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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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TECHNOLOGY PROFILES*

Prepared by

G. Appelgren

UNIDO Consultant

* The views expressed in this paper are those of the author and do not necessarily reflect the views of the Secretariat of UNIDO. This document has not been edited.

V.89-58358

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OBJECTIVES

The objectives of the undertaking that forms the base for this report were to make an inventory of technology options available at UNIDO Headquarters in the following industrial sectors: food processing, agricultural machinery and fishery products.

On the basis of the inventory, a selection was to be made of technologies considered to be suitable for promotion at the International Forum on Appropriate Technology for Africa, to be held during the second half of 1989.

METHODOLOGY

In order to make the inventory, the following sources within UNIDO were tapped:

(i) The competent branches of the Division for Industrial Operations;

(ii) The Industrial Development Abstracts (IDA) database of the Industrial Technology Development Division;

(iii) The VIC Library computerized databases covering the relevant subjects; and

(iv) The Inquiry Service of the Industrial Technology Development Division.

A list of technology options revealed by the search of these sources can be found below.

The criteria for selection of suitable technologies were:

(i) The specific process or technology had not already been presented as a profile in the "How to Start Manufacturing Industries" series or any other UNIDO publications;

(ii) The information had to contain some indication on investment requirements and, preferably, give an idea of the elements of the production cost;

(iii) The technological information had to be in an easily digestible form and, where needed, accompanied by illustrations, flow charts, etc.

TECHNOLOGY DATABASE

The Consultant felt that it would be worthwhile to prepare a database system containing technology options available at UNIDO Headquarters. The database thus created contains, in addition to the title of the technology option, information on:

* Industrial sector;
* Level of automation;
* Detail of information;
* Scale of operation;
* Date of information;
* Source of information;
* Investment information available;
* Type of deal offered; and
* Area of origin.

This database can be searched for any of the above mentioned categories of information. It can also be searched for any combination of characteristics, e.g. small-scale agricultural machinery production with detailed information and not older that ten years.

OBSERVATIONS

The search revealed that most of the documentation available at UNIDO regarding technology deal mainly with issues such as policies governing transfer, development, licensing, etc. of technology. The actual technology is described only in a very limited number of cases. Therefore the candidates for selection were few, particularly in the agricultural machinery and fishery sectors. This can be seen from the list of technologies with substantial or detailed descriptions.

UNIDO - Technology Profile No. 25

1. Technology: Maize milling using hammer mills

2. Final products and use: Maize meal and grits; culinary purposes

3. Process:

The hammer mill consists of a cast iron body through which passes a horizontal rotary shaft powered by an external energy source. The latter is usually an electric motor or a diesel engine. The capacity of the electric motor in this profile is about 10 - 12 kW.

A disc or discs, from which project short hammer-like plates, are attached to the end of the rotor shaft and enclosed in a metal casing. The hammer rotates at speeds of up to 3,600 r.p.m. The plates may be of the fixed or swinging type, and vary in number from 1 to 32. The fixed hammers are usually in the form of an iron casting whereas the swinging type are often made from heat-treated, 1.0 per cent chromium steel.

A screen, mounted on a fixed circular support, surrounds the hammers. The maize grain must be sufficiently reduced in size to pass through the screen before it is discharged from the milling chamber. A range of screens is available for the production of a variety of grades of ground material. A conical hopper, fixed above the milling chamber, holds the whole grain which is gravity fed into the mill.

Size reduction in a hammer mill occurs principally by impact as the grain hits the hammers, the metal of the screen, and the back wall and the front casing of the mill. Impact also occurs between the grains themselves. The grain is trapped and sheared between the hammer and the holes of the screen. The broken grain is retained in the milling chamber until its size is reduced sufficiently to allow its passage through the screen perforations.

The output of ground material varies according to the capacity of the motor, the size of the perforations in the screen and the variety and moisture content of the maize. As a general guide, the output per kW per hour is approximately 74 kg for maize with a moisture content of 16 per cent and a screen with 3 mm holes.

4. Technical data:

- Hammer mill, 10 - 12 kW
- Energy requirement: 26,400 kWh
- Manpower requirements: Manager/owner, one skilled worker, three unskilled workers
- Output: 2,400 tonnes/year (8 tonnes/day x 300 days)

5. Financial data: (all figures in US dollars, 1986 prices)

Yearly costs:

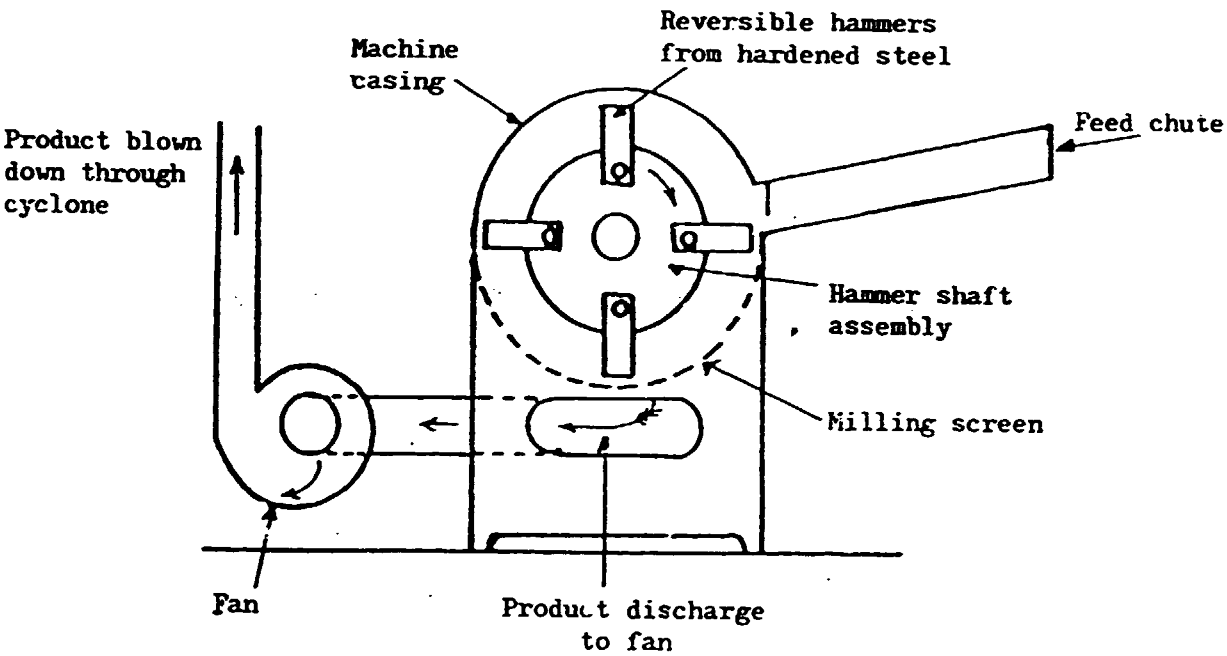
Labour cost	9,600
Equipment & Bldg depreciation	805
Energy	2,640
Spare parts	120
Land rental	1,200
Interest on working capital	4,500
Profits	12,000
Total yearly costs	30,865

Unit production cost:

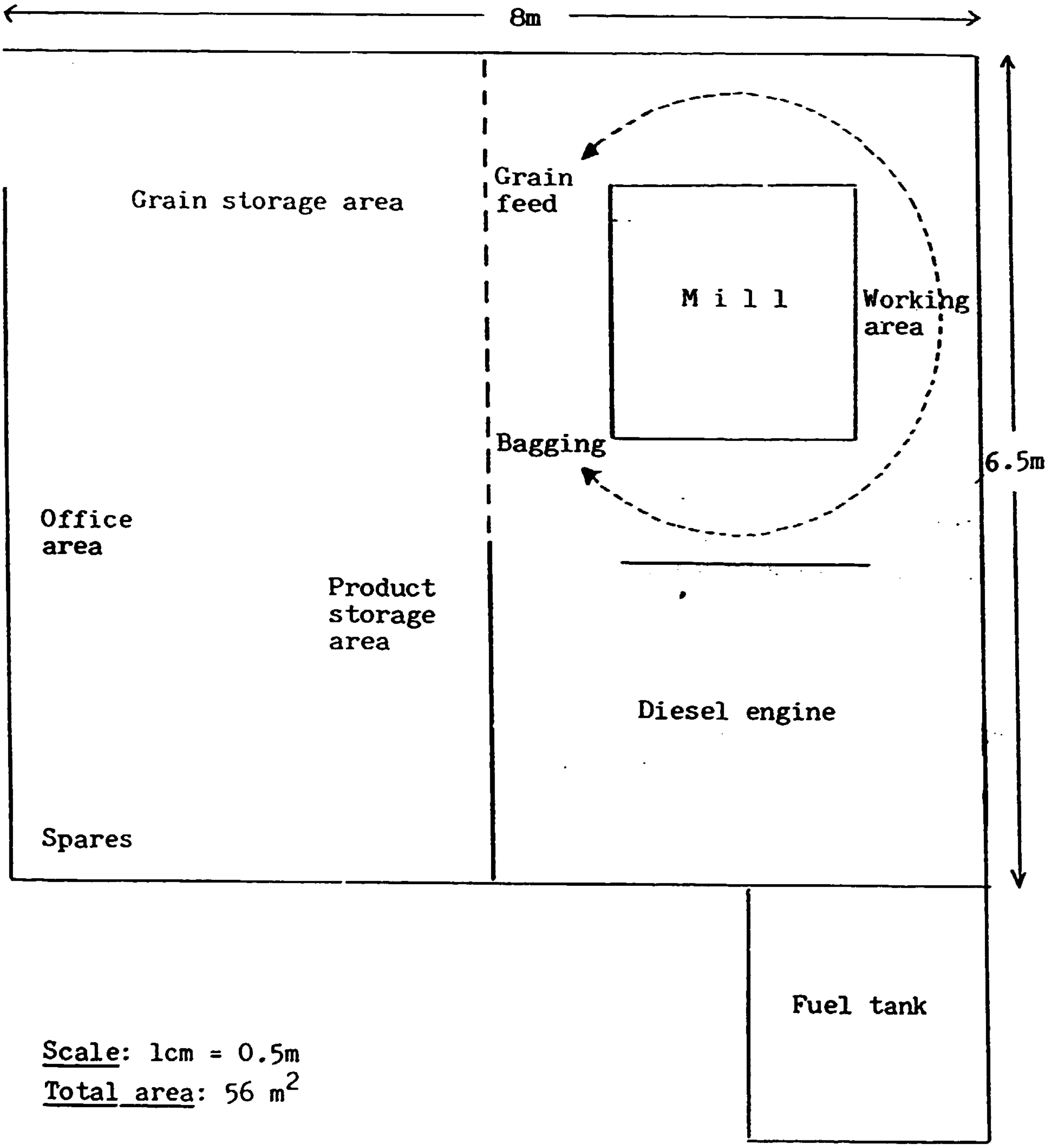
Total yearly costs	30,865
Total yearly output (tonnes)	2,400
Unit production cost	13
Min. wholesale price of meal	163

6. Transfer of technology

Free of charge



Diagrammatic representation of
a hammer mill



Scale: 1cm = 0.5m
Total area: 56 m^2

Commercially-operated, diesel-powered hammer mill -
4 tonnes maize per 8 hours

UNIDO - Technology Profile No. 27

1. Technology: Ferro-cement bins, cylindrical

2. Final products and use: Pre-cast cylindrical ferro-cement units for grain storage, water storage, bio-gas, etc.

3. Process:

The ferro-cement bins described in this profile are cylindrical in shape and are assembled from prefabricated units, namely a reinforced concrete base slab, ferro-cement wall units and a dome-shaped ferro-cement roof unit. The wall units have a diameter of 120 cm and a height of 100 cm. Depending on the individual consumer's requirement, 1-, 2- or 3-ton bins may be assembled by erecting one, two or three wall units on top of each other and filling the joints with cement mortar. A manhole is provided in the roof unit for loading and an outlet is provided in the bottom wall unit for unloading the grain. Rubber gaskets are provided both for the inlet and for the outlet to make the bins airtight. Locking arrangements are also provided for the inlet and the outlet openings. The outside of the bin is painted with a bituminous aluminium paint to make them moisture proof.

The sizes of the various components have been selected so that they can be handled and erected by 4 or 5 persons. The base slab, which is the heaviest of the pre-fabricated components, weighs about 140 kg. The cylindrical shape is preferred for the wall units because it is suitable for mass production at the factory level. These cylindrical wall units are cast using a semi-mechanized process. The required equipment is shown in Fig. 1. The details of the various pre-fabricated components of the bins are given in Fig. 2.

The equipment for the casting of the wall units consists of a wooden cylindrical collapsible mould resting on two A-frames. A wire mesh spindle feeds wire mesh during the casting. The process of casting consists of manual application of cement mortar on wire mesh. The application is done layer by layer until the required thickness is obtained. After 24 hours, the mould along with the casting is removed from mild steel frames and the unit is demoulded. The wall unit is given a finishing coat on the inside surface and is cured for 28 days.

The ferro-cement bins possess the following advantages:

- They are cheaper than steel bins, reinforced concrete bins and aluminium bins.

- They are lighter than conventional reinforced concrete bins.

- They require little or no maintenance.

- The condensation and moisture migration problems in the stored food grains are much less serious than in steel bins.

- They can be easily fabricated at the rural level.

- The fabrication technique is simple and can easily be acquired by the local labourers.

- They are rodent-, fire- and moisture-proof and can easily be made airtight by sealing the inlet and outlet openings.

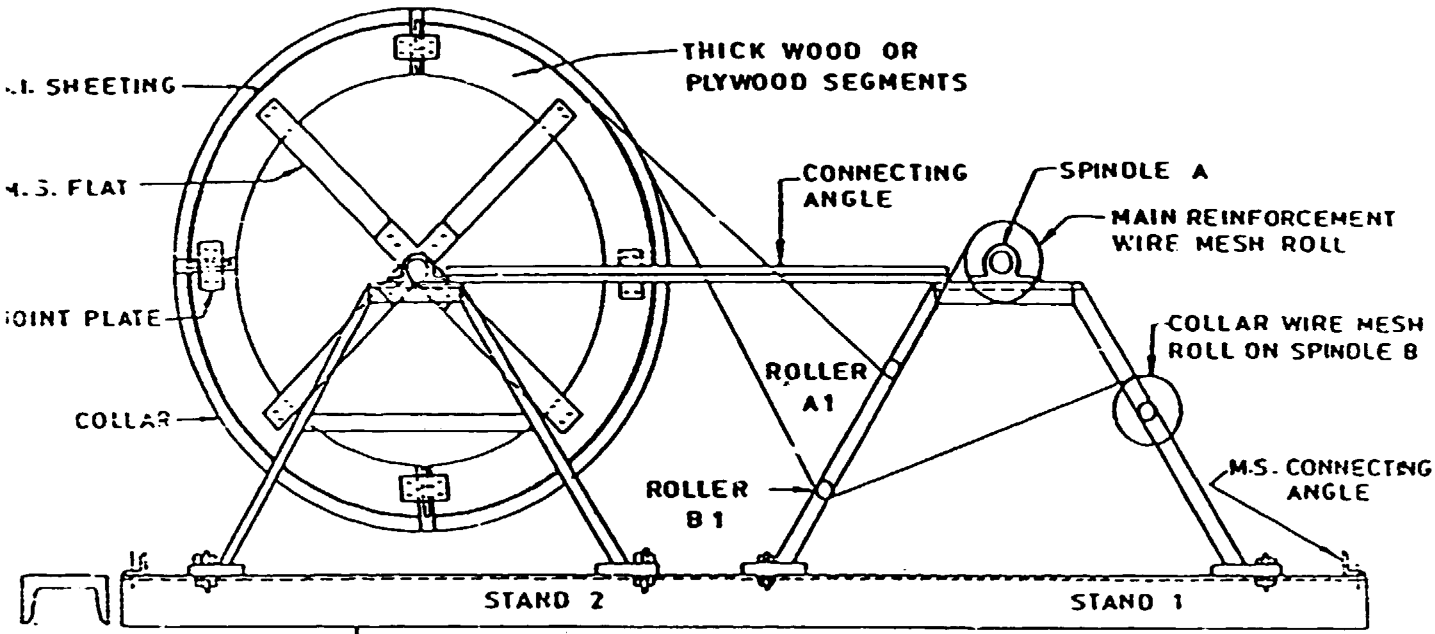
- Any structural damage can easily be repaired by plastering over the wire mesh.

4. Transfer of technology:

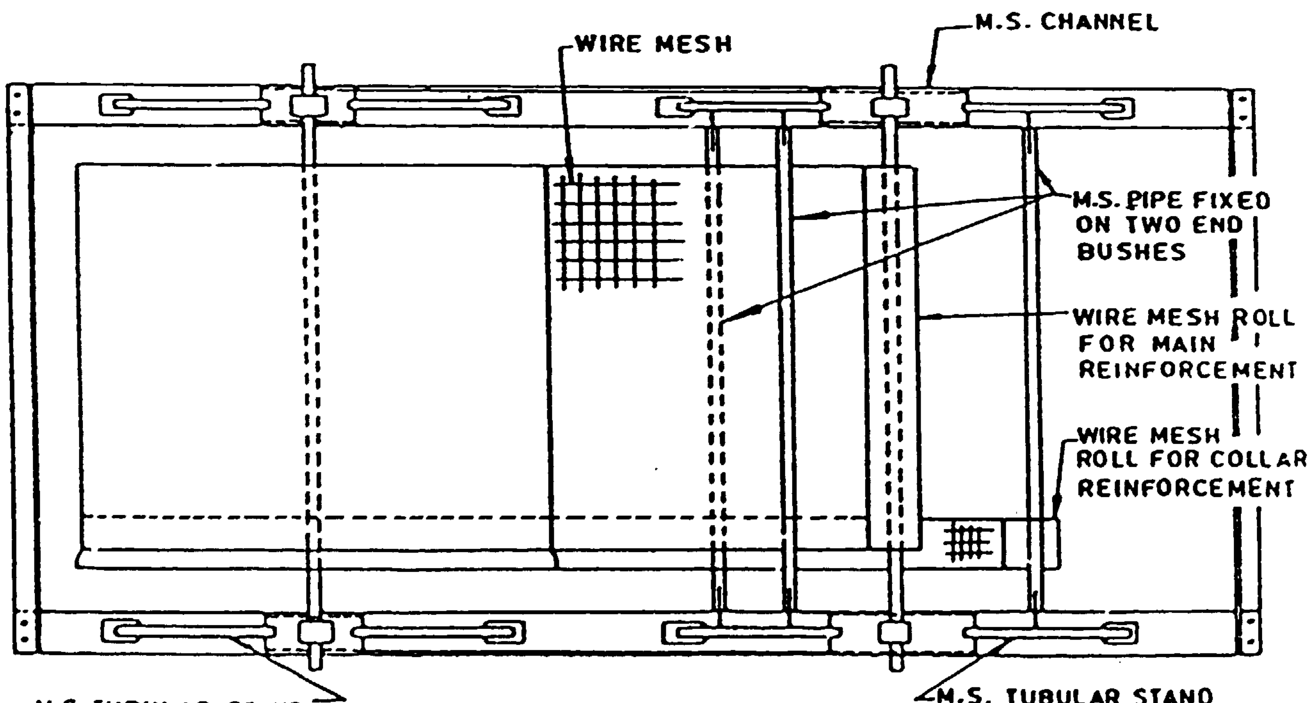
License

5. Contact address:

Structural Engineering Centre
CSIR Complex
Adyar, Madras 600 020
India



ELEVATION



PLAN

Fig.1: Casting process for cylindrical ferrocement wall units

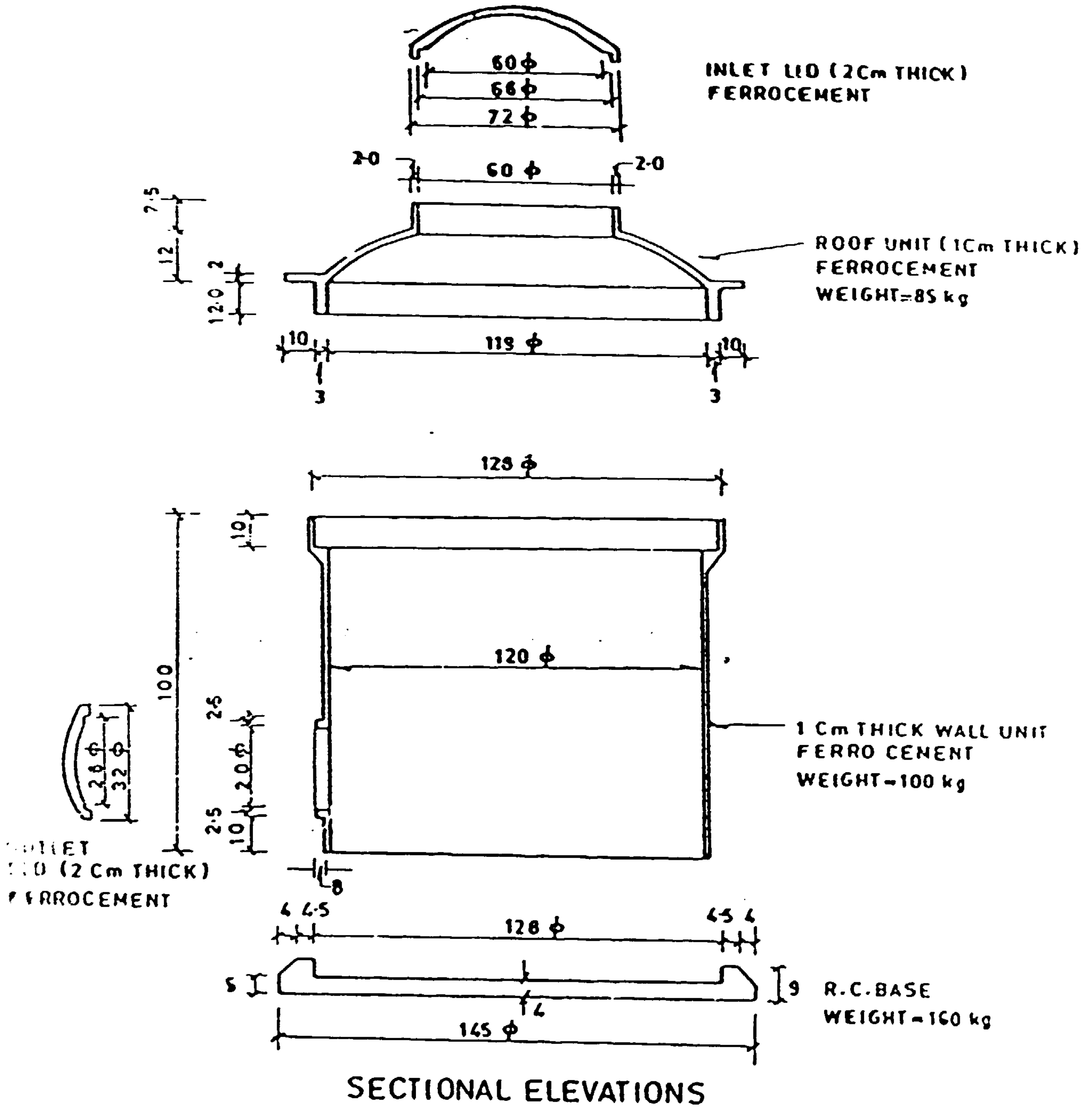


Fig.2: Pre-fab units for bins up to 3-tonnes capacity

UNIDO - Technology Profile No. 48

1. Technology: Multi-purpose agricultural machine production

2. Final products and use: The Mochudi Toolbar, a multi-purpose agricultural machine for farm use

3. Process:

To the animal-driven toolbar described in this profile can be attached almost any type of cultivation tool. It can also be used for carting or transporting drums of water. By removing some of the components from the toolbar, a walking model can be created which allows inter-row cultivation when crops are taller. With this machine a new appropriate tillage system may be created. The toolbar can also be fitted with a mouldboard plough or be used as a two-row planter and thus be applicable to conventional methods.

The multi-purpose machine consists of an iron frame, on two wheels, equipped with several implements. The full range of implements is carried on transverse sub-frames which clamp onto the edge of the iron frame. Since the sub-frames can be positioned anywhere along the width of the iron frame, either one or two planter units, for example, may be used at row widths varying from 75 to 100 cm. Other tools can be positioned in a similar manner according to needs and prevailing circumstances. All bolts used in the assembly and adjustment of the components are of the same size, 12 mm, so that only one size of spanner is required.

The frame of the toolbar can be raised or lowered depending on what working depth is required. A planter unit incorporates the seed metering drum, the seed press wheel, the chain drive and an open drag. The fertilizer applicator consists of a metering device and a sub-soiler shank with a tube extending down the back to deliver the fertilizer deep into the soil. The unit is designed so that it can be used in combination with the planter. The disk hillers may be used both for throwing away the soil from the plants and for ridge building. Full sweeps may be fitted for stubble mulching. With the tool frame in the down position it is at a very convenient height for carrying water drums or other goods. By fitting floor boards and sides the toolbar becomes a Scotch cart capable of carrying 500 kg. Furthermore, a walking implement can be assembled, which can be used for inter-row cultivation.

As well as being extremely versatile, the toolbar incorporates a number of additional features that will aid crop productivity and quality. Thus, the use of the toolbar will help:

- reduce soil erosion by maintaining the crop residues as a surface mulch;

- conserve moisture by leaving the surface mulch while tilling only the top 10 mm of soil;

- control weeds with the use of the Texas style sweeps in combination with disk hillers;

- increase germination and reduce seedling mortality. A lister share ahead of the planter will allow the seed to be placed in the moist soil;

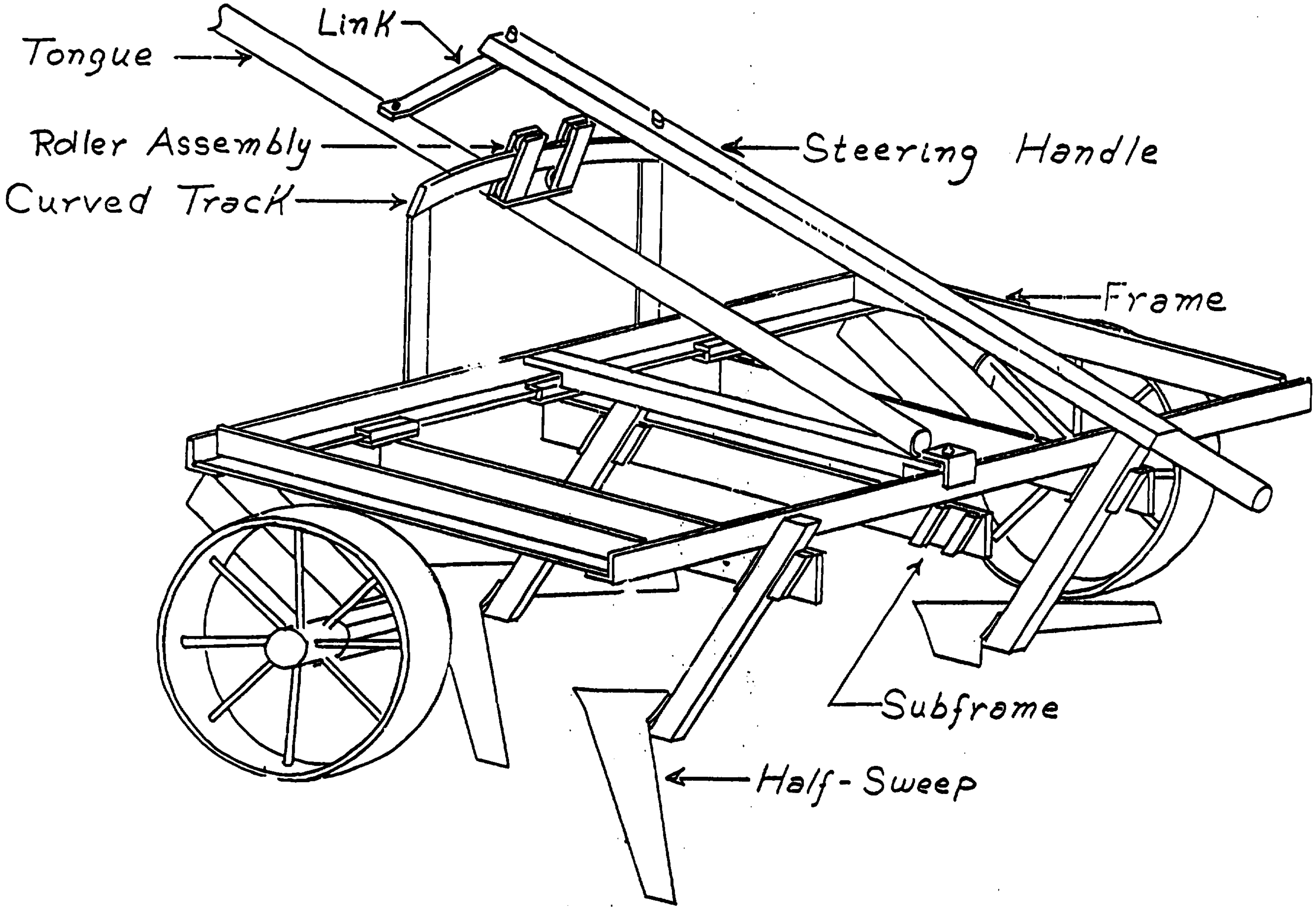
- imbed the seed firmly in moist soil before covering it with the seed press wheel; and

- make better use of fertilizers by applying the fertilizer below the seed when planting.

A detailed report and a complete set of drawings are available from the contact address below.

4. Contact address:

Mochudi Farmers Brigade
Box 208
Mochudi
Republic of Botswana


Link
Tongue
Roller Assembly
Steering Handle
Curved Track
Frame
Subframe
Half-Sweep

UNIDO - Technology Profile No. 59

1. Technology: Agriculture hand tools manufacture

2. Final products and use: Spades, hoes, forks and sickles; agricultural purposes

3. Technical data:

This profile covers simple hand tools, namely spades, hoes, forks and sickles. These simple tools for agriculture are most used by small farmers in developing countries. Since it is very difficult for small-scale producers to export their goods, their prospects depend on local demand. Local market possibilities should be carefully studied.

For the operation described in this profile, expert assistance may be required if modern equipment is used. Expert advice on heat treatment can improve product quality.

Product specification:

Product	Specification
Spade	Blade and shank size, overall length 20 in.; blade size 8 in. x 6 in.; weight 1.5 kg
Hoe (tined)	Maximum length of tine 10 in.; width 6 in.; tine diameter ½ in.; weight 1 kg
Fork	Weeding fork, 3 prongs, length 14 in.; width 7 in.; diameter of prong 5/8 in.; tang bore diameter 1¼ in. (minimum) to 2½ in. (maximum); weight 2 kg
Sickle	Length 9 in.; maximum width 1 in.; handle 5 in.; weight ½ kg

Material specifications

Material specifications for hand tools are SAE 1078, carbon 0.72%-0.85%, manganese 0.30% - 0.60%. The material is suitable for forge and heat treatment.

Production volume (based on 250 working days and an eight-hour shift)

Product	Daily production	Annual production
Spade	12	3,000
Hoe	12	3,000
Fork	12	3,000
Sickle	12	3,000
Total	48	12,000

Floor area

The required floor area is 1,200 ft² (40 x 30 ft).

4. Financial data: (all figures in US dollars, 1979 prices)

Estimated cost of machinery and equipment

Description	Quantity	Estimated cost ($US)
Power shear, ¼ in.	1	500
Oil- or coal-fired furnace, ½ hp, 24x24x18 in.	1	5,000
Mechanical spring forge hammer, 1 t, 3/4 hp	1	4,000
Quenching tank, 36x36x36 in.	1	500
Anvils with pedestal, 200 kg	2	200
Double-ended pedestal grinder, ½ hp, 12 in. wheel	1	400
Double-ended polishing machine, ½ hp	1	400
Manual roll bending machine	1	200
Electric arc welding machine, 120 A	1	200

Blacksmith's tool set, ¼ in. portable drill, paint can and brushes	1 set	600
Miscellaneous		500
Total		12,500

Investment requirement

Basic investment	Amount
Fixed Capital	
Land	-
Building, 1,200 ft² at $5	6,000
Furniture, fittings, racks, etc.	600
Machinery and equipment	12,500
Electrical installation	1,000
Building	300
Transport, trolley	500
Contingencies	300
Total fixed capital	21,200
Working capital	
Direct material (3 months)	2,370
Labour (3 months)	2,875
Indirect costs	600
Training costs	500
Contingencies	155
Total working capital	6,500
Total investment[a]	27,700

[a] Excluding cost of land.

Annual direct material cost

Item	Weight of blade (kg)	Price of raw material or unit	Annual production (kg)	Total raw material ($)	Cost ($)
Spade[a]	1.5	0.30	3,000	4,500	1,350
Hoe[a]	1.0	0.30	3,000	3,000	900
Fork[a]	2.0	0.30	3,000	6,000	1,800
Sickle[a]	0.5	0.30	3,000	1,500	450
Subtotal			12,000	15,000	4,500
Wooden handle[b]		0.40		9,000	3,600
Handle[b]		0.10		3,000	300
Nails and ferrules[b]					400
15% scrap for steel					675
Total					9,475

[a] Manufactured in own shop.
[b] Bought finished.

Annual indirect material cost

Item	Amount
Lubricants, coolants, etc.	50
Maintenance and spare parts	1,000
Paints, office supplies	500
Total	1,550

Utilities

Item	Amount
Electricity, 60,000 kWh	2,500
Fuel, coal and oil	1,000
Water	100
Total	3,600

UNIDO - Technology Profile No. 59

Annual labour cost

Category	Number	Annual wage rate ($)	Total ($)
Direct labour			
Skilled	5 (incl. owner)	1,500	7,500
Semi-skilled	2	1,000	2,000
Unskilled	1	800	800
Subtotal			10,300
Indirect labour			
Skilled	1 (accounts clerk)	1,200	1,200
Total	9		11,500

Summary of annual manufacturing cost

Item	Amount
Direct material	9,475
Indirect material	1,550
Utilities	3,600
Transport	500
Labour	11,500
Total	26,625

Annual sales

Product	Unit selling price ($)	Annual production (units)	Annual sales ($)
Spade	2.50	3,000	7,500
Hoe	3.00	3,000	9,000
Fork	3.00	3,000	9,000
Sickle	1.50	3,000	4,500
Total		12,000	30,000

Total annual cost

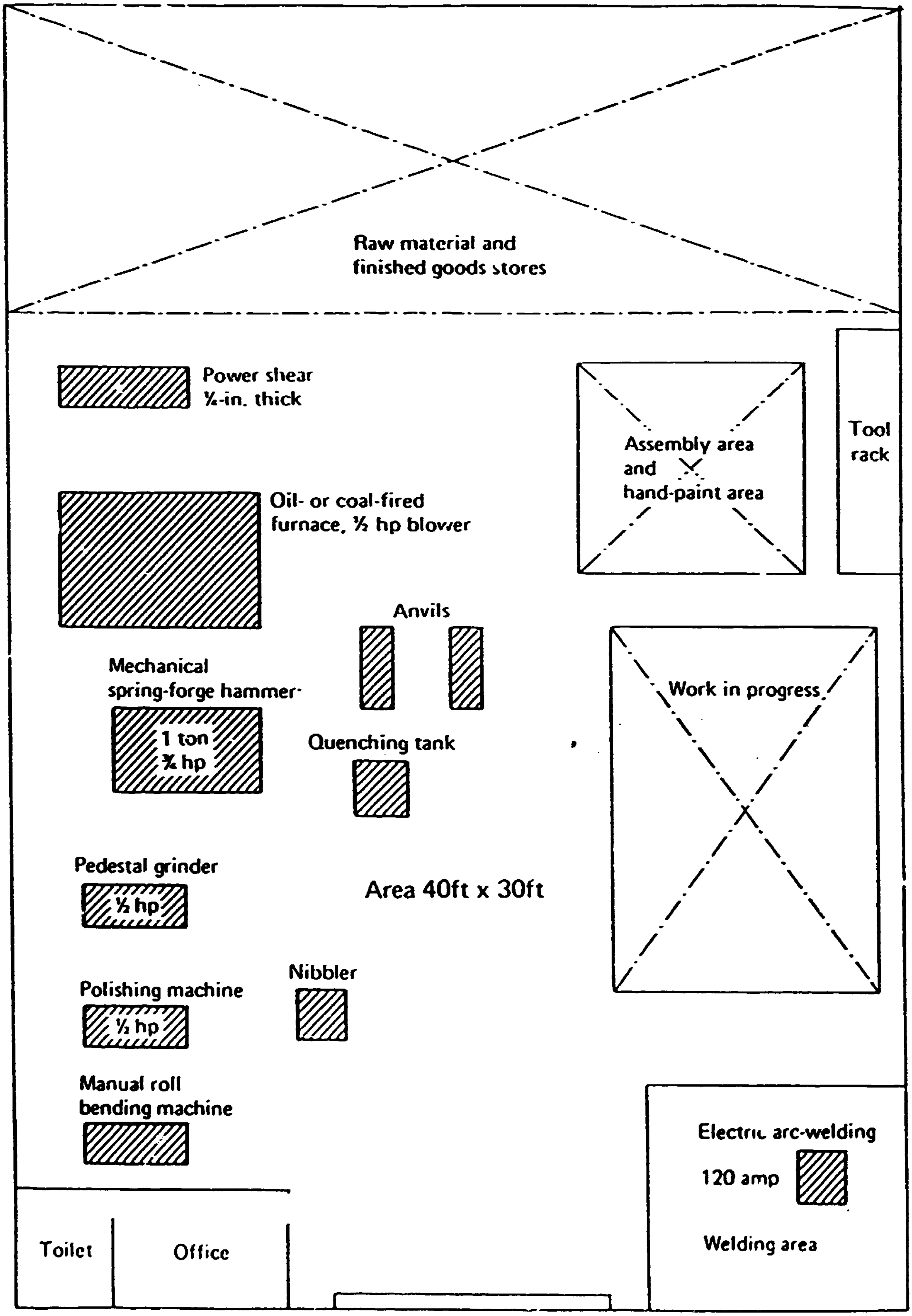
Item	Amount
Manufacturing cost	26,625
Sales cost	1,000
Depreciation of fixed capital (10 %)	1,250
Total	28,875

Profit

Item	Profit
Annual sales	30,000
Total annual cost	28,875
Profit (before tax)	1,125

6. Transfer of technology

Free of charge


Raw material and
finished goods stores
Power shear
¼-in. thick
Assembly area
and
hand-paint area
Tool
rack
Oil- or coal-fired
furnace, ½ hp blower
Anvils
Mechanical
spring-forge hammer
1 ton
¾ hp
Quenching tank
Work in progress
Pedestal grinder
½ hp
Area 40ft x 30ft
Nibbler
Polishing machine
½ hp
Manual roll
bending machine
Electric arc-welding
120 amp
Welding area
Toilet
Office

UNIDO - Technology Profile No. 62

1. Technology: Coconut cream production

2. Use of final product: Culinary purposes

3. Process:

Sound mature coconuts are selected and de-shelled. The coconut water is collected and made into coconut skim milk or vinegar. The pared meat is washed, weighed and ground. The ground meat is mixed with 1/2 to 2 times its weight in water and passed through a screw press or expeller to extract the coconut milk. The residue is used for animal feed. The whole coconut milk is transferred to the centrifuge to separate the cream from the watery (skim milk) portion. The skim milk is used for making "nata de coco" or coconut syrup. The cream is mixed with 1/2 to 2 times its weight in water and pasteurized for about 25 minutes. The pasteurized cream is mixed thoroughly with a stabilizer and passed through a homogenizer. The homogenized mixture is heated almost to boiling, filled hot in tin cans, sealed immediately and processed at 6 to 10 psi for 45 to 70 minutes in the autoclave. From the autoclave, the coconut cream in tin cans is cooled immediately by submerging in a cooling tank with running water, dried and packed in cartons of 24 each.

4. Technical information

4.1 Capacities:

Coconut meat grinder:	1 ton of fresh coconut meat/hour
Screw press:	1 ton of fresh coconut meat/8 hours
Centrifuge:	200 litres/hour
Processing tank:	500 litres of coconut milk
Homogenizer:	200 gallons/hour
Can sealer:	23 cans/minute

5. Financial data

5.1 Cost of equipment (approximations):

Coconut meat grinder	$US 6,000
Screw press	$US 3,000
Centrifuge	$US 10,000
Processing tank	$US 15,000
Homogenizer	$US 20,000
Can sealer	$US 2,000
Autoclave	$US 2,000
TOTAL	$US 58,000

6. Transfer of technology

Free of charge.

7. Contact address

Engineering Research Department
Industrial Research Center
NIST, P.O.Box 774
Pedro Gil St.
Ermita, Manila
Philippines

UNIDO - Technology Profile No. 63

1. Technology: Desiccated coconut

2. Final products and use: Desiccated coconut; culinary purposes

3. Process:

The first step in the process is the harvesting of the nuts.

Once harvested, the nuts are gathered into heaps, and usually husked on the estate as it saves transport. The husks from seasoned nuts are brown and can be sold for fibre manufacture.

The husked nuts are transported to the factory where they are stored before they are used. Husked nuts are not usually kept for more than two or three days before processing.

The first process in the factory is that of removal of the shell and is known as shelling. At this stage the substandard, spoilt nuts are separated from the good ones and sent for copra manufacture. The shell is removed by sharp taps on the shell and the kernel separated from the shell.

Shelling usually leaves the kernel including the testa intact, with the water inside. The next step is paring the kernel to remove the brown testa. The shelled nut is taken by chute, or manually placed in receptacles close to the parers. The brown testa is shaved off using a special type of knife and the kernel is pierced to let the coconut water out. This usually goes to waste.

The now white kernel is washed in chlorinated water. Inspection of the kernel for parings or spoilt or discoloured parts take place at this stage. Any imperfections are trimmed or removed.

The coconut may be treated with a solution producing sulphur dioxide, so that the product has a pure white colour after processing. This procedure also prevents any enzyme activity.

Pasteurization of the coconut can take place at this stage or after disintegration. The coconut pieces are sent through a tank of hot or boiling water for a specified period. Temperature and time could be varied according to the process design and steam may also be used instead of water. When pasteurization takes place after grinding, steam under pressure (dry steam) is used for approximately eight to ten minutes.

Disintegration of pasteurized or unpasteurized coconut meal is by an attrition known as the "Devil Disintegrator". This shreds the coconut to pieces varying in size from 5.00 to 1.00 mm. When fancy grades are produced, different cutting machines are used.

The disintegrated and pasteurized kernel is transferred to the driers for drying. The product is dried to a moisture content of approximately 2.5 per cent. This is now desiccated coconut.

The desiccated coconut may be cooled before taken to the sifters for grading. Medium and Macaroon (fine) are the grades commonly produced.

The graded coconut is packed into polythene lined Kraft paper sacks of prescribed standard. The standard pack is 100 lbs or 50 kilograms. The packed bag is weighed, the poly-liner is heat-sealed and the Kraft-paper sack stitched with a bag stitching machine. A bag flattener is used to flatten the bags after packing and stitching. This facilitates stacking during shipment.

Before sealing, however, samples are taken from the bags for testing for physical quality and bacteria.

4. Technical data:

Equipment:

Hatchet or axe/chisel
Paring knife
Washing tanks
Sterilizing tanks
Sulphur dioxide treatment tank
Disintegrator
Drier
Sifter
Packer

5. Financial data: (all figures in US dollars, 1986 prices)

Total cost for the equipment and machinery for a plant with a capacity of 100 tons of coconuts per day input, is about $US 400,000

6. Transfer of technology

UNIDO - Technology Profile No. 64

1. Technology: Canning of sardines

2. Final product and use: Canned sardines; culinary purposes

3. Process:

This profile is concerned only with the canning procedures in the course of which the can is heated so that the fish flesh is cooked and the bones softened. The product can be eaten directly from the can.

(a) Only raw material of the highest possible quality should be canned. Although fish can be either chilled or frozen, this is not recommended for sardines as the finished product will not be of the best quality.

(b) The preparation of the fish is usually undertaken by hand. At this point in the process, waste and offal is collected which could be used in the manufacture of fish meal or fish silage.

(c) The fish are immersed in a brine tank for a few minutes. The aim is to ensure a salt content of about 2% in the finished product; brine strength and brining times are varied to achieve this end with fish of different sizes and varying fat contents.

(d) It is assumed that the cannery uses rectangular cans holding 125 g of fish and oil. The cans are filled with fish, by hand, so that the processed can contains approximately 90 g of fish.

(e) The cans are steam-cooked and then inverted to drain off exuded water. Lean sardines require a longer cooking time than fatty ones.

(f) Approximately 25 g of oil or tomato sauce is added to the can. In small canneries this may be done by hand, more usually a dispenser is used.

(g) The cans are then sealed by an automatic vacuum sealer with a capacity of up to 50 cans per minute.

(h) Processing times at 115°C (240°F) vary from 30 minutes for a small can to 180 minutes for a large can.

(i) The cans are wrapped in heavy paper, usually an oiled paper, packed in cartons and stored.

(j) A small factory does not need an expensive quality control laboratory, but simple facilities should be provided. Sample cans must be drawn from each day's production and stored at 37°C for 14 days to check that they were properly sealed and have been adequately processed.

4. Technical data:

Equipment:

2	Washing and brining tanks
1	Beheading and gutting machine
1	Filling table, stainless steel
1	Cooker and racks
1	Oil dispenser, 60 cans/minute
1	Seamer, 20 cans/minute
1	Automatic weighing machine, 30 cans/minute
1	Retort
1	Can washer, 60 cans/minute
1	Can labeling machine
1	Boiler
1	Chlorinator unit
1	Effluent treatment equipment

Other:

Conveyors	Trolleys, trays,etc
Fish weighing machines	Oil storage tank
Water storage tank	Office equipment
Water and electricity fittings	

Electricity requirement	18,500 kWh (at £0.045/kWh)
Fuel oil	34,000 litres (at £0.2/litre)
Water	8,750 m^3 (at £0.066/m^3)
Manpower	1 manager (£1,750/annum) 1 engineer (£1,400/annum) 1 supervisor (£850/annum) 2 clerks (£600/annum) 56 semi-skilled/unskilled (mainly seasonal, average £430/annum)

Raw materials and packing materials:

500 t	Sardines	at £120/tonne
87.5 t	Filler	at £400/tonne
10 t	Salt	at £20/tonne
2,525,000	Cans	at £0.042/can
25,000	Cartons	at £0.33/carton

5. Financial data: (all figures in pounds sterling (£), 1981 prices.)

Capital costs

Plant and equipment	82,770
Buildings	30,000
Land	1,000
Contingencies	11,380
Total fixed cost	125,150
Working capital	177,780
Total investment	302,930

Operating costs

Fish	60,000
Filler	35,000
Cans	106,050
Cartons	8,250
Salt	200
Personnel	27,900
Water and sewage	580
Electricity	830
Fuel oil	6,800
Maintenance and spares	5,240
Insurance	1,050
Quality control	5,000
Sundries and unforeseen	10,000
TOTAL OPERATING COSTS	266,900

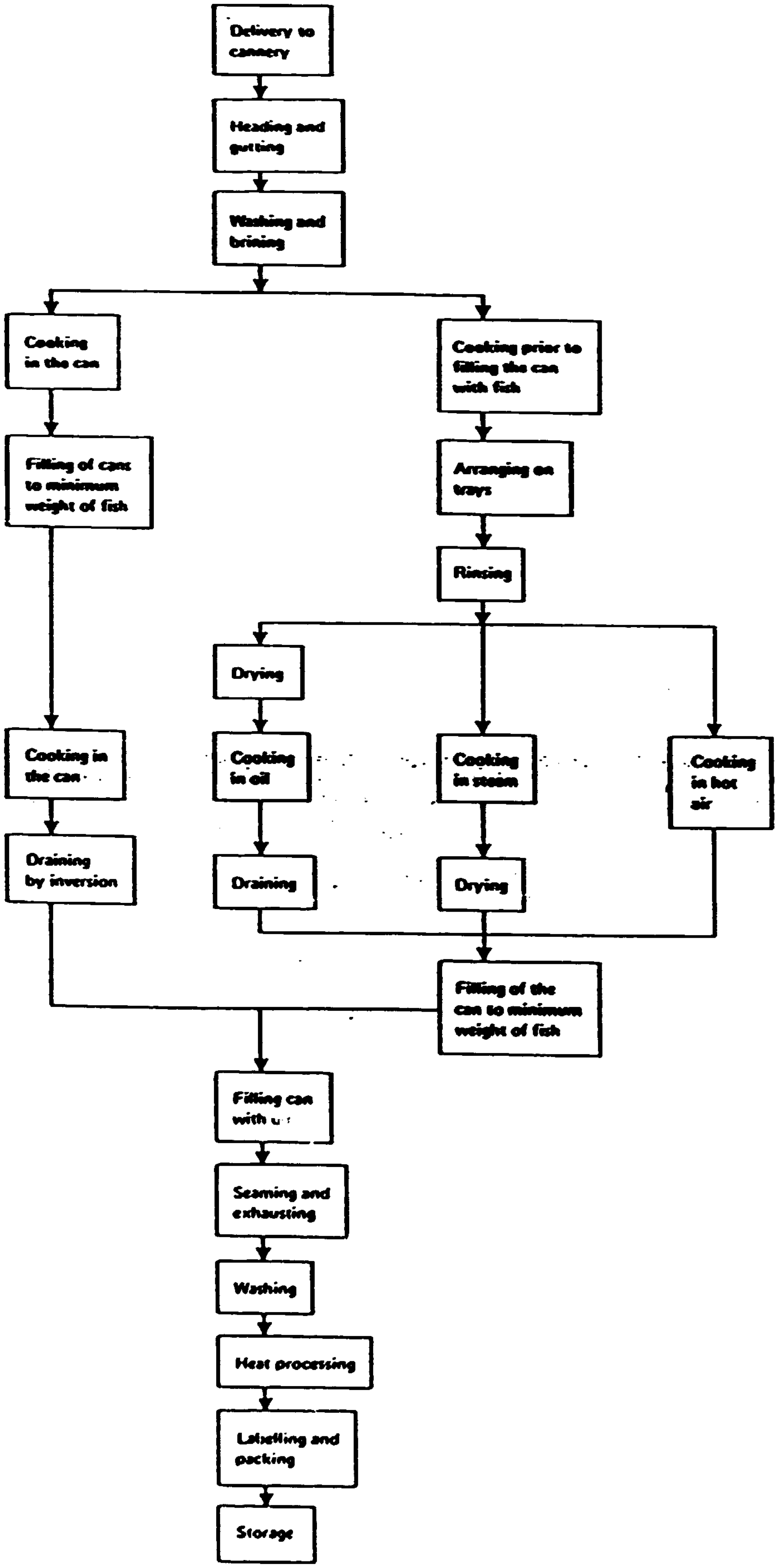
Revenue

Cans of sardines	450,000
Fish waste	2,475

TOTAL REVENUE	452,475

6. Transfer of technology

Free of charge.


Delivery to cannery
Heading and gutting
Washing and brining
Cooking in the can
Cooking prior to filling the can with fish
Filling of cans to minimum weight of fish
Arranging on trays
Rinsing
Drying
Cooking in the can
Cooking in oil
Cooking in steam
Cooking in hot air
Draining by inversion
Draining
Drying
Filling of the can to minimum weight of fish
Filling can with
Seaming and exhausting
Washing
Heat processing
Labelling and packing
Storage

UNIDO - Technology Profile No. 65

1. Technology: Oil extraction from copra using a small package expeller mill

2. Uses of final product: Culinary purposes

3. Process

The capacity of this mill is 800 kg raw material per day if the plant is operated on a one-shift basis. Thus the capacity could be increased to 2.4 tonnes per day. In this profile the one-shift version is described.

The three main stages of oil processing are:

(1) Pre-treatment: namely, the stages prior to the extraction stage, such as cleaning, crushing and scorching.

(2) Extraction: this stage involves the separation of the raw material into oil and residue.

(3) Post-extraction treatment: comprising the packaging of the oil and cake for marketing. Oil refining, common in large-scale production, is not considered in this profile.

Pre-treatment stages

(a) Remedial drying is carried out in the open air or in a covered shed. Artificial drying over the seed scorchers may also be possible.

(b) Raw material storage is done under roof and requires enough space for approximately 4 tonnes of copra.

(c) Cleaning/inspection are performed manually on the (preferably concrete) floor.

(d) Crushing/breaking up into pieces of 6 mm square is carried out using a crusher of the swing beater type or a power hammer mill. The capacity should be about 200 kg/hour.

(e) Scorching is performed at 60-90°C for 20-30 minutes.

Oil extraction by pressing

A motor-driven expeller capable of processing 120-140 kg/hour of raw material is required. A duplex unit is most suitable for this purpose. If a single expeller is to be used, it should have a power of 5 hp and run at 350 r.p.m.

Post-extraction stages

(a) Filtering. The oil is passed through the expeller screen into a small holding tank from where it is pumped mechanically through a small chamber filter press.

(b) Settling. After the filtering, the filtered oil is left to settle for a couple of days. Two separate tanks are used for this purpose.

(c) Packing. The oil is transferred into tins via a funnel from a tap on the tank.

(d) Oil storage. Space to store a few days' production should be provided.

(e) Cake breaking-up. The cake is removed from the expeller manually. It will need little or no further breaking up.

(f) Bagging. The broken up cake meal can be loaded into bags manually.

(g) Cake storage. A few days' storage space, similar to but separate from the copra storage, will be necessary.

4. Technical information

Capacity:	800 kg of raw material per 8-hour shift
Output:	490 kg oil and 264 kg cake
Water:	No special provisions necessary unless the chosen expeller is water-cooled.
Electricity:	75 kWh/day
Plant site area:	200 m^2 (maximum)

UNIDO - Technology Profile No. 65

Equipment:

- movable scales, capable of weighing up to 80 kg.
- drying platform over seed scorchers (optional)
- one 200-400 kg/hour crusher mill with a 6 mm square screen (4 hp).
- two seed scorching pans, 100 cm diameter x 15 cm deep with mechanically driven stirrer (drive run off crusher mill powered by V-belt and pulley).
- one duplex expeller unit, with an input capacity of 100 kg/hour (6 hp). The oil content in the cake should be 5-6 %. Alternatively, a 5 hp expeller may also be adequate.
- one oil holding tank 75 x 75 x 90 cm.
- one chamber filter press with 12 plates 25 x 25 cm to filter up to 100 or more litres/hour, with attached oil pump.
- two aluminium settling tanks, 100 x 100 x 120 cm (cap. for two days' output), with oil outlets and sediment drainage.
- one small pump with plastic hose for pumping filtered oil into tins.

Manpower: Three workers, one of which should be skilled in simple maintenance and repair tasks, especially the repair of the worms and bars.

5. Financial data all figures in US dollars, 1984 prices.

Fixed investment cost

Land	1,000
Building	16,000
Equipment cost	32,000
Spares	1,600
Working capital	2,000

Total investment cost	52,600

Annual fixed investment cost

Land	100
Building	1,697
Equipment	5,207
Spares & Maintenance	2,400

Total	9,404
Annual working cap. cost	200

Total annual fixed cost	9,604

Annual variable cost

Raw material	53,352
Water	-
Electricity	2,025
Filter cloths	150
Tins (18 kg)	4,416
Labour cost	3,000

Total annual cost	72,547
Annual revenues	75,360
Annual gross profits	2,813

PROCESSING STAGES

1. REMEDIAL DRYING
2. RAW MATERIAL STORAGE
3. CLEANING/INSPECTION
4. CRUSHING/BREAKING UP
5. SCORCHING
6. PRESSING

OIL	CAKE
7 FILTERING	11 BREAKING-UP
8 SETTLING	12 BAGGING
9 PACKING	13 STORAGE
10. STORAGE	

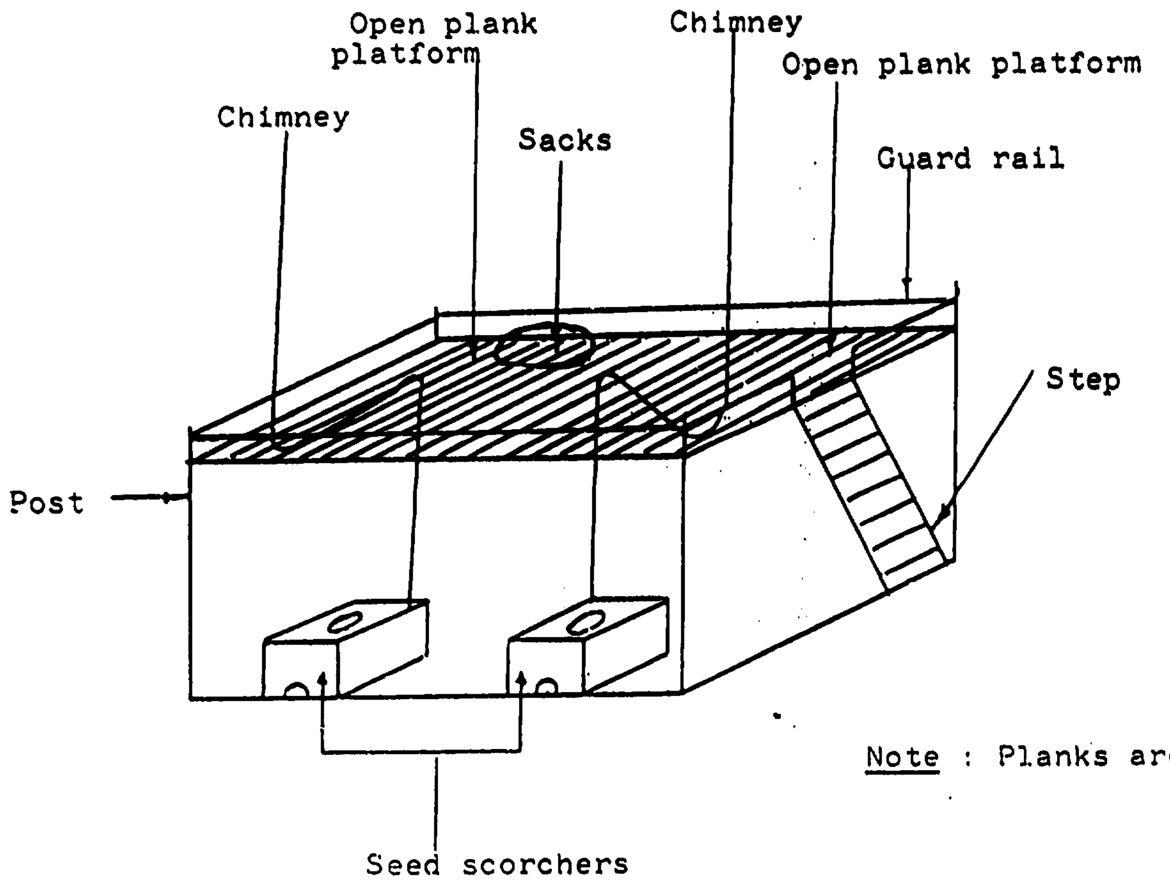
ANCILLARY SERVICE STAGES

14 WATER

15 PROCESS HEAT

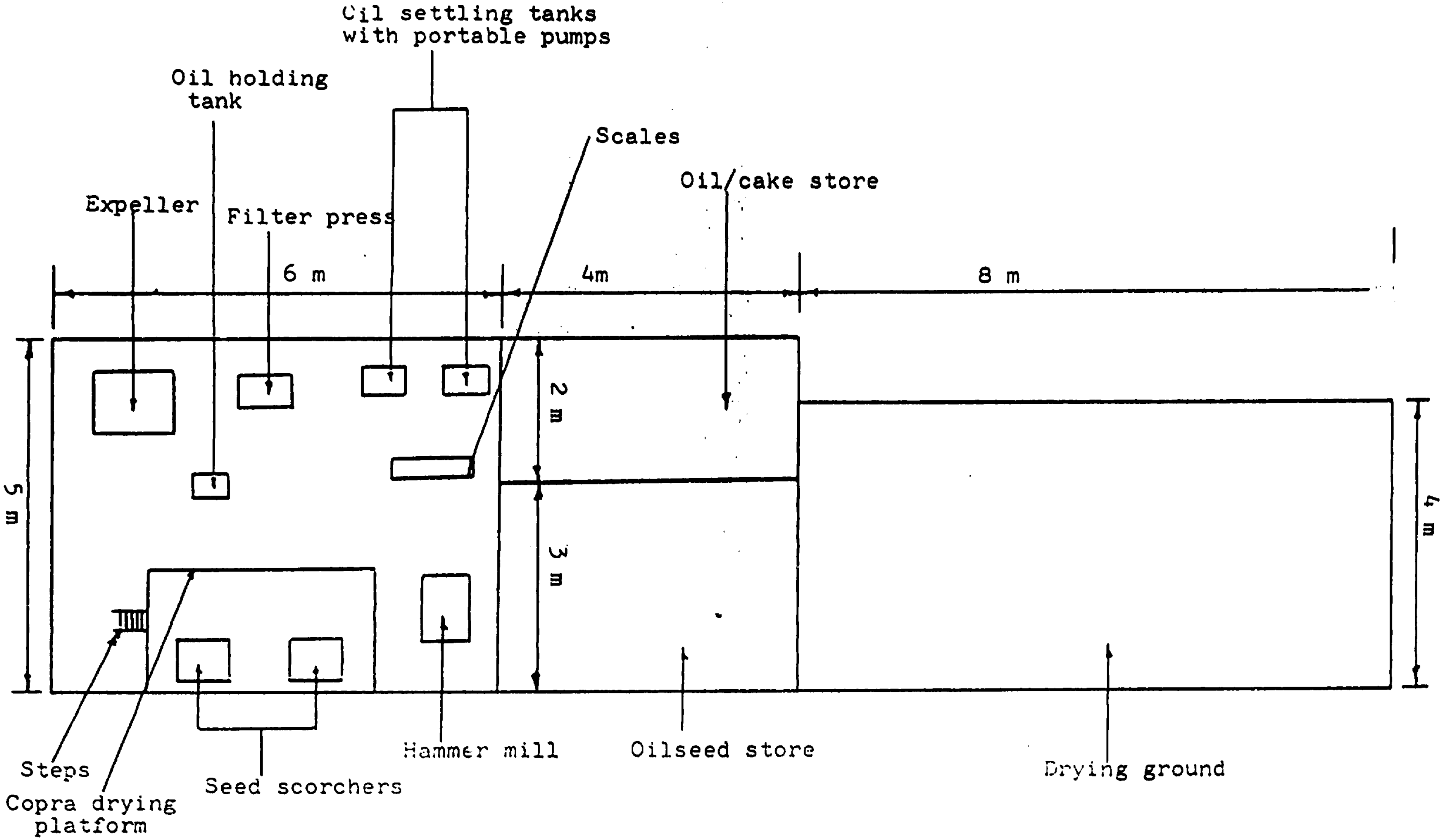
16 ELECTRICITY

17 MAINTENANCE



Note : Planks are 4 cm wide and 15 cm apart

Copra drying platform over scorchers



Plant lay-out for a small package expeller mill

UNIDO - Technology Profile No. 66

1. Technology: Freezing of prawns

2. Final products and use: Frozen prawns; culinary use

3. Process:

The process described in this profile utilizes the horizontal plate freezing method. The plant produces prawns frozen in blocks with or without ice surrounding the prawns. The plant is equipped with a refrigerated chillroom for storing iced raw material prior to processing and a refrigerated cold store for storage of finished products. The type of facility chosen for the profile is of a pre-fabricated modular construction, selected for its high thermal efficiency, flexibility of design, ease of transportation and erection on site. Chillroom capacity allows for the holding of sufficient raw material for 10 days' operation of the plant, although normally the raw material would not be stored that long before processing. The cold store is designed to hold one month's output of finished product.

A flake ice plant has been included as past of the equipment. Flake ice, as opposed to block ice, was selected for a number of reasons which include:

(a) output of ice commences almost immediately the icemaker is switched on, making the plant more flexible;

(b) handling is simplified if a flake ice is installed on top of an insulated storage bin, since the ice simply drops into the bin and is ready for use;

(c) there is less chance of damage to the raw material as individual flakes of ice do not have sharp edges and are lighter than chunks of block ice; and

(d) whilst the principal advantage of block ice is that it can be transported relatively easily over long distances, the freezing plant in this profile is intended to be located adjacent to the fish landing site so that ice can be loaded directly onto the fishing boats.

The required ratio of ice to prawns is about 3 parts of ice to 1 part of prawns.

The operator of the plant is assumed to act as a principal, buying in raw material and then selling the finished product.

The plant is furnished with a stock of high density polyethylene fish boxes appropriate to the capacity and out put of the plant. It has been assumed that they would be rented out to the fishermen for the storage and carriage of their catch, and that the rental fee would be sufficient to replace damaged and lost boxes.

3.1 Freezing of prawns

A problem which may occur in iced prawns prior to freezing is black spot. In such cases it may be necessary to dip the raw material in a solution of metabisulphate as soon as possible after catching. It is imperative to keep the raw material well iced at all times.

From the chillroom the prawns are moved on to the preparation stage where grading and sorting takes place. Depending on the finished product required, beheading and/or peeling would then take place. In certain circumstances, this could be followed by dipping the product in a chlorine solution immediately prior to freezing in order to reduce any bacterial contamination picked up during handling. Chlorine dipping, however, renders the product unacceptable on certain markets and careful hygiene control elsewhere in the process may make this dip unnecessary.

Prawns are generally weighed into cartons before freezing, then the filled cartons are arranged on the freezer trays. As with fish, it may be a custom requirement that the cartons are toped up with water at this stage so that the final product emerges as a complete frozen block. Once frozen, the cartons are packed into outers and taken straight into the cold store to await despatch.

The freezers are designed to take waxed card cartons each containing 2 kg of prawns. The cartons are then packed in strapped and stapled board outers each containing 10 cartons.

A loss of 5 per cent is allowed for in the financial analysis of this plant.

4. Technical data:

Working days	250/year
Shifts	2 eight-hour shifts/day
Prawns	
Output/day	0.9 tonnes
Output/year	225 tonnes
Ice	
Output/day	2.7 tonnes

Equipment

4 station mini-freezer; total charge 180 kg; 5 charges/day
Chillroom, 10 tonne capacity, temperature range -1°C to +1°C
Cold store, 20 tonne capacity, design temperature -30°C
Freezer trays, 30 x 2
Fish boxes, 500
Ice plant, 2.7 tonnes/24 hours
Ice storage bin, local construction
Standby generator, 70 kVA
Weighing machines, 100 kg flat bed
Work tables, 6 with stainless steel tops and wooden supports
Steam cleaner, one, with water input, diesel powered

Labour requirements

	Number	Salary (£/month)
Manager	1	500
Personal assistant	1	100
Shift supervisor	2	250
Clerk/cashier	2	100
Mechanic	2	150
Tallyman	2	60
Reception		
Foreman	2	50
Labourers	10	40
Freezing		
Foreman	2	50
Labourers	26	40

Cold store

Foreman	2	50
Labourers	10	40

5. Financial data: (all figures in pounds sterling, £; 1980 prices)

Capital costs:

1.	Building	15,000
2.	Plate freezer	9,900
3.	Chillroom	4,400
4.	Cold store	7,800
5.	Freezer trays	1,300
6.	Fish boxes	2,750
7.	Ice plant	8,800
8.	Ice storage bin	2,200
9.	Standby generator	6,215
10.	Weighing machine	300
11.	Work tables	2,000
12.	Steam cleaner	1,300
13.	Production line items	2,200
14.	Office equipment, clothing, etc.	2,200
15.	Pick-up truck	5,500
	Total	71,865
	10 per cent contingency	7,185
	Total	79,050
	c.i.f. at 20 %, items 2-15	11,370
	10 % inst. & comm., items 2-15	5,680
	GRAND TOTAL	96,100

Operating costs:

1.	Labour	37,200
2.	Power, 250,000 kWh @ £0.05	12,500
3.	Packaging, 450/day of 2 kg inners plus 45/day of 20 kg outers	13,250
4.	Water, 1000 m^3 @ £0.25/m^3	250
5.	Insurance, spares, maintenance, repairs	3,450
	TOTAL	66,650

It can be seen that labour is by far the most important annual charge and is therefore the factor to which sensitivity analysis should be applied. In certain parts of Africa the labour rates may well be considerably lower than those used. Thus an additional calculation has been made with the annual cost of labour reduced by one third.

Revenue is calculated on the assumption that the total annual output of packaged frozen prawn products amounts to 0.9 tonnes x 250 days = 225 tonnes. A range of ex-plant prices have been assumed, giving the following annual revenues:

Ex-plant price £/kg	Annual revenue £
1.00	225,000
2.00	450,000
3.00	675,000
4.00	900,000

On this basis the quantities of raw material would be as follows:

(i) Production of whole frozen prawns:

Allowing for a 5 per cent waste and/or loss, approximately 237 tonnes of raw material are required for an annual production of 225 tonnes of whole frozen raw prawns; and

(ii) Production of headless frozen prawns:

Allowing for a headless yield of 60 per cent and an overall waste and/or loss of 5 per cent of total throughput, approximately 394 tones of raw material are required for the production of 225 tonnes of headless raw frozen prawns per year.

Given the costs outlined above and the anticipated revenue, it is possible to calculate the price that the operator of the plant could afford to pay for the raw material, based on Internal Rates of Return (IRR) of 10 and 20 per cent respectively. The following table summarizes the results, showing annual cash availability together with quantitative requirements for raw material.

Derived raw material prices for the production of frozen prawns

	Ex-plant price per kg	Annual cash available for raw material	Raw whole	Derived price/kg	Raw headless	Derived price/kg
	£	£	t	£	t	£
IRR = 10 %						
A. Basic cost model	1.00	141,750	237	0.60	394	0.36
	2.00	366,750	237	1.55	394	0.93
	3.00	691,750	237	2.92	394	1.76
	4.00	816,750	237	3.45	394	2.07
B. Reduced cost model	1.00	154,460	237	0.65	394	0.39
	2.00	379,460	237	1.60	394	0.96
	3.00	704,460	237	2.97	394	1.79
	4.00	829,460	237	3.50	394	2.10
IRR = 20 %						
A. Basic cost model	1.00	132,530	237	0.56	394	0.34
	2.00	357,530	237	1.51	394	0.91
	3.00	682,530	237	2.88	394	1.73
	4.00	807,530	237	3.41	394	2.05
B. Reduced cost model	1.00	145,550	237	0.61	394	0.37
	2.00	370,550	237	1.56	394	0.94
	3.00	695,550	237	2.94	394	1.76
	4.00	820,550	237	3.46	394	2.08

6. Transfer of technology

Free of charge

Product Flow for Prawn Processing

Prawns arrive at Plant in Boxes

↓

1. Inspection → REJECT:
   return to supplier
   or
   buy, hold and sell
   or
   possible fishmeal
   or
   dry for fertiliser
   or
   destroy.

↓

2. ACCEPT for freezing

↓

3. Weigh (tally and pay supplier)

↓

4. Wash and preliminary sorting

↓

5. Box

↓

6. Into chillroom

↓

7. To preparation line

↓

8. Sort (head off/peel)

↓

(8a.) (Chlorine dip — optional)

↓

9. To freezing line

↓

10. Weigh and fill cartons

↓

11. Into trays (add water — close cartons)

↓

12. Freeze

↓

13. Remove trays from freezer

↓

14. Knock out cartons from trays

↓

15. Cartons into outers

↓

16. Into cold store

↓

17. Despatch

1–6. RECEPTION
7–8. PREPARATION
9–14. FREEZE
15–17. PACK, STORE, DESPATCH.

UNIDO - Technology Profile No.118

1. Technology: Guava processing

2. Final products and use: Canned guava and guava puree; culinary purposes, the latter to prepare guava nectar, flavouring, jam, etc.

3. Process:

Before processing the guava fruit should be inspected. Damaged fruit are removed and green fruit separated for ripening. From the inspection belt the sorted fruit pass to a washing tank containing an appropriate detergent where dirt and debris are removed by mechanical agitation. The fruit are removed from the washing bath by an elevator belt onto which is sprayed potable chlorinated water to remove the detergent from the fruit.

The majority of guava fruit used for processing are either canned as halves or slices in syrup or macerated into puree. Jams and jellies are also produced.

3.1 Halves or slices in syrup

Canned guava is prepared by peeling the trimmed fruit and cutting it into halves or slices. The fruit is then filled into cans together with syrup of the appropriate concentration. The cans are sealed and heat treated to 85°C and then rapidly cooled by water sprays to about 40°C. The cans are then air-cooled to room temperature. The cans used should be of the enameled type, preferably with two coats of enamel (citrus enamel + vinyl, or fruit enamel + vinyl) to prevent de-tinning by the guava fruit.

3.2 Guava puree

Canned guava puree is the raw material for a number of other guava products. Sugar and water may be added to make a nectar or fruit drink. The puree can be used directly with commercial mixes for making ice cream, sherbet, etc. As a flavouring for pastries, the pure guava puree or a sweetened version may be used.

For the production of guava puree the whole fruit is fed into a paddle pulper for maceration. If the fruits are firm it may be necessary to attach a slicer or chopper to the hopper which feeds the pulper. It is advisable to chop the fruit before it enters the pulper as this gives a more uniform rate of feed. After pulping and finishing to remove the seeds and stone cells, it is advisable to pump the puree through a de-aerator to remove entrapped air. The advantages of de-aeration are the removal of oxygen to prevent oxidation, a more uniform and smoother puree with a better colour, and the prevention of foaming.

Two methods are used for the heat preservation of canned guava puree. The first method (batch process) involves heating the puree in a steel jacketed kettle until it reaches 85°C while the second method uses a flash pasteurizer or heat exchanger to heat the product to a high temperature for a much shorter period of time (HTST). For guava puree the recommended relationship would be 60 seconds at 90.6°C. Flash pasteurization does less damage to the flavour of guava puree than the low temperature pasteurization process. After heating the puree should be filled immediately into enameled cans. Cans with two coats of enamel should be used for the best results with guava puree. The cans are sealed, inverted, held for three minutes and then cooled with water sprays to lower the temperature of the cans rapidly to about 40°C. The cans are then air-cooled until they reach room temperature.

3.3 Products prepared from guava puree

3.3.1 Guava nectar. Depending on the soluble solids of the puree appropriate amounts of sugar and water are added to make the nectar drink. Generally winter fruit contain 6-8%, soluble solids and summer fruit 8-10%. The level of soluble solids in each batch of puree should be determined in order to control the final soluble solids in the nectar. The following recipe, having 20% puree by weight, is calculated so that the finished product will have approximately 11% soluble solids and the acidity will be between 3.3 and 3.5 (depending on that of the original fruit pulp).

Guava puree	100 kg
Cane sugar	48 kg
Water	352 kg

Yield of nectar	500 kg

The sugar is mixed with the water in a mixing kettle or tank until it has dissolved. The puree is added at a steady rate and mixed thoroughly. The mixture is then pumped through a heat exchanger at 82.2 - 87.8°C and held there for 60 seconds. The product is filled into enameled cans. The cans are sealed, inverted, held for 3 minutes and cooled with water to 37.8°C. After labelling and casing the cans are ready for shipping. It is suggested that the addition of a small amount of citric acid enhances the natural flavour of guava.

3.3.2 Guava jelly and jam. A jelly stock can be prepared by cooking graded washed whole fruit with an equal amount of water for about an hour until the fruit is soft. The juice is then strained through a cloth or jelly bag. The resulting stock contains about 4% soluble solids and can be used to make guava jelly. However, to make a jelly from this stock would need excessive boiling to concentrate the mixture to 65° Brix as the stock is rather dilute. Excessive boiling affects the colour and flavour of the jelly. Better quality jelly stock can be obtained by cooking the stock with a new batch of fresh fruit. It may be necessary to work with a third batch to reach the optimum soluble solids contents of 7.7° Brix. When this level is reached, the stock is mixed with sugar in the ratio 45-55 together with pectin acid and other optional ingredients. The mixture should be boiled until a temperature of 105°C is reached. After allowing to stand for a few moments, it is filled hot (88°C) into clean jars which are capped immediately and the jelly allowed to cool and set.

Guava puree can be used to produce a very acceptable jam. To obtain the best flavoured jams, 50 parts of puree are mixed with 50 parts of sugar. After weighing the puree into a steam jacketed kettle, pectin may be added if needed. A weighed amount of sugar is then added in portions while stirring continuously. When the temperature reaches 38-55°C the steam valve of the kettle is opened fully and the mixture heated to 105°C. At this temperature the level of soluble solids in the jam is slightly more than 65° Brix. If a jam of exactly 65° Brix is required, a refractometer should be used to determine the point at which boiling should be stopped.

4. Quality control

A sampling procedure which allows adequate checking of quality of all production batches should be set up. Immediate examination permits corrections to be made and any substandard products to be removed. Similar analyses to those made of the fresh raw material should be applied to the finished products. These tests should include colour, flavour, texture, pH, vitamin C content and soluble solids. Measurement of head space, fill weight and vacuum should also be made with canned products. Any product stored for any considerable length of time should be examined periodically and storage times and temperatures recorded and logged.

UNIDO - Technology Profile No.118

4. Technical data:

Equipment (major pieces):

Washing baskets
Comminuting machine
Pulper
Filter press
De-aerator
Can sealer
Bottling machine

5. Financial data: (all figures in US dollars, 1981 prices)

The capital investment for the listed equipment is approximately 55,000 US dollars.

6. Transfer of technology

Free of charge.

7. Contact address

The Secretary General
National Council for Scientific Research
P.O.Box CH 158
Chelston
Lusaka
Zambia

UNIDO - Technology Profile No. 120

1. Technology: Dehydration of chillies

2. Final product and use: Chilli powder; culinary use

3. Process:

The technology in this profile utilizes fresh chillies as raw material and consists of the following steps:

(a) Washing. The fresh chillies are thoroughly washed in running water to remove adhering dirt and contamination.

(b) Dipping (chemical treatment). The washed chillies are dipped in a chemical solution for a period of 20-30 minutes. The solution is a water-based emulsion containing potassium carbonate, refined groundnut oil, gum acacia and butylated hydroxy anisole (BHA) in the following concentrations:

Potassium carbonate	2.5 %
Refined groundnut oil	1.0 %
Gum acacia	0.1 %
BHA	0.001 %

The potassium carbonate and the gum acacia are dissolved separately in water. The BHA is dissolved in the groundnut oil. The BHA-oil solution is then added slowly to the water-based solutions while stirring continuously. The mixture is passed through a homogeniser twice at 200 kg/cm^2.

About 7.5 litres of the emulsion - at a cost of approximately $US 1 - is required to treat 100 kg of fresh chillies.

(c) Slicing. The treated chillies are sliced to smaller pieces in a slicing machine. This operation increases the surface area available for drying and hence drying will be faster.

(d) Drying. The wet, sliced chillies are charged into trays with perforated bottoms (16" x 32" in size). About 2-2.5 kg of chillies can be charged into each tray. The drying time will be about 4-5 hours under controlled temperature.

(e) Grinding. