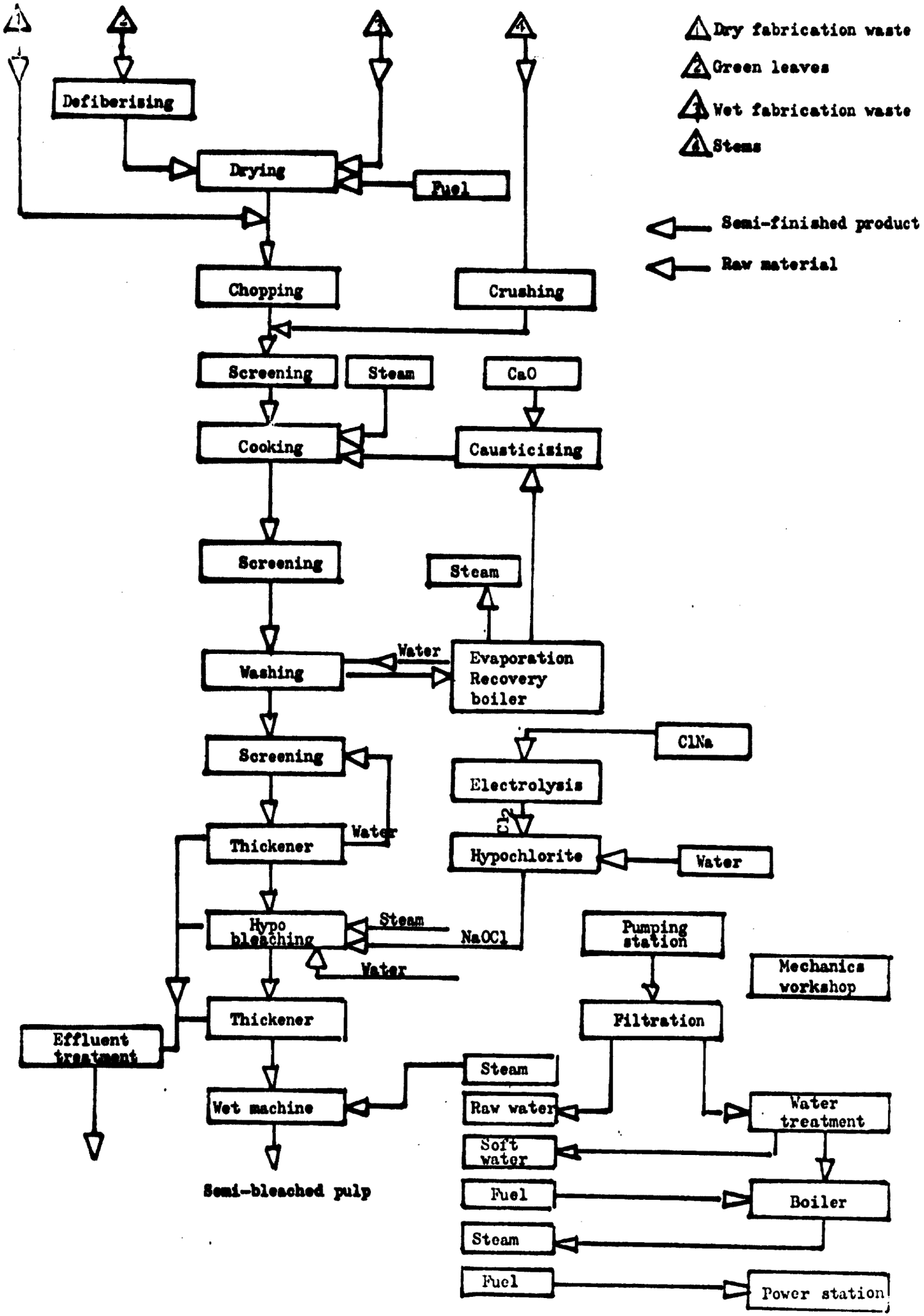
Firstly, we shall consider an annual 20,000 to 30,000 ton capacity, so, 125 daily tons maximum with utilisation, as raw material of present fabrication waste and outgrown stems, with a complementary supply of whole plants coming from the five years old closely set plantations.

Interest of the latter raw material supply is utilisation, after adequate defiberising, of high quality fiber for papermaking purpose, so as to improve the pulp grade.

Our second eventuality would consider a more important capacity of 100,000 annual tons, i.e. 400 daily tons, at the moment when Sisal pulp market will be confirmed and better known. At this stage, raw material supply would depend upon closely set plantation workings (12,000 ha. every 5 years).

This second eventuality could only be put into effect if mill water supply potentiality was assured.

SEMI-BLEACHED PULP MILL



42 - SITE OF THE MILL

We have studied in this paragraph, different factors which are liable to intervene in location of the contemplated mill.

421 - Raw material supply

We have seen in item 3, the possibility of supplying mill with raw material. For a 30,000 yearly pulp ton mill, we had considered following origins : defiberizing waste and flume tow, tow and debris from brushing, stems out of cyclical vegetation, the whole yielding 16,000 yearly pulp tons due account given to present 25,000 yearly tons textile fiber commercially serviceable production. The complementary 14,000 pulp tons would come from the closely set plantations, 342 ha. of which would be worked every year. The fiber, after a coarse defiberizing, would be kept in storage for the pulpmill exclusively.

For a 100,000 yearly pulp ton mill, the closely set plantations for papermaking purpose would be worked as well. These workings would bear on 2,400 ha. every year.

The present plantations in the Mandrare Valley amounts to about 19,000 ha. in full production, spread out on about 100 kms along the two Mandrare river banks (see map.). It seems feasible to find the necessary lands for further plantation. They are located on the map by hachure.

As the bulk of the raw material is rather important, it seems appropriate to locate the mill in the midst of the existing or possible extensive plantations so as to evade heavy conveyance costs. Therefore, the mill would be located near Ambossary, the raw material supply being taken into account.

Lastly, we shall note, in case this mill was to be erected, that plantation extensions would have to be discussed with the planters, and that traditional rights of the Antandroy tribe should be considered.

422 - Facilities for the other products

These are supply facilities for : sea salt, lime, salt cake, sulfur, sulfuric acid, and miscellaneous reagents.

422.1 - Sea salt

This supply would come from Diego Suarez. The price delivered at mill has been valuated : FMG 12,000 per ton. We shall furthermore note that saltern experimentation has been made on the edge of Anony Lake. If results are satisfactory and salt grade suitable for electrolysis (NaCl purity), Anony Lake saltern exploitation ought to bring the cost down to FMG 5,000 per ton of salt delivered at mill.

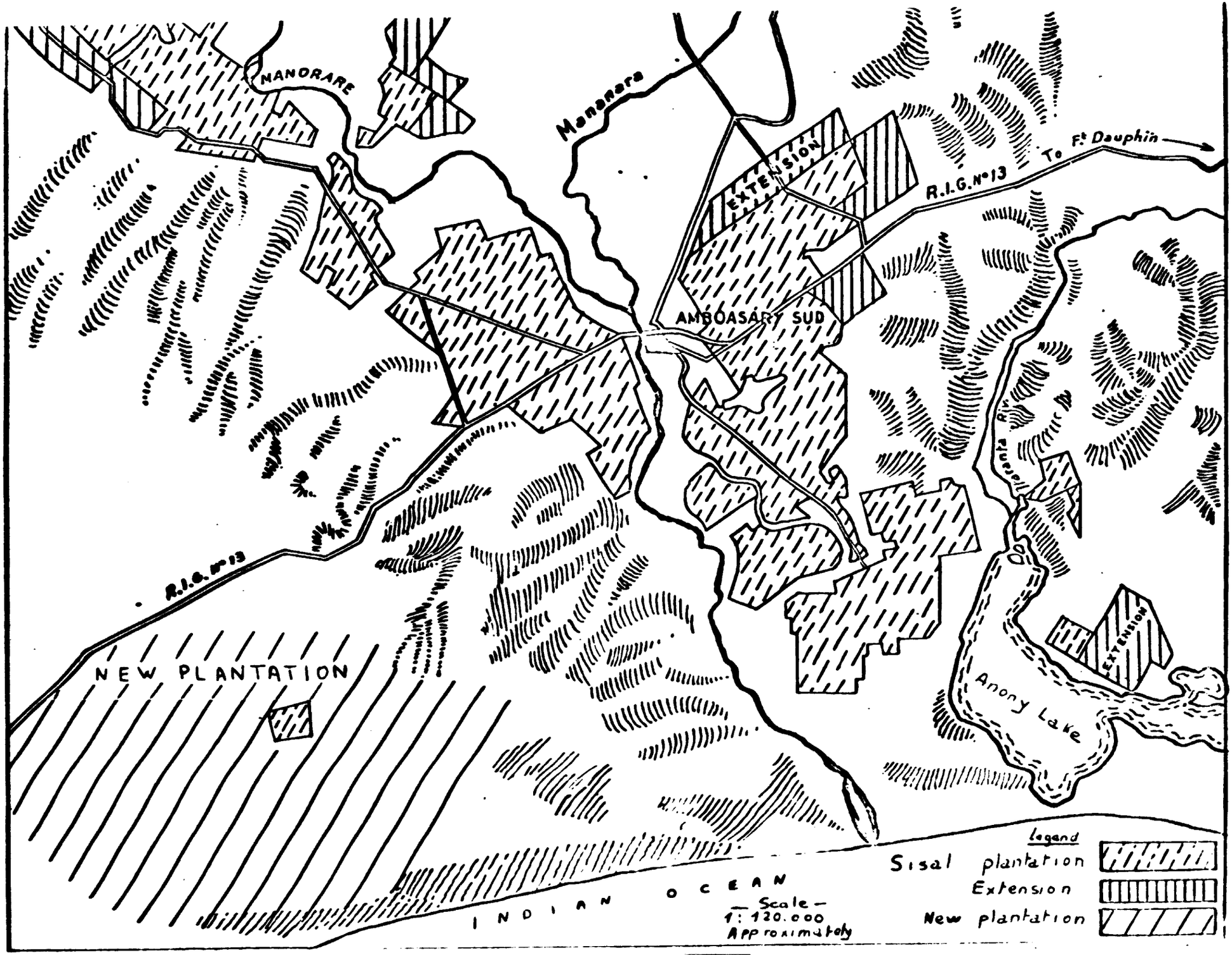
422.2 - Other chemicals

The other materials will have to be imported from Europe, and unloaded at Fort-Dauphin port. Activity of this port is at present time rather low and this new traffic could be carried out without special improvements, at least in the case of a 30,000 ton mill (see 425 and following).

423 - Water supply

Information from ORSTOM shows that the Mandrare River water levels are extremely variable according to years. Here are figures which were given to us at Amboasary.

Year	Month	Minimum flow, liters per second
1952	September	800
	November	5,000
1960	September	400
	November	3,600
1962	September	2,000
	November	60
1963	October	600/800
1966	September	22


NANORARE
Manarare
EXTENSION
To Ft Dauphin
R.I.G. N°13
AMBOASARY SUD
R.I.G. N°13
NEW PLANTATION
EXTENSION
Anony Lake
INDIAN OCEAN
Legend
Sisal plantation
Extension
New plantation
Scale
1: 120.000
Approximately

During 1962/63, the flow was lower than 1,000 l/second during 26 days.

The actual water requirements have not been checked in laboratory for Sisal fiber treatment and will not possibly be checkad before semi-industrial tests.

However, we may believe that these requirements should not appreciably exceed those for Pine fiber treatment, i.e. 300 m3 per blsached pulp ton produced.

This is why, on account of irregular water level between September and November, we recommend operative mill during only 240 days a year instead of usual 330 days. This would give a daily production of :

125 tons for the 30,000 yearly ton mill,
400 tons for the 100,000 yearly ton mill.

The necessary minimum river flow rate would then be :

20 to 30,000 yearly ton mill :	100,000 yearly ton mill :
450 liters/second	1,400 liters/second

This flow rates are important for the 100,000 ton mill, sinca it would be located above Amboasary Town and will have moreover to allow for population supply, and the defiberizing mill located below the town, as well as for the troughs for the herds in the vicinity.

The defiberizing mills consumption in full operation is put to 140 liters/second.

Therefore, previous to the 100,000 yearly ton mill srection decision, it would be advisable to proceed with drilling tests in the river bed so as to make sure of increasing the available water capacity for the operative mill. In this way, the Mandrare subterranean water flow would be serviceable.

On account of water requirements, the mill could be located near the Mananara and Mandrare river junction.

424 - Power supply

424.1 - Electricity

The total capacity of the local electric company at Fort-Dauphin is only 810 KVA. On the other hand, construction of a hydro-electric dam is anticipated for a bauxite mining concern.

The local production being just enough for Fort-Dauphin requirements (the contemplated mill location is 110 Kms. away) and as the construction of the dam could be postponed during many years, the mill will have to produce its required electric power.

424.2 - Other power supplies

There are no other power supplies available, so the whole of the necessary fuel will come from Tamatave by coastal freight to Fort-Dauphin, and then from Fort-Dauphin port to mill by tank trucks.

The fuel cost price was put to FMG 13,000 per ton delivered at mill.

425 - Conveyance facilities

There is a highway "nr. 13 R.I.G." from Amboasary to Fort-Dauphin, tarred all the way, in very good condition and quite appropriate for raw material and manufactured goods conveyance by trucks from mill to shipment and unshipment port.

The present Sisal workings have a good beaten track network for fibrous raw material conveyance to mill.

The actual Fort-Dauphin port traffic is a yearly 45,000 tons, of which 10,000 tons of hydrocarbons. Shipment and unshipment is effected by lighterage in open roadstead.

The erection of a 30,000 yearly ton pulp mill would practically double the present traffic. It does not seem necessary to forecast existing port equipment. In the case of a 100,000 yearly ton mill erection, works would have to be arranged for an increased traffic from 45,000 up to nearly 200,000 yearly tons.

426 - Labour availabilities

The Antendroy population are herdsmen and land labourers with no industrial ability. In spite of all the Madagascar Government endeavours in the educational branch, there is not available technical personnel in the region, and this personnel will have to be trained beforehand.

On the opposite, available unskilled labour is easy to find and quite sufficient for cultivation extension and needs of contemplated mill.

The skilled labour will have to come from the continental highland and from the coast where technical schools have been established and some kind of basic training is teached.

During early operative years, the technical fabrication personnel will be composed of foreigners as long as local personnel will not be available.

427 - Sewage treatment and disposal

On account of lack of sufficient water supply, special attention must be given to mill effluent water treatment. The water circuit and water recovery will have to be carefully studied so as to reduce importance of the treatment station.

The general mill diagrams (see 412) indicate for the two fabrication processes, the water recovery possibilities.

The present techniques enable discharging decanted water under satisfactory biological conditions over Amboasary Town. Available ground around the mill site ought to enable appropriate treatment.

It is recommended to provide a sewage bed for sludge, the surface of which will depend upon the process of the selected treatment. The sludge might be burnt.

The clarified water will have to go through oxidation before discharge into the Mandrare river.

26 - CONCLUSION

The Malagasy pulp market study related to the Malagasy local and regional market, the East African countries, the Middle East, the Indian sub-continent and Europe (as ragards to the world market).

The sale of pulp prospects show as follows in the ourline of year 1980 :

Table list 26 - Sale prospects

Country or region	Unbleached Pine pulp	Bleached Pine pulp	Bleached Sisal pulp
Madagascar	4,000	1,000	-
Reunion Island	-	-	-
Mauritius	-	-	-
East Africa	-	-	-
Middle East	30 to 45,000	30 to 45,000	12 to 20,000
Indian sub-continent	-	-	-
Europe	40 to 100,000	40 to 100,000	-

In 1980, a gross 3,500,000 tons pulp deficiency for Europe is expected (Scandinavia included). It therefore seems probable that Madagascar would easily find outlets in the European Community Countries or in the Free Exchange countries.

In the Middle East, the softwood pulp requirements are divided by halves between unbleached pulp (bags, cardboard) and bleached pulp (printing/writing paper).

As regards to bleached Sisal pulp, subject to obtention of a fair grade, a 12 to 20,000 tons production should be easily sold in the Middle East.

It also seems possible that a higher production quantity, up to 100,000 yearly tons would find outlets, subject to a promotion scheme creation.

428 - Consumption center vicinity

The Sisal mill located near the present plantations will be far from Madagascar consumption center (Tamatave or Tananarive). The production exported to the Middle East, Europe or sold to other Madagascar places, will go through Fort-Dauphin at 110 Kms. distance.

429 - Conveniences of chosen site

For reason formerly developed, erection of mill is suggested at a place called Tanambao, in the district South of Amboasary, near the Mandrare and Menanara rivers junction, following plan herewith.

This location has the convenience of needing just a new road for connecting the mill to the n° 13 R.I.C. highway (1). The mill would be somewhere near the geographical center of the raw material supplies which spread over the two banks of the river. It would be near the river for the water supply and at a convenient distance from Fort-Dauphin.

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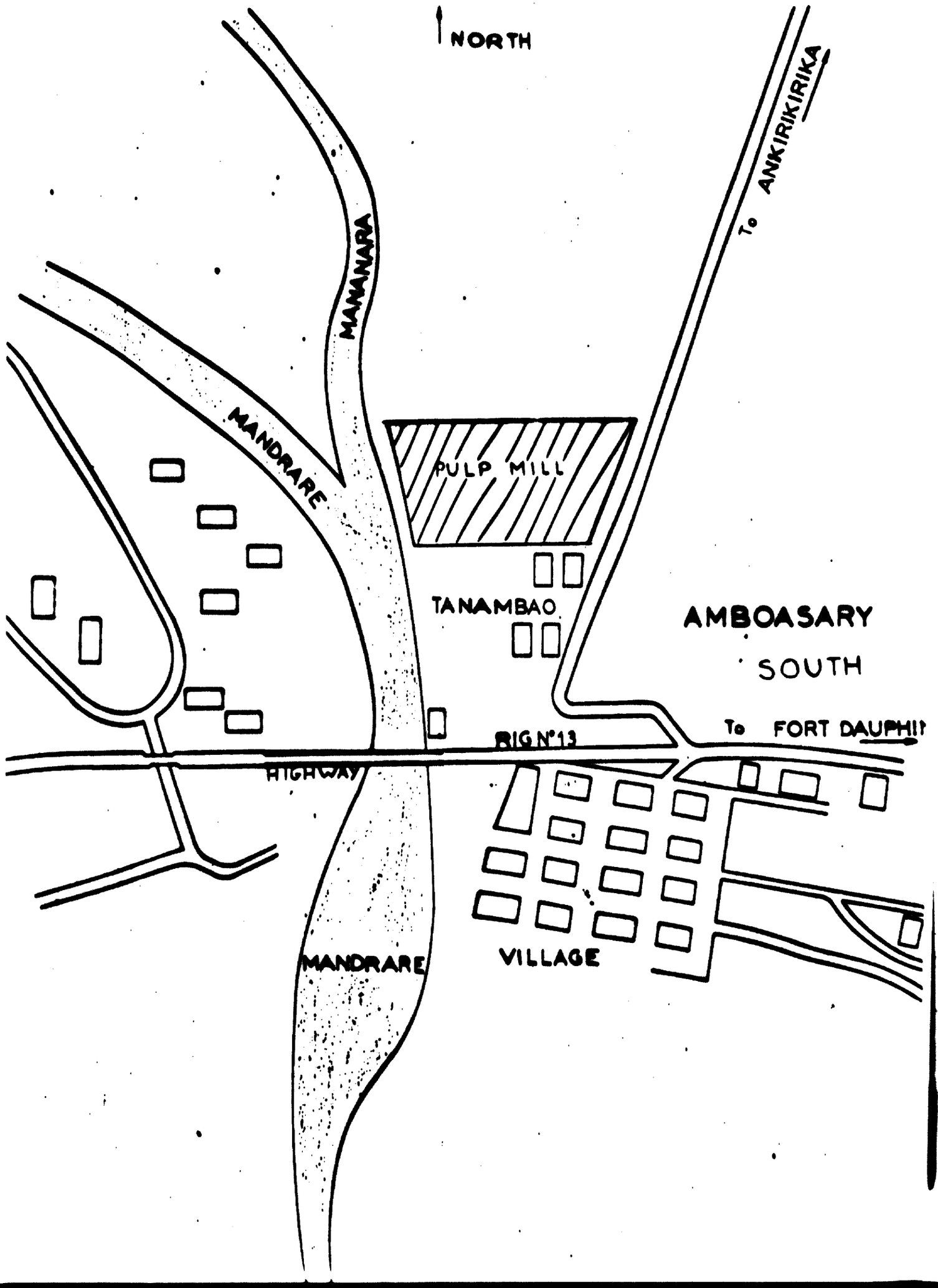
(1) in French : "Route d'Intérêt Général".


NORTH
To ANKIRIRIKA
MANANARA
MANDRARE
PULP MILL
TANAMBAO
AMBOASARY
SOUTH
To FORT DAUPHIN
RIG N°13
HIGHWAY
MANDRARE
VILLAGE

43 - ECONOMIC INFLUENCE

We shall study one after the other : labour, investments, production costs and returns for the two anticipated capacities.

431 - Necessary labour

For the two projected mills, following labour has been considered :

- 30,000 ton mill : 20 foreigners and 164 Malagasies or natives,
- 100,000 ton mill : 20 foreigners and 207 Malagasies "

We note in this regard that this is labour for the mills at normal rate. It seems without doubt that the double of foreign personnel will be required during the starting up period.

Distribution of personnel, according to branches, will be :

431.1 - Office and Managing personnel

These are : Management, Accountantship, Office and Purchase personnel, which are the same in nomber for both mills :

- 2 foreigners and 18 Malagasy employees.

431.2 - Technical department

This department includes personnel for mill maintenance and working, exclusive of production servi[illegible]. This personnel would be :

- 8 foreigners and 18 Malagasy technicians

for both mill schemes.

431.3 - Production department

By dividing into : raw material reception and preparation plant, cooking and washing plant, bleaching and chemicals plant, wet machine and baling plant, laboratory and dispatch, the personnel would be :

- 30,000 ton mill :
  - . for bleached pulp : 20 foreigners and 164 Malagasy technicians and workers,
  - . for semi-bleached pulp : 16 foreigners and 148 Malagasy technicians and workers.

- 100,000 ton mill :

20 foreigners and

207 Malagasy technicians and workers.

Repartition by professional order is :

	Management	Foremen	Skilled workmen	Employees	Specialized workmen or unskilled workers
30,000 ton mill					
(1)	5	15	60	18	86
(2)	5	11	50	18	80
100,000 ton mill	5	15	80	18	109

(1) bleached pulp mill

(2) semi-bleached pulp mill

432 - Investment

As regards to the two fabrication processes for the 30,000 ton mill (bleached sulfate pulp and semi-bleached pulp) and for the 100,000 ton mill, following investments have been previsd.

in million FMG

	30,000 ton mill		100,000 ton mill bleached pulp
	bleached pulp	semi-bleached pulp	
Investment properly speaking (studies engineering,-utility works, equipment, fitting up, starting up)	5,000	4,000	12,000
Worker's garden city	200	200	300
Working capital	200	180	600
Total	5,400	4,380	12,900
or US $ (1000)	19,500	15,800	46,500

432.1 - Investment proper

The invested capital may be distributed as follows :

millions FMG

	30,000 ton mill		100,000 ton mill
	bleached pulp	semi-bleached pulp	bleached pulp
Infrastructure and utility works	700	400	900
Equipment (conveyance, building, and fitting up)	3,700	2,800	9,000
Study expenses and engineering	250	250	600
Contracting expenses fitting up and starting up	650	550	1,400
Total	5,000	4,000	12,000

Detail of investments concerning mill equipment will be found in appendix.

Infrastructure costs include mill connection with n° 13 R.I.G. highway as well as water connections and effluent water sewer after clarifying.

432.2 - Worker's garden city construction (1)

Housing construction for personnel and management personnel has been forecast. The total cost would be :

200 millions FMG for the 30,000 ton mill
and 300 millions FMG for the 100,000 ton mill

432.3 - Working capital

Working capital was valuated at 4 months mill fabrication production cost, so :

---

(1) - We have taken into account the particular climatological conditions prevailing in the region. We have reckoned FMG 4 millions per unit for staff, and 1 million to 500,000 for understrappers.

- 200 millions FMG for 30,000 ton bleached sulfate mill
- 180 millions FMG for 30,000 ton semi-bleached sulfate mill
- 600 millions FMG for the 100,000 ton mill.

We have included in this item, labour, and management, and maintenance personnel, as well as erection expenses (current expenses during mill erection or, more precisely, bank advance money interest).

432.4 - Spreading out of investments

In the two mill capacity eventualities, spreading out of mill erection may be effected as follows :

	months
Complementary research and tests	12
Erection decision and financing pursuits	(as a reminder)
Mill erection.:	
Studies	12
Main equipment orders	6
Equipment building	20
Civil engineering	12
Maritime and land transport	6
Fitting up	14

We come to the following chronology - D day is the day of the decision for erection.

D	Starting studies
D + 6 monts	1st equipment order
D + 10 months	Starting up civil engineering works and housing
D + 20 months	Equipment ready for delivery
D + 22 months	1st delivery of equipment
D + 26 months	Last delivery of equipment and starting of fitting up.
D + 36 months	End of fitting up and 1st starting up
D + 42 months	Delivery of the whole industrial complex.

The whole time is about 4 years 1/2, due account to complementary tests and researeh (1 year) being made. The mill may be erected in 3 years 1/2, exclusive of decision time and financing pursuits.

We have presumed the same erection time, whatever mill capacity being decided upon.

Investment cost spreading out would therefore be :

million FMG

	30,000 ton mill		100,000 fon mill bleached pulp
	bleached pulp	semi bleached pulp	
1st year	2,000	1,800	4,000
2nd year	1,800	1,600	4,800
3rd yeard with working capital	1,600 (200)	980 (180)	4,100 (600)
Total	5,400	4,380	12,900

433 - Production cost factors

We shall study production cost per pulp ton for the two fabrication grades of the 30,000 ton mill, and for the 100,000 ton mill. We shall first survey the different factors of this cost.

433.1 - Raw material

Raw material cost per pulp ton was reckoned in chapter 3. It is (see table list 345) :

FMG 7,319 for the 30,000 ton mill
FMG 7,143 for the 100,000 ton mill

433.2 - Labour

The labour costs include production direct costs and management and general services indirect costs. These costs amount to :

	30,000 ton mill		100,000 ton mill
	bleached pulp	semi-bleached pulp	
Direct costs	FMG 87,716,000	FMG 67,716,000	FMG 99,946,000
Indirect costs	FMG 63,470,000	FMG 59,420,000	FMG 65,570,000
	FMG 151 186,000	FMG 127,136,000	FMG 165 516,000

so an incidence per ton of pulp equal to :

	FMG 5,040	FMG 3,905	FMG 1,655
with the following repartition :			
Direct costs	FMG 2,924	FMG 2,257	FMG 1,000
Indirect costs	FMG 2,116	FMG 1,648	FMG 655

433.3 - Chemicals

The chemicals requirements differ following the two considered processes, but will be presumed the same whatever mill capacity.

433.31 - Bleached sulfate pulp

The chemicals requirements were estimated according to the laboratory tests. It will be noted that these figures may be subject to revision during semi-industrial tests. The consumption per pulp ton is estimated :

Sea salt	120 kg x FMG 12	=	FMG 1,440
Lime	50 kg x FMG 5	=	FMG 250
Surfuric acid	14,5 kg x FMG 19.20	=	FMG 278
Salt cake	25,7 kg x FMG 17.20	=	FMG 442
Various products	estimated		FMG 300
Maintenance cost of fittings			FMG 100
			FMG 2,810

so FMG 2,810 per pulp ton

433.32 - Semi-bleached sulfate pulp

Here, chemicals differ on account of one stage bleaching instead of five in preceding case. The consumption per pulp ton is estimated :

Sea salt	217 kg x FMG 12	=	FMG 2,604
Lime	40 kg x FMG 5	=	FMG 200
Salt cake	25 kg x FMG 17,20	=	FMG 430
Other products	estimated	=	FMG 100
Maintenance cost of fittings		=	FMG 60
			FMG 3,394

so FMG 3,394 per pulp ton

433.4 - Power

Power will be produced entirely in the mill from imported fuel.

Here would be requirements per pulp ton :

0.3 ton for bleached pulp

0.45 ton for semi-bleached pulp

at FMG 13,000 per ton price delivered at mill.

The corresponding costs of the equipment producing power, including maintenance, will be :

maintenance	0.5 x 13,000 = FMG 6,500 + 100	=	FMG 6,600	in the first case
maintenance	0.45 x 13,000 = FMG 5,850 + 100	=	FMG 5,950	in the second case

per produced pulp ton.

433.5 - Maintenance and spare part expenses

Spare parts purchase for processing equipment was forecast in the capital investment. Maintenance has already been reckoned in chemicals and power costs. The fabrication machines cost is partly covered by a part of the overheads and by further investments hereafter described :

433.6 - Overhead costs

These are commercial expenses (travelling, miscellaneous supplies), reception and office expenses. They have been roughly estimated :

FMG 1,000 per pulp ton

Are not precedingly included : the financing expenses (loan repayment) and the invested capital amortalisation (see 436.22 and 436.33).

434 - Pulp ton production cost

We have put forth in following table list production cost in each considered hypothesis :

FMG

	30,000 ton mill		100 ton mill
	bleached pulp	semi-bleached pulp	bleached pulp
Raw material	7,319	7,319	7,143
Chemicals	2,810	3,394	2,810
Power	6,600	5,950	6,600
Direct wages	2,924	2,257	1,000
Indirect wages	2,116	1,648	655
Overheads	1,000	1,000	1,000
Production cost (before amortalization and taxes)	22,769 or $ 82,05	21,568 or $ 77,72	19,208 or $ 69,21

The preceding table list shows that a bleached pulp production cost is more profitable for a 100,000 ton mill than for a 30,000 ton mill whereas semi-bleached pulp cost is lower than that of bleached pulp for a same capacity. It seems, at this stage of the study that the greatest influence on the returns of the forecast mill is inherent in the weight ratio of investments.

435 - Cost price ex-mill

We have held for good FMG 48,000 C.I.F., or $ 172,- the price per ton of Sisal bleached pulp at 85 photovolts. The April 10th, 1970 quotation having been FMG 49,650 per ton for coniferous wood pulp of the best grade, we have selected a medium price between bleached coniferous pulp and hardwood pulp.

Analogously, as to the difference between semi-bleached and bleached softwood pulp, for semi-bleached Sisal pulp we have applied a FMG 1,500 abatement on preceding price, i.e. a C.I.F. price of :

FMG 46,500 per ton, or $ 168.-

To get an ex-factory price, the maritime freight, the 1.5 % discount for cast payment, the conveyance from mill to port with wharf handlings, must be cut off from C.I.F. price.

In many ways, Pine pulp and Sisal pulp seem to be in competition. So as to develop sales of the latter, it would be worth producing a high grade material for special fabrications (unwoven gradee, de luxe paper, etc...) of a different use from medium grade softwood pulp.

As regards to possible Malagasy pulp sale prices, they will be defined in Chapter 4 for Sisal pulp, and in Chapter 5 for Pine woodpulp. Sales will be indeed subject to pulp world quotations, on a C.I.F. basis which are to be found in paragraph 25.

435.1 - Maritime freight and discount

Presuming sale of 2/3 of the production to the Middle East and 1/3 to Europe, and a charter transport, maritime freight may be estimated :

- to Middle East FMG 3,500 per ton
- to Europe FMG 4,500 per ton

i.e., an average of FMG 4,350 per ton or $ 15.67 (freight and insurance included) due account given to a 1.5 % discount for cash payment.

435.2 - Wharf handlings

The miscellaneous shipping, stowing and wharf warehouse costs were estimated at FMG 1,000 per ton, taking into account T.U.T. (transaction tax) exemption, and export customs duty exoneration.

435.3 - Conveyance from mill to port

At usual transporters tariff, per transported ton, this is :

FMG 6 x 110 kms = FMG 660 per ton
+ FMG 40 " for loading and unloading

giving a total of FMG 700 per ton

435.4 - Price ex-works

The sale ex-works price will then be :

for bleached pulp :

48,000 - (4,350 + 1,000 + 700) = FMG 41,950 per ton

and for semi-bleached pulp :

46,500 - (4,350 + 1,000 + 700) = FMG 40,450 per ton

436 - Economic feasibility of projected mills

We may now endeavour to get an approximate economic feasibility of the projected mill.

The following reckonings are an estimate of previsional economic feasibility of the project. We may point out once more that some of the costs herein may be subject to revision, after experimentation or perfecting on an industrial or semi-industrial scale.

436.1 - Economic feasibility

To estimate economic feasibility, we shall draw the cash flow investment relation, in current year. So, the following tabls list :

Table list 436.1

	30,000 ton mill		100,000 ton mill
	bleached pulp	semi-bleached pulp	bleached pulp
Price ex-mill/ton (in FMG)	41,950	40,450	41,950
Production cost/ton (in FMG) (without amortalization)	22,769	21,568	19,208
Cash flow/ton in FMG	19,181	18,882	24,742
Yearly cash flow (in million francs)	575.43	566.46	2,474.2
Investment amount	5,400	4,380	12,900
Economic feasibility %	10.65	12.44	19.17

This table list stresses interest in/ a high capacity mill rather than a medium capacity one, as well as interest in a semi-bleached pulp mill rather a bleached pulp one.

However, economic feasibility of a small mill is low, whatever the pulp grade, for a private investor to take interest.

The two extreme eventualities will now be studied in view of defining :

- cash flow
- internal returns ratio
- financial balance sheet
- nst returns ratio

436.2 - 30,000 ton bleached pulp mill

We have drawn the following table list presuming the mill reaches full capacity after being operative for 3 years, the three first years being devoted to studies and mill erection.

millions of FMG

Year	Yearly production (in pulp tons)	Mill capacity (%)	Turnover	Production cost	Cash flow
1	-				
2	-				
3	-				
4	18,000	60	755.1	409.8	345.3
5	24.000	80	1,006.8	546.4	460.4
6	30,000	100	1,258.5	683.0	575.5
30	30,000	100	1,258,5	683,0	575.5

436.21 - Internal returns ratio

To find out the internal returns ratio of the contemplated mill, we have reckoned the returns ratio cancelling in actualized values over 30 years the invested capital and the cash flow.

Year	Real values (million FMG)		Actualized values at 10 %	
	Investment	Cash flow	Investment	Cash flow
1	2,000		1,818	
2	1,800		1,487	
3	1,600		1,202	
4		345		236
5		460		286
6		575		3,709
30		575		
			4,507	4,231

The ratio establishes at about 9.5 % and ought to allow for lodging a long term loan to finance a part of the investments.

436.22 - Balance sheet

The balance sheet, with resort to a loan amounting to 60 % of investments (FMG 3,400 million) at the B.N.M. (Banque Nationale Malgache du Développement) may be established presuming a 40 % contribution by an investor (FMG 2,000 million).

The usual rate of this bank is 6.5 % for a long loan (see "Guide de l'Investisseur", page 44-45).

Balance sheet over 30 years

millions of FMG

Year	Capital proper	6.50 % loan	Capital to be refunded	Cash flow	Repayment amount	Investment or amortalisation	Taxable income	Tax	Net profit
1	2,000								
2		3,400							
3		3,621							
4		3,856	3,556	345	300		45	14	31
5		3,787	3,387	460	400	50	10	3	7
6		3,607	3,107	575	500	50	25	8	17
7		3,309	2,809	"	500	50	25	"	"
8		2,992	2,492	"	500	"	"	"	"
9		2,654	2,154	"	500	"	"	"	"
10		2,294	1,794	"	500	"	"	"	"
11		1,911	1,411	"	"	"	"	"	"
12		1,503	1,003	"	"	"	"	"	"
13		1,068	568	"	"	"	"	"	"
14		605	105	"	"	"	"	"	"
15	2,000	112		"	"	"	"	"	"
16	1,612			"	500	"	"	"	"
17	1,112			"	500	"	"	"	"
18	612			"	500	"	25	8	17
19	112			"	112	"	413	128	285
20						50	525	163	362
↕				"		↕	↕	↕	↕
				"					
30				575		50	525	163	362
Total				15,280	7,312	1,300	6,668	2,042	4,626

The preceding table list considers as possible a FMG 3,400 million loan at 6.50 % on term (15 years) with a 3 year differed payment. However, the mill profit is rather low.

436.23 - Added value of mill

We have estimated the direct added value brought to Malagasy economy by the mill. The wages, the taxes levied by state and the net profit were accounted for, so :

Yearly wages	: FMG 5,040 x 30,000 t.	= FMG 161,000,000
Yearly average taxes	: $\frac{2,062}{30}$	= FMG 67,000,000
Yearly average profit	: $\frac{4,626}{30}$	= FMG 154,000,000
	Total :	FMG 372,000,000

The capital coefficient is then : $\frac{5,400}{372}$ = **14.5**

which is too high for this kind of firm. This amount is still not negligeable as regards the local economy.

436.24 - Mill internal returns ratio

Lastly, if we consider on one hand, the net profit after amortalisation, tax payment and capital refunding (funds + 6.5 % loan), and on the other hand, investment capital, the internal returns ratio in actualised value over 30 years is negative. It would deter a possible private investor.

As a conclusion, eventuality of a 30,000 ton bleached sulfate pulp mill ought to be discarded on account of too low economic feasibility. We shall now consider the 100,000 yearly ton eventuality.

436.3 - 100,000 ton bleached pulp mill

436.31 - Cash flow

We shall set up cash flow on a 30 year period from following table list :

Year	Yearly production (pulp ton)	Mill capacity %	Turnover	Production cost	Cash flow
1					
2					
3					
4	60,000	60	2,517	1,152	1,365
5	80,000	80	3,356	1,537	1,819
6	100,000	100	4,195	1,921	2,274
↕	↕	↕	↕	↕	↕
30	100,000	100	4,195	1,921	2,274

From this table list, we have reckoned the internal returns ratio cancelling in actualised value over 30 years, the invested capital and the cash flow. This comes out somewhere near 14 %. It appears as being better than the preceding one.

436.32 - Internal returns ratio

Year	Real value (million FMG)		Actualized value	
	Investment	Cash flow	14 % investment	Cash flow
1	4,000		3,508	
2	4,800		3,691	
3	4,100		2,767	
4		1,365		808
5		1,819		944
6		2,274		
↕		↕		↕
30		2,274		8,188
			9,966	9,870

436.33 - Balance sheet

This ratio ought to allow for lodging a loan for an important part of investments. We have presumed that the loan would cover 60 % of the whole and that 40 % would be invested on the investor's funds proper. We shall apply a 6.5 % rate with a long term loan (15 years).

Balance sheet over 30 years (millions of FMG)

Year	Capital proper	6.5 % loan	Capital still to be refunded	Cash flow	Repayment amount	Invest or amortal.	Taxable income	Tax	Net profit
1	5,000								
2		7,900							
3		8,414							
4		8,961	7,961	1,365	1,000		365	113	252
5		8,478	6,978	1,819	1,500	150	169	52	117
6		7,432	5,432	2,274	2,000	150	124	38	86
7		5,785	3,785	↑	2,000	150	124	38	86
8		4,031	2,031		2,000	150	124	38	86
9	5,000	2,163	163		2,000	150	124	38	86
10	3,163				2,000	150	124	38	86
11	1,163				1,163	150	961	298	663
12						150	2,124	658	1,466
↕						↕		↕	↕
30				2,274		150		658	1,466
Total				60,034	13,663	3,900	42,471	13,155	29,316

The preceding table list leads to ascertain possibility of quick loan repayment (8 years) as well as substantial profits from the 12th year after starting erection of mill.

436.34 - Added value of the concern

If we reckon the average direct added value coming from the contemplated mill, we come to :

Distributed yearly wages	: 1,655 x 100,000	=	FMG	165 millions
Average yearly taxes	: $\frac{13,155}{30}$	=	FMG	438 "
Average yearly profit	: $\frac{29,316}{30}$	=	FMG	977 "
		so	FMG	1,580 millions

which corresponds to a capital coefficient of

$$\frac{12,900}{1,580} = \boxed{8,16}$$

This is quite fair for a papermaking unit.

436.35 - Net returns ratio of mill

If we compare investments with previsible net profit in actualised value during the period, we get a rate somewhere near 5 % which is a noteworthy result for an industrial concern.

437 - Economic conclusion

The economic study of preceding three projects (the two extreme eventualities only, have been examined in detail) leads to following conclusions :

- the 30,000 t/bleached pulp mill requires a FMG 5,400 millions or $ 19.5 million investment and has only a 10.65 % gross returns ratio.
- the 30,000 t/semi-bleached pulp mill requires a lesser FMG 4,380 millions or $ 15 8 million investment and brings about a better gross returns ratio : 12.44 %.
- the 100,000 t/bleached pulp mill which requires an investment valuated FMG 12,900 millions or $ 46.5 million has a 19.17 % gross returns ratio.

Evidently, the latter project is the most favorable. However, it is not to be excluded that an intermediate solution might be considered : this is to erect a 30,000 ton bleached pulp mill, and then, when the export market will be well known, to extend the production to 100,000 yearly ton.

In the most unfavorable case, that is the 30,000 ton bleached pulp mill, it seems feasible to make sure of 60 % of investment financing by a long term 6.5 % loan.

Erection of a Sisal pulp industry in the Mandrare region will have the main benefit of setting up an added value of average amount, comprised between FMG 370 and 1,580 millions every year following capacity decided upon.

But the main benefit is in the way of newly created employment, for the operative mill as well as newly created plantation.

The following table list defines the amount of various investments and of previsable employment.

Table list n° 437

	Investments (million FMG)	Previsable permanent employment
30,000 t mill	5,400 or 4,380	184 or 162
Plantations and workings labour	406	281
Total	5,800 or 4,800	465 or 443
100,000 t mill	12,900	207
Plantations and workings labour	1,105	1,475
Total	14,005	1,682

We see here that the main benefit of the pulp mill erection resides in the created complementary employment. In the small mill case, with a rough FMG 4,800 to 5,800 million investment, we get to 443 to 465 further employment posts. In the 100,000 ton mill case, with FMG 400 million investment, 1,682 employment post will be created.

However, before considering erection of a mill, a number of tests and researches must be prevised. They are set forth in paragraph 44.

44 - CONCLUSION AND RECOMMANDATIONS

441 - Conclusion

441.1 - Fiber treatment

It may be implied from laboratory results that the chemical treatment of the whole plant and non-treated leaves must be discarded on account of :

- prohibitive soda consumption (26 %)
- yield of the resulting pulp (35 %)
- poor resulting physical characteristics.

We shall hold as good that processed from previously dried flume tow (defiberised waste), fabrication waste, and textile fiber, have characteristics equal to hardwood pulp with a better tearing strength.

441.2 - Economic aspect

Economic aspect shows that bleached pulp production at a 100,000 ton yearly capacity is profitable.

However, semi-bleached pulp production is not to be disregarded. It yields a commercially serviceable pulp which would allow for a two stage investment :

- Semi-bleached pulp production (30,000 tons)
- Bleached pulp production (100,000 tons)

We note in the economic study that eventuality of a 30,000 yearly ton capacity mill erection would yield limited returns.

It would however enable an industrial start in a particularly remote region where employment could be developed as well as the port traffic and the local trade.

441.3 - Cultivation extension

It will be necessary to develop Sisal cultivation in the two following cases :

3 - SISAL, RAW MATERIAL FOR PAPERMAKING

31 - SUPPLYING POSSIBILITIES OF THE FORECAST MILL

311 - Defibering waste

312 - Tow and flume tow

313 - Stems after their cyclical vegetation

314 - Closely set plantations for purpose of papermaking

32 - VARIOUS PROBLEMS TO BE SOLVED

321 - Defibering waste

322 - Tow and flume tow

323 - Utilization of stems after their cyclical vegetation

324 - Closely set plantations

325 - Agricultural and cultivation improvements

33 - PRICE OF RAW MATERIEL DELIVERED AT MILL

331 - 16,000 tons per annum mill

332 - 30,000 and 100,000 tons per annum mill

333 - Yearly cost of raw materiel

34 - INVESTMENT, RETURNS AND LABOUR

341 - Case of the 16,000 tons mill

342 - Case of the 30,000 tons mill

343 - Case of the 100,000 tons mill

344 - Complementary labour

345 - Conclusion

35 - LABORATORY PAPER STUDY

351 - Sampling

352 - Chemical compoaition of samples

353 - Micrometric characteristics of fibers

354 - Kraft cooking of samples

355 - Neutral sulfite cooking of samples

356 - Various treatments

357 - Problems in relation with fines

358 - Conclusion

- In the case of a 30,000 yearly ton mill, a sufficient production in in quantity and quality could be obtained by creating at least costs, further cultivations for papermaking purposes on the outskirts of the present plantations. The necessary land has been estimated about 1,750 ha. over 5 years.
- In the case of a 100,000 yearly ton production, cultivation extension will require setting up of about 12,000 ha. plantations for papermaking purpose.

442 - Recommendations

These recommendations concern complementary studies and tests.

The preceding study has brought about difficulties regarding fiber recovery problem, particularly on the stems, as well as the problem of Sisal fiber treatment for papermaking purpose.

These difficulties require complementary studies and therefore more elaborate tests on :

- fiber working and recovery
- complementary laboratory tests
- semi-industrial tests.

The setting-up of a complementary test and studies scheme is essential but such a scheme may only be set up in accord with the planters and the industrial people interested in Sisal utilisation.

442.1 - Fiber working and recovery

It would be desirable that the plantations for papermaking purpose be of close density, 10,000 plants per hectare, the fiber product of which I.R.C.T. has asserted as profitable.

It will be necessary to make sure in this case, that leaves mechanical gathering will be feasible by providing the necessary space between the lines for the wheels of the fork collector to pass through.

Stem or stalk fiber recovery is an appreciable supply. However, it must be taken into account that for an avaraga 15 Kg weight in the green state, only 2 to 2.5 Kg fiber par stem ara serviceable. So it is advisable to collect thesa stems when they ara as dry as possibla.

It has been noted that in the fields, drying of the stems ara very different from one stem to anothar for a same time of exposure; it will be necessary to hasten natural drying.

For hastening drying, cutting two ends of a sten is suggestad so as to facilitate natural elimination of the heart which is a sort of pith cells; this operation could be affacted if mechanical experiments give good results.

We suggest that experimantation ba made by I.R.C.T. or planters to find out whether this devica or another ona would enable collecting these stems as dry as possibla.

I.R.C.T. should carry on rasearch on soil fertility maintenanca, Sisal varieties paper grade studias, cultivation methods. It seems essential to maintain the Mandrara experimental station and ensure financially its working.

442.2 - Further laboratory tests

The laboratory tests have enablad defining the best raw material returns and we confirm that further tests must be made, due account being given to fiber supplies. These tests would be effected according to following distribution :

- <u>1st case</u> :	<u>for a 30,000 yearly ton mill</u>	%
	. Defiberised waste	9
	. Waste from brushing	4
	. Closely set plantation fiber	37
	. Stems or base of leaves	50
	Total :	100 % fibers

- 2nd case : for a 100,000 yearly ton mill	%
. Defiberised waste	2.5
. Waste from brushing	1
. Closely set plantation fiber	84.5
. Stems or base of leaves	12
Total :	100 % fibers

These suggestions are a fair representation of different fibers in the two studied cases.

It seems that yields and grades will be different from those registered during preliminary laboratory tests, which have been mentioned precedingly.

Perfecting of bleaching technique must also be seen to. We have seen that pulp bleaching resulted in less bright, less stable and more degraded pulp than conventional paper pulp. Influence of fines has been emphasized during preceding tests, but it has not been possible to define the very influence of fines in the waste. In other words, the question is to find out whether a pulp from waste entirely void of fines bleaches as easily or less easily than a standard paper pulp. In the latter hypothesis, a more elaborate bleach study would probably enable ameliorating results.

Lastly, semi-industrial test control, which will be dealt with in the following paragraph, will also require laboratory tests.

442.3 - Semi-industrial tests

The main endeavour must be made at this stage. We shall distinguish two types of tests :

- tests for removing fines
- confirmation tests for pulp cooking and bleaching.

442.31 Tests for fine removal

The first idea that comes in mind is to proceed with tests already in use for bagasse screening.

Two screen types are in use on an industrial scale : the dry operating screens and the wet state operating screens. Some plants are equipped with both types of devices.

The dry operating screens are the Horkel device which beats the bagasse, pulverizes the fines and facilitates in this way their removal through gauged openings. As regards to the wet state screaning, bagasse is hung up in a continuous hydrapulper which also helps pulverizing the fines aggregates. Bagasse afterwards goes through a special Horkel device where the fines are removed, after which they are filtered, dried and burnt.

Several bagasse pulp units are equipped with these devices : in South America, Cuba, Egypt and India.

A solution would be to make up a list of units equipped with an adequate equipment and then to contact one or several of the most of interest for Madagascar in view of coming to an agreement on an experimentation as to Sisal cut waste (operation cost, quantity of necesaary waste, etc...).

Refined Sisal could be treated in the same unit, or brought to France for cooking and papermaking in a station such as "Centre Technique de la Papeterie" at Grenoble.

The experimentation at mill would have the benefit of being more proving but would probably need very important quantities of raw material with a lack of operative elasti:ity. Station test would need a small raw material quantity and would be of a better operative adaptability (cooking and bleaching).

These experiments may bring about insufficient Sisal screening. In this case, a perfecting of another screening of the pulp after cooking could be considered. This could be effected by simply putting the pulp through a rotary drum screen. If other difficulties appeared like clogging of the rotary drum screen, another device would have to be found : (Seleco, Dorr Oliver).

Above mentioned tests should be performed on the one hand with a type of Sisal still to be defined and on the other hand, with the whole plant or part of same. Both tests could be made at different times.

As far as Madagascar is concerned, another solution would consist of building up an experimental station, but this would probably be more costly. In our opinion, such a decision should not intervene prior to a preliminary test performed in already equipped mill, being understood that the equipment chosen could, after due adjustment, suit Sisal.

442.32 - Confirmation tests for pulp cooking and bleaching.

We have seen in 442.21 that industrial cooking in a mill might be considered. If such an operation were quite successful, a confirmation cooking test in a semi-industrial station would be of no use. But we have seen that it might be more profitable to effect only raw material screening in a mill, and to effect cooking and bleaching in a station, with more probablity of getting the best results. As regards to bleaching, in particular, the adaptibility of a small station allowing for processing various stages with chlorine dioxyde would be of more interest, and it probably could not be done in a bagasse mill.

442.4 - Complementary test costs

	FMG
A - Agronomical tests	
Soil fertility, choice of paper grades, cultivation methods, working mode	10,000,000
B - Debates with Sisal producers	
Two journeys to Madagascar for two persons	3,000,000
C - Purchase and fitting of a grinder and straw-chopper	15,000,000
D - Laboratory workings	
Tests on further samples, bleach study, semi-industrial pulp control	5,000,000
E - Semi-industrial and industrial tests	
Sisal cutting and purchase	as a reminder
Research, inquiries, contacts with bagasse mills, dispatching 200 tons of Sisal, renting of an industrial station for tests, journeys for control	15,000,000
F - Semi-industrial tests at "Centre Technique de la Papeterie"	
Cooking, bleaching, various tests, control	5,000,000
G - Purchase or renting of special equipment	10,000,000
H - Report writing and printing and miscellaneous	2,000,000
Total	65,000,000

5 - PINEWOOD PULP MILL

51 - TECHNICAL DESCRIPTION

511 - Description of the plants

512 - Fabrication products

513 - Production characteristics

52 - PERSONNEL

521 - General organisation

522 - Amount of wages

53 - INVESTMENT

531 - Equipment investment

532 - Detailed investment of technicological Equipment

533 - Complementary investment

534 - Spreading out of operations

54 - DRAWING UP OF PRODUCTION COST

541 - Production cost factors

542 - Production cost

55 - ECONOMIC FEASIBILITY OF THE PROJECT

551 - Return ratio and added value

552 - Feasible financing

56 - CONCLUSION

561 - Economic aspect

562 - Conveyance problem

563 - Plantation problem

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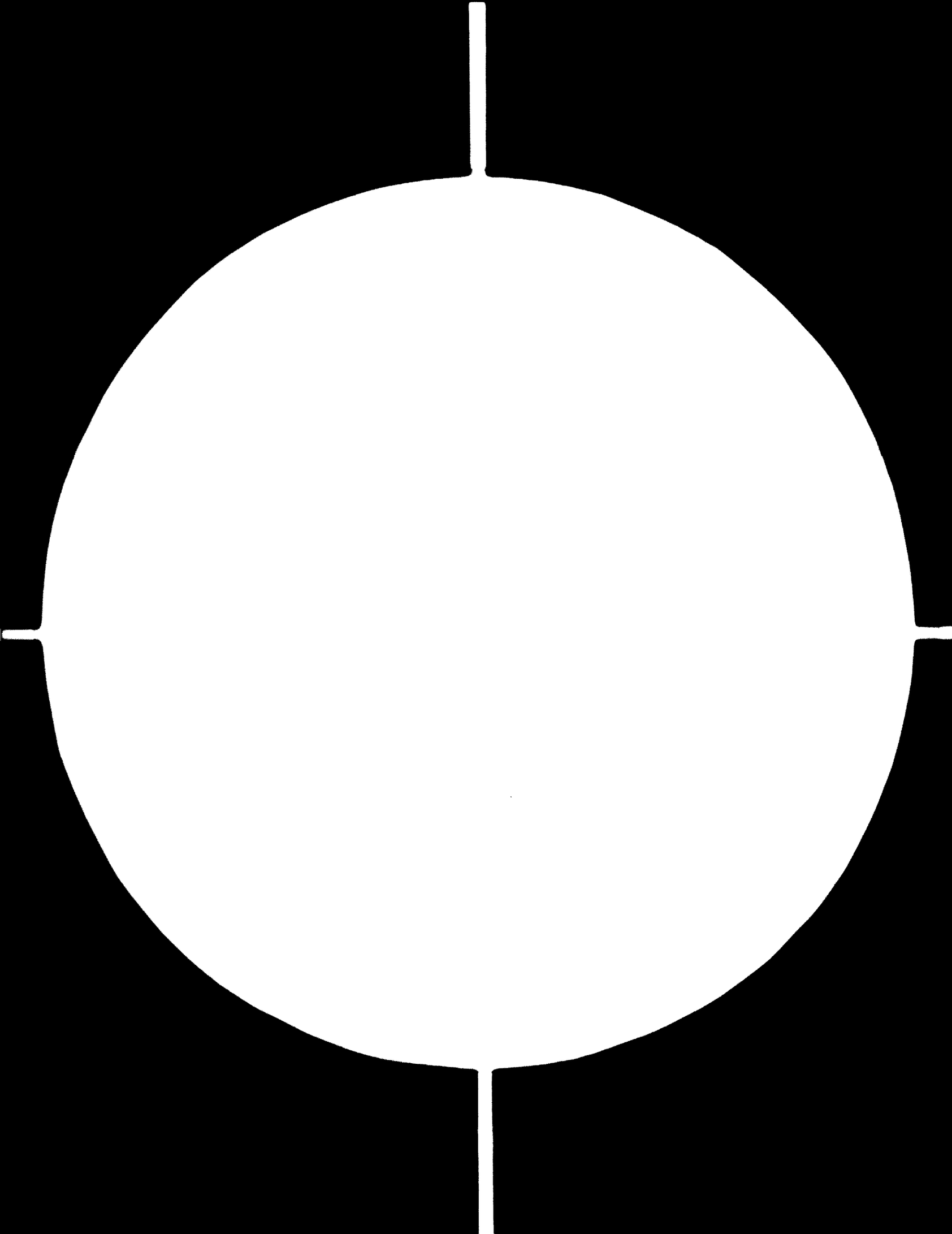
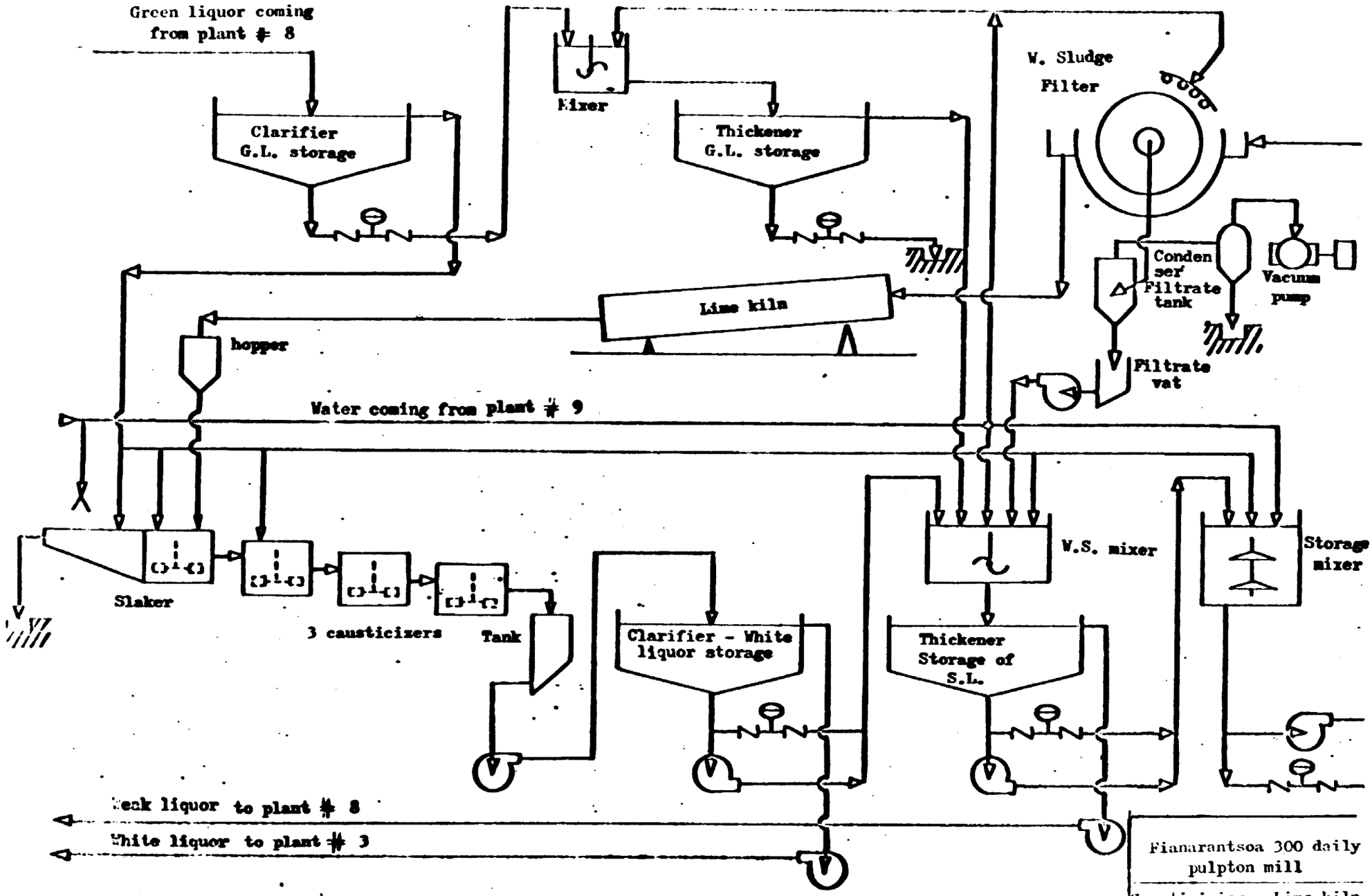




Fianarantsoa 300 daily pulpton mill

Causticizing - Lime kiln Plant # 2

- A weak liquor centrifugal pump takes up the ovarflow of the weak liquor thickaner and directs it to the dissolver.
- Reclaiming of the weak sludge is effected by means of two pumps, one is a diaphragm pump, and the other, centrifugal.
- This sludge is again diluted and stored in a mixer fitted with a paddle agitator, and sent to the white sludge filter by twe pumps (1 cantrifugal, 1 disphragm).
- A white sludge drum filter equipped with its vat, its hood, its spray bars, its feeding and discharging spouts. This appsratus will be set on a higher level so as to enable feeding of the lime kiln. It will be protacted by a small construction. A metallic tank for filtrates, of a cylindrical shape, is set under this filter.
- A vacuum pump with a condenser to feed the filter.
- A tank and a centrifugal pump for filtrates to return to the whita aludge mixer.

The causticisars, clarifiers, slakars, mixers are connected by grated cat walks.

The thickeners, clarifiers and pumps are sat on the floor. The other apparatuss are on a higher leval on concrate beds or platforms.

511.3 - Cooking

This plant, one of the more elementary of the production, is entiraly aet up outside. Its site enables easy feeding by the chip conveyor coming from plant 1, the digester being filled by the top, and baing about 50 meters high.

The whole of the feeding equipment of the digester is set upon a metallic framework which takes its baaring on the top of the digester.

This equipment is :

- A loading hopper with its weighing device already refarred to in the plant 1.

- A low pressure rotative feeding valve, steam heated, loads the chips continously into the first level of the heating. The rotor of this valve is set with adjustable blades for tightness.

- The first heating is operated at about 120°C in a horizontal cylindrical helicoidal type conveyor apparatus always at the top of the digester. The air surrounding the chips is blown out by the steam under pressure and is cleared out through the feeding rotary valve.

- A second rotary valve, of high pressure type, ensures the joint between the digester and the heating first level. This valve is also steam heated.

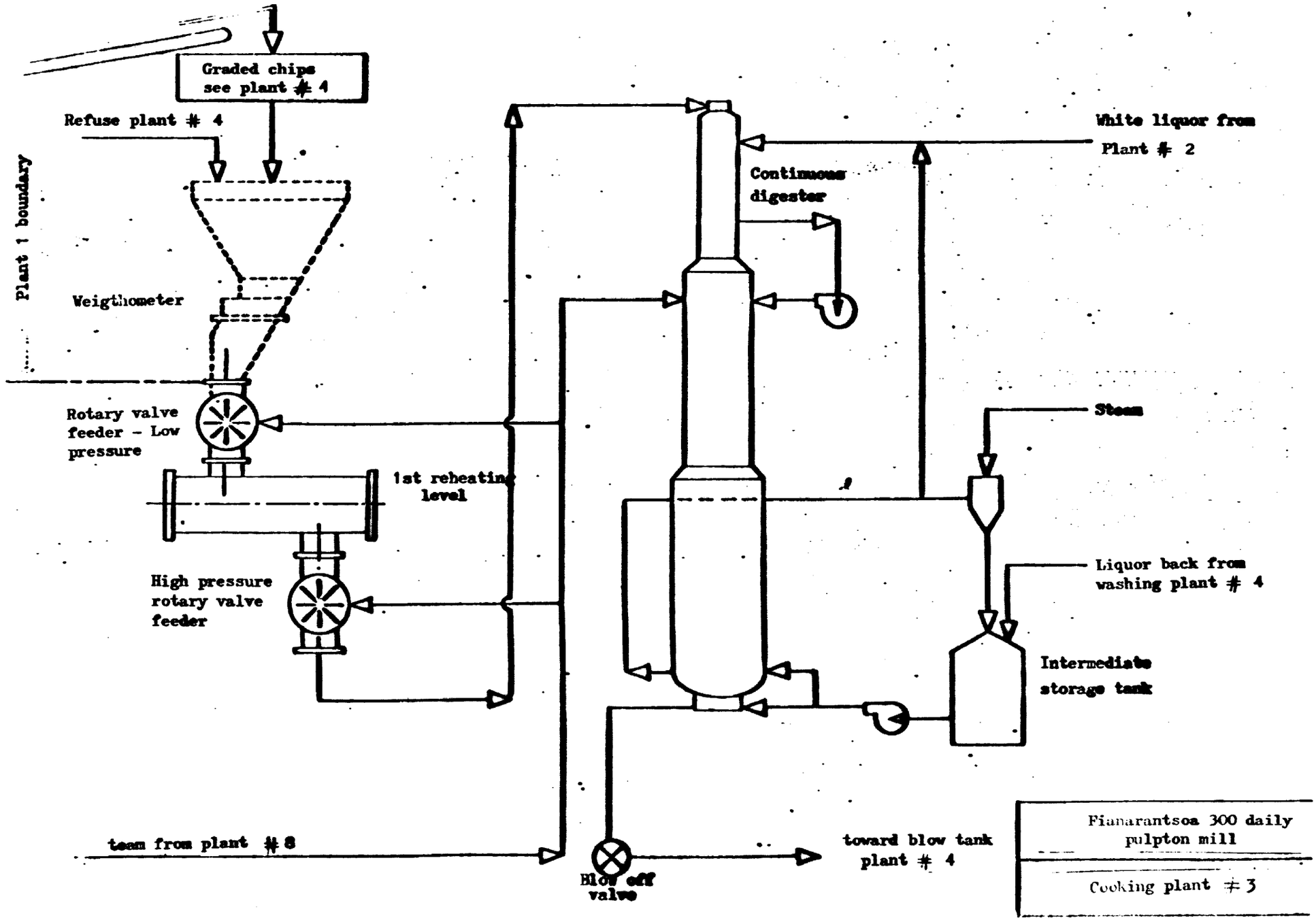
- In the second heating level the chips are filled into the digester by a vertical screw, and control of the cooking time is operated by acting on the speed of this screw. When they come out of this level the chips have reached their cooking temperature.

- On going down into the digester, the chips will go through a white liquor impregnation part. The white liquor is fed at top of the part and is reclaimed at bottom after having progressed with the chips.

- The chips then pass through the cooking zone proper, in which liquor is fed at the appropriate temperature. The liquor is admitted by self-washable filtering devices, which are equipped with individual screen scrapers.

- At the bottom of the digester, pulp temperature is brought down to 95°C by adding liquor coming from the wash. The pulp is then reclaimed through a blow valve and is sent to the top of the blow-tank.

- The black liquor is collected at the bottom of the digester to be stored in an intermediate storage chest. This chest received additional liquors coming from washing. The drawing off is effected by a centrifugal pump set on the floor, and this drawing off feeds the cooling space and bottom of the digester with black liquor.



Fianarantsoa 300 daily pulpton mill

Cooking plant # 3

511.4 - Blow-tank - Washing - Screening

This plant is set immediately after the cooking. For treating 80 to 85 % Pine patula for 15 to 20 % Eucalyptus, two blow-tanks are nacassary, but only one washing system is enough.

The equipment of this plant is as follows :

- Two steel blow-tanks, set up out-doors collect the pulp under pressure from the cook. Fiber separation is made here by expansion effect. A revolving agitator set in the lower cone of the device mixes the pulp with the recycled liquor coming from the first liquor storage vat, and dilutes the pulp to the point when it may be pumped.

- A dilution box, set before gradings, brings down the degree of solid matter in suspension to 1.5 or 2 %, by additional recycled liquor.

- A battery of vibrating screens for discarding the non cooked matter. These screens must be set at a level such as to allow feeding of the first washing filters by gravity.

- Coming out of the screens, the pulp is diluted once more by additional liquor recycled in a steel feeding box, set above the first filter.

- A washing-filter battery with vacuum rotary drums, fitted on a concrete floor. These filters are fitted in steel vats, and are provided with a set of spray bars, the first filter being fed with hot water and the other two by filtrates of the preceding filter.

- The discharge of these 3 filters is taken up and diluted with additional filtrates, in defibrating pulpers set between each pair of filters; concentration of the "cake" which comes out of the first filter at 10 to 12 % is brought down in this way to about 1 %. This apparatus is also put in use as feeding boxes for the next filters.

- The filtrates are recovered in cylindrical vats placed underneath. They are used for pulp dilution at the preceding washing floor. They are conveyed by centrifugal pumps to the floor of the filtrate vats.

- A foam reservoir, of cylindrical form, of steel construction, is set on the floor. It collects the foam produced in each filtrate tank. It has s foam breaker on its top part and once the foam is beaten down, it is sent by a centrifugal pump in the first filtrate tank, with return to the head of the plant (see diagram).

- When the pulp comes out of the third filter, it is directed by a repulper conveyor, at a 10 to 12 % consistency, to the storage chest.

- This chest, of a cylindrical shape, made of steel, secures retention prior fine screening. Pulp suspension is ensured by propeller stirrers set at the bottom of the chest.

- The pulp is reclaimed by a pump and sent to the thickening filter after going through the fiber screening plant.

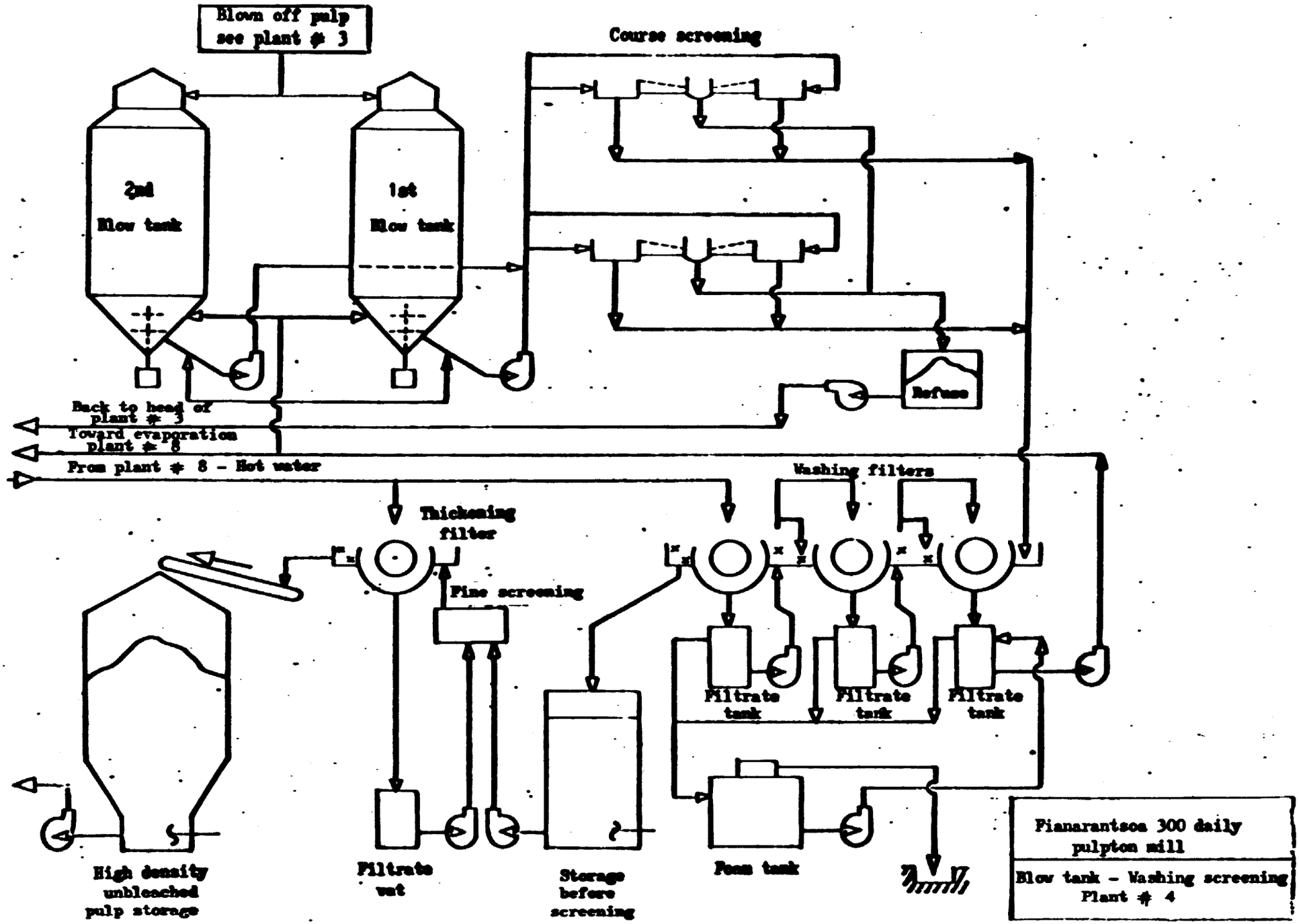
- The thickening filter is of the same type as for washing, equipped with a feeding box, spray bars, a repulper conveyor which breaks the pulp "cake" and conveys it above the belt conveyor feeder. The vat is of steel, and this filter is set on the same floor as the three other filters.

- The filtrate tank receives the filtrates of the thickeners and they are sent to screening by a centrifugal pump.

- A belt conveyor directs the washed high density pulp from the thickening filter to the unbleached pulp storage hopper. In fact, this conveyor connects the washing plant with the storage tower.

- The storage tower enables an eight hour temporary stop of the next plant, snd will have a 1,000 m3 storage capacity of 10 to 12 % density pulp. Built of steel, it is provided at its base with dilution tuyeres, and propeller agitators to keep down pulp consistency so as to facilitate conveyance to the next plant.

All this equipment, excepted the blow-tanks and the unbleached pulp storage tower which are outdoors, is set up inside with a metallic framework construction, concrete floors on iron bars and masonry fillings.


Blown off pulp
see plant # 3
Course screening
2nd
Blow tank
1st
Blow tank
Refuse
Back to head of
plant # 3
Toward evaporation
plant # 8
From plant # 8 - Hot water
Washing filters
Thickening
filter
Fine screening
Filtrate
tank
Filtrate
tank
Filtrate
tank
High density
unbleached
pulp storage
Filtrate
vat
Storage
before
screening
Foam tank
Pianarantsoa 300 daily
pulpton mill
Blow tank - Washing screening
Plant # 4

A connecting foot-bridge enables inspection and support of the belt conveyor between the building and the unbleached pulp storage tower.

511.5 - Bleaching

The bleaching plant was designed for treatment of woodpulp in five stages (chlorination, first sodation + H_2O_2 . First stage ClO_2; second sodation + H_2O_2, second stage ClO_2). After these processings, the pulp should attain the Elrepho brightness of 90° to 92°.

The technological equipment of this plant has essentially the following composition :

- An homogenization vat for putting the pulp in appropriate suspension after its storage and its dilution at the base of the preceding tower. Built in stainless steel, it is fitted with propeller agitator.

- Drawing out the pulp is effected by a centrifugal pump set on the floor, feeding the chlorine tower through the pre-chlorination tower.

- A chlorine mixer, which mixes the chlorine gas in very fine bubbles with water, before letting it into the upper side of the pre-chlorination tower. The shell is made of polyester, and the nozzle or tuyere, of polyvinyle chloride.

- The pulp-chlorine mixing begins in the pre-chlorination tower, which is a small metallic tank provided with a blade agitator, and the object of this is to enable a several minute pulp-chlorine contact before controlling and regulating the chlorine amount at the admission into the chlorination tower. The inside of the tank is lined with ebonite.

- A chlorination tower which is set up outdoors, built of concrete, and tiled inside. It has a discharging spout and a propeller in the upper part, and two propellers in the lower part.

- Two cylindrical sodation towers built of concrete, tiled inside, are inside the building, filled by the top, and have dilution tuyeres and propellers to facilitate pulp discharging by the bottom.

- Two chlorine dioxide towers in concrete and tiled inside which are outdoors. There is a plum-bob at the top for pulp circulation. At the base, propellers to ensure circulation. Extraction is made by means of pulp dilution tuyeres.

- Five bleached pulp thickening filters, fitted on the upper floor of the plant. These are drum filters aquippad with washing ramps, set in concrete, and tiled vats.

- Five filtrate tanks with tangential inlets under the filters on an intermediate floor. They are metallic, and round.

- Two high-density pulp gearpumps for conveying the pulp to the ClO_2 towers, equippad with their baseplates, driving motors, and set on the floor.

- Five pulp centrifugal pumps fitted on the floor.

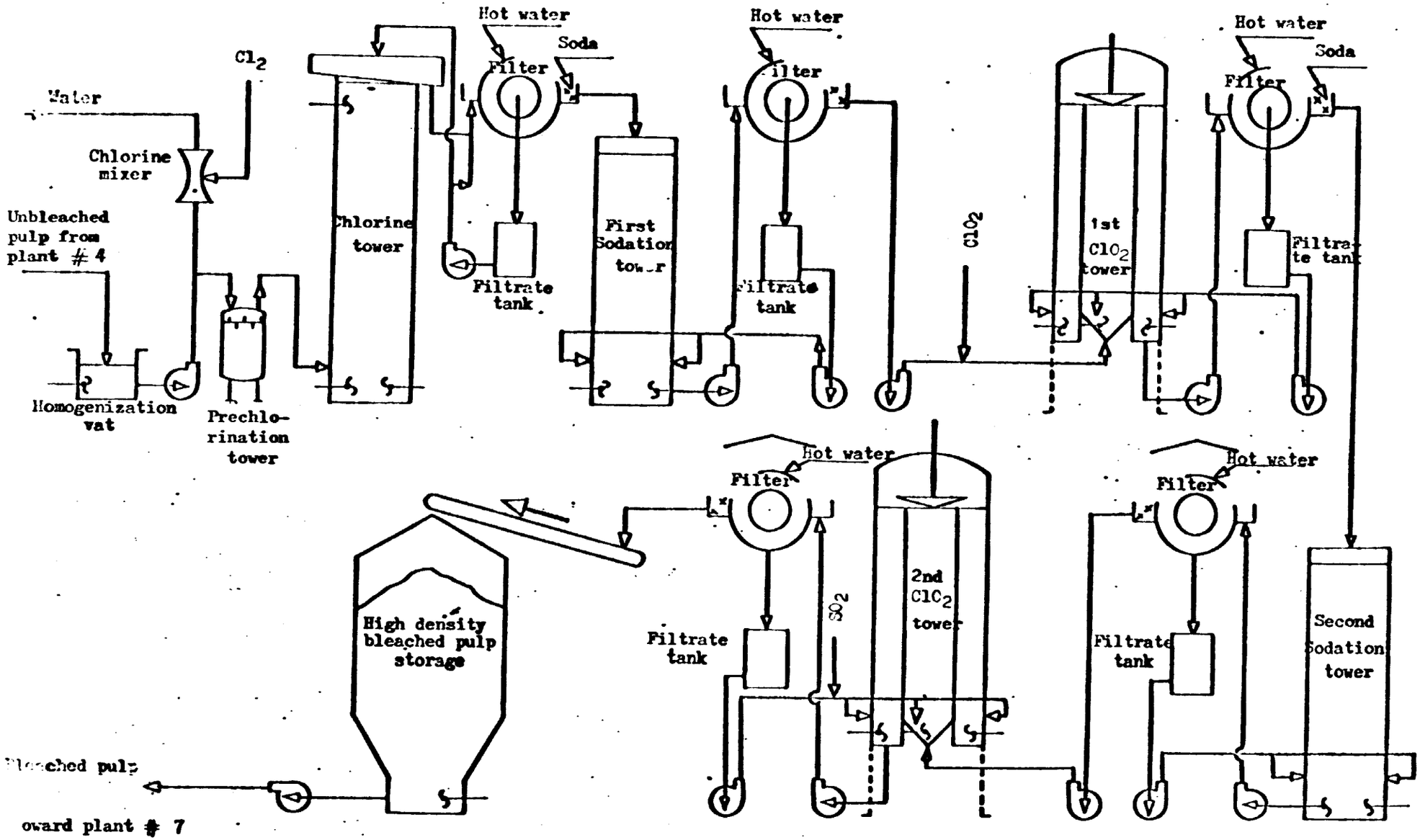
- Five filtrate centrifugal pumps fitted on the floor under the filtrate tanks.

- Five conveyor re-pulpers which break tha pulp "cake" coming out of the filter apron, ensure dilution for transport purpose, and direct the pulp horisontally over the following apparatus feeding device. The vats of these apparatus are an integrate part of the filter vats.

- Four mixer-heaters fitted under the filters, to crush the pulp, mix it completely with the chemical reagent and to heat by steam the mixing at adequate temperature for chemical treatment. The shells are of stainless steel as well as the mechanical parts.

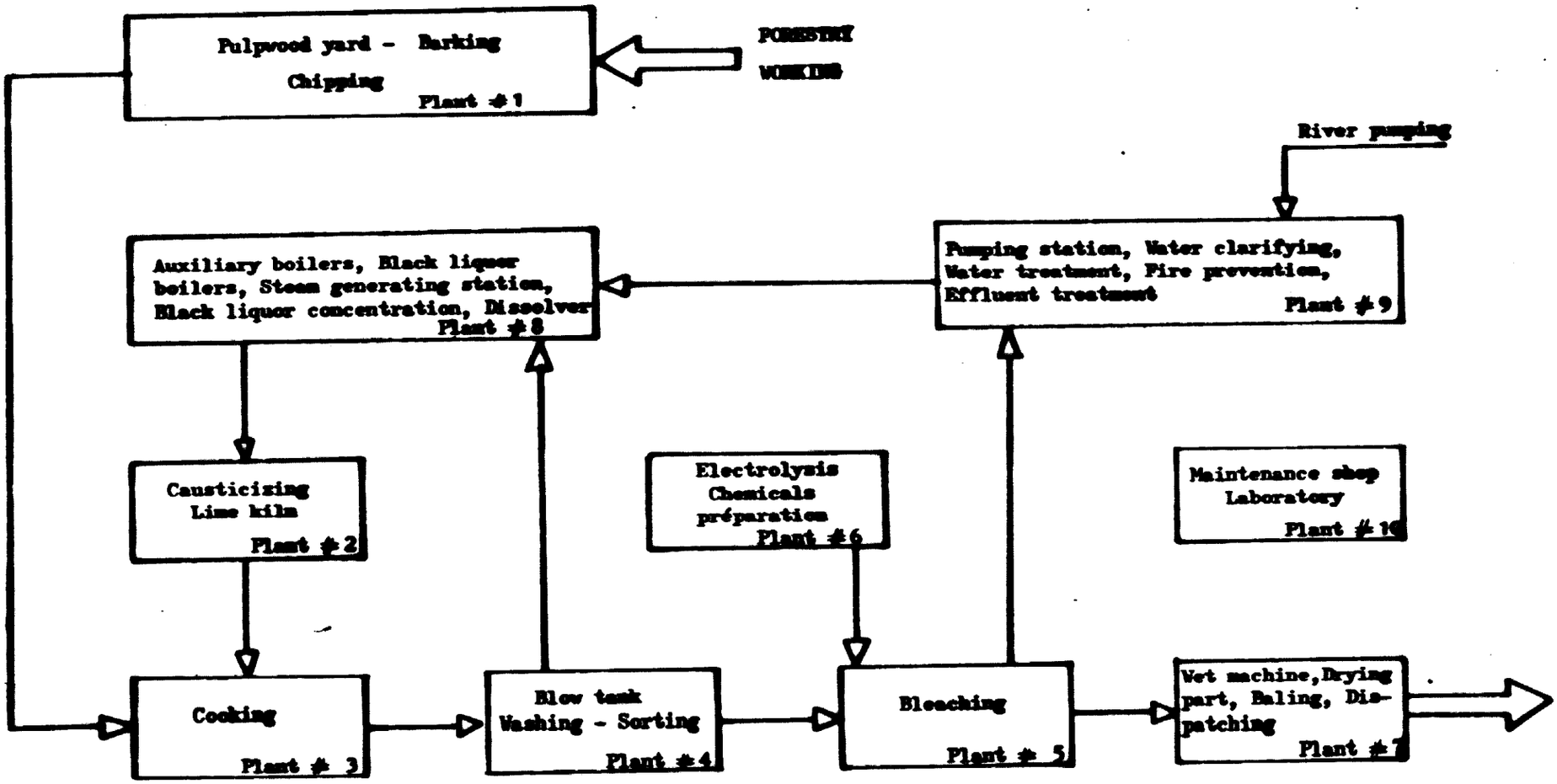
- A chlorine dioxide mixer which effects the mixing of the ClO_2 solution with the pulp, before its admission into the treatment tower. The shell is of steel covered with titanium. The shafts and the mechanical parts are of Hastelloy.

- A belt conveyor to transfer the filtered and bleached pulp to the last stage, from the building to the bleached pulp storage tower.



Fianarantsoa 300 daily pulpton mill

Bleaching Plant #5



Fianarantsoa 300 daily pulpton mill

General diagram

- A bleached pulp storage tower steel lined, of a 1,000 m3 capacity, i.e. 8 hours production. At its base, two propellers and combined tuyeres ensure the mixing and the dilution necessary for its extraction in view of conveyance to the next plant. This tower is outdoors.

This plant is coupled with the washing plant, and some floors may be common, the filter floor in particular.

The bleached pulp storage towers, the chlorination and chlorine dioxide towers, may be installed outdoors. All the other units are fitted in a metallic framework building with concrete floors and masonry fillings. There is also a metallic footbridge supporting the belt conveyor between the construction and the storage tower for bleached pulp, which can also be used for the maintenance of the conveyor.

511.6 - Preparation of chemicals

This plant is designed for providing the different chemicals to the cooking, bleaching, water and effluent treatment plants.

The geographical situation of the mill dismisses any economic possibility of interest to supply the main products by containers conveyed by road or rail.

It does not seem that there exists in Madagascar an industrial plant producing chlorine, soda, hydrogen peroxide and chlorine dioxide.

For this, three main workshops are necessary :

- Chlorine, soda processing plant. This plant has five main divisions :
  - . A power converter set 30 KA, 70 V.
  - . A mercury-cell electrolysis shop
  - . A brine-preparation shop
  - . A chlorine treatment and liquefaction shop
  - . A sodium hypochlorite processing shop.

All these units are enclosed in reinforcet concrete buildings, and have all the necessary preventive securities in relation with basic material storage and with chlorine neutralisation, etc...

- Hydrogen peroxide plant. It has three divisions :

  . A power converter set 2 x 3 KA - 290 V.
  . A 3,000 A. electrolytical-cell shop comprising 24 cells
  . A shop for distillation, rectification and storage of hydrogen-peroxide.

  This plant is set in an reinforcet concrete building, and possesses all the necessary handling equipment for dismantling the cells.

- The chlorine-dioxide plant includes :

  . A power converter set of 30 KA - 80 V.
  . A chlorete-cell shop comprising 20 cells
  . A ClO_2 generating shop comprising :
    - Sodium chlorste storage
    - Sulfuric acid storage
    - A duplex pump for proportional distribution of ClONa and SO_4H_2
    - A complex for distribution and preparation of SO_2 for the reactor
    - A primary reactor
    - A secondary reactor
    - A scrubber
    - An absorption tower and its blower
    - A storage vat for ClO_2 with its centrifugal circulation pump

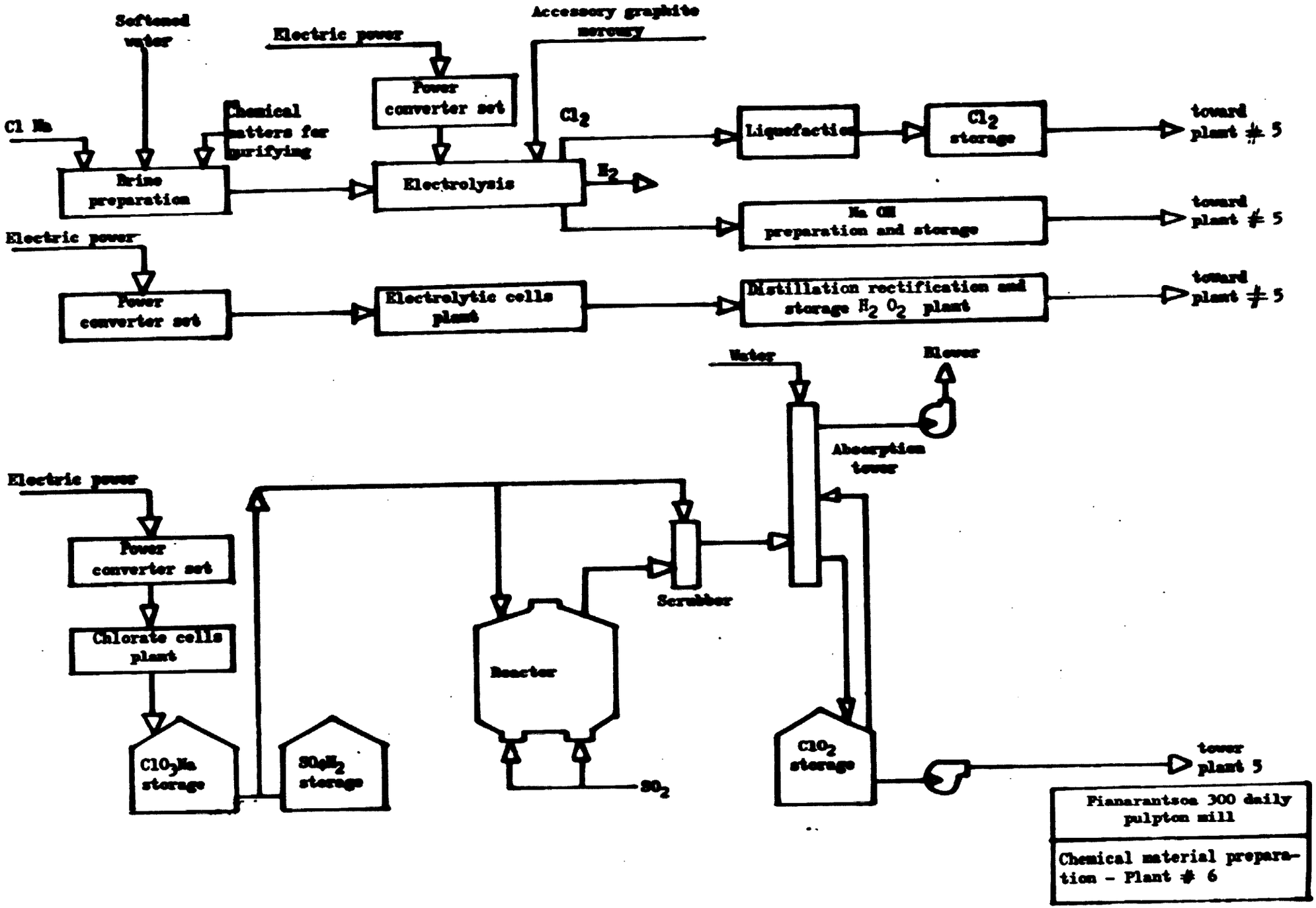
  This plant is also enclosed in a concrete building with masonry filling, floors of concrete.

These three plants will be erected near the bleaching, and will have to be supplied by rail or by trucks. As we shall see in the chapter "Consumption", the production, on the spot of these chemicals, brings about a considerable power consumption, and a daily supply of basic materials.

A last word, on the ground surface of these plants :

- Chlorine - Soda	1,200 m2
- Hydrogen peroxide	300 m2
- Chlorine dioxide	850 m2

...


Softened water
Electric power
Accessory graphite mercury
Power converter set
Cl Na
Chemical matters for purifying
Brine preparation
Electrolysis
Cl_2
Liquefaction
Cl_2 storage
toward plant # 5
H_2
Na OH preparation and storage
toward plant # 5
Electric power
Power converter set
Electrolytic cells plant
Distillation rectification and storage H_2 O_2 plant
toward plant # 5
Water
Blower
Absorption tower
Electric power
Power converter set
Chlorate cells plant
ClO_3Na storage
SO_2H_2 storage
Reactor
Scrubber
SO_2
ClO_2 storage
tower plant 5
Pianarantsoa 300 daily pulpton mill
Chemical material preparation - Plant # 6

511.7 - Wet machine - Drier - Baling - Dispatching

This plant is located near the bleaching, the wet machine being fed by the bleached pulp storage tower.

The equipment of this plant is detailed as follows :

- A head box of the open type with expansion chamber, recirculation and multitubular distributor. (Stainless steel construction).

- A wire part - width 3.60 m., length about 25 m.- with forming board, suction boxes, dandy roll and couch roll (Steel and stainless steel construction).

- A press section and pre-drying unit comprising :

  . Two grooved wet press
  . Six pre-drying steam heated cylinders
  . A third grooved wet press

- A series of accessories for preceding equipment such as : control cabinet, suction box collector, vacuum pumps, etc...

- A drying section of 60 steam-heated dryers with oil tank, automation equipment and central lubrication system.

- A slitter for slitting and cross cutting, including pressing rolls; a cross-cuttex with rotary knives; a group comprising a sheet belt conveyor, and a lay-boy with uptake conveyor.

- Two broke recovery vats under the third press and after the drying section, in polished stainless steel, equipped with a desintegrator allowing broke recycling at head of machine.

- A vat for collecting, mixing and diluting broke. It is concrete-made, equipped at its base with a propeller agitator, and is fitted under the wire part.

- Four rscirculstion pumps for broke, fitted on the floor.

- A storage and reclaiming tank for broke, fitted beside the wet part of the machine, with its circulation pump for recycling the pulp at head of machine.

The whole of this equipment, excepted vats, tanks or chests and pumps, is fitted on a concrete platform of about 100 m. length.

The corresponding part of the building is provided with an appropriate ventilating installation, for removal of the vapours coming from pulp-sheet drying.

The next division concerns baling and dispatching. It includes the following equipment :

- A baling-press. Bales are convayed by a belt to the under-mentioned machines :

  . packing machine
  . weighing "
  . labeling "
  . binding "

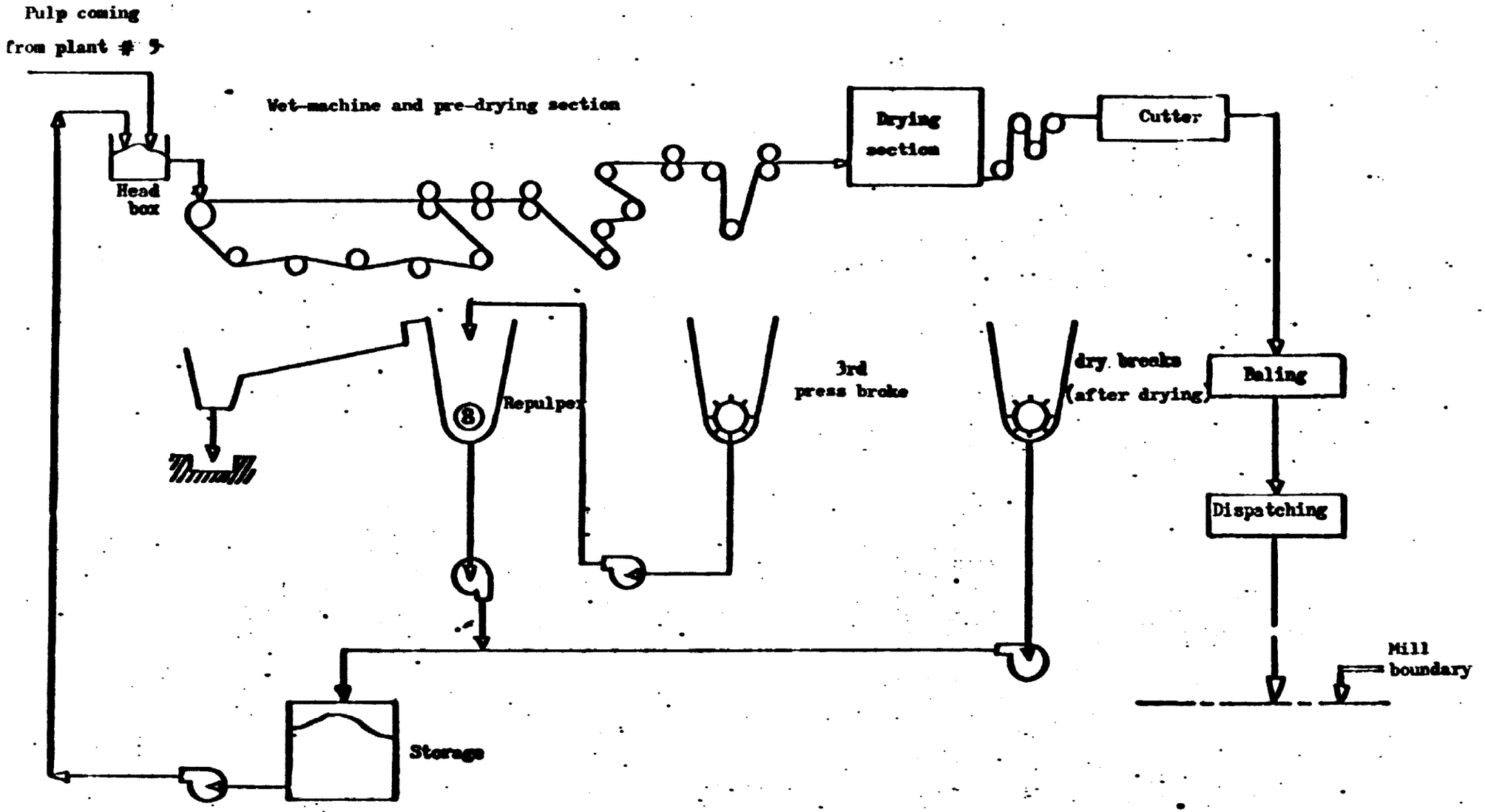
Afterwards, storage is made in a metallic hangar, ready for dispatch. Warehouse storage capacity : one month production or about 5,000 m2 ground surface.

Buildings covering the dry section, preases, etc... baling, dispatching and warehouse, are metallic; the walls are of masonry filling and the roofs are plated.

The warehouse has a dispatching platform with offices and dispatching control aervice.

The other part of the building is served by a traveling bridge crane enabling disassembling of heavy equipment.

The whole of the plant covers about 8,000 m2, warehouse included.



Fianarantsoa 300 daily pulpton mill

Press - Drying - Baling Dispatching

Plant # 7

511.8 - Black liquor concentration - Black liquor boiler - Auxiliary boilers - Power station - Dissolver

This plant is divided into three distinct divisions : liquor concentration, boilers and dissolver power production. These are three separate buildings but adjoining one another.

Black liquor concentration

The technological equipment is essentially composed of :

- A drum filter removing the shives which are in the liquor coming back from washing; a filtrate tank is disposed underneath with its filtrate centrifugal pump.
- A steel vat for storage of diluted black liquor, with a centrifugal suction pump fitted on the floor.
- A series of evaporators, fed by steam from the boiler, fitted on the floor of preceding filter.
- A storage steel tank for concentrated liquor with a centrifugal feed pump and a reclaiming pump.

This building is entirely of reinforced concrete and masonry.

Boilers and dissolver

Equipment is essentially :

- A smoke precipitator, which is used for liquor reheating
- A cascade evaporator continuing black liquor concentration, one part of which goes back to storage by mean of a centrifugal pump.
- A recovery boiler burning the black liquor and producing the steam for the power station.
- A dissolver using the weak liquor coming from the causticizing plant, to dissolve the boiler ashes.
- An auxiliary boiler for bark burning and production of steam.

The whole is fitted in a reinforced concrete and masonry building.

Power station

- Turbo-alternator-generator producing a part of the power consumed by the mill.

- A complementary turbo-alternator-generator for power : as we shall see further on, the actual power recovered in bark and black liquor burning is not sufficient for the whole mill requirements.

These generators are fitted in a reinforced concrete building, equipped with a traveling bridge for possible disassembling of heavy equipment.

511.9 - Pumping station - Water purification - Water treatment - Fire prevention system - Effluent treatment

The water source for mill requirements is the Matsiatra River. According to preceding studies, its flow seems sufficient even at low water level.

The water of this river is slightly acid and carries laterite in suspension during its floods (about three months a year).

Water pumping is effected in the river and needs, in short, the following equipment :

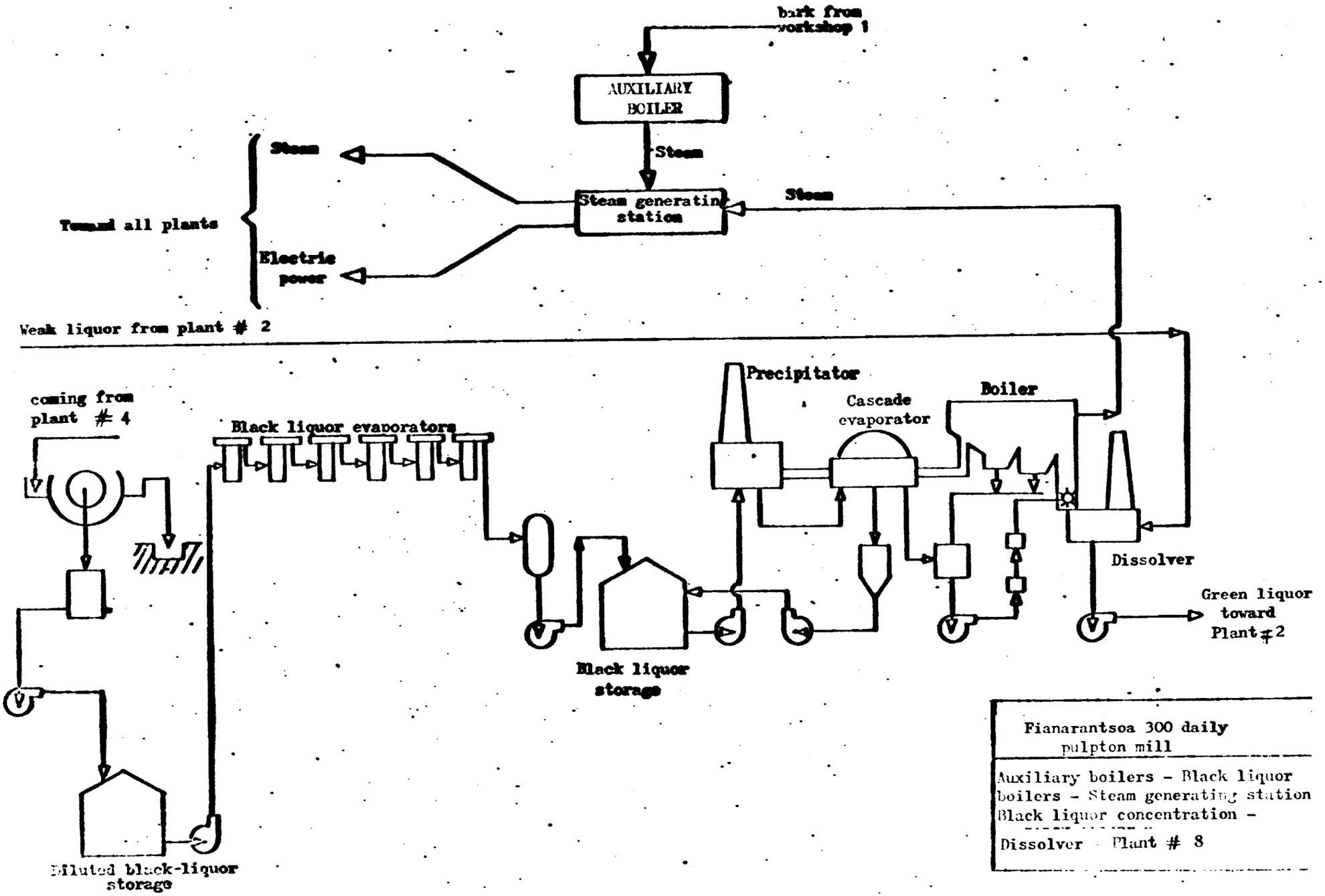
- A concrete location on the bank at an appropriate place (nature of ground and flowing speed),

- A stationary retention screen for large size floating matters carried by the stream,

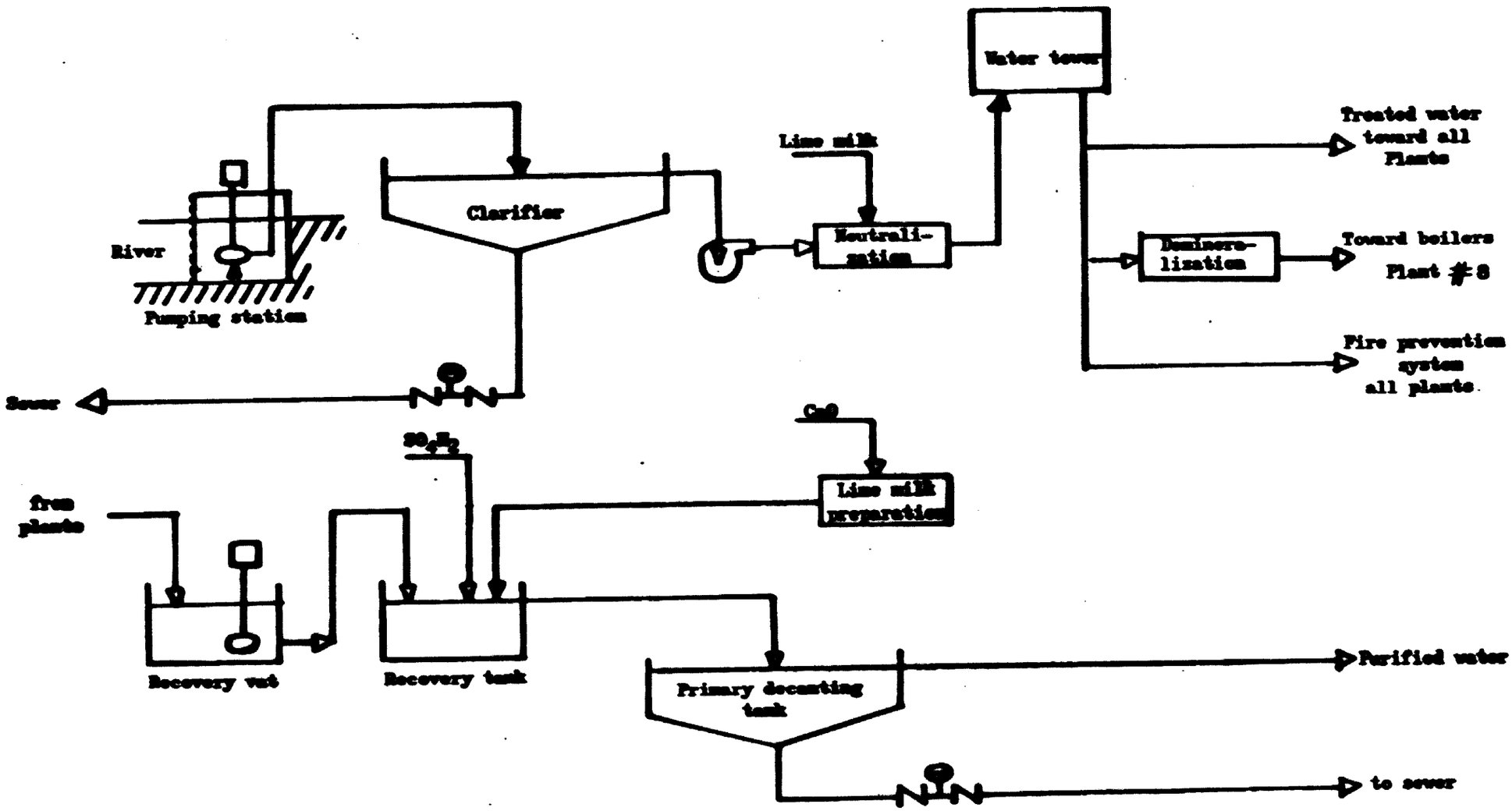
- An automatic micro-filter, the wire of which will have a mesh lower than 0.5 mm.

- A pumping set.

This equipment is devised so that the flow through the screens may not exceed 50 cm/s, and each part of the water intake may be isolated by water gates.



Fianarantsoa 300 daily pulpton mill
Auxiliary boilers - Black liquor boilers - Steam generating station Black liquor concentration - Dissolver Plant # 8



Fianarantsoa 300 daily pulpton mill
Water pumping. Clarifying and treatment. Fire prevention. Effluents -Plant # 9

5 - PINEWOOD PULP MILL

The object of the present study is to establish, at the request of the Government of Madagascar, the cost price per ton of unbleached or bleached woodpulp produced by a mill located near Fianarantsoa (Forgeot) of a 300 ton daily capacity. This unit would produce about 100,000 yearly pulp tons from Pinus patula (80 to 85 %) and Eucalyptus robusta (15 to 20 %).

51 - TECHNICAL DESCRIPTION

511 - Description of the plants

The mill has been divided into ten plants, which corraspond to detailed diagrams represented on the general diagram of the mill. These plants ara :

- Plant 1 :
  - . Wood yard
  - . Barking
  - . Chipping (Reception, cutting, pulpwood and bark preparation)
- Plant 2 :
  - . Causticising
  - . Lime kiln (White liquor praparation for the cooking plant)
- Plant 3 :
  - . Cooking (chip cooking in a continuous digester)
- Plant 4 :
  - . Blow tank
  - . Washing
  - . Screening

    (Washing and screening after cooking of Pina woodpulp and Eucalyptus woodpulp. Two independant blow-tanks, but only one washing and screening plant).
- Plant 5 :
  - . Bleaching (unbleached pulp, bleaching and storage)

Clarification of the water requires a large diameter decanting device (50 meters) on account of presence of laterite suspension in the pumped water.

This clarificator will have a cylinder shape, placed on the ground, and concrete built, and equipped with a continuous rotary scraping mechanism which will collect muds through center of unit.

The mud is pumped by a diaphragm and ball pump, and dispatched to a sewing farm, or else, discharged down-stream with the effluents.

The clarified water then goes through a neutralization installation, arranged in a small masonry building near the clarificator. Lime milk preparation is processed on the spot.

A pumping station feeds a water tower, 50 m. high and of a 2,000 m3 capacity, providing safety for fire prevention needs.

Three sorts of water are produced at this stage :

- Drinking water for the buildings, offices, plants, houses dispensaries, laboratories,
- Demineralized feed water for boilers,
- Clarified water just neutralized. This is the highest output for general use in all the processing plants.

The mill is provided with a fire prevention system fed by a permanent reserve in the above-mentioned water tower.

The effluents cast out by the various plants cannot be directly discharged into the river, the stream being too slow to ensure sufficient dilution.

The treatment installation will be established on the river bank, and will have the following equipment :

- A vat collecting the effluent coming from the plants, equipped with appropriate pumps,

- A neutralization vat for bringing effluent pH to neutrality, either by adding lime or adding sulfuric acid. This vat is equipped with a paddle mixer for ensuring component unity.

- A section for storage and preparation of sulfuric acid and milk of lime,

- A wide diameter primary decanting apparatus (same size as the pumped water clarificator). The mud will be pumped by a diaphragm pump, and sent to the sewer farm. The overflow will be sent into the river.

Excepting milk of lime preparation and chemicals distribution, the whole installation is entirely outdoors.

511.10 - Maintenance workshop - Laboratory - General Services

The maintenance workshop will be established the nearest possible to the center of the mill. It will have a repair-maintenance division and a stock-house.

It is a metallic building with masonry filling. It will be equipped with a traveling bridge to facilitate any kind of handling.

Inside, the following sections are planned :

. Drilling - Sawing - Planing - Lathing
. Oxycutting - Welding and brazing
. Forge
. Handling-engines repairing yard, such as for loaders, etc... of the FENWICK or other types
. Iron and metalsheet yard
. Spare-parts house for the engines in use in the various plants
. Maintenance department offices.

The laboratory is located at the center of the mill, aside the central storage section, and has all the necessary implements permitting any analysis to control the different production sectors.

It is s conventional building made of reinforced concrete and masonry.

As a reminder, we just mention the other buildings, mainly :

. General management, administration, accountancy
. General services
. Staff restaurant
. Cloakroom, shower-baths, sanitary equipments,
. Parkings, personnel and visitors parking cars

These may be located at the entrance of the mill near the most convenient road access.

512 - Necessary products for the fabrication

512.1 - Chemicals

The main chemical consumers sre the cooking and bleaching plants.

Bleaching chemicals are produced by electrolysis. The following quantities have been checked :

512.11 - Cooking

. 21,500	daily Kgs.	salt cake
. 9,000	"	soda
. 9,000	"	make-up limestone

512.12 - Bleaching

. 18,000	daily kgs.	chlorine
. 4,500	"	soda
. 4,800	"	chlorine dioxide
. 2,700	"	hydrogen peroxyde
. 1,850	"	sulfur

Production of the bleaching agents leaves the necessary extra soda for cooking plus 5,000 kgs of sodium sulfate originating from ClO_2 processing.

Consequently, the cooking liquor regeneration will be made with only 16,500 daily kgs. of sodium sulfate make-up.

The basic necessary bleaching chemicals are :

. 39,000	daily kgs.	salt
. 1,9	"	mercury
. 31	"	graphite
. 7,770	"	sulfuric acid at 98 %
. 2,600	"	sulfur
. 18	"	ammonia
. 180	"	ClH at 100 %
. 45	"	$Na_2Cr_2O_7$
. As a reminder :		reagents and chemicals for brine purification.

We note that SO_2 has been considered as processed on the spot from sulfur, but that sulfuric acid has been forecast as conveyed by tankers, at a 98 % concentration.

On the other hand, the quantity of chemicals for brine purification has not been checked as the quality of the salt to be used is not yet known.

512.2 - Steam

The average consumptions accounted for are :

. Cooking and washing	450	daily tons
. Bleaching	150	"
. Pulp drying	450	"
. Causticizing	50	"
. Black liquor concentration	700	"
. Heating	-	
. Fuel and boiler feed water	150	"
	1,950	daily tons

Pressure varies between 1.5 and 3 Hps (hectopieses)

512.3 - Water

The requirements are about 300 m3 of water for processing one ton of bleached pulp, i.e. : 3,800 m3 flow per hour.

512.4 - Fuel

The power balance sheet is set as follows :

512.41 - Consumptions

. 1,950 daily tons steam as per details in § 512.2
. 360,000 KWh as per details in § 512.5

512.42 - Production

. The black liquor can provide through regenerating process, 1,650 daily tons of steam
. Recovered bark combustion can provide about 120 daily tons of steam.

There are still 180 daily tons of steam and 360,000 KWh per day to be provided for. Therefore, the further supply will have to be 165 tons of fuel, of which 45 tons are used for electrolysis and 120 tons for the steam and power requirements of the plants.

512.5 - Electric power

The power consumption schedule may be summed up as follows :

512.51 - Electrolysis : 175,000 daily KWh, of which :

. 50,000 daily KWh. for chlorine and soda production
. 70,000 " for hydrogen peroxide
. 55,000 " for production of ClO_3Na to process ClO_2

512.52 - Fabrication - Workshops : 185,000 KWh daily, of which :

. 25,000 daily KWh. for the pulpwood yard, barking, slashing and chipping
. 95,000 " for cooking, washing, coarse and fine screening
. 20,000 " for bleaching
. 35,000 " for liquor production
. 10,000 " for miscellaneous and leakages

512.6 - Pulpwood supply

512.61 - Species

Supply areas study is not previsad in the present report. This problem has already been surveyed in previous C.T.F.T. studies.

The mill has been designed to be run with Eucalyptus robusta and Pinus patula supplies.

512.62 - Quantities - Means of supply

The running of this mill requires a supply of 500,000 m3 pulpwood per annum, i.e. 470,000 tons, divided as follows :

. 215,000 m3	or	195,000 tons of logs
. 285,000 m3	or	275,000 tons of boles
500,000 m3	or	470,000 tons.

The pulpwood is delivered unbarked at the mill. The logs are about 1.10 m. long and the boles, 8.50 m. long. It would be better to supply lengths smaller than 6 meters, for a more convenient mechanical handling in the pulpwood yard.

In this study, we have presumed that pulpwood were delivered at mill by road, without accounting for its origin, and supply feasibility by rail has been excluded.

512.7 - Refuse matters

512.71 - Effluent water

The general pollution of the mill comes from partial pollutions of the different plants (in particular : cooking, washing, bleaching and black liquor evaporation).

a) the 3,800 m3/h water, taken out of the pumping station are nearly all restored.

b) the sludge pumped at the primary decanting apparatus for effluent treatment represents 1 ton/hour (dry) which is to be discharged to the sewer farm.

512.72 - Miscellaneous

The pumping station clarifier collects during the three months flood the laterite in suspension, and discharges up to 4,500 kgs/hour (dry) to the sewer. The rest of the year, a basis of 500 kgs/hour is to be taken.

513 - Production characteristics

513.1 - Unbleached woodpulp processing

The mill was designed for processing unbleached pulp as well as bleached pulp. In the case of unbleached pulp production, the pulp stored at the end of the washing plant goes direct to the wet machine. This supposes a location of the washing and bleaching plants accordingly.

The grade of the processed woodpulp, after refining at 40°SR, has the following characteristics :

. Photovolt brightness	26
. Breaking length	8,400
. Bursting	59
. Tearing	132 (170 at 20° SR)
. Bulk	1.55
. Double fold	1,100
. MnO_4K number	17.5

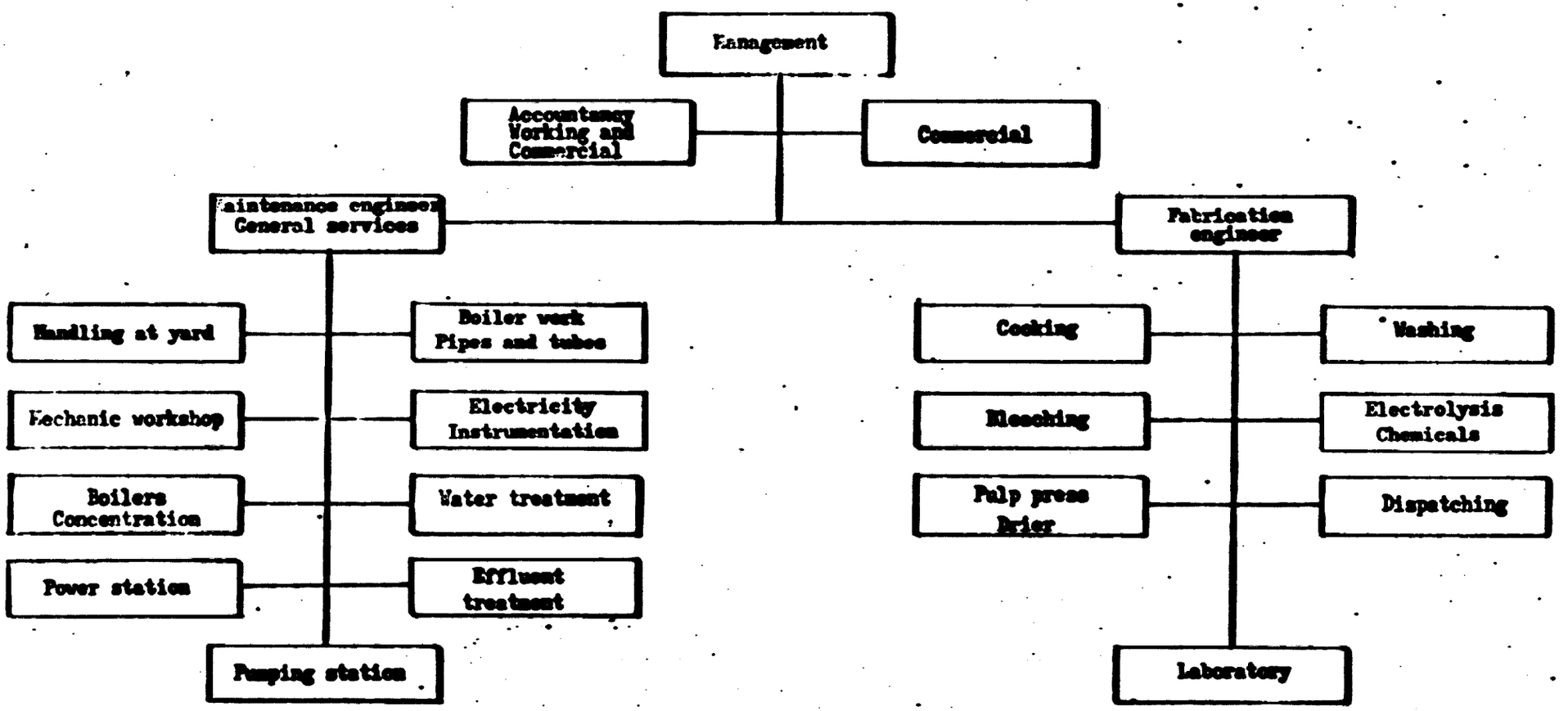
513.2 - Bleached woodpulp processing

The grade of the produced bleached woodpulp is :

. Photovolt brightness	91 - 92
. Brightness stability	92
. Polymerisation degree	585
. Breaking length	7,200

. Bursting	51
. Tearing	102 (120 at 20° SR)
. Bulk	1.55
. Double fold	500

Daily production : 300 tons i.e. 100,000 tons per annum.



Pianarantsoa 300 daily pulpton mill

Personnel distribution

52 - PERSONNEL

The mill personnel has been estimated at :

368 persons

in normal operative conditions.

521 - General organisation

The diagram herewith sets the general organisation of the personnel. Table list 521.a distributes the necessary labour of the mill over the different plants.

Distribution of labour over the plants

Table list 521.a

Plants	Foreigners	Malegasies
Pulpwood and chipping (2 daily shifts)	2	62
Causticizing, Cook, Washing (2 daily shifts)	5	45
Chemicals, Bleaching (3 daily shifts)	5	45
Wet machine, Baling (3 daily shifts)	4	48
Dispatch (1 daily shift)		9
Boiler, Concentration, Power (3 daily shifts)	5	42
Pumping, Clarifing (3 daily shifts)		15
Maintenance, Laboratories (3 daily shifts)	15	32
Management, General service (1 daily shift)	4	30
Total	40	328
	368	

- Plant 6 :
  . Electrolysis
  . Chemicals preparation
    (Processing and preparation of the necessary chemicals for bleaching and causticising)

- Plant 7 :
  . Wet machine
  . Drier
  . Baling
  . Dispatching
    (Preparation of pulp for dispatching)

- Plant 8 :
  . Black liquor concentration
  . Black liquor boilers
  . Auxiliary boilers
  . Power station
  . Dissolver
    (Steam and electric power station, heat recovery, chemicals recovery and green liquor preparation)

- Plant 9 :
  . Pumping station
  . Water clarification
  . Water treatment
  . Fire prevention system
  . Effluent treatment
    (Mill water supply - effluent treatment)

- Plant 10 :
  . Maintenance shop
  . Laboratory
    (Maintenance - repairs - spare parts - laboratories).

In Table list 521,b the personnel has been divided in a professional order :

Table list 521,b - Distribution of personnel per a professional order

Manager	1	Gaugers	40
Heads of fabrication	3		
Head of technical department	1		
Head of maintenance "	1	Skilled workmen	124
Head of laboratory Chemist	2		
Foremen	18		
Foreman-Brasier	1	Unskilled workers	126
Electricians Braziere Mechanics	12		
		Employees and	
Head accountant	1	Miscellaneous	38
	40		328

We note that this personnel is the personnel of the mill after starting up period. During the starting up period, it will probably be necessary to double the foreign personnel in view of treining the local personnel. In the same way, as the Malagasy personnel coming out of schools and profeesional schools will progressively join the mill, a part ot the foreign personnel will be replaced in consequence.

522 - Amount of the wages

The weges have been reckoned taking into account wages properly speaking and social expenses as well as travelling and insurance for the foreigners.

Table list n° 522 - Yearly labour expenses

F.M.G.

- Management	1 x 7,000,000 =	7,000,000
- Heads of febrication	3 x 5,000,000 =	15,000,000
- Heeds of Technical Depertment	1 x 6,000,000 =	6,000,000
- Heads of maintenance Department	1 x 5,000,000 =	5,000,000
- Head of leboratory	1 x 5,000,000 =	5,000,000
- Chemist	1 x 4,000,000 =	4,000,000
- Foremen	18 x 4,000,000 =	72,000,000
- Head accountent	1 x 4,000,000 =	4,000,000
- Brezier foremen	4 x 5,000,000 =	20,000,000
- Electricians	4 x 4,000,000 =	16,000,000
- Mechanics	4 x 4,000,000 =	16,000,000
- Gaugers	40 x 500,000 =	20,000,000
- Skilled workmen	124 x 600,000 =	74,400,000
- Workers (Unskilled)	126 x 108,000 =	13,608,000
- Chemistry helps	4 x 1,500,000 =	6,000,000
- Management secretery	1 x 725,000 =	725,000
- Accountant assistants	2 x 900,000 =	1,800,000
- Brezier for pipes end tubes	4 x 900,000 =	3,600,000
- Accountants	3 x 500,000 =	1,500,000
- Secretary	1 x 365,000 =	365,000
- Head of supplies	1 x 750,000 =	750,000
- Supply employees	2 x 500,000 =	1,000,000
- Head of personnel	1 x 900,000 =	900,000
- Secretary	1 x 400,000 =	400,000
- Nurse	1 x 600,000 =	600,000
- Nurse help	1 x 400,000 =	400,000
- Plenner	1 x 3,500,000 =	3,500,000
- Draftsman	1 x 500,000 =	500,000
- Store-keeper	1 x 500,000 =	500,000
- Store-keeper assistant	2 x 250,000 =	500,000
- Chauffeurs	2 x 108,000 =	216,000
- Watchmen	4 x 108,000 =	432,000
- Social service-Resteurant	6 x 108,000 =	648,000
Total of yearly wages - Sociel expenses included		301,944,000

53 - INVESTMENT

The necessary investment for the woodpulp mill includes :

- Equipment investment properly speaking,
- Erection of a worker's village
- Working capital.

531 - Investment properly speaking

Table list 531.a - Equipment investment

Plants	Amount in FMG
1. Pulpwood yard - Barking - Chipping	1,240,000,000
2. Causticizing - Lime kiln	450,000,000
3. Cooking	900,000,000
4. Blow tank - Washing - Coarse screening	640,000,000
5. Bleaching - Fine screening	1,890,000,000
6. Electrolysis - Chemicals preparation	1,620,000,000
7. Wet machine - Drier - Baling - Dispatching	1,650,000,000
8. Black liquor evaporation - Black liquor boiler - Auxiliary boiler - Power station - Dissolver	2,500,000,000
9. Pumping station - Clarification of water Water treatment - Fire prevention system - Effluent treatment	600,000,000
10. Maintenance shop - Laboratory - General buildings	440,000,000
Total	11,930,000,000

The two following table lists (531.b and 531.c) set engineering and fitting up allround expenses as well as civil engineering expenses.

Table list 531 b Study, Engineering and fitting up expenses

FMG

Plants	(1) Studies, engineering and allround contracting	Fitting up
1. Pulpwood yard	65,000,000	130,000,000
2. Causticizing	28,000,000	55,000,000
3. Cooking	58,000,000	115,000,000
4. Washing	50,000,000	75,000,000
5. Bleaching	105,000,000	210,000,000
6. Chemicals	100,000,000	195,000,000
7. Baling	90,000,000	175,000,000
8. Evaporation	160,000,000	310,000,000
9. Water treatment	30,000,000	60,000,000
10. General services	15,000,000	30,000,000
Total	701,000,000	1,355,000,000

(1) - The civil engineering expenses do not come in here, they will be found in the following table list.

Dispersion of utility works give following figures :

Table list 531 c Civil engineering expenses

FMG

Plants	Works	Ducts Sewers	Studies Engineering
1. Pulpwood yard	85,000,000	23,000,000	12,000,000
2. Causticizing	18,000,000	4,500,000	2,500,000
3. Cooking	23,000,000	6,000,000	3,000,000
4. Washing	39,000,000	10,500,000	5,500,000
5. Bleaching	200,000,000	50,000,000	30,000,000
6. Chemicals	176,000,000	45,000,000	24,000,000
7. Baling	145,000,000	35,000,000	20,000,000
8. Evaporation	185,000,000	40,000,000	25,000,000
9. Water treatment	105,000,000	25,000,000	15,000,000
10. General services	120,000,000	10,000,000	15,000,000
	1,096,000,000	249,000,000	152,000,000

Total : 1,496,000,000

Table list n° 531 d

SUMMING UP OF INVESTMENTS PROPER — FMG

N° of Plants	Technological equipment	Control and regulation	Power and lighting	Pipes, tubes, and valves	Fitting up	Conveyance of equipment to Madagascar	Engineering studies allround Contracting	Civil Engineering and Studies Ducts sewers	Spare parts
1	515,000,000	45,000,000	30,000,000	50,000,000	130,000,000	35,000,000	65,000,000	120,000,000	250,000,000
2	225,000,000	20,000,000	15,000,000	25,000,000	55,000,000	15,000,000	28,000,000	25,000,000	42,000,000
3	460,000,000	40,000,000	30,000,000	45,000,000	115,000,000	30,000,000	58,000,000	32,000,000	90,000,000
4	300,000,000	25,000,000	20,000,000	30,000,000	75,000,000	20,000,000	50,000,000	55,000,000	65,000,000
5	840,000,000	75,000,000	50,000,000	85,000,000	210,000,000	55,000,000	105,000,000	280,000,000	190,000,000
6	770,000,000	70,000,000	50,000,000	75,000,000	195,000,000	50,000,000	100,000,000	245,000,000	65,000,000
7	700,000,000	60,000,000	45,000,000	70,000,000	175,000,000	45,000,000	90,000,000	200,000,000	265,000,000
8	1,240,000,000	110,000,000	80,000,000	125,000,000	310,000,000	75,000,000	160,000,000	250,000,000	150,000,000
9	230,000,000	20,000,000	15,000,000	25,000,000	60,000,000	15,000,000	30,000,000	145,000,000	60,000,000
10	120,000,000	5,000,000	20,000,000	5,000,000	30,000,000	10,000,000	15,000,000	145,000,000	90,000,000
	5,400,000,000	470,000,000	355,000,000	535,000,000	1,355,000,000	350,000,000	701,000,000	1,497,000,000	1,267,000,000

Total : 11,930,000,000 FMG

532 - Detailed investments per plant

532.1 - Pulpwood yars - Barking - Chipping

- Technological equipment ..... FMG 515,000,000

. 1 automatic unloading table
. 1 bole conveyor
. 1 machine for slashing boles into logs
. 1 conveyor to barking
. 1 barking drum
. 1 conveyor out of drum
. 1 sorting table
. 1 conveyor for refuse recycling
. 1 chipper
. 1 sorting set - chip screen
. 1 conveyor to storage
. 1 pneumatic conveyor-elevator on yard
. 1 traction-loader
. 1 loading hopper
. 1 chip conveyor to cook
. 1 collecting loading hopper over digester
. 1 weightometer
. 1 bark conveyor at outlet of barking drum
. 1 bark crusher with hopper and spouts
. 1 bark conveyor to auxiliary boiler

532.2 - Cauticising - Lime kiln

- Technological equipment ..... FMG 225,000,000

. 1 clarificator for green liquor
. 5 diaphragm pumps
. 1 green sludge mixer
. 1 green liquor thickener
. 1 horizontal rotary lime kiln
. 1 lime loading hopper
. 1 dosimeter
. 1 lime slaker
. 3 causticisers

. 1 green liquor reclaiming tank
. 1 white liquor clarifier
. 1 white liquor pump
. 1 white sludge centrifugal pump
. 1 white sludge mixer
. 1 weak liquor thickener
. 1 white liquor centrifugal pump
. 1 weak liquor centrifugal pump
. 2 weak sludge centrifugal pumps
. 1 weak sludge mixer
. 1 white sludge filter
. 1 filtrate tank
. 1 vacuum pump
. 1 condenser
. 1 reclaiming tank
. 1 filtrate centrifugal pump

532.3 - Cooking

- Technological equipment ..... FMG 460,000,000

. 1 low pressure feeding rotary valve (L.P.)
. 1 primary reheater
. 1 high pressure feeding rotary valve (H.P.)
. 1 continuous digester
. 1 black liquor storage chest
. 1 black liquor centrifugal pump
. 1 blow-off valve

532.4 - Blow tank - Washing - Coarse screening

- Technological equipment ..... FMG 300,000,000

. 2 blow tanks
. 1 dilution box
. 1 set of vibrating screens
. 1 filter feeding box
. 3 drum washing filters
. 2 defibrator - repulpers
. 3 filtrate tanks
. 3 centrifugal pumps for filtrates

. 1 foam tank
. 1 foam pump
. 1 pulp-conveyor
. 1 retention vat
. 1 pulp pump
. 1 filter thickener
. 1 filtrate tank
. 1 filtrate pump
. 1 belt conveyor
. 1 storage tower for high density pulp

To be noted that the size of the digester may involve problems as regards conveyance by road in Madagascar, and before final decision on this continuous cooking solution, it would be advisable to check the road conveyance possibilities from Tamatave by a special convoy.

532.5 - Bleaching

- Technological equipment ..... FMG 840,000,000

. 1 homogeneisation vat
. 1 stock centrifugal pump
. 1 chlorine mixer
. 1 pre-chlorination tower
. 1 chlorination tower
. 2 soda towers
. 2 chlorine dioxide towers
. 5 thickening filters
. 5 filtrate tanks
. 2 pumps for high density stock
. 5 stock centrifugal pumps
. 5 filtrate centrifugal pumps
. 5 pulp-conveyors
. 4 mixer-reheaters
. 1 chlorine dioxide mixer
. 1 belt conveyor
. 1 stock storage tower

532.6 - Preparation of chemicals

- Technological equipment

. Chlorine-soda processing plant	FMG	160,000,000
1 electric converter set		
1 mercury cell electrolysis plant		
1 brina preparation plant		
1 chlorine liquefaction and treatment plant		
1 sodium hypochlorite processing plant		
. Hydrogen peroxide processing plant	FMG	320,000,000
1 electric converter set		
1 alectrolytic cells plant		
1 distillation, rectifying and hydrogen peroxide storage plant		
. Chlorine dioxide processing plant	FMG	160,000,000
1 electric converter set		
1 chlorate cells plant		
1 ClO_2 generation plant		
. Miscellaneous - Storage - Decanting	FMG	130,000,000
Total for equipment	FMG	770,000,000

532.7 - Wet machine - Drier - Baling

- Technological equipment	FMG	700,000,000
1 head-box		
1 wire part		
1 prass and pre-drying section		
1 sat of accassories		
1 dryer section		
1 slitter at end of machine		
2 recovery chests		
1 broka chest		
4 recirculation pumps		
1 storage tank		
1 baling press		
1 packing machine		
1 weighing machine		

1 labeling machine

1 binding machine

1 ventilation system

532.8 - Black liquor evaporation - Black liquor boiler and auxiliary boilers - Thermal power station - Dissolver -

- Technological equipment FMG 1,240,000,000

1 drum filter

1 filtrate tank and a pump

1 black liquor storage tank with pump

1 black liquor evaporator unit

1 concentrated black liquor storage tank with pump

1 smoke precipitator, black liquor reheater

1 cascade evaporator

1 black liquor boiler

1 dissolver

1 bark-fed auxiliary boiler

1 turbo-alternator generator

1 auxiliary oil-fuel boiler

532.9 - Pumping station - Water clarifying - Water treatment - Fire prevention system - Effluent treatment.

- Technological equipment FMG 230,000,000

. Pumping station

Screens

Micro-screens

Pump sets

. Clarifying - Neutralisation - Water treatment

1 clarificator

1 diaphragm pump

1 neutralisation installation

1 demineralisation installation

1 set of circulation pumps

511.1 - Woodyard - Berking - Chipping

Forestry and economic studies precedingly carried on show that it is mora profitable to convey the timber in bolas convayed on bole-trucks from the falling yard and operate the slashing at the mill, insteed of cutting them in pieces on the spot, manually. However the mill will receiva a percentage of logs all the same (about 40 %). The mill will therefora have to check at the entry :

- 8.50 m. long boles (1) for local production conveyed by trucka
- 1.10 m. long logs for production conveyed by rail.

To feed this mill, 500,000 m3 of pulpwood per annum are necessary, ao about 465,000 tons of unbarked pulpwood. Aa in the rainy seaaon the roads are not precticeble, only 185 days a yeer will be left to unload about 120 daily bole trucks in the pulpwood yard, i.e. 2,500 tona of pulpwood.

This unloeding is made on en automatic tebla directly from the truck platforms. There will be some difficulty in finding a machine enabling thia eutomatic unloading for lengths up to 11.50 m. In this cese, it might be better prevising a half length cutting in the forast (about 6 metres).

The logs after cutting in will go to a berking drum. Thia cylinder device, set horizontaly on a concrate platform, works without water on eccount of the low water level of the river which sypplies the mill. The barkad logs fall, through the medium of a special device, on a transversel conveyor which takes them to a sorting table, where en operator directs the unbarked logs back to the head of the drum, end the barked logs to the chipper.

This chipper is set on the floor on a concrete bed and fed by the top. This high-power machine is located neer the operator.

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(1) Conveyance of boles of en average of 8.50 m. length has been anticipeted. However, the conveyed lengths might be from 5.50 m. to 11.50 m.

. Effluent treatment

1 neutralisation mixer

1 chemicals unit

1 primary decanting device

1 diaphragm pump

. Fire prevention system

1 set of equipment

1 2,000 m3 water tower

532.10 - Maintenance workshop - Laboratory - General services

- Technological equipment FMG 120,000,000

. workshop tools and machines

. handling devices

. store equipment, offices, sanitary, social premises, various furnitures.

533 - Complementary investment

Besides the mill construction, a worker's garden-city is to be erected for personnel housing, and a working capital must be provided for.

533.1 - Worker's garden city

To house the staff (foreigners and Malagasies), necessary investments have been estimated to :

FMG 300 millions or $ 1,100,000

The average cost to be considered is :

- for the foreigners FMG 3 to 5 millions
- for the Malagasies FMG 0,5 to 1 million

Furniture and construction maintenance expenses are chargeable to the persons concerned and they will pay a monthly rent to cover the above-mentioned expenses.

533.2 - Working capital

To cover the first working expenses and for current money facilities (apart from normal bank advances), a working capital equal to a 4 months production cost of the mill working on full capacity, has been previsad as hereafter detailed :

533.21 - Bleached woodpulp production

In this eventuality, we shall estimate the cost per ton at FMG 21,000, i.e. : 100,000 x 21,000 = FMG 2,100,000,000 per annum whence a working capital of :

FMG 700,000,000 or $ 2,5 millions

533.22 - Unbleached woodpulp production

As there is no chemicals preparation and no bleaching to be considered, and because of a reduced staff, the cost per ton will be smaller, i.e. : FMG 18,000 per ton.

The yearly cost will be : FMG 1,800,000,000 i.e. a working capital of

FMG 600,000,000 or $ 2,2 millions

Total investments will therefore be :

for bleached woodpulp :

FMG 11,930,000,000	(see table 531.d)	
300,000,000		
700,000,000		
FMG 12,930,000,000	or	$ 46,6 millions

for unbleached woodpulp :

As there is no bleaching plant (5) and no chemicals preparation (6) to consider, equipment investments will be reduced to :

11,930 - (1,890 + 1,626) = FMG 8,420 millions, i.e.

FMG 8,420,000,000		
300,000,000		
600,000,000		
FMG 9,320,000,000	or	$ 33,6 millions

533.3 - Note

In preceding assessments, no mention has been made as to necessary investments for pulpwood working and conveyance to mill site. It is presumed included in the cost of the wood delivered at mill or of the necessary investments for woodpulp or various means of conveyance (trucks, cars, etc...). For same, a special investment might be considered; it would be deducted from the production costs registered in § 54 (equipment amortalisation).

534 - Schedule of operations

534.1 - Spreading out of works

From the date of ordering the starting up works, it will be required :

- 12 months : for studies
- 6 months : for first equipment orders, the more sophisticated equipments being expected 14 months later (20th month)
- 6 months : delivery on site
- 10 months : (from the first day), to begin preparatory civil engineering
- 20 months : for total civil engineering completion (30th month)
- 18 months : to fit up equipments

So, we obtain the concise following chronology :

D. day + 0 month - starting studies
" + 6 months - first equipment orders
" + 10 months - starting up civil engineering
" + 20 months - last equipment deliveries and star of the fitting up
" + 26 months - last equipment deliveries
" + 30 months - end of civil engineering
" + 40 months - end of fitting up
" + 42 months - final acceptance

Necessary completion time : about 3 1/2 years

534.2 - Spreading out of investments

We have stated the spreading out of investments as follows :

1,000 FMG

Year	Bleached woodpulp mill	Unbleached woodpulp mill
1	4,000	3 000
2	7,000	4,550
3	1,230	1,170
4	700	600
	12,930	9,320

To be noted that in the economic feasibility (§ 55), we presume utilization of the working capital on the 3rd year, the financing requirements being then :

FMG 1,930 and 1,770 millions

54 - DRAWING UP PRODUCTION COSTS

541 - Cost production factors

541.1 - Pulpwood cost

From the working and conveyance study concerning the Upper Matsiatra afforestations, it results for barked wood delivered at mill, a price of :

FMG 1,600 per m3, or $ 5.76 per m3

For 100,000 tons pulp, 500,000 pulpwood will be required, which price will be :

$$\frac{500,000 \times 1,600}{100,000} = \text{FMG } 8,000 \text{ per ton, or } \$ 28.82$$

541.2 - Personnel costs

Wages cost amount was precedingly reckoned in § 52. For bleached woodpulp, it is assessed at : FMG 301,944,000 per year, i.e.

FMG 3,020 per ton pulp, or $ 10,90

As regards to unbleached pulp, the cost will be smaller, since wages of personnel in plants 5 (bleaching), and plant 6 (chemicals), must be deducted.

1	Head of fabrication	FMG 5,000,000	yearly wages
4	Foremen	16,000,000	"
9	Gaugers	4,500,000	"
24	Skilled workmen	14,400,000	"
12	Unskilled workers	1,296,000	"
		41,196,000	"

i.e. yearly : FMG 260,748,000, and per ton pulp

FMG 2,610 or $ 9.40

541.3 - Steam and power

Supply of power and extra steam requirements will be made by mean of fuel-oil.

For bleached woodpulp, we shall have an expense of 165 daily tons fuel-oil. Without bleaching process, we shall spare 20,000 KWh. 5 tons fuel-oil is therefore necessary to the bleaching itself, and 45 tons fuel-oil, if electrolysis process is left out.

The daily fuel-oil requirements for unbleached woodpulp will be assessed at 115 tons daily.

Price of fuel-oil delivered at mill being FMG 9,000 per ton, the fuel-oil cost per ton pulp will be :

- for bleached pulp :

$$\frac{165 \text{ t} \times \text{FMG } 9{,}000}{300 \text{ t.}} = \text{FMG } 4{,}950 \text{ or } \$ \ 17.83 \text{ per ton pulp}$$

- for unbleached pulp :

$$\frac{115 \text{ t} \times \text{FMG } 9{,}000}{300 \text{ t.}} = \text{FMG } 3{,}450 \text{ or } \$ \ 12.43 \text{ per ton pulp}$$

541.4 - Chemicals

We shall consider one after the other the case of production of :

Bleached woodpulp

and

Unbleached woodpulp

541.41 - Case of bleached woodpulp

Per fabrication day (300 t. pulp) needs will be :

Make-up limestone	9 t x FMG 5,000	FMG	45,000
Sodium sulfate	16,5 t x FMG 17,200		284,000
Sodium chloride	39 t x FMG 11,000		429,000
Sulfuric acid	7,77 t x FMG 19,200		149,000
Sulfur	2,66 t x FMG 19,200		51,000
Other products (assessed)			50,000
	Total	FMG	1,008,000

i.e., per bleached ton : FMG 3,360 or $ 12.10

541.42 - Case of unbleached woodpulp

The following requirements are, for 300 tons daily :

Make-up limestone	9 t x FMG 5,000	FMG 45,000
Sodium sulfate	21,3 t x FMG 17,200	366,000
Soda (1)	9 t x FMG 30,000	270,000
	Total	FMG 681,000

i.e., per unbleached ton : FMG 2,270 or $ 8.18

541.5 - Overheads

These expenses include : commercial expenses (travelling and miscellaneous provisions), visitors, end office expenses. On the other hand, management and general services (indirect cost) and salaries are already accounted for (capital refunding).

As regards to the maintenence costs, they are included in the cost price of the necessery production chemicels and for the remaining fabrication material in the overheads. Spereparts have already been included in investments.

Overheads represent about 10 % of pulp production cost, i.e.

- for bleached pulp : FMG 2,100 per ton, or $ 7.60
- for unbleached pulp : FMG 1,800 per ton, or $ 6.50

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(1) We have considered a quantity of imported soda equal to that coming from the electrolysis plant in the case of bleaching. In fact, it could have been replaced by a sodium sulfate complement, which would be of equal expense.

542 - Production cost

Table list 542 sets the production cost for both of the fabrication methods :

Table list 542 - Production cost per ton of pulp

	Bleached pulp		Unbleached pulp	
	FMG	$	FMG	$
Wood cost at mill	8,000	28.80	8,000	28.80
Personnel expenses (direct and indirect)	3,020	10.90	2,610	9.40
Power	4,950	17.80	3,450	12.40
Chemicals	3,360	12.10	2,270	8.20
Overheads	2,100	7.60	1,800	6.50
Total (ex-amortalization and taxes)	21,430	77.20	18,130	65.30

The above production cost has been esteblished on the basis of a delivered at mill cost in accordance with information from B.D.P.I. of Madagascer. The figures may be modified following decisions regarding connection Tamatave/Tananariva with the mill. In any case, preferential tariffs will have to be granted to the mill which will be e customer of importance (150,000 yearly tons of goods in both ways during a normal year).

55 - STUDY OF THE PROFITABILITY OF THE PROJECT

Taking into account above data, we may now study the economic feasibility of the two considered productions :

551 - Sale price ex-mill

The mill ought to produce 100,000 yearly tons, the sals of which would be made in Madagascar, or in the Middle East or in Europe.

The quantities on sale per annum are assessed, around 1980 :

- in MADAGASCAR (Tamatave and Tananarive)	3,000 tons
- in the Middle East	40,000 "
- in Europe	57,000 "

We shall establish hereafter average sale price, as regards to preceding sales :

551.1 - Sale price in Madagascar

551.11 - Bleached pulp

Papeteries de Madagascar (P.A.P.M.A.D.) actually import bleached kraft woodpulp from Scandinavia at FMG 53,000 per ton delivered at mill.

By deducting FMG 1,000 per ton for Pinus patula bleached pulp, slightly lower in grade to Spruce bleached pulp of Scandinavian origin, we get to a price ex-mill of :

$$52{,}000 - \left[(400\ \text{Km} \times \text{F}\ 4) + \underset{\text{(loading and unloading)}}{\text{F}\ 500} + \underset{\text{1,5 \% cash payment discount}}{\text{F}\ 800} \right] = \underline{\text{FMG 49,100 or \$ 177}} \text{ per bleached pulp ton (1)}$$

551.12 - Unbleached pulp

Unbleached pulp CIF European port actually costs : FMG 41,300 per ton

Whereas bleached pulp is sold : FMG 49,650 per ton

Therefore the difference is FMG 8,350 per pulp ton.

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(1) Cost of kilometric ton (T.K.) has been reckoned FMG 4. This is a preferential tariff by rail. The Antsirabe-Fianarantsoa branch line is presumed as built.

The sale price of unbleached pulp in Madagascar will therefore be :

49,100 - 8,350 = FMG 40,750 or $ 147 per ton

551.2 - Sale price in the Middle East

The prices will be those of world market Scandinavian pulp, reduced by FMG 1,000 per ton, Pinus patula being of a slighty lower grade than the best Scandinavian Spruce pulps.

Bleached pulp	FMG 48,650 per ton CIF
Unbleached pulp	FMG 40,300 per ton CIF

To get the sale price ex-mill, we shall deduct from CIF price :

- 1.5 % discount for cash payment, so respectively : FMG 730 and 605 per ton
- maritime freight and insurance : FMG 3,500 per ton
- conveysnce from mill to Tamatave, presumed entirely effectued by rail or by truck and rail, so : 800 km x FMG 4 = FMG 3,200/t

So the price ex-mill will be :

. Bleached pulp	FMG 41,220 per ton
. Unbleached pulp	FMG 33,495 per ton

551.3 - Sale price in Europe

With the same above considerations, but with a FMG 4,500 per ton freight rate on "charter" ship, the sale prices ex-mill will be respectively :

. Bleached pulp	FMG 40,220 per ton
. Unbleached pulp	FMG 32,495 per ton

551.4 - Average ex-mill sale price

The bleached pulp will have an average sale price of :

$$\frac{(49,100 \times 3,000) + (41,220 \times 40,000) + (40,220 \times 57,000)}{100,000} = \text{FMG } 40,886 \text{ or } \$ 147.33$$

The average unbleached pulp price will be :

$$\frac{(40,750 \times 3,000) + (33,495 \times 40,000) + (32,495 \times 57,000)}{100,000} = \text{FMG } 33,143 \text{ or } \$ 119.43$$

The chips are discharged into a spout and brought to e sieve battery which sorts the bigger chips for recycling, and the finer ones for discarding (thess are stored outside to be burnt later on in the auxiliary boilers).

The gauged chips fall on a belt conveyor and go on to a chip yard where they are heaped up by a pneumatic conveyor. This storege is planned to feed the mill for six weeks.

The reclaiming of chips from the storage is made by a traction loader on to a belt conveyor which feeds the loading hopper pleced at the heed of the cooking plant.

This loading hopper is installed at the top of the digester end has at its end a weightometer which checks the pulpwood amount admitted into the digester.

Bark, when out of the barking drum is conveyed on e belt to the crusher, then taken up again and directed to the auxiliary boilers. About 250 tons of bark are conveyed daily in this way to an intermediate storage, as the barking and chipping plant only works on two shifts, whereas the boilers are operative 24 hours a day.

This plant is installed at the convoy entrance. The unloading table is outdoors, but all the slashing, barking, chipping, siefting and crushing equipment is in a plated metallic construction. Inside, footbridges connect the diffsrent controls which are not accessible from the floor.

A traveling bridge crane is provided for disassembling heavy equipment. Outside, are the chipyard, the bark storage yerd (which is covered by a light metallic shed), the fine chips (1) and the chip end bark conveyor.

Severel remarks are to be made as to this combined installation :

---

(1) The fine chips are the small particles efter chipping.

552 - Cash-flow

We may now establish the cash flow for the two sorts of pulp.

552.1 - Bleached pulp

Per pulp ton, the cash flow is :

40,886 - 21,430 = FMG 19,456

so yearly :

FMG 1,946 millions for 100,000 tons

The gross returns ratio will thus be :

$$\frac{1,946}{12,930} = \boxed{15.05\ \%}$$

If the considered prices were confirmed, this returns ratio is just about medium. It seems however sufficient to guarantee utilisation of actual afforestations for papermaking.

552.2 - Unbleached pulp

Per pulp ton, the cash flow is :

33,143 - 18,130 = FMG 15,013

so yearly :

FMG 1,501 millions

The gross returns ratio is thus :

$$\frac{1,501}{9,320} = \boxed{16.10\ \%}$$

In the case of unbleached pulp, the ratio is more profitable.

553 - Balance sheet

We have studied financing possibilities of a loan, by considering the less profitable case : the bleached pulp mill.

Supposing 40 % of capital on proper funds and 60 % of capital on a loan, the amount of the latter will be FMG 7,800 million, interest rate being 6.5 % and the refunding on long term (on 15 years with deferred over 3 to 5 years).

The cash flow establisches as follows :

million FMG

Year	Capacity	Cash flow
1		
2		
3		
4	60	1,167
5	80	1,556
6	100	1,946
↕	↕	↕
30	100	1,946

The balance sheet will then be : (see p. 224)

This balance sheet allows for possibility of considering a 60 % investment loan, with refunding of the loan over 11 years (capital and interest) as well as the proper capital. Furthermore the concern has a profit and pays taxes from the 4th year onwards after starting up of works.

554 - Added value of the concern

The direct added value will be on a yearly average of :

- Distributes wages	:		FMG 300 millions
- State tax (31 %)	:	$\frac{9,718}{30}$	FMG 324 millions
- Net profit of concern	:		FMG 720 millions
			FMG 1,344 millions

This added value corresponds to a capital coefficient of :

$$\frac{12,930}{1,344} = \boxed{9.62\ \%}$$

approximate by the same but higher, than the one stated in § 436,34 for the case of a Sisal mill of 100,000 tons.

555 - Net returns ratio

By comparing investments and forecast net profit, in actualised value during the period, we get an internal return ratio of : **3.5 %**

This a fair rate for a concern of this type.

The balance sheet will then be :

Year	Capital proper	loan 6,5 %	Capital to refund	Cash flow	Refunding	Further inv^{t} or amort.	Taxable income	Tax	Net profit
1	5,100								
2		7,800							
3		8,307							
4		8,847	7,847	1,167	1,000	150	17	5	12
5		8,357	7,057	1,556	1,300	150	106	33	73
6		7,516	5,916	1,946	1,600	150	196	61	135
7		6,300	4,700	↑	1,600	↑	"	"	"
8		5,005	3,405		1,600		"	"	"
9		3,626	2,026		1,600		"	"	"
10		2,158	558		1,600		"	"	"
11	5,100	594			1,600		"	"	"
12	4,094				1,600		"	"	"
13	2,494				1,600		196	61	135
14	894				894		902	280	622
15							1,796	557	1,239
16							↕	↕	↕
↕									
30				1,946		150	1,796	557	1,239
Total				51,373	15,994	4,050	31,329	9,718	21,611

56 - CONCLUSION

561 - Economic aspect

From the preceding economic study, we may conclude to the fact that the erection of this mill near Fianarantsoa is feasible, and that the unbleached pulp production is more profitable (16.10 %) than the bleached pulp production (only 15.05 %).

The answer to the question whether to combine the two productions (bleached and unbleached pulp) is in the negative. It would be anti-economic, since the investment and personnel costs for bleaching and chemical product preparation would only be effective during one part of the year.

Although the returns ratio in the unfavourable case (bleached pulp production) is not very high (15.05 %), 60 % of the necessary capital might however be subject to a loan that could easily be refunded over a 12 year period.

This mill would furthermore have the benefit of creating in the Betsileo region an average yearly added value of more than FMG 1,300 million as well as a regional development factor of an important multiplicator effect.

As regards to the answer to the question whether to decide upon another more profitable scheme (mill located at Mangoro or in Tampoketsa area) instead of the Fianarantsoa scheme, this seems more of a political than of an economic concern.

As regards the present project, Madagascar has the great privilege of having some 28,000 Ha of plantations liable to be worked immediately (in the 5 coming years) and of being able to secure as soon as 1975-1980, foreign markets the requirements of which are known, and the other competitive projects elsewhere will not be completed before 1985-1990 under the most favourable circumstances. When the export market will be started, the woodpulp of the mill of a 200 or 250,000 ton capacity, will be sold easily.

In our opinion, the resinous woodpulp requirements are such, considering consumption increase (doubling every 12 or 15 years), that one may foresee, without any risk, erection in succession of :

- FIANARANTSOA mill (unbleached pulp) in 1975-1980
- another mill in the MANGORO region (bleached pulp) in 1985-1990.

These two mills would not be in competition on the export market but would be complementary.

562 - Conveyance problem

The Malagasy portuary works experts consider that the MANAKARA port is not serviceable for an important traffic, ranging about 150,000 yearly tons. In preceding reckonings the considered prices take into account transit of various products and of woodpulp through TAMATAVE.

For connecting the mill with this port, it may be assumed with the Malagasy railway manager, that the ANTSIRABE-FIANARANTSOA railroad will be built in the next 5 years.

In this case, we may depend upon a preferential tariff of FMG 4 per kilometrical ton for transport between the mill and TAMATAVE (800 Km).

Otherwise, transport cost price will have to be slightly increased for road transport to ANTSIRABE and then loading on railway cars.

We note however that prices considered for chemicals and fuel are accounted for under present transport conditions.

The increase would concern, in the most unfavourable case (no railroad connection between mill-ANTSIRABE), the export product transport cost only.

563 - Plantation problem

Necessary investments for plantations (extension and reforestation) have not been reckoned herewith. We presumed that pulpwood price delivered at mill made allowance for amortalization of these investments.

The already afforested lands (afforestation was started in 1956) amount to :

$$28{,}000 \text{ Ha} \times 225 \text{ m3} = \underline{6{,}300{,}000 \text{ m3}}$$

standing pulpwood, having a 15 m3/Ha yearly yield and a 15 years old logging term, which is enough to supply the mill for 12 years. The F.A.O. experts in Madagascar are expecting to confirm before the end of the year the accuracy of above statement on growth rate of the afforestations.

If the decision to erect the mill were reached, afforestation should be continued as well as reforestation after logging.

In this way, we may conclude as to the feasibility of the projected mill providing following conditions :

- solving the transport problem
- finding investors in Europe, in the Middle East (1) or North America
- processing unbleached woodpulp in preference to bleached woodpulp. In this case, investments could be lower, for a better profit.

(1) During market study in Israel, papermaking pulp importers were most interested by the Malagasy woodpulp concern and seemed ready to take part in financing the erection of a mill.

6 - SUMMING UP AND RECOMMENDATIONS

61 - SUMMING UP

611 - Recalling previous studies

612 - Woodpulp and paper market study

613 - Sisal, papermaking raw material

614 - Sisal pulp mill

615 - Pine woodpulp mill

62 - RECOMMENDATIONS IN RELATION WITH SISAL

621 - Working and fiber recovery

622 - Further laboratory studies

623 - Semi-industrial tests

624 - Assessment of complementary costs

6 - SUMMING UP AND RECOMMENDATIONS

61 - SUMMING UP

611 - Recalling previous studies

In chapter 1, we have summed up previous studies relating to establishment of a Pinewood cellulose mill in the Fianarantsoa, Mangoro or Tampoketsa regions, Pinus patula supplies and their development, pulp and paper world market and lastly the Sisal problem in Madagascar and its utilization for papermaking.

A list of studied reports or works are included in an Appendix.

612 - Study of pulp paper market

Chapter 2 relates to a paper product market in Madagascar, Mauritius and Reunion on one hand, in the neighbouring countries of the Indian Ocean (South Africa, East Africa, India and Pakistan) and of the Middle East, on the other hand.

Furthermore, we have effected an up to date paper pulp world market study, and stressed the important european market requirements (3,500,000 tons of pulp will be imported in 1980).

The prospects as regards to a year 1980 outline, lead to expect the following potential sales for Madagascar :

- Sales on the Malagasy market	:	4 to 5,000 Pinepulp tons
- Sales in the Middle East	:	60 to 90,000 "
		12 to 20,000 Sisal pulp tons
- Sales in Europe	:	80 to 200,000 Pinepulp tons

Conclusions of the market study enable to establish yearly potential outlets for :

- 110,000 to 290,000 tons of Pinewood pulp to Europe and the Middle East
- 12,000 to 20,000 tons of Sisal pulp to the Middle East in 1980. It is therefore possible to consider erection of a 100,000 ton Pinepulp mill as well as of 30 to 100,000 ton Sisal pulp mill, these two grades being

competitive and possessing appreciably the same utilizations, bearing in mind that, for Sisal, a number of technical problems are yet to be solved.

613 - Sisal, papermaking raw material

In chapter 3, we have studied in succession the actual raw material which will vary following the forward mill capacity.

For a capacity lower than 20,000 yearly tons, the supplies will be defiberizing waste or flume tow, tow or various debris as well as stems or stalks, supposing the present commercially serviceable fiber volume, which is 25,000 yearly tons, will remain steady.

To get to a 30,000 ton capacity, preceding supplies will have to be completed by closely set plantations for papermaking purpose, the extent of which would be 342 Ha worked every year, or 1,710 Ha ever 5 years. These forward cultivations can easily be made in the vicinity of present plantations.

Lastly, if we consider a 100,000 ton capacity, further closely set plantations (12,000 Ha over 5 years) will have to be set up.

It seems that these forward plantations might fairly easily be made in the Mandrare region, providing an agreement to be reached with local populations as regards pasture land.

The raw material sale price delivered at mill has been estimated per pulp ton. It is for the three preceding capacities :

FMG 7,474, 7,319 and 7,143 per ton

or $ 27, 26,4 and 25,70

Complementary investment for working, and preparing the raw material, and planting more lands spreads out from FMG 240 to 1,015 millions, with a resulting 68 to 1,475 more persons employed (see table list 345).

The 2nd part of chapter 3 deals with laboratory tests, made at C.T.F.T. on Sisal samples from Madagascar. Irregular quality of these samples has been noted (Flume tow represents refined defibration waste, and the other wastes contain many parenchyma, cell and wax debris).

The best results come from fiber actually commercialised. Those coming from other raw material origins (hackled whole plant included) are of a lower quality. Whatever the samples, the presence of fines is e serious complication. It seems necessary to survey fines refining methods before and after cooking to get to a satisfactory result.

Finally, the kraft pulp processing is the one which seems to yield best results. One must also bear in mind that bleaching does not seem as easy as for woodpulp bleaching, when a high degrse of brightness is required.

The suggested complementary experimentation will be found in § 62.

614 - Sisal pulp mill

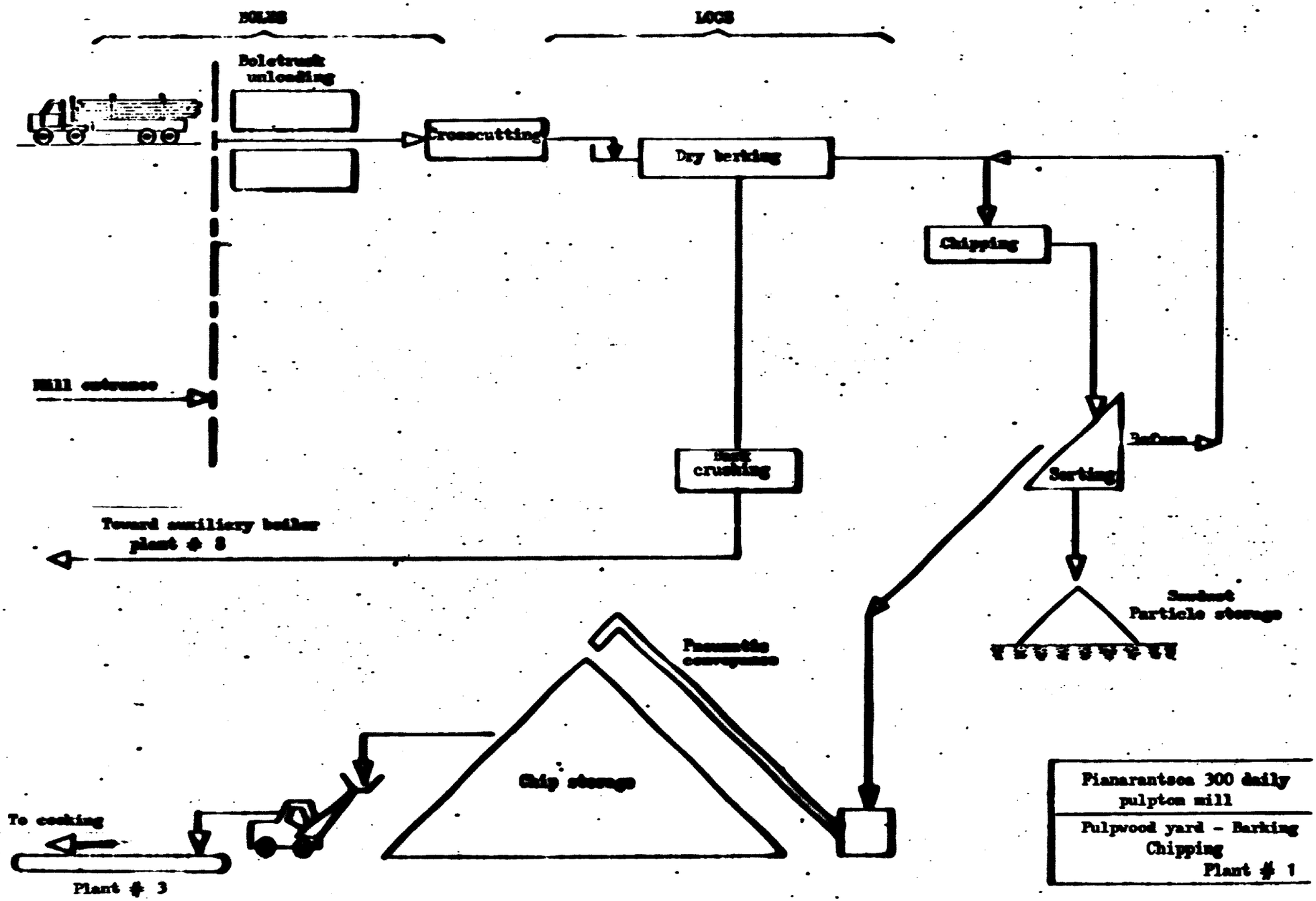
In chapter 4 we have dealt with establishment of a Sisal pulp mill and have surveyed in this relation raw material supplies, available water supplies, transport facilities, power potentiality, chemicals, etc...

The suggested location is over the south district of AMBOASARY town, near the junction of the MANANARA and MANDRARE rivers.

An allround technical description has been made, considering bleached sulfate pulp production and unbleached sulfate production as well as the two production capacities : 20 to 30,000 yearly tons and 100,000 yearly tons.

A pulp ton production cost estimate the necessary investment assessment and the economic feasibility of the project have been established.

A view of the inquiry in this regard is given in following table list :


LOGS
LOGS
Boletruck unloading
Crosscutting
Dry barking
Chipping
Mill entrance
Bark crushing
Toward auxiliary boiler plant # 8
Sorting
Sawdust Particle storage
Pneumatic conveyance
Chip storage
To cooking
Plant # 3
Pianarantsoa 300 daily pulpton mill
Pulpwood yard - Barking Chipping
Plant # 1

	30,000 ton mill		100,000 ton mill
	Bleached pulp	Unbleached pulp	Bleached pulp
Mill investment (million FMG)	5,400	4,380	12,900
Yearly cash flow (million FMG)	575	566	2,474
Gross returns ratio (%)	10.65	12.44	19.17

Lastly, if we consider the entire investments, including those upstream of the mill and created employment (working and forward plantations), the results are as follow :

	Investments (million FMG)	Employment
<u>30,000 yearly ton mill</u>		
. Bleached pulp	5,800	465
. Unbleached pulp	4,800	443
<u>100,000 yearly ton mill</u>	14,005	1,682

On the whole, providing tests and perfecting, detailed in § 62, the 100,000 yearly ton mill seems to be the only profitable one. An intermediate solution might be : erecting the 30,000 yearly ton mill first of all and then extending it to 100,000 tons later on.

615 - <u>Pinewood pulp mill</u>

At the request of B.D.P.I., chapter 5 had in view the defining of the technical characteristics of a 300 daily ton unit (100,000 tons a year) located near FIANARANTSOA as well as the production cost. The object was to provide for the necessary data enabling a choice between two possible productions (bleached or unbleached pulp).

- 100,000 yearly ton mill for bleached pulp processing

. Investment	FMG 12,930 million
. Personnel	368 persons
. Gross returns ratio	15.05 %

- 100,000 yearly ton mill for unbleached pulp processing

. Investment	FMG 9,200 million
. Personnel	296 persons
. Gross returns ratio	16.10 %

We note a slight advantage in favour of unbleached pulp production. Possibility of applying for a long term loan (15 years) at 6.5 % with 3 to 5 years deferred payment seems reasonable. The added value is an average of FMG 1,300 million every year.

It seems that, in spite of other schemes of plantations for papermaking purpose at MANGORO and TAMPOKETSA, that the Fianarantsoa Pinewood pulp mill is financially feasible, providing that the important transport problem be settled, and the necessary financial means be found.

62 - RECOMMENDATIONS IN RELATION WITH SISAL

Following suggestions are in relation with necessary tests and perfecting in view of Sisal utilisation for papermaking.

621 - Working and recovery of fibers

A method must be perfected for mechanical harvesting of the leaves and the stems as well as a method for drying the latter material. Furthermore it would be advisable that I.R.C.T. proceed with its research on soil fertilization maintenance, on useful Sisal paper sorts and on appropriate cultivation methods.

622 - Further laboratory tests

The laboratory tests will have to be gone through again with a better screened and better conditioned raw material than was the case for the preliminary tests. These new tests would bear on a raw material made up of a better specified mixing of the different fibrous supplies so as to extrapolate results to the stage of the projected mill.

During these further studies, fines elimination, and bleaching processing will be given special attention.

623 - Semi-industrial tests

Before erecting the mill, semi-industrial tests are essential in view of eliminating the fines before and after the cooking, and in view of establishing the best pulp cooking and bleaching methods.

The screening of fines will be experimented in the dry or the wet state. These tests could take place in a bagasse mill or in an experimental station in Madagascar. The latter solution would be the more expensive.

624 - Estimate of the complementary study costs

The entire costs of these complementary tests have been assessed FMG 65 million, of which FMG 10 million for agronomical experimentation. The latter experiments would last several years, whereas the technological tests would be completed within a year.

Decision as regards the erection of the Sisal mill could be taken only after due confirmation of these tests.

APPENDIX

APPENDIX I.A

LIST OF THE STUDIES COMPLETED ON THE MADAGASCAN PAPERMAKING CONCERN

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1 - Studies in relation with Pine or Eucalyptus

1960 - Investigation on establishment of pulp mills and fibre panels in Madagascar out of tropical species of rapid growth (profitableness, outlets) - Centre Technique Forestier Tropical - PARIS.

1961 - Reafforestation, preliminary condition for development of Madagascar - E. UHART - Doctorate thesis - Faculté de Droit et de Sciences Economiques in PARIS.

1962 - Prospects for establishment of a woodpulp industry in Madagascar - Société d'Etudes et de Développement Economique et Social - PARIS.

1963 - Establishment of a papermaking and a cellulose industry in Madagascar - Office Central de Cooperation et de Recherches - PARIS.

- Prospects of utilization of Eucalyptus stands in the Perinet - Moramanga region for woodpulp processing - SEDES - PARIS.

1964 - Project of statute of the Upper Matsiatra Forestry Development Company - C.T.F.T. TANANARIVE.

- Various notes { Mr LABBE Laurent
  Forestry Ministry
  Mr PERRAUDIN
  Ministry for Public Works and Transport
  Power Department.

1965 - Account of a suggestion for the industrial use of the Upper Matsiatra reafforestations (Mr LABBE Laurent).

- Pine plantations and papermaking industry in Madagascar - MM. ROBBE and ROUANET (consultants U.N.O.).

- Forestry workings and wood industry in Madagascar - C.T.F.T. TANANARIVE.

1965 - Cost price of Eucalyptus Robusta pulpwood in the Moramanga - Perinet region - C.T.F.T. TANANARIVE.

1966 - Pine plantations in Madagascar and in Cameroons - C.T.F.T. PARIS.

- The woodpulp and paper world market - S.E.D.E.S. - C.T.F.T. PARIS.

- Paper industrialization prospects in Madagascar - S.E.D.E.S. - C.T.F.T. PARIS.

1967 - Upper Matsiatra : reafforestation possibilities, outline of a rational development - Agricultural Development and Promotion Bureau.

- Forestry studies on Upper Matsiatra Pinus patula plantations - PARRAT - C.T.F.T. TANANARIVE.

- Development scheme for extension of Upper Matsiatra reafforestations - PARRAT - C.T.F.T. TANANARIVE.

- Study of logging and conveyance problems in the Upper Matsiatra reafforestations - C.T.F.T. PARIS.

- Industrial utilization of Pinus patula :

  . papermaking study - C.T.F.T. PARIS.
  . technological study - C.T.F.T. TANANARIVE.

1969 - Upper Matsiatra Pine reafforestations - DINARD - C.T.F.T.

2 - Studies in relation with Sisal

1968 - The Sisal situation, by Mr Inspector General DALMAS (January).

- Sisal use for papermaking - Mr G. PETROFF's note (February).

- Sisal in Madagascar - Paul Le BOURDIEC - Revue de géographie N° 13 (July-December).

1969 - Preliminary study for development of the Mandraré and of the South-East of Madagascar (January), by a British mission :

  . Ovearup & Partners - Consulting engineers - LONDON.
  . Engineering & Power - Development consultants - LONDON.

- The Madagascan Sisal - F.A.O. report (confidential), by Mr MUSIC (December).

APPENDIX CHAPTER II

- Appendix II.A - Dispersion of non printed paper and cardboard imports in the O.C.A.M. countries.

- Appendix II.B - Evolution of Gross Interior Product at market prices in current francs.

- Appendix II.C - Evolution of Gross Interior Product at market prices in constant francs.

- Appendix II.D - Chief Iranian paper and cardboard importers.

Dispersion of non printed paper and cardboard imports in the O. C. A. N. countries : Senegal, Mali, Ivory Coast, Upper Volta, Niger, Dahomey, Congo, R. C. A., Tchad, Cameroon, Togo, Madagascar.

APPENDIX II.A

	QUANTITIES IN TONS			VALUE in M. C. F. A.		
	1966	1967	1968	1966	1967	1968
48-01	23,340	26,471	25,688	1,443.2	1,358.8	1,349.7
48-02		87	239		9.6	20.9
48-03		378	324		53.9	48.0
48-04	3,849	232	138	3,849	15.1	11.7
48-05		3,722	5,940		266.0	396.0
48-06		81	193		23.3	29.5
48-07	2,368	3,183	3,778	2,368	266.2	297.8
48-08	11	16	50	7.1	8.1	13.5
48-09	4,451	4,075	4,126	129.3	114.8	122.1
48-10	154	233	180	25.1	75.8	70.8
48-11		16	5		3.4	1.7
48-12	1,436	451	1,403	101.2	86.9	103.5
48-13	338	559	649	242.4	389.0	391.3
48-14	766	892	1,148	183.3	211.4	254.7
48-15	3,177	3,333	3,827	544.7	603.0	714.9
48-16	14,999	12,515	13,651	1,032.8	1,170.2	1,301.5
48-17	21	52	13	7.9	10.7	4.6
48-18	3,978	4,862	5,134	1,020.4	1,015.8	1,146.6
48-19	625	930	820	149.5	266.0	265.8
non defined	522	1,968	1,304	132.5	250.7	319.5
Total		64,054	68,610		6,198.7	6,864.1

Evolution of Gross Interior Product at market prices, in current francs (at actual average progression rate of 4,6 % per annum)

APPENDIX II.B

in millions of FMG

Years	1960	1962	1966	1968*	Prevision 1975	Prevision 1980	
Gross Interior Product	113.8*	128.4*	150.7*	166.3*			Actual average yearly progression rate of G. I. P.
Service by Administrations	19.2*	27.0*	28.8*	30.4*			
Service by domestic servants	1.6*	1.8*	2.1*	2.1*			
Gross Interior Product at market prices	134.6*	157.2*	181.6*	198.8*	264.0 to 265.0	310.0 to 312.0	
G. I. P. index	100	116	134	147	196	246	4,6 %

Ref. : I. N. S. R. E.

* : Provisional evolution.

Evolution of Gross Interior Product at market prices, in constant francs (in million F. M. G. - 1962 basis)

APPENDIX II.C

Years	1960	1962	1964	1966	1967	1968
Gross Interior Product at market prices	134.6	157.2	160.7	181.6	188.7	198.8
G. I. P. standard frs index	85	100	102	115	120	126
Retail price index (europ family consumption)	-	100	108.1	114.1	117.2	120.4
G. I. P. corrected index in 1962 frs	-	100	93.9	100.9	102.8	105.6
G. I. P. evolution in 1962 frs		157.2	147.6	158.6	161.6	166.0

Valuation of Gross Interior Product yearly average progression rate at market prices in constant francs (rate below 1 %) allows for plain illustration hereafter :

G.I.P. prevision in 1962 francs :

- 1975 : FMG 179 millions (114 index)
- 1980 : FMG 188 " (120 index)

- The pulpwood necessary for feeding this mill for six weeks implies a wide surface chip storage yard (about 8,000 to 10,000 m2 for 60,000 m3 storage).
- The road traffic for conveysnce of the raw material requirements of the mill will need an important truck park, maintenance workshops, and a garage which are not included in this study.
- As indication, about forty bole or log trucks seem necesaary for effecting three rotations in sixteen hours, if we consider the average distances noted in C.T.F.T. report on Upper Matsiatra pulpwood working and conveyanca.

511.2 - Causticizing - Lime-kiln

The object of this plant is the processing and the preparation of the whita liquor for the cooking. It is installed in open air, and at the nearest posaible diatance from the dissolver and the cooking plant.

The equipment is as follows :

- A green liquor clarifier which provides at the same time the clarification of tha green liquor coming from tha diasolver, and its atorage. It is a large aize tank equipped with an apparatus for continuous scraping of aludge.
- A pump for the green sludge of this clarifisr. This pump is a diaphragm and ball type one.
- A graen sludge mixer which dilutes the sludge from the preceding clarifisr. It is a metallic tank equipped with a central paddle agitator.
- A graen liquor thickener from which the weak liquor overflow goes to the atorage chest and the underflow to the sewer. This is also a large size tank, equipped with a scraping system for the sludge settled at the bottom.
- A sludge pump of the same type as the preceding one for discharging the underflow.
- A lime kiln of a horizontal rotary type procesaes the quicklime from whits sludge and a makè-up lime stone. This kiln is set upon a rsised concrete platform, and conveysnce of the quicklime to the storage loading hopper is affected by a bucket elavator.

Chief Iranian paper and cardboard importers

APPENDIX II.D

- KAGHAZ IRAN C°
  162, avenue Nasser Khosrow
  TEHERAN

- PAKHSHE KAGHAZ C°
  Serayé Chitsaz
  TEHERAN

- TEHERAN TOKYO TRADING C°
  Serayé Hafez, avenue Bouzardjomehri
  TEHERAN

- MOANELAT KAGHAZ VA MOCHAVA C°
  Bazar Soltani
  TEHERAN

- KAGHAZ FOROUSHI IRAN
  162, passage Golestan, avenue Nasser Khosrow
  TEHERAN

- COMMERCIAL OMID C°
  Serayé Omid
  TEHERAN

- RANG C°
  302, avenue Shah Réza
  TEHERAN

- SADR C°
  Serayé Bank, Bazar Beinol-Haramein
  TEHERAN

- TAZAYOUD C°
  Serayé Omid
  TEHERAN

- TEHERAN KAGHAZ
  11, Serayé Safa, Bazar
  TEHERAN

- CORONET C° LTD
  Aftab Shargh Building, 801, avenue Ferdowsi
  TEHERAN

- GUTENBERG PRINTING C°
  325, avenue Saadi
  TEHERAN

- PERINEX TRADING C°
  17/18, Serayé Majdieh, avenue Bouzardjomehri
  TEHERAN

- PORKAR & C°
  Serrah Azari, avenue Ghazvine, rue Chandi
  TEHERAN

- ZANG C° LTD
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  TEHERAN.

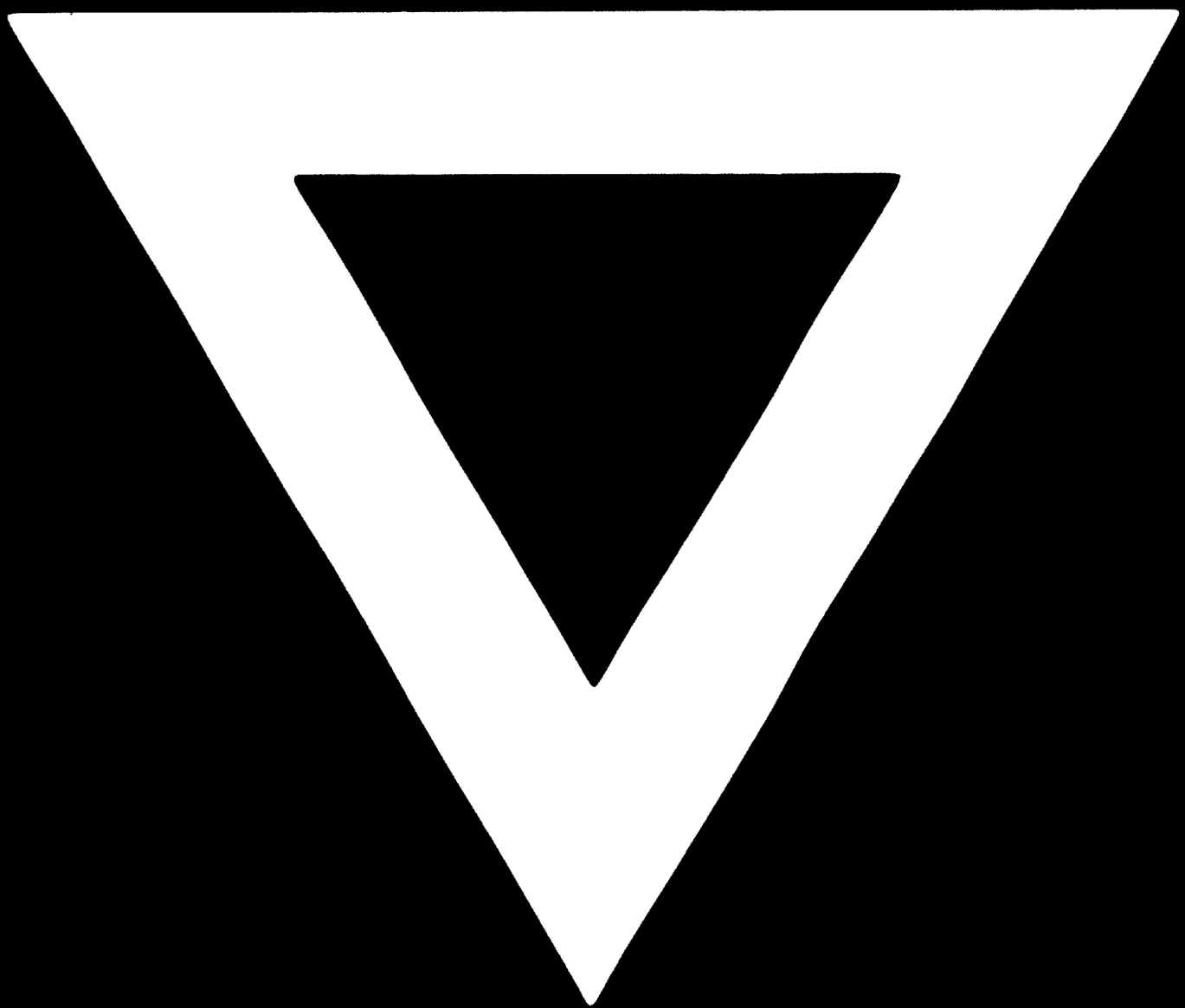
APPENDIX IV

Details of investments for sisal Mills

	Million FMG Bleached sulfate 30,000 t factory	Million FMG Semi-bleached sulfate 30,000 t factory	Million FMG Bleached sulfate 100,000 t factory
I - Fabrication equipment			
Reception and preparation of raw material	200	200	400
Unbleached pulp fabrication	400	400	1 000
Bleaching	600	170	1 050
Chemicals preparation	300	170	750
Wet machine and baling	700	700	1 950
Conveyance	200	190	600
Civil engineering	250	180	600
Fitting up and general contracting	480	380	900
Engineering	125	100	500
Spare parts	200	75	600
Partial total	3,455	2,565	8,350
II - Recovery unit			
Boiler	350	350	900
Evaporation, oxidation, deodorization	150	150	450
Causticizing and lime kiln	140	140	350
Conveyance	40	40	100
Civil engineering	75	50	200
Fitting up and general contracting	100	80	300
Engineering	50	50	75
Spare parts	20	30	100
Partial total	925	890	2,475

	Million FMG Bleached sulfate 30,000 t factory	Million FMG Semi-bleached sulfate 30,000 t factory	Million FMG Bleached sulfate 100,000 t factory
III - General services			
Power station	160	120	330
Pumping and water treatment	130	100	300
Laboratory	10	10	10
Maintenance shop	50	50	60
Ducts & pipes	10	20	20
Conveyance	20	20	40
Fitting an and general contracting	60	60	200
Civil engineering and office building	75	70	100
Engineering	75	70	25
Spare parts	20	15	100
Partial total	610	535	1,185
General total	4,990	3,990	12,010
	₣ 5,000	4,000	12,000
	$ 18 million	14.4 million	43.250 million

C-920



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- A metallic loading hopper for quicklime atorsge. This hopper is fitted on a metallic platform which heightens it as regards to the slaker. The lime is reclsimed by means of a rotsry table, and is loaded into the slaker locatsd below.

- A lime slaker, which slakes the quicklime with the overflow of the green liquor clarifisr and with s make-up water. A continuous scraping apparatus dischargea sand and residuas, and s paddle agitator in the axis of the tank maintains the matter in suspension before it is poured into the first causticizer. This slsker is on a higher level as regards to the floor and sst upon a concrete plstform.

- Thres causticizers fitted in series, for white liquor preparation. These ateel tanks are set on concrste beds and flow one into the other by means of spout, while a continuous stirring is maintained in esch tank by a paddle agitator.

- A metsllic tsnk for the reclsiming of the white liquor coming from the last causticizer feeds the white liquor pump.

- A white liquor pump of the cantrifugal typs for supplying the white liquor clarifier.

- A white liquor clarifier, which also enaures the storage consists of a high capacity tank, equipped with s continuous apparatus for scrsping the sludges continuously.

- Two pumps for the white sludge. Ons is a disphragm pump snd the other one is centrifugal. These pumps drive back the white sludge into the following mixsr.

- A white sludge mixer which ensures their dilution by means of the overflow of the clarifier and of the green liquor thickeners as well aa of the filtrates from the white sludge filter and s water contribution. This mixsr which is placed on s higher level than the thickener one, is set on a concrete bed. Mixing is effected by a psddle sgitator set in the center of the vat.

- A weak liquor thickener which also enaures storsge. It has the same general characteristics as the clsrifier.

- A white liquor centrifugal pump takes up the overflow of the white liquor clarifier for feeding the cooking.