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SHORT-TERM CONSULTANCY IN THE WHEAT-MILLING INDUSTRY

SI/SEY/86/802/11-51

SEYCHELLES

Technical report: Selection of equipment for and advice on the establishment of a flour mill

Prepared for the Government of Seychelles
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of D. Brieger,
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United Nations Industrial Development Organization
Vienna

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Explanatory notes

The currency in Seychelles is the Seychelles rupee (SR). During the period covered by the present report, the value of the Seychelles rupee in relation to the US dollar was $US 1 = SR 6.15.

The following abbreviations have been used:

BEP	break-even point
IRR	internal rate of return
NPV	net present value
SMB	Seychelles marketing board

ABSTRACT

The Seychelles currently imports most of its food requirements, including flour. Grain is not grown on any of the islands, but a number of countries have offered to donate wheat. The Government of Seychelles therefore requested assistance from the United Nations Industrial Development Organization (UNIDO) in September and October 1985 to assess the feasibility of establishing a mill by providing an expert who would: undertake a study on the demand for flour and related products during the next five years; prepare an opportunity study for setting up a flour mill; advise the Government on the most appropriate equipment for the flour mill, taking into consideration various offers of equipment received from different countries, and suggest a suitable location for the mill; advise the Government on the incorporation of wheat-aid grants in the flour mill; prepare a preliminary study of by-products for animal feed; establish possible linkages with the Animal Feed Factory; and draw up an implementation schedule together with a training programme for personnel.

The mission "Short-term consultancy in the wheat-milling industry" (SI/SEY/86/802) was carried out by an expert in corn processing from 21 April to 23 May 1986. The Seychelles Marketing Board (SMB) was the counterpart agency. UNIDO provided the services of the expert; the Government of Seychelles provided all necessary administrative and secretarial support services as well as transport within the country.

The expert concluded that it would be feasible to establish a mill with a capacity for producing 8 t/d of flour.

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INTRODUCTION

Seychelles is an archipelago of scattered granite and coral islands with a total area of 435 m^2. The main island, Mahe, is located 4^o south of the equator.

The country currently imports most of its food requirements and consumer durables, although cinnamon, tea, coffee, vanilla, maize, rice, bananas, manioc and other foods are grown and soft drinks, beer, cigarettes, plastics, fibreglass and soap are manufactured. Efforts are being made by the Government to develop agro-based industries using domestic raw materials. Tourism is also one of the main industries.

No grain is grown on the islands, but some countries have offered to donate grain. The Government therefore requested the assistance of UNIDO in providing an expert who would: assess demand and prepare an opportunity study on the establishment of a flour mill; select a site and give advice on equipment for the mill; and prepare an implementation schedule and training programme.

The mission "Short-term consultancy in the wheat-milling industry" (SI/SEY/86/802) was carried out from 21 April to 23 May 1986. The co-operating agency was the Seychelles Marketing Board (SMB), which is responsible for imports and marketing in the Seychelles. In particular, Mr. Glenny M. Savy, the Divisional Manager of the Board, and Mr. Mukesh Valabhji, Divisional Manager of the Import Division, provide the expert with information on the project. The flour mill project falls under the Agro-Industrial Production Division, one of the eight divisions of the Board.

CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

1. By establishing a flour mill, Seychelles would be able to meet the total demand for flour in the country and would be able to take advantage of offers made by other countries to donate wheat.

2. In the past there have been disturbances in the import of flour. If a mill is established, there will be a constant supply of fresh flour, and the quality is expected to improve.

3. The mill would provide employment for 15 people.

4. By-products of the mill (bran and wastes) could be sold to the local animal feed factory.

5. The Government could save on currency currently used to import flour, and, if wheat donations are used, a high profit can be expected.

B. Recommendations

1. A mill should be built to process 16 t/d wheat into 8 t/d flour and 2.66 t/d bran (250 working days a year) which would meet current demand (4.9 t/d) and future demand for flour.

2. The mill should be located on Mahe, the main island, near the animal feed factory. This site is near the harbour, which would save transport costs.

3. The mill should be established on a turnkey basis. SMB has received offers from suppliers of mills in Austria, Italy, the Federal Republic of Germany and Switzerland. These should be evaluated and technical negotiations should be carried out. Machinery should be ordered well in advance and stored under proper conditions prior to installation.

I. MARKET AND CHARACTERISTICS OF PROPOSED PLANT

A. Market demand and sales

Present and future demand

During the period 1981-1985, Seychelles imported flour from Australia, France, Japan, Mauritius, Singapore, South Africa, the United Kingdom of Great Britain and Northern Ireland and the United States of America. The amounts imported and the daily consumption of flour in the country are given in table 1.

Table 1. Imports and consumption of flour, 1981-1985

Year	Imports of flour (tonnes)	Consumption (tonnes/day)	Increase in imports over previous year (tonnes)	Value (SR)	Mill capacity a/ (t/d)
1981	1 529	4.19	-	-	6.11
1982	1 667	4.56	138	-	6.65
1983	1 855	5.00	188	-	7.41
1984	2 006	5.49	151	6 001 814	8.01
1985	1 903	5.21	-103	5 677 182	7.60

a/ The mill capacity that would have been necessary to meet demand, assuming 250 working days per year.

The average daily consumption of flour for the period 1981-1985 was 4.90 tonnes or about 1,800 tonnes per year. Based on that figure, the selected flour mill capacity would be for 2,000 tonnes flour per year (8 tonnes flour per day, for a mill operating on two shifts 250 working days per year).

The estimated consumption of flour for the period 1985-1995 and the mill capacity necessary to meet the demand are shown in table 2.

Table 2. Estimated demand for flour a/ and mill capacity requirement, 1985-1995

Year	Inhabitants	Tourists	Flour consumption (tonnes/day)	Flour consumption (tonnes/year)	Capacity of flour mill (tonnes/day)
1985	57 000	50 000	5.21	1 903	7.61
1986	57 787	55 000	5.47	1 996	7.98
1987	58 075	60 000	5.73	2 090	8.36
1988	58 365	65 000	5.98	2 184	8.74
1989	58 656	70 000	6.24	2 277	9.11
1990	58 949	72 000	6.35	2 318	9.27
1991	59 244	72 000	6.36	2 323	9.29
1992	59 540	73 000	6.43	2 346	9.38
1993	59 837	73 000	6.44	2 351	9.40
1994	60 136	74 000	6.50	2 374	9.50
1995	60 437	74 000	6.52	2 380	9.52

a/ Assuming a constant per capita consumption of about 17.7 kg/year.

Sales

The flour will be sold by SMB, Import Division, to the local consumer. The by-products, bran and wastes (broken grain), will also be sold by the Import Division of SMB to the local animal feed plant. A new sales programme is not necessary.

The price of imported flour in 1984 and 1985 was SR 2.99/kg; it was sold on the local market to the consumer at SR 5.20/kg. For the by-products, an estimated price (based on other countries in the area) of SR 1,500 per 1,000 kg of bran and SR 1,200 per 1,000 kg of wastes was established.

B. Characteristics of the proposed plant

Based on the estimated demand (table 2), the plant should be able to produce, on two shifts, with 250 working days a year, the following quantities:

Flour	8 t/d (75 per cent extraction)
By-products	2.66 t/d (25 per cent extraction)
Wastes	0.21 t/d (less than 2 per cent)

The mill will require 16 t/d grain as raw material to produce these quantities.

The minimum storage requirements are:

Raw material (wheat)	700 t
Final product (flour)	80 t
By-product (bran)	15 t
Wastes (broken grain etc.)	2 t

As a basis for determining the characteristics of the proposed plant, SMB provided a flour sample, which gave the following laboratory results:

	Percentage
Ash content	0.55 (based on dry matter) a/
Protein content	14.30 (based on dry matter) b/
Colour (Kent Jones)	1.20
Maltose	1.80
Starch damage	11.20
Moisture	13.7
Gluten	35 (wet) swelling figure Q 0 = 21 Q 30 = 20
Granulation	99.5 (through a sieve 183 microns) 99.0 (through a sieve 129 microns) 73.5 (through a sieve 85 microns) 55.0 (through a sieve 55 microns) 29.0 (through a sieve 35 microns)

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a/ The ash content indicated by the supplier was 0.4 per cent. This was based on a moisture content of 14 per cent, which corresponds to 0.55 per cent based on dry matter.

b/ The protein content indicates a very strong flour made of hard wheat (North American or Australian). The mills supplying this flour usually obtain an extraction of 74-75 per cent. The same extraction can be obtained from the proposed mill, whereby the laboratory results can vary according to the wheat varieties and the harvesting conditions of a particular year.

Some countries have offered to donate wheat to Seychelles, which would have to be analysed along these lines. SMB is also considering the import of French wheat, which would call for mill requirements shown in table 3.

Table 3. Plant parameters

Flour quality		Capacity of flour mill (two shifts)	
Ash content (percentage)	Extraction (percentage)	Flour (t/d)	Bran (t/d)
Up to 0.52	70-72	7.46-7.68	3.2-2.99
Up to 0.70	75-78	8.00-8.32	2.66-2.34
Up to 1.80	85-90	9.06-9.60	1.6-1.06

The proposed production and sales programme for the first year of operation of the flour mill is shown in table 4.

Table 4. Production and sales of proposed mill during the first year of operation

Product	Output at 100 per cent capacity (tonnes/day)	Yearly output (t)	Local price per kg (SR)	Sales revenue, including sales tax (SR)
Flour	8.00	2 000	5.20	10 400 000
Bran	2.66	665	1.50	997 500
Broken grain	0.21	5.25	1.20	63 000

II. MATERIALS, MACHINERY AND UTILITIES

A. Materials

Raw material

The wheat will be delivered in bags or containers and stored in a warehouse near the mill. It is proposed to import French wheat and to take advantage of the offers of some countries to donate wheat to Seychelles. The cost of 1,000 kg of French wheat is SR 1,850.

The quality of the flour will depend on the quality of grain. It should have the following characteristics:

Bulk density, 0.75-0.80 kg/dm^3

Moisture content between 12 and 13 per cent maximum

Minimum gluten content, 24-25 per cent

Maximum damaged kernels (broken wheat, dried up wheat, crushed wheat, deformed wheat, visibly damaged wheat, wheat with grain disease; wheat destroyed by insects; sprouted wheat with visable germ; mouldy wheat), 2 per cent

Maximum other cereals in the wheat (rye, berley, oats, wild oats, black oats etc.), 1 per cent

Maximum impurities (sand, stones, dust, mud balls, metal, glass wire etc.; all weeds and weed seeds as well as seeds of all plants; straw particles, spoiled and rotten wheat, wheat with damaged endosperm, wheat that has been decomposed by bacteria; blasted wheat, dirty kernels, excrement, dead and living mill pests; all matter that can fall through sieves with 1-mm slots), 2 per cent.

The wheat should be of a quality such that the flour produced has good baking qualities. Good baking flour contains 26-32 per cent gluten and 12-14 per cent protein, whereas flour with poor baking qualities may have only 12-20 per cent gluten and 8-10 per cent protein.

A certificate should be presented for each shipment of grain.

Packing material

The packaging material needed for one year's production is listed in table 5.

Factory supplies

The following supplies will be necessary

100 kg lubricating fluid
100 pallets
3 wheelbarrows for bags
1 000 litres insecticide, such as "Nuvan 7" and "Phostoxin"

Table 5. Packaging materials

Product	Packaging	Material	Quantity per year	Quantity of product packaged (tonnes/day)
Flour	25-kg bags a/	Woven polypropylene	72 000 bags	7.2
		Thread	40 000 m	
Flour	1-kg bags	Plastic or paper	200 000 bags	0.8
Bran b/	30-kg bags	Polypropylene	22 167 bags	2.6
		Thread c/	13 300 m	
Wastes b/	50-kg bags	Polypropylene	1 050 bags	0.2

a/ Depending on the type of sewing machine and stitches.

b/ Empty wheat bags can also be used for bran and wastes.

c/ For manually closing bags.

B. Machinery

A flour mill with a capacity of 16 t/d of wheat will require machinery for intake, cleaning, milling and the laboratory. In addition, a supply of spare parts will be necessary. The equipment needed is summarized in table 6.

Table 6. Machinery and equipment costs a/

Item No.	Quantity	Item	Price (SR)
Mechanical equipment (intake, 8 t/h; cleaning, 1 t/h)			
		Machines	
1	1	Magnetic apparatus - metal construction, permanent magnet lift-out type for removing metal material	
2	1	Scourer - metal construction, inspection opening, with connection to aspiration equipment	
3	1	Separator - metal construction, oscillating sieve box with automatic sieve cleaning	
3A	1	Dry stone separator - metal construction, inclined vibrating table with screen netting	

continued

Table 6 (continued)

Item No.	Quantity	Item	Price (SR)
4	1	Damper - metal construction, with paddle wheel rotating in a case	
5	1	Dump scale for wheat - bucket dump 10 kg capacity 0.8 t/h, mechanical nominal weight weighing. Spring indicator head with plus indication, bottom hatch door release on weighing container, electro-pneumatically actuated, inlet surge bin with full level signal, scale hopper	
6	1	Magnetic apparatus - metal construction, permanent magnet, lift-out type for removing metal material	
7	1	Round filter for separating dust from aspiration air - metal construction, cylindrical, air nozzles for bag cleaning, filter bags with fastening supports, discharge airlock, rinsing unit, rotary piston blower	
8	1	Centrifugal fan - metal construction, vibration damper with mounting device	
	Subtotal, machines		440 558.50
		Transport equipment and accessories	
9A	1	Bucket elevator for wheat - height 11 m, capacity 10 t/d, metal construction, belt tensioning device, belt, buckets and bucket bolts, speed monitor, non-reverse stop with limit ledge	
9	2	Bucket elevator for wheat - height 11 m, capacity 5 t/h, metal construction, belt tensioning device, belt, buckets and bucket bolts, speed monitor, non-reverse stop with limit ledge	
10		Screw conveyor - Belts etc. for machines, metal construction, screw shaft with full flights, troughs covered, end and intermediate bearings, outlets	
11		Belts etc. for machines	

continued

Table 6 (continued)

Item No.	Quantity	Item	Price (SR)
12		Gravity flow pipes - straight pipes, elbows, inspection pipes with cover transition and connection spouts, cuffs, Y-pipes, quantity regulating slides, valve boxes, clamp, rings, tension rings etc. - prefabricated, made of metal sheets, diameter 120 mm	
13		Aspiration ducts - straight ducts, elbows, Y-spouts, connection spouts to machines, clean-out slides, butterfly valves, duffs hangers - prefabricated, made of galvanized sheet metal	
14		Steel constructions - prefabricated as far as possible. Supports and suspensions for machines and conveying equipment, various small erection material such as screws, handles, buttons, sealing material, paint	
15		Belt guards, if necessary	
16	2	Sacking-off spout and buckle - diameter 300 mm, metal construction	
17	1	Sacking-off board-metal construction	
18	2	Supports - metal construction	
18A	2	High and low level indicator	
Subtotal, transport equipment and accessories			270 562.75
		Mill machines	
10	3	Roller mills - metal construction, compact design, grinding rolls made of high-quality centrifugally cast iron, length 800 mm, diameter 250 mm	
19A	2	Assembling and lifting device for milling rolls	
19B	1	Spare parts (pair roller, flute)	
20	1	Vibratory feeder - metal construction, cast aluminium	

continued

Table 6 (continued)

Item No.	Quantity	Item	Price (SR)
21	1	Hammer mill - metal construction, with vibration damper, perforated sieve, withdrawable	
22	1	Plan sifter - metal construction, 8 compartments, 14 withdrawable sieves, abrasion-resistant, sieve cleaners	
22A		Spare parts: 8 spare sieve frames, not clothed, with sieve cleaners	
23	2	Drum detacher - metal construction	
24	1	Bran finisher - metal construction	
26	1	Impact detacher - metal construction, round casing	
26	1	Round filter - for separating dust from aspiration air, metal construction, cylindrical, air nozzles for bag cleaning, filter bags with fastening supports, discharge airlock, without rinsing unit	
Subtotal, mill machines			1 327 320.20
		Transport equipment and accessories	
27		Pneumatic conveying parts - all necessary parts, high-pressure fan, single receiver, airlocks, pipes, installation materials	
28	4	Screw conveyor - belts etc. for machines, metal construction, screw shaft with full flights, troughs covered, end and intermediate bearings, outlets	
29		Belts and drives	
30		Gravity flow pipes - straight pipes, elbows, inspection pipes with cover transition and connection spouts, cuffs, Y-pipes,	

continued

Table 6 (continued)

Item No.	Quantity	Item	Price (SR)
		quantity regulating slides, valve boxes, clamp, rings, tension rings etc. - prefabricated, made of metal sheets, diameter 120 mm	
31		Aspiration ducts - straight ducts, elbows, Y-spouts, connection spouts to machines, clean-out slides, butterfly valves, duffs hangers - prefabricated, made of galvanized sheet metal	
32		Steel constructions - prefabricated as far as possible. Supports and suspensions for machines and conveying equipment, various small erection material such as screws, handles, buttons, sealing material, paint	
33		Belt guards, if necessary	
34		Supports for motors, if necessary	
35	2	Sacking-off spout and buckle - diameter 300 mm, metal construction	
36	2	Sacking-off spout and buckle - diameter 300 mm, metal construction	
37	2	Sacking-off board - metal construction	
38	4	Supports	
39	2	Rope support	
40	2	Bar support	
Subtotal, transport equipment and accessories			513 203.25
		Packaging	
41	1	Gross bagging machine - bran capacity 30 kg, metal construction, lever mechanism with bag spouts and counter-weight pans, separate pre-loading	

continued

Table 6 (continued)

Item No.	Quantity	Item	Price (SR)
		equipment for coarse and fine stream, bag clamp manually operated, product feed with screw conveyor	
42	1	Bag sewing machine - metal construction, sewing head type, including spring load, suspension device	
43	1	Gross bagging machine - flour capacity 25 kg, metal construction, lever mechanism with bag spouts and counter-weight pans, separate pre-loading equipment for coarse and fine stream	
44	1	Single-spout bagging machine for flour - for open bags, with scale, metal construction, capacity 1 to 5 kg bags with double-screw feeder	
45	1	Vibro-discharge apparatus for flour - metal construction, round upper part with connection flange for fastening to the silo bin discharge, elastic suspension elements and flexible connection cuff, vibro motor	
46	1	Vibro-discharge apparatus for bran - metal construction, round upper part with connection flange for fastening to the silo bin discharge, elastic suspension elements and flexible connection cuff, vibro motor	
Subtotal, packaging			689 463.50
		Diverse accessories	
		Spare parts for 2 years' operation	100 500.00
		Accessories:	234 500.00
1		Fork lift, 1.5 tonnes	
100		Pallets	
3		Wheelbarrows	

continued

Table 6 (continued)

Item No.	Quantity	Item	Price (SR)
	div	Brooms, shovels Spraying gun for insecticide, including 1,000 l insecticide	
		Packing material	
	72 000	25-kg bags, polypropylene	92 460.00
	200 000	1-kg bags, paper	33 500.00
	Total, mechanical equipment		3 402 068.10
	Electrical equipment		
47 to 58	-	Motors and gear motors - totally enclosed, fan-cooled, fan cover, for intake, cleaning, mill, bagging equipment, insulation class F, protection IP54 220V, 50 Hz	
59	-	Electrical control systems for cleaning and mill - switch panel dust-tight steel-sheet design, doors on front side, bush-bars, contactors, individual on-and-off actuating elements for every motor, with interlocking. Main switch, ammeters, voltmeters, acoustic trouble indicator, with internal writing. One emergency shut-off switch on every floor with maintenance switch at the motors	
	Subtotal, electrical equipment		355 904.00
		Power factor correction equipment	27 135.00
59A	1	Equipment	
	Total, electrical and power factor correction equipment		383 039.00
	Laboratory equipment (optional)		
60	1	Laboratory plan sifter for sifting analysis	
61	1	Desicator - 1 bottle blu gel, 200 grams	

continued

Table 6 (continued)

Item No.	Quantity	Item	Price (SR)
62	1	Hectolitre scale for determining the hectolitre weight of all types of grain - sample capacity 0.25 litre. Measuring device with cut-off slide, scale with a set of weights, comparison table	
63	1	Gluten washer - washing dish made of corrosion-proof resin plastic and washing tray, complete with standard accessories: 1 dough-preparation bowl 1 dough-preparation rod 1 dough-preparation plate 1 gluten press 1 pair of tweezers 1 pipette for 10 cm^3 3 settling glasses for 50 cm^3 1 mariotte bottle for 5 litres salt solution 2 clamps for the rubber tube 3 meters rubber tubing	
64	1	Electronic analytic balance - readability 0.1 mg, weighing range 0.82 g	
65	1	Laboratory break mill - degree of fineness adjustable	
66	1	Electric ash test oven - for ash test samples up to a maximum of 1,100 °C, temperature control with indication	
Total, laboratory equipment			97 083.00
Total, all machines, equipment and accessories			3 882 190.10

The machinery should be ordered well in advance, but it should not arrive at the port of Victoria more than three months prior to installation. Facilities will be needed for storing and loading and unloading machinery and equipment until the building is completed. The facilities necessary for such storage are shown in table 7.

Table 7. Storage conditions for equipment

Equipment	Open-air storage	Sheltered storage	Closed, dry storage	Motor protected by plastic	Polished part to be lubricated	Crane for loading	Fork-lift truck for unloading
Magnetic apparatus		x			x		
Scourer		x			x		x
Dry-stone separator		x		x	x		x
Separator		x		x	x		x
Dampener		x			x		
Dumper scale		x			x		x
Cyclone		x		x	x		x
Centrifugal fan		x		x			x
Round filter		x		x	x		x
Bucket elevator		x		x	x		x
Screw conveyors		x			x		x
Belts for bucket elevator			x				x
Chain drives		x			x		x
Metal spouting		x					x
Aspiration ducts		x					x
Belts for machines			x				
Sacking-off board		x					
Gravity-flow pipes		x					x
Roller mills		x		x	x	x	
Vibratory feeder		x		x			
Hammer mill		x		x	x		x
Plan sifter		x		x	x	x	
Drum detacher		x		x			x
Impact bran finisher		x					x
Impact detacher		x		x			x
Pneumatic parts		x	x	x	x		x
Air locks		x		x			
Screw conveyor		x		x	x		x
Scales		x			x		x

continued

Table 7 (continued)

Equipment	Open-air storage	Sheltered storage	Closed, dry storage	Motor protected by plastic	Polished part to be lubricated	Crane for loading	Fork-lift truck for unloading
Bagging machine		x		x	x		
Vibro discharge apparatus		x			x		
Electrical equipment		x	x				x
Electrical control system			x				x
Laboratory equipment			x				x
Wood construction		x					x
Steel construction	x						x
Erection materials			x				x
Building materials, steel construction	x					x	

C. Utilities

The factory will require daily 124.8 kW electricity (see table 8), 26.0 kW for air-conditioning and lighting (this equipment can be purchased on the local market) and 0.4 m^3 water.

Table 8. Energy consumption of electrical equipment

Drives	Equipment	Total consumption (kW)
1	Scourer	5.5
1	Separator	-
1	Dry stone separator	0.8
1	Damper	1.1
1	Dump scale	-
1	Round filter	3.0
1	Centrifugal fan	5.5
1	Bucket elevator, 10 t/h	1.5
2	Bucket elevators, 5 t/h	3.0
1	Screw conveyor	1.1
3	Roller mills (total)	44.0
1	Vibratory feeder	0.2
1	Hammer mill	11.0
1	Plan sifter	3.0
2	Drum detachers	3.0
1	Bran finisher	2.2
1	Impact detacher	3.0
1	Round filter	3.0
1	High-pressure fan	18.5
4	Screw conveyors	8.8
1	Gross bagging machine - bran	2.2
1	Bag sewing machine	1.1
1	Gross bagging machine - flour	2.2
1	Single-spout bagging machine - flour	1.1
	Total	124.8

III. SITE AND BUILDING

A. Site

The flour mill will be located on the island Mahe, the main island of Seychelles (154 km^2). The island has an estimated population of 57,500; its capital, Victoria, has 23,000 inhabitants. It is situated 4° south of the equator and has a moist, tropical climate and constant temperatures, the annual rainfall being 2,294 mm, humidity 80 per cent and average temperature 24.5 °C. The climatic conditions of the island over a 12-month period are shown in table 9.

The structure of agriculture in Seychelles is very fragmented. It consists of a few large estates and outlying islands mainly involved in coconut and copra production; several hundred small farmers or small holders, usually with less than 5 acres of land and mainly involved in fruit and vegetable production; and several small livestock holders. There is no grain under cultivation on the island; it must be imported from abroad.

Since the location of the flour mill is dependent on the location of the animal feed plant, representatives of SMB have located a site in the new harbour of Victoria opposite the animal feed plant. The advantages of the site are savings in the cost of transporting building materials and raw materials as well as savings in investment costs and labour. A description of the site and infrastructure is given in table 10.

The site is located on new ground with a granit rock base that was refilled with stones and soil six to seven years ago. Ground water is about 1 m below the surface. Thus, the mill should be constructed on a concrete foundation plate on which the steel structure for the building could be mounted. The concrete foundation for the building will be designed and executed locally according to the construction data provided by the supplier of the equipment and building, who will co-ordinate construction. Because the area is new, boundaries can be drawn up as required.

A general layout showing the position of the mill and storage facilities and the animal feed factory is given in figure I. The costs of land, site preparation and the concrete plate are given in table 11.

B. Building

The building will be of prefabricated steel. The flour mill portion of the building (4 x 18 m) will have 2 and 3 storeys with a height of from 9.4 to 13.4 m. The storage area for raw material and bran (20 x 18 m) will flank the mill on one side, the storage area for flour (8 x 18 m) on the other. The storage areas should be about 5 m high. Drawings of the mill and storage areas are presented in figures II-VI. The estimated costs are given in table 12. The building should be constructed to provide adequate ventilation (natural and with the aid of ventilators), and pest control and fumigation should be easy (it should be possible to close off the building). The compact design should allow for optimal transport possibilities between raw-material storage, the flour mill and final product storage. The extension of storage areas is possible, if required.

Table 9. Climatic conditions on Mahe a/ (average for 1972-1983)

	January	February	March	April	May	June	July	August	September	October	November	December	Year
Rainfall (mm)	405	295	177	203	107	54	65	90	132	212	241	314	2 294
Sunshine (hours per day)	5.1	6.4	6.9	7.6	8.5	7.9	7.3	7.6	7.6	7.3	6.8	5.3	7.0
Mean maximum temperature (°C)	29.8	30.4	30.9	31.3	30.6	29.4	28.5	28.5	29.0	29.6	30.1	29.9	29.8
minimum temperature (°C)	24.1	24.7	24.8	25.0	25.6	25.0	24.2	24.1	24.3	24.3	24.0	23.8	24.5
Humidity (percentage)	82	80	79	80	78	79	80	79	79	80	80	83	80

a/ At the International Airport (sea level). Maximum winds are 61 knots.

Table 10. Utilities and infrastructure available on site

Item	Description
Location	Victoria, New Port (sea level)
Size	Land: 65 x 60 m For buildings: 32 x 18 m
Streets	Not constructed, except for main road
Water supply	Treated water (1.5 ppm chlorine level) available. No water lines on site
Electricity	3-phase, 220/41 V, 5 Hz, three-point, square pin plugs necessary. Electric lines not available on site
Fuel	Available in sufficient quantities
Waste disposal	Waste must be transported from site. Sewerage system must be erected by local authorities
Railways	None
Water transport	New Port, 3-4 km from site. Storage facilities at port
Air transport	International Airport, 8 km from site. No storage facilities available
Passenger transport	Bus or taxi
Communications	Post office, telephone, telex, telegraph and radio available from Cable and Wireless Ltd. on a 24-hour basis
Manpower	Available in sufficient numbers
Construction, erection and maintenance facilities	Available from local companies such as Seychelles Construction Company (SCC), Mahe, Victoria; Building and Civil Engineering Contractors, Mahe, Victoria; Seychelles Electricity Corporation, Mahe, Victoria
Building materials	Sand, stones, packed and bulk cement (SR 20-40/kg) available on local market
Living conditions	Usually in guest house or hotels; European food available; recreation on weekends; greengrocer, supermarket
Medical facilities	Visitors may obtain emergency treatment under the National Medical Service at a basic consultation fee of SR 75. Prescribed medicines and drugs available at hospital pharmacy and some chemists. Main hospital, out-patient clinic and dental clinic located at Mont Fleuri

Figure I. Site plan of mill and animal feed factory

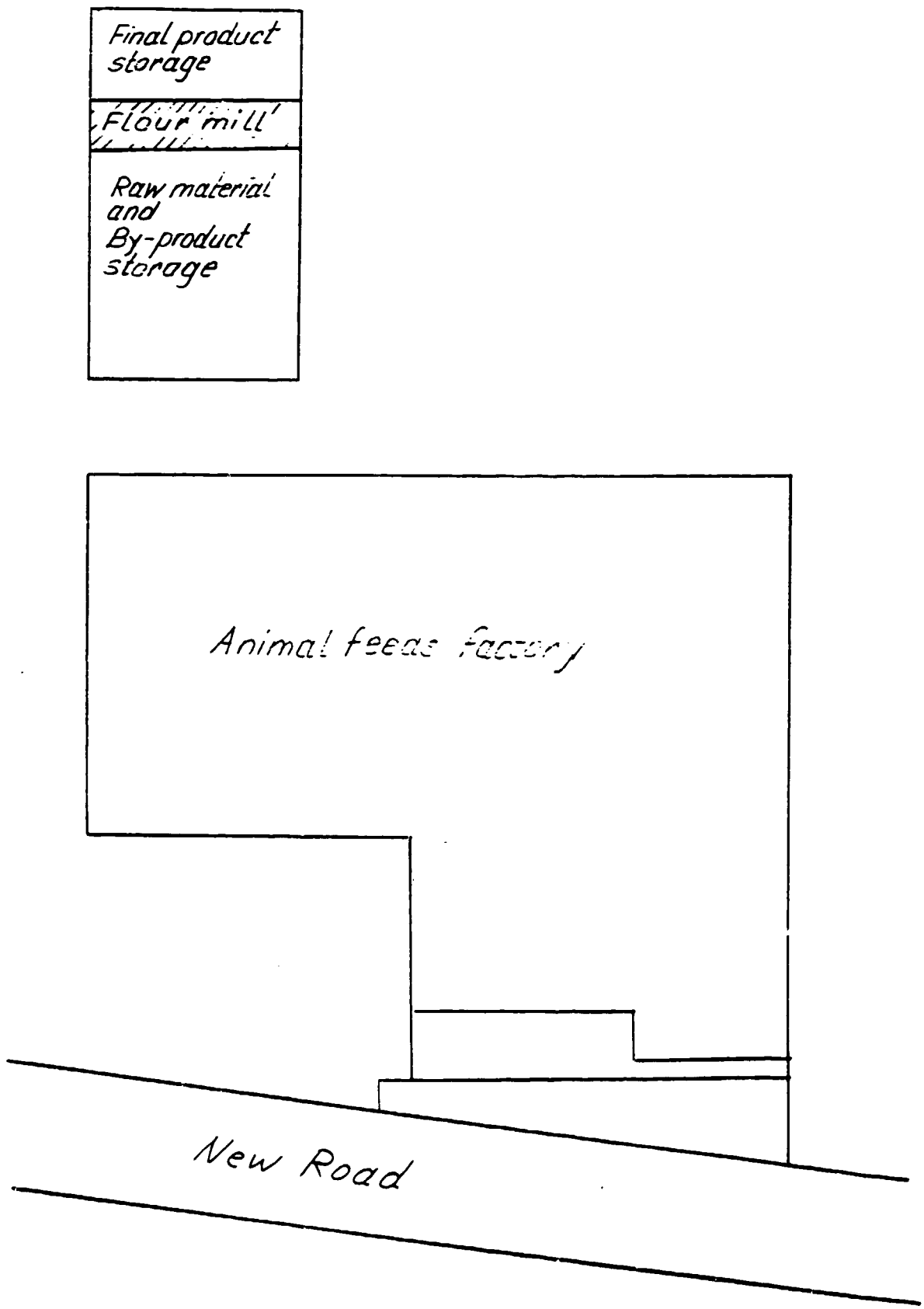


Table 11. Cost of site, preparation and concrete base

Item	Cost (SR)
Base plate (576 m^2 at SR 600/m^2)	
Flour mill (72 m^2)	43 200
Raw material storage (360 m^2)	216 000
Final product storage (144 m^2)	86 400
Subtotal	345 600
Site preparation, fencing, roads	80 000
Water supply, sewerage	4 000
Electricity and communications	16 000
Land	42 900
Total	488 500

Table 12. Cost of building

Description	Material (SR)	Erection (SR)
Flour mill a/		
Steel construction (18 main and secondary beams for intermediate floor with 600 kp/m^2, 8 roof beams, 6 other beams, diverse roof and vertical wall beams)	168 950.00	43 090.00
Silo (two silos, 20-t capacity)	278 783.00	22 568.00
Chequered plates for floors (72 m^2 at SR 285.20/m^2 of plates and SR 93/m^2 for laying plates)	20 534.40	6 696.00
Staircase, floors of gratings, hand-rails, testing	21 700.00	4 588.00
Roof covering (0.7 mm steel trapezoid galvanized, screwed-on steel beams, including closing)	12 028.00	4 836.00
Facade covering (0.7 mm steel plate, galvanized, covered with colour safety foil)	28 334.00	15 159.00
	530 329.40	96 937.00
Subtotal, flour mill	627 266.40	
Storage areas b/	1 164 639.00	
Total, mill and storage areas	1 791 905.40	

a/ 18 x 4 m; 9 m or 13 m high. Total weight of steel construction about 35 t. Total erection time with crane about five weeks.

b/ 20 x 18 m for raw material, 8 x 18 m for flour, both 4 m high. These areas can be constructed by the same contractor as the flour mill.

Figure II. Cross-section drawing of mill and storage areas

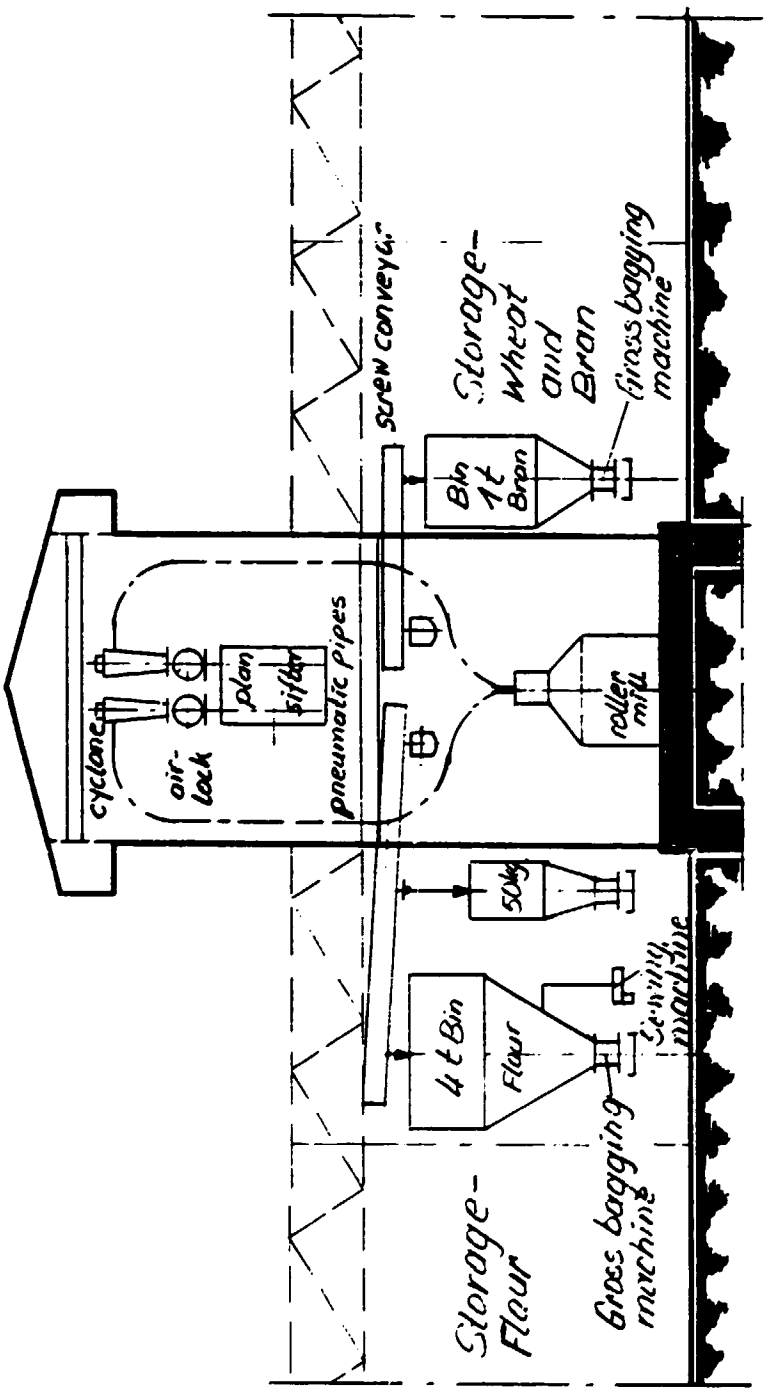


Figure III. Mill, side view

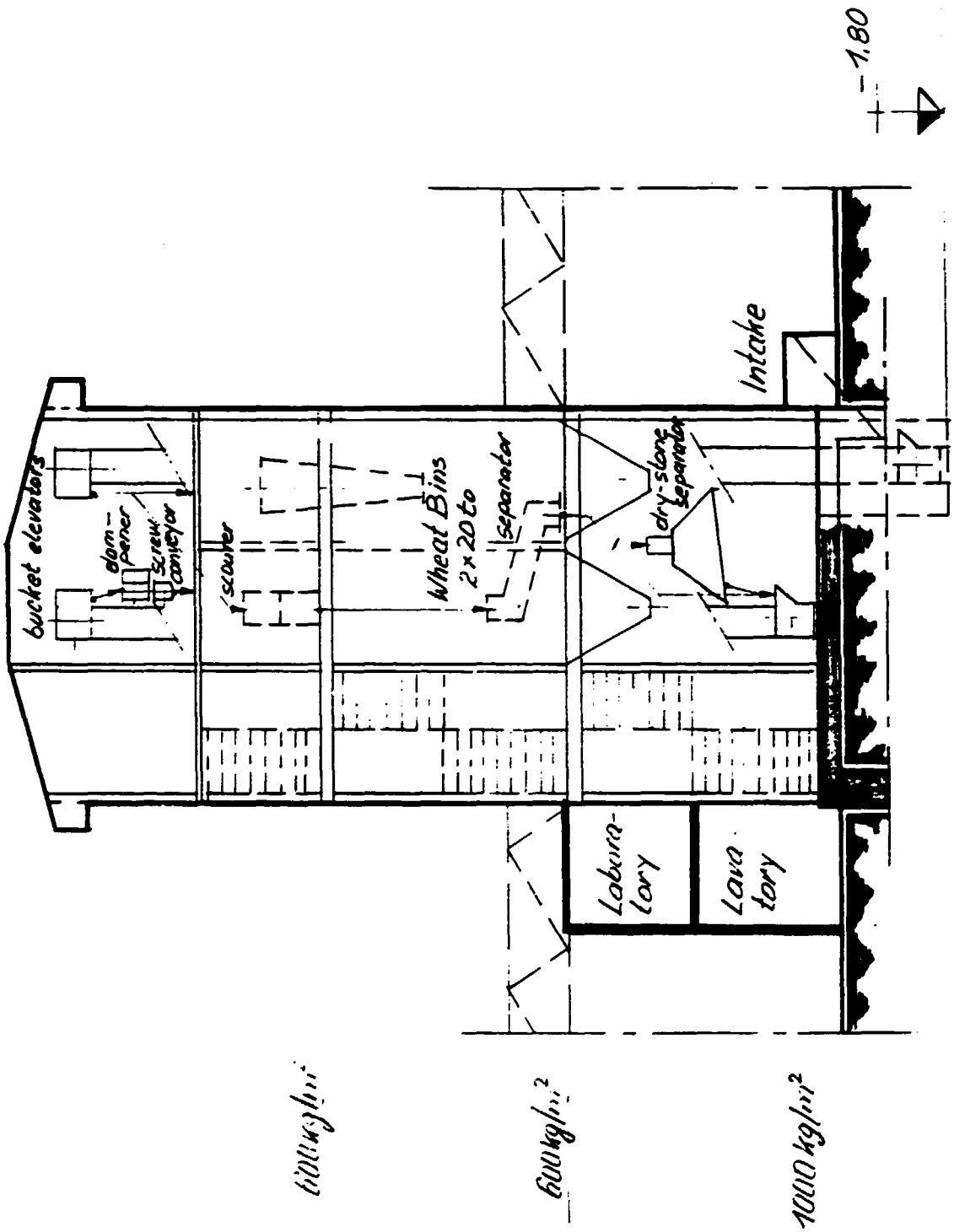


Figure IV. Mill, longitudinal view

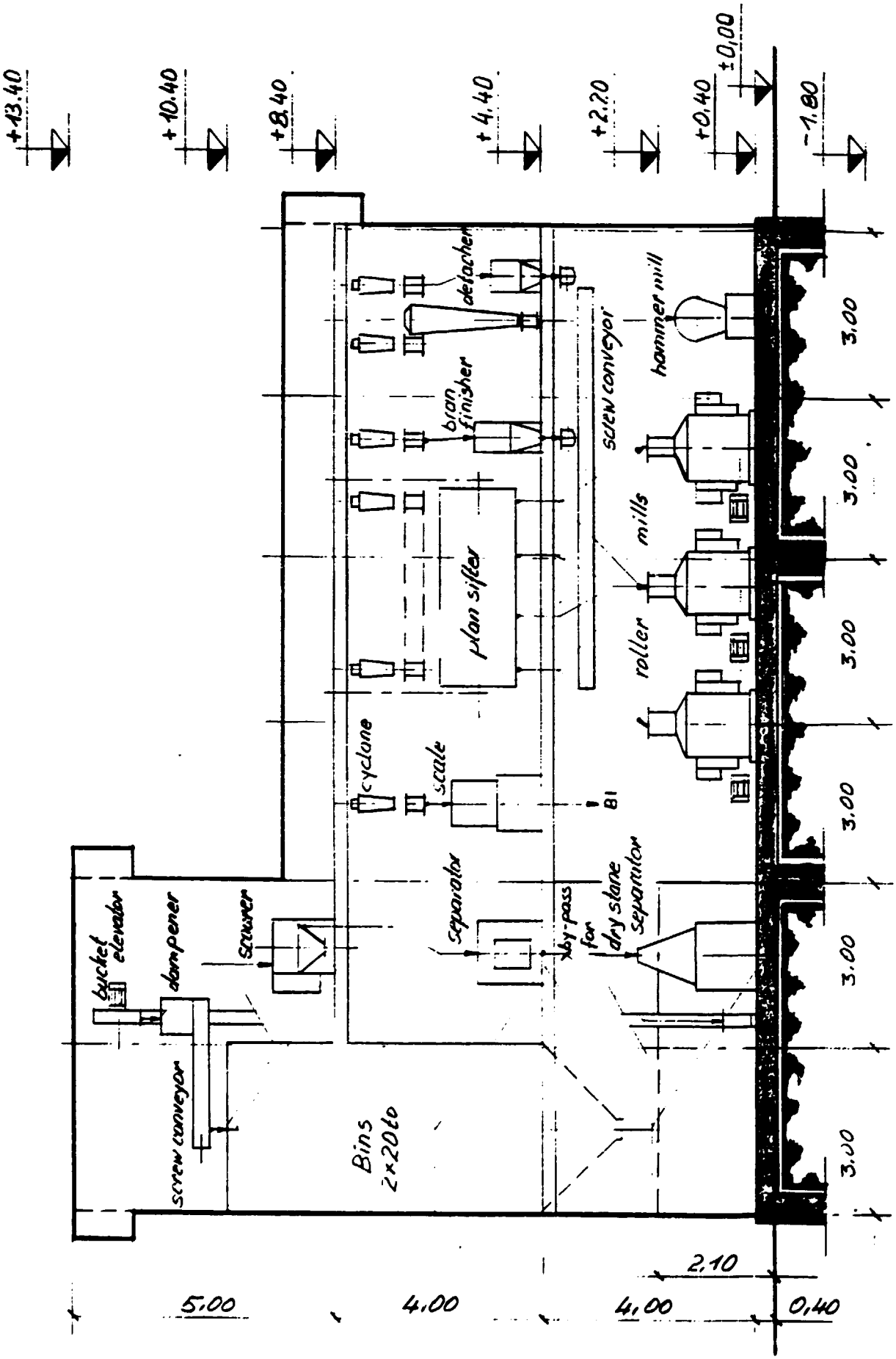


Figure V. Layout of mill, ground level

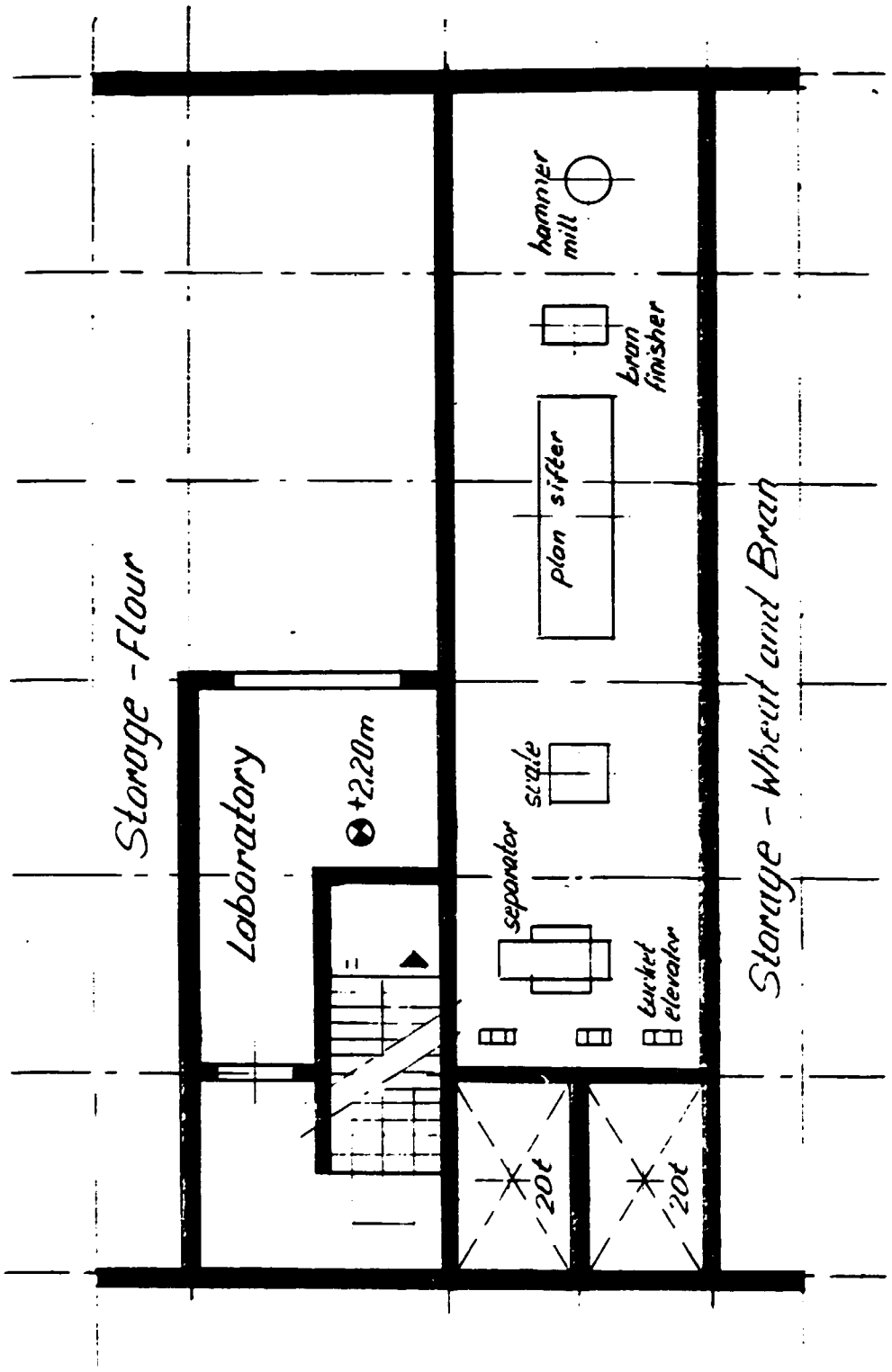
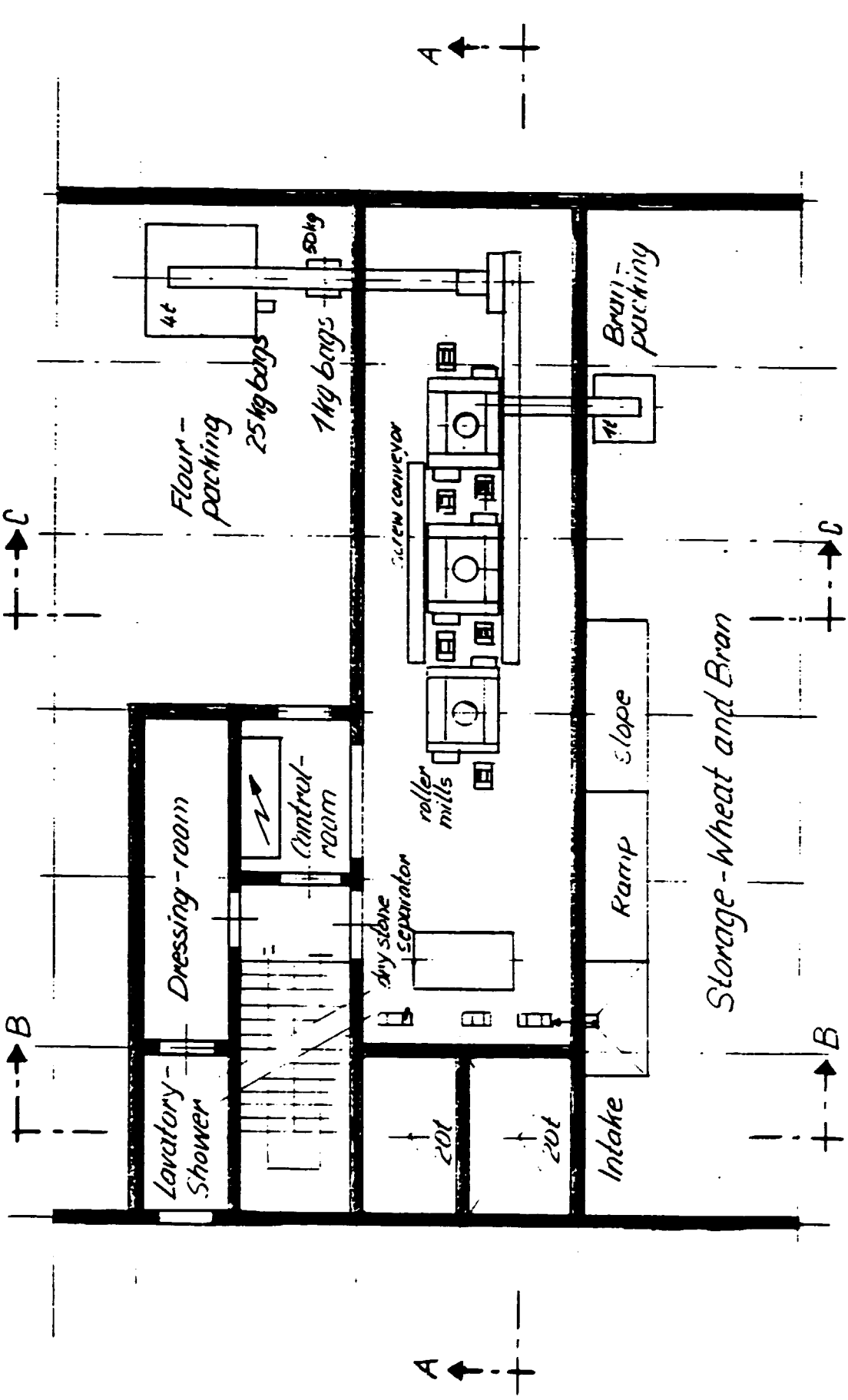


Figure VI. Layout of mill, upper level



IV. PROCESS

A. Technology

The flour mill will have the following departments (see figure VII):

Intake, capacity 8 t/h
Cleaning, capacity 1 t/h
Mill, capacity 16 t/d of wheat (two shifts) = 8 t/d of flour
Packing
  Flour, in 1-kg and 25 kg bags
  By-product (bran), in 30-kg bags

The processing steps are described below.

Intake

The grain from containers or bags passes through the intake and is lifted up by a bucket elevator and stored in metal or concrete bins with a capacity of 20 t.

Cleaning

The grain is taken from the storage bins by gravity flow pipes; it is lifted up by bucket elevator and passes through the following stages:

Magnet, for the elimination of metal parts

Scourer, which separates impurities such as sand, dust and small seeds; removes dirt and husks adhering to the grain; reduces the bacteria content; and eliminates insects and their fragments

Separator, for cleaning grain, sizing various seed products, classifying by-products

Dry-stone separator, for the removal of inorganic matter such as grain-sized stones, glass or metal parts from pre-cleaned grain and for the separation of other foreign bodies

Dampener, for dampening grain with water

Screw conveyor, for mixing damped wheat and transport

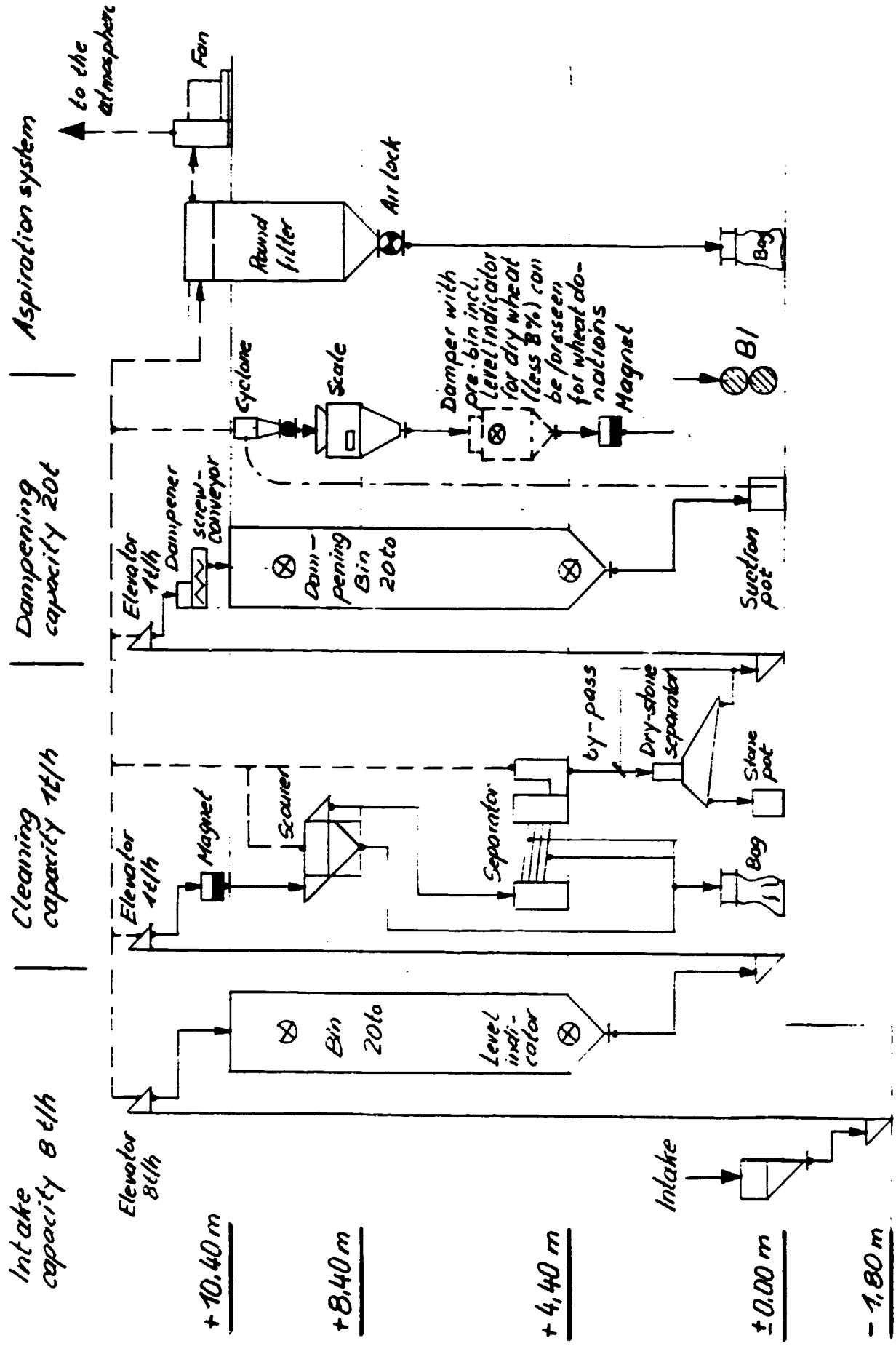
Conditioning bins, with a capacity of 20 t, for storage

Mill

Roller mills. The conditioned soft wheat is removed pneumatically from the conditioning bins and passes through a cyclone to a dump scale, for measuring the quantity, and the magnet, for the elimination of metal parts and is processed in the mill by three roller mills. The roller mills are subdivided in four passages, equipped with four break passages with flute rollers and eight extraction passages with smooth rollers. The roller diameter is 250 mm and the length 800 mm. 1/ The endosperm is reduced to small pieces in several steps or passages. The husk of the wheat pieces should be kept as large as possible.

1/ Each fluted roller can grind 2,000-3,000 t of wheat and is thus in operation about three years. The rollers must then be fluted again, probably in Kenya, which is the nearest location where this can be carried out.

Figure VII. Technical diagrams



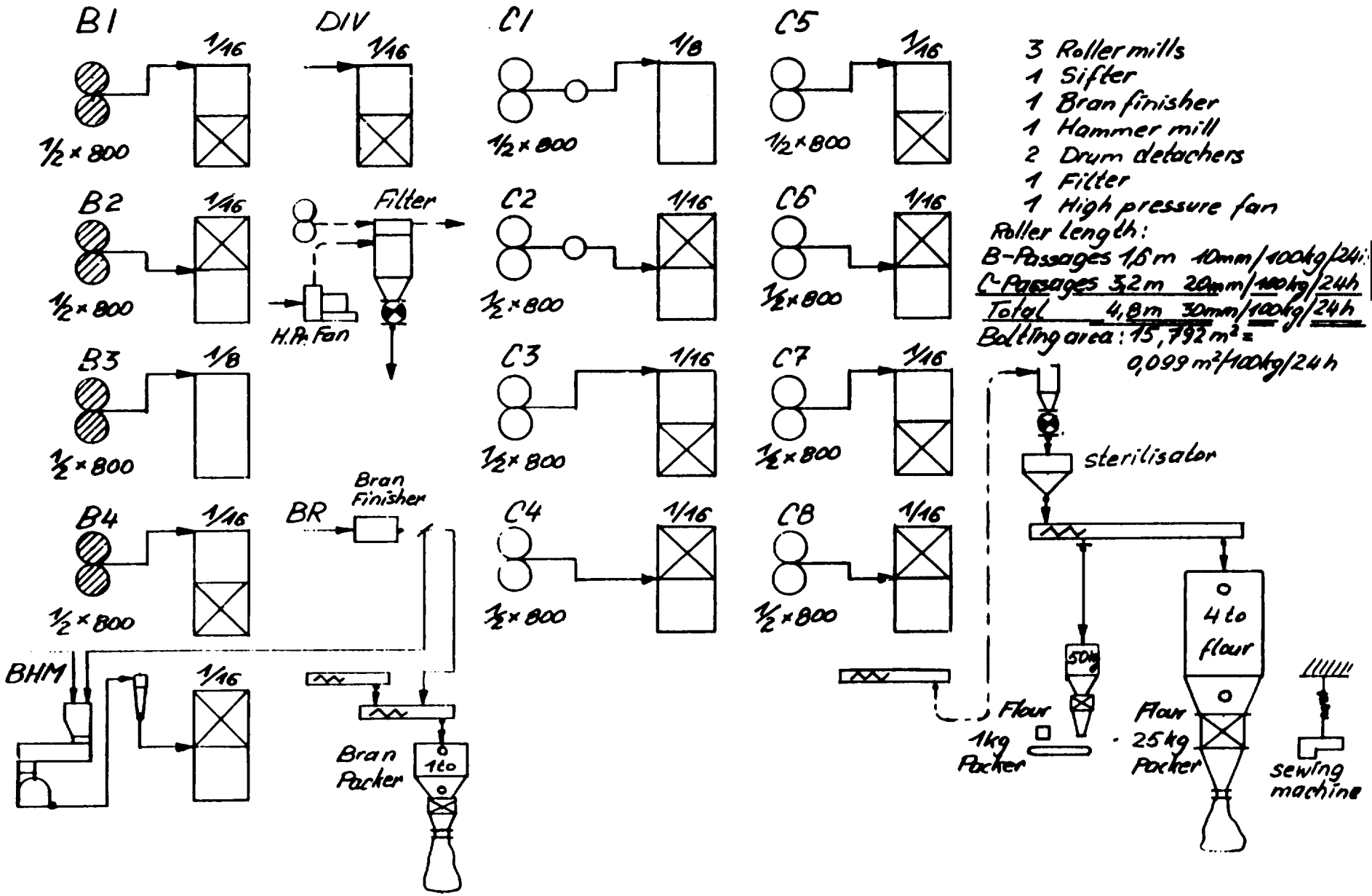


Figure VII. Technical diagrams (continued)

Plan sifter. The plan sifter consists of eight compartments with four sieves and six compartments divided in two passages so that the products of each roller mill passage can be sieved individually. After each passage, the grinded product is sorted by sieves into several groups in the plan sifter. If the product has the required granulate size, it is passed on to the final product stage. Other (larger granulate) groups (dust, semolina) are reduced to small pieces.

Impact bran finisher. The by-product bran passes through an impact finisher to obtain the remaining flour components. The bran can be packed or transported to a hammer mill.

Hammer mill. Bran is ground and transported to the plan sifter, if required, where the bran is separated and a dark flour (85-90 per cent extraction, ash content approximately 2 per cent) is obtained.

Drum detacher. Two reductions are foreseen for the milling process.

Mixing of flour. The flour from the plan sifter is collected and mixed in a screw conveyor and conveyed to an impact machine.

Impact machine. Existing insects, including eggs, are destroyed to obtain good storage properties.

Packing. The final product is packed as follows:

Flour, 25 kg bags. Flour is transported to a bin with a capacity of about 4 t. The 25-kg bags can be filled from the bin manually during the day shift using a gross bagging machine.

Flour, 1-kg bags. Flour from the large bin passes through a slide valve to a small bin with a capacity of about 50 kg. Bagging is done only during the day shift, using a single-spout bagging machine located below the 50-kg bin.

Bran, 30-kg bags. Bran is transported to a bin with a capacity of about 1 t. The 30-kg bags are filled manually during the day shift using a gross bagging machine. It can be sold to the animal feed factory.

Taking off impurities. Impurities from the cleaning machines can be collected in bags and sold to the animal feed factory.

Aspiration. The aspiration air from the whole plant (cleaning and mill) is purified by round filters and then blown out into the atmosphere.

Laboratory. The wheat and flour should be tested in the laboratory, which is equipped with: laboratory plan sifter, desiccator, hectolitre scale, gluten washer, electronic analytic balance, laboratory break mill and ash test oven.

B. By-products of the flour mill

During the milling process of wheat to flour, by-products are obtained. Wheat feed flour consists of susceptible after-flour from the coating of the grain. Bran consists mainly of the husk and other remaining pieces or kernel.

In order to sell these by-products to the animal feed plant, they should be free of animal pest and not contain lumps, mould or metal parts. Impurities such as broken grain etc. are ground by a hammer mill in the animal feed factory.

The smell of the by-products is characteristic but not unpleasant. The by-products can be used for the manufacturing of mixed animal feeds for animal breeding by an industrial process to make a prepared prescription for poultry feed, cow feed, pig feed and special feed.

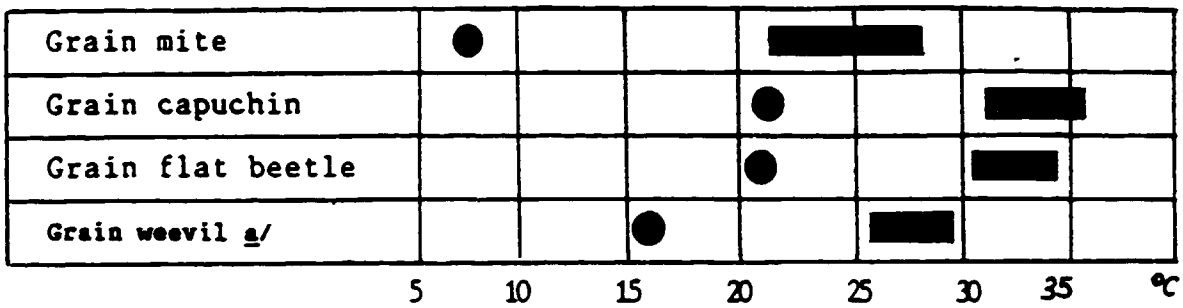
The production of wheat feed flour is not foreseen in the proposed flour mill. The animal feed factory has special requirements, some modification in the mill are necessary (additional gravity-flow pipes and one sack off board). This can be done at any time.

C. Infestation in grain and flour

As noted above, the planned capacity is 2,000 tonnes flour per year, which is some 200 tonnes over the estimated consumption. One reason for this is that an allowance has to be made for the possible infestation of grain or flour.

Grain and flour are subject to attack by pests and mites at certain temperatures and humidity (see figure VIII and table 13). Primary damage can be caused by grubs on the wheat germ, thus polluting the stored grain (mite mud, lava, mites etc.). Secondary damage occurs when the humidity and temperature of the grain increases, which can result in future waste owing to mould, beetles and disagreeable smells.

Figure VIII. Temperatures at which grain pests are active



a/ Very dangerous.

Table 13. Conditions for flour mite infestation

Stage	Temperature (°C)	Relative air humidity (%)
Start of life, without mass increase	10-20	63
Mass increase possible	25-30	67.5-72.5
Optimal conditions for mass increase	15-25	80-90

The temperature and cleanness of the grain must therefore be checked carefully. In particular, the bor'er layers of the grain are subject to attack. In order to fight agains sts, the grain should not have a moisture content exceeding 13.5-14 per cen It should be cleaned such that impurities do not exceed 2 per cent. The air temperature should not be more than 5-6 °C lower than the grain temperature. Chemical methods such as the sprayer method for fumigation with "Nuvan 7" every six weeks or fumigation with "Phostoxin" every six months may be used, but they are not 100 per cent effective.

V. STAFF AND TRAINING REQUIREMENTS

The staff of the plant are organized as shown in figure IX.

A. Administration

The administration staff (five people) is to be provided by SMB, Agro Division. The staff consists of:

One general or commercial manager/co-ordinator who is responsible for contracts to buy wheat and sell flour and for discussing quality and quantity with local authorities

One secretary, who organizes the office work

One accountant, who calculates expenses, handles receipts, the settlement of accounts, payment on accounts and keeps accounts

Two security officers for day and night duty

B. Mill staff

The flour mill staff (ten people) consists of:

Two head millers (one for each shift), who are directly responsible for production and co-ordination in the mill, quality, quantity, control and operation

Two electricians, who check daily the electricity consumption and carry out electrical maintenance in the factory

Two mechanics, who check the machines and lubrication, the strength of belts and carry out maintenance in the factory

One storekeeper, who also acts as quality- and pest-control supervisor. The storekeeper keeps track of incoming and outgoing stock, is responsible for the storage of raw material, flour and bran and checks for quality and quantity of storage and for infestations of grain and flour and carries out fumigation. The storekeeper is assisted by the intake and packaging operators. He is also responsible for the fumigation of the flour mill

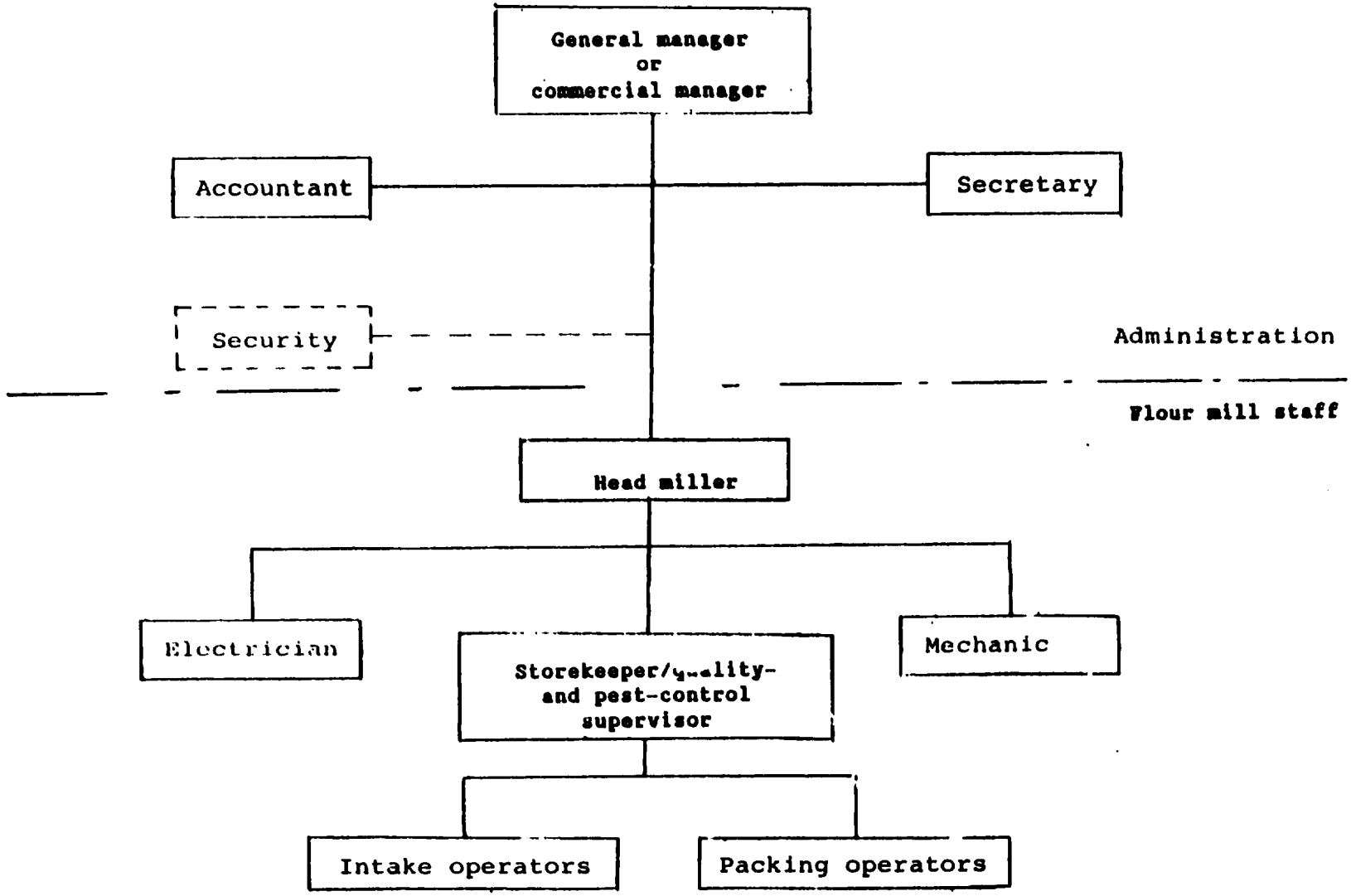
One intake operator, who takes over the grain and stores it under good conditions, puts grain in the intake, cleans the wheat bags and stores the bags for packing bran and packs bran and stores it until it is sent to the animal feed plant

One packing operator, who collects 1-kg and 25-kg bags and is responsible for packing, weighing, manual closing (1-kg bags) or sewing (25-kg bags), loading, cleaning the storage area and transportation

One reserve worker, as intake or packing operator as required

A total of seven flour-mill staff are required for the day shift and three for the late shift (head miller, electrician and mechanic).

Figure IX. Organizational structure



C. Salaries and wages

The total costs of salaries and wages are given in table 14.

Table 14. Salaries and wages a/

Position	Salary or wage per month (SR)
Administration b/	
General Manager	6 000
Secretary	2 000
Accountant	2 000
Security	1 500
Security	1 500
Total salaries per month	13 000
Total salaries per year	156 000
Mill staff	
Head millers (2)	8 000
Electricians (2)	6 000
Mechanics (2)	6 000
Quality- and pest-supervisor	3 000
Intake operator	1 500
Packing operator	1 500
Reserve operator	1 500
Total wages per month	27 500
Total wages per year	330 000
Total, salaries and wages per month	40 500
Total, salaries and wages per year	486 000

a/ Working eight hours per day, 250 days per year for a total of 80 hours per day or 20,000 hours per year.

b/ Five staff, for a total of 60 working months per year.

D. Training

The head millers, electricians and mechanics should receive training through a programme consisting of a practical and theoretical course.

Head millers

The theoretical course should cover specialized knowledge, grain processing, process engineering, mechanical engineering, testing methods and maintenance and operation of a flour mill, machines, conveyors and scales.

The practical course should cover grain processing, intake, pre-cleaning, milling, mixing, packing, storage of final products, mechanical engineering, explanation of the machines and plant parts in grain processing, process engineering, organization and testing for the whole process in the flour mill. Starting from intake of grain to the output of final products, the course should include:

(a) Planning, preparation, management and testing of the production process;

(b) Production techniques;

(c) Quality parameters for the flour mill and laboratory, handling of various laboratory equipment and testing (preparation for and carrying out the analysis of raw materials and final products) according to standards, norms and laws;

(d) Insect and pest control in the mill and storage;

(e) Planned maintenance;

(f) Recognition and removal of disturbances during operation;

(g) Procurement of aids, tools, and spare parts;

(h) Checking energy consumption;

(i) Grinding and fluting of roller mills;

(j) The relationship between throughput, output and quality and study of diagram techniques;

(k) Determination of simple parameters for quantity, aspiration and pneumatic calculations;

(l) Daily control of milling, quantity, humidity, quality, kinds of grain, impurities etc.;

(m) Visit to different flour mills.

After erection of the flour mill, it would be possible to employ one head miller from the supplier of equipment for about three months; during that time the miller can teach the local employees.

Electricians

The theoretical course should cover specialized knowledge, grain processing, process engineering, testing methods, maintenance and operation of electrical equipment. It should also include the electro-technical basis for and functioning of electrical equipment, electrical installations, electrical machines, accumulators, electrical cables and lines, protection devices, the control system and measuring and test instruments. The practical course should cover the operation and functioning of electric plants, the maintenance of electric plants for the flour mill and climate equipment, carrying out of repairs, organization of spare parts, power and lighting installations and switch gears. With regards to electrical equipment, it should cover circuit diagrams, the control system, economical electricity consumption, construction, the purpose and maintenance of the main control room and work with electrical diagrams. The electricians should also visit different flour mills.

Mechanics

The theoretical course should cover specialized knowledge, grain processing, process engineering, mechanical engineering, testing methods and the maintenance and operation of flour mill machines, conveyors, scales etc. The practical course should cover working with tools and equipment for metal treatment, electrical and oxygen welding, bearings, lubrication, the maintenance and organization of spare parts and conveyors (screw, chain and bucket elevators) and the erection and maintenance of milling machines. It should also cover the erection, maintenance, grinding and fluting of main rollers and grain gravity-flow pipes as well as winding up of hoppers, connection pieces, and the installation of grain gravity-flow pipes, aspiration and pneumatic pipes. The course should also include maintenance of scales and other flour mill machines and practical work in a flour mill workshop.

Normally, the training of the staff and operating personnel for a plant of this size is done on the site during the installation of mechanical and electrical equipment and also during the start-up period. However, training should also be carried out at a training centre abroad. A suitable training period would be two months.

Training costs would include, for six people, the actual training cost (SR 130,200) plus air tickets for training abroad (SR 82,667.70). Thus the total cost would be SR 212,867.70.

VI. IMPLEMENTATION

A. Preliminary work

Implementation management

The Agro Division of SMB should initially provide an implementation manager and secretary. The implementation manager could later become general or commercial manager of the mill, if requested. The implementation manager is the counterpart to contractors (supplier of equipment and building), construction company and local authorities and is responsible for the observance of time schedules and all economical consequences as a representative of SMB. The two employee for 18 months would cost SR 144,000 in wages (manager, SR 6,000/month; secretary, SR 2,000/month).

Arrangements for technology supply

Machinery and equipment has been recommended by the expert (see table 6). The final technical negotiations should be carried out for the demarcation of co-operation obligations for handing over a turnkey flour mill. After technical negotiations are completed, arrangements for project financing have to be made with the supplier (sub-contractor).

Engineering and civil work tendering

In normal cases, investments are made following tendering, the evaluation of tenders, contract negotiations and preparatory work for site. It is also possible to select one of the existing offers and enter into technical negotiations and a discussion of terms of contract for a turnkey flour mill. It depends on which offer fulfils the requirements.

Financing arrangements

After discussion and selection of the offer, project financing and investment costs such as credit and merchandise exchange must be discussed. Suppliers' credits are also acceptable. An example for this project would be:

10 per cent down payment
10 per cent covered by a letter of credit
80 per cent payable in 10 equal half-yearly instalments with an interest of 7.5 per cent per annum net

B. Installation of machinery and equipment

The installation of mechanical and electrical equipment for such a small flour mill should not take longer than three months. The staff (from supplier) needed for installation consist of:

1 head miller
1 chief of installation (mechanic)
1 electrician
Skilled workers
Helpers

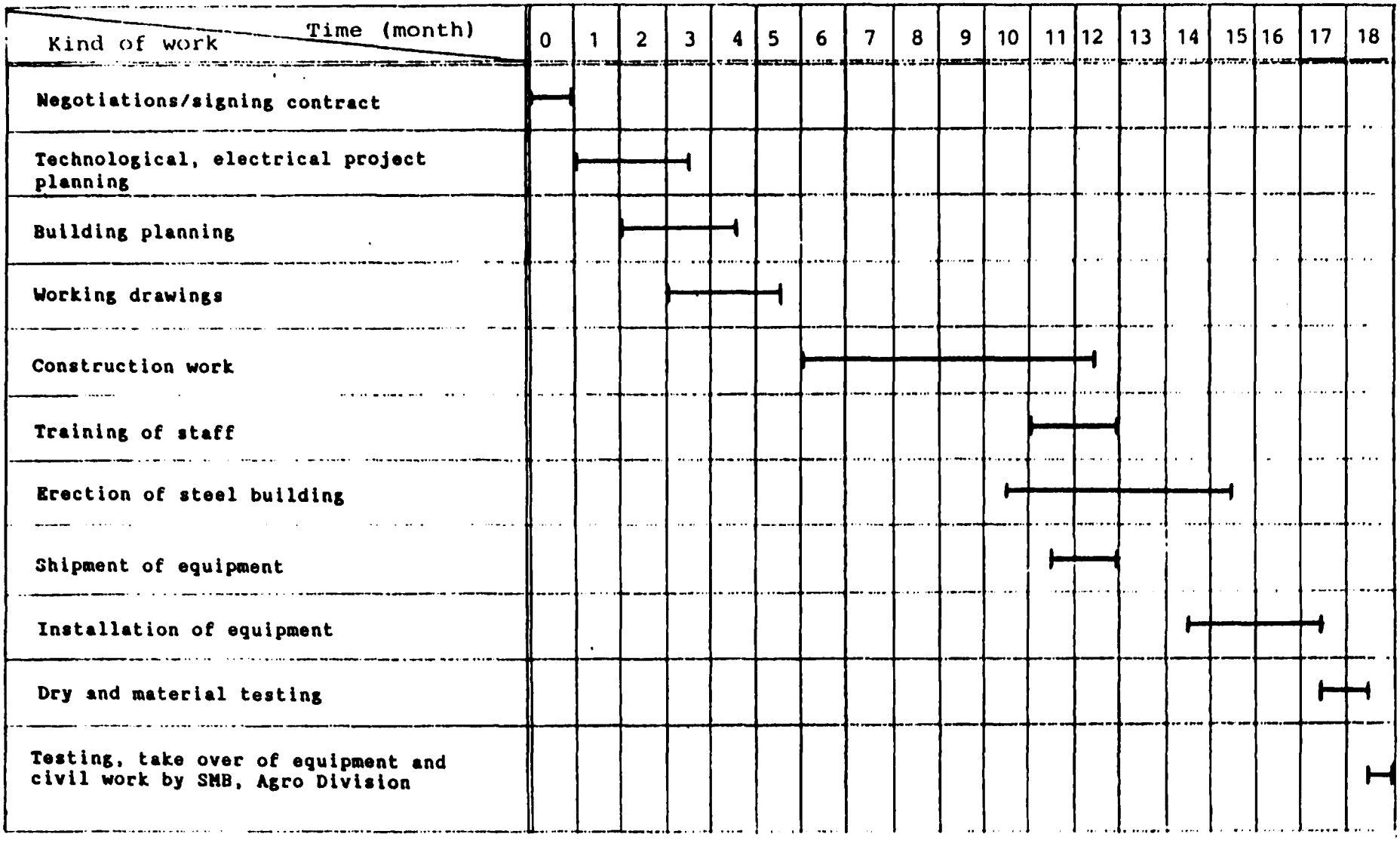
Included in installation time are: the finishing of construction work; finishing sanitary, electrical and lighting work, water supply, sewerage works; the actual installation; and the removal of waste.

The approximate cost for the personnel for the installation and start up of the flour mill, including air tickets and transport costs are (SR):

Installation	197 160.00
Tickets	41 335.40
Transport	77 500.00
Total	315 995.40

A plan for the total installation time is given in figure X.

Figure X. Implementation schedule



VII. COSTS AND FINANCIAL AND ECONOMIC EVALUATION

A. Costs

The total investment costs, as itemized in the previous chapters, are summarized in table 15.

Table 15. Investment costs

Item	Foreign currency equivalent (SR)	Local currency (SR)	Total (SR)
Machinery and equipment			
Mechanical equipment, including spare parts	3 309 234.50		3 309 234.50
Electrical equipment, including spare parts	329 344.00		329 344.00
Laboratory equipment	89 838.00		89 838.00
Delivery of equipment, c.i.f. port of Victoria	279 000.00		279 000.00
Land		42 900.00	42 900.00
Site preparation and development		100 000.00	100 000.00
Concrete base for building		345 600.00	345 600.00
Building, civil works, auxiliary and service facilities	1 791 905.40		1 791 905.40
Training	212 867.70		212.861.70
Installation costs	315 995.40		315 995.40
Packing materials	390 476.00		390 476.00
Total	6 718 661.00	488 500.00	7 207 161.00

As noted in chapter VI, section A, a manager and secretary will be needed in the preliminary stages (total expenditure SR 144,000), but these services may be provided by SMB.

The necessary working capital for the first three months is calculated in table 16.

Table 16. Estimated working capital (three months)

Quantity	Description	Cost (SR)
700 t	Wheat (soft)	1 295 000
700 t	Transport, wheat flour	21 000
	Packing material	63 956
8 400 kWh	Electricity	109 200
350 m^3	Water (technology, sanitary)	3 500
	Auxiliary materials	12 600
15 persons	Salaries and wages	127 701
Total		1 632 957

The costs of producing one tonne of wheat into flour are shown in table 17.

Table 17. Estimated production costs per tonne of wheat

Quantity	Item	Unit cost	Cost (SR)
1 000 kg	Transport wheat, flour	30.00	30.00
1 000 kg	Wheat (soft)	1 850.00	1 850.00
27 pieces	Polypropylene bags, 25 kg	1.19 a/	32.13
75 pieces	Paper bags, 1 kg	0.15 a/	11.62
3 pieces	Polypropylene bags, 30 kg	6.00	18.00
1 piece	Polypropylene bags, 50 kg	10.00	10.00
12 kWh	Electricity (technology lighting, air-conditioning)	13.00	156.00
0.50 m^3	(Water (technology, sanitary)	10.00	10.00
	Auxiliary materials (maintenance, oils, grease cleaning, paints, insecticide etc.)	18.00	18.00
15 workers	Salary and wages		182.43
3 900 m^2	Site depreciation (2 per cent, approximately 50 years)		1.07
	Building depreciation (4 per cent approximately 30 years)		34.22

continued

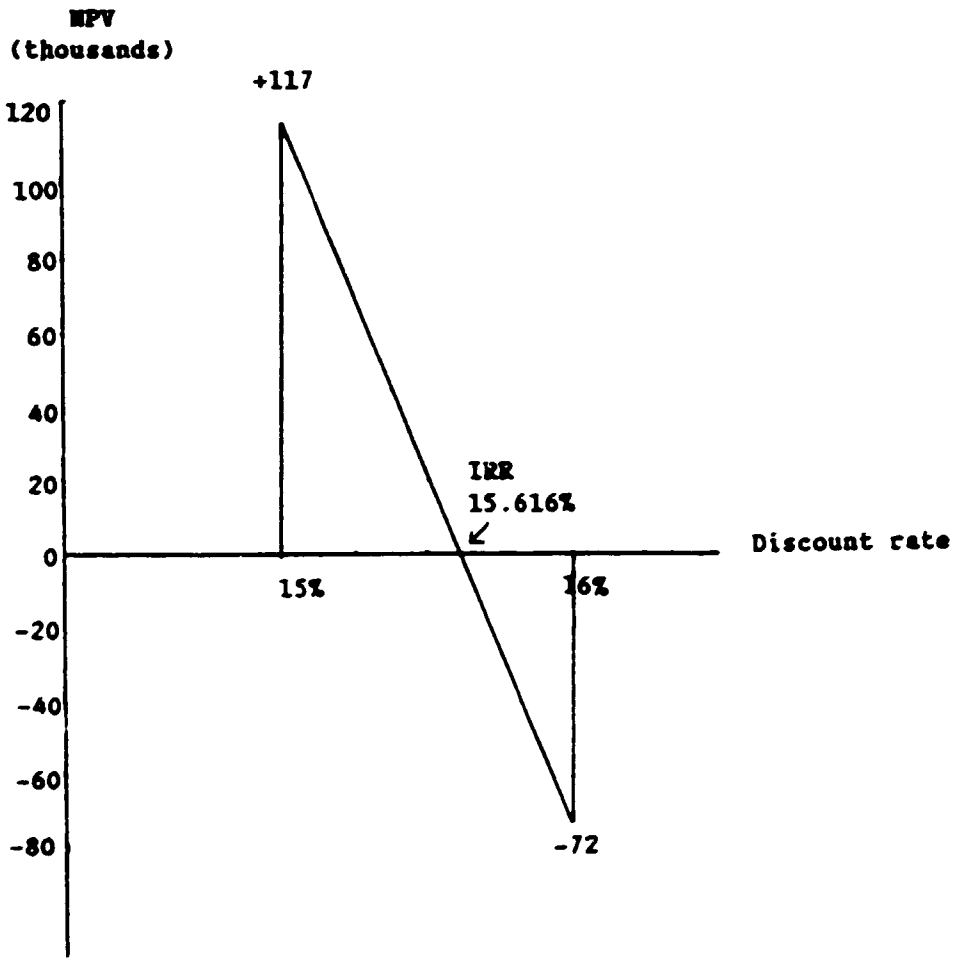
Table 17 (continued)

Quantity	Item	Unit cost	Cost (SR)
	Mechanical/electrical equipment (including freight, mounting, start, training etc.) - depreciation (5 per cent, approximately 10 years)		92.43
	Interest (7.25 per cent)		196.06
	Credit repayment (10 equal half-yearly instalments)		540.87
	Total		3 182.83
	Total annual estimated production costs for all materials and inputs		8 482 241.90

a/ Foreign currency.

IRR can be depicted graphically (see figure XI).

Figure XI. Internal rate of return



B. Financing

The decision on financing the project has not yet been taken. Some offers have indicated the normal payment terms for such a small project. Credit facilities from suppliers have also been investigated (10 per cent down payment, made with order; 10 per cent by a letter of credit; and 80 per cent payable in 10 equal half-yearly instalments, including an interest rate of 7.5 per cent). It is also possible that the project can be through loans.

C. Financial evaluation

Net present value

The net present value (NPV) of a project is defined as the difference between the present values of its future cash inflows and outflows, using the equation:

$$NPV = \sum_{t=0}^{n} (CI - CO)_t \, a_t$$

Where:

$\sum_{t=0}^{n}$ = sum total for life of the project (12 years), including construction time of 18 months

CI_t = cash inflow in year t

CO_t = cash outflow in year t

a_t = discount factor in year t, selected rate 7.5 per cent (interest rate from the supplier of equipment)

Thus, NPV = SR 7,614,816

Internal rate of return

The internal rate of return (IRR) is the discount rate at which the present value of cash inflow is equal to the present value of cash outflow (see table 18).

Calculation:

$$i_r = i_1 \pm \frac{PV\ (i2 - i1)}{PV + NV} = 15 + \frac{117\ 000.30(16 - 15)}{117\ 000.30 + 72\ 685.70} = \underline{15,616\%}$$

Simple rate of return

The simple rate of return is defined as the ratio of the profit in a normal year of full production to the original investment outlay. The simple rate of return method is based on accounting principles that frequently change from country to country, depending on existing legislation, and that do not allow the method to reflect the real profitability of the project.

Table 18. Internal rate of return

Year	Net cash-flow schedule	Discount factor at 16 per cent	Net present value	Discount factor at 15 per cent	Net present value
1	-1 384 452.00	0.862	-1 193 397.60	0.870	-1 204 473.20
2	-4 367 391.80	0.743	-3 244 972.10	0.756	-3 301 748.20
3	-1 456 758.80	0.641	-933 782.39	0.658	-958 547.29
4	1 453 874.20	0.552	802 538.55	0.572	831 616.04
5	2 910 633.00	0.476	1 385 461.30	0.497	1 446 584.60
6	2 910 633.00	0.410	1 193 359.50	0.432	1 257 393.40
7	2 910 633.00	0.354	1 030 364.00	0.376	1 094 398.00
8	2 910 633.00	0.305	887 743.06	0.327	951 776.99
			-72 685.70		117 000.30

The simple rate of return is calculated as follows:

Production per tonne of wheat:

	SR
Flour (750 kg at SR 5.20)	3 900.00
Bran (250 kg at SR 1.50)	+375.00
	4 275.00
Production cost per tonne	-3 182.83
Profit per tonne	1 092.17
Profit per year	2 910 633.00

Simple rate of return = $R_e = \frac{P}{Q}$

Where:

R_e = simple rate of return

P = net profit per year (SR 2 910 633.00)

Q = equity capital invested (SR 7 207 161.00)

$R_e = \frac{2\ 910\ 633.00}{7\ 207\ 161.00} = 40.3$ per cent

Pay-back period

The calculation of the pay-back period is shown in table 19.

The calculation indicates that the orginal investment costs will be recovered after approximately 3.5 years, including the construction period of 18 months. If the working capital is included in the total investment, it will be recovered after approximately 4 years.

Table 19. Pay-back period

Description	Nominal amount	Capital at the end of year
Total investment a/	7 207 161.00	-
(working capital)	(1 636 457.00)	-
Year 1	1 384 452.00	-
Year 2	5 822 708.30	-
Annual net cash earnings		
Year 1	-	-1 384 452.00
Year 2	1 455 316.50	-4 367 391.80
Year 3	2 910 633.00	-1 456 758.80
Year 4	2 910 633.00	+1 453 874.20

a/ Without working capital.

Break-even analysis

The break-even point (BEP) is the point at which sales revenues equal production costs. It is calculated (in terms of physical units) using the equation:

$$BEP = \frac{FC}{SP - VC}$$

Where:

BEP = break-even point
VC = variable cost per kg (SR 2.01)
SP = Selling price per kg (SR 5.20)
FC = annual total fixed costs (SR 820 374.00)

Thus,

$$BEP = \frac{820\ 374.00}{5.20 - 2.01} = \frac{820\ 374.00}{3.19} = 257\ 170.53 \text{ kg}$$

In terms of sales revenue, the BEP is:

$$BEP = p\left(\frac{f}{p - v}\right) = 5.20 \cdot \frac{820\ 374.00}{5.20 - 2.01} = \text{SR } 1\ 337\ 286.70$$

Profits

According to the calculations above, a profit of SR 1,092.17 per tonne of flour is expected. Some countries have offered to donate wheat to Seychelles, however, and the country would be able to take advantage of these offers once the flour mill is established. It is estimated that this will result in a savings in raw material cost per tonne of flour of SR 1,850 and would reduce the production costs to SR 1,332.83. The profits, with and without donations, are shown in table 20.

Table 20. Profits per tonne of flour

	Without wheat donations	With wheat donations
Sales of wheat	4 275.00	4 275.00
Production costs	(3 182.83)	(1 332.83)
Profit	1 092.17	2 942.17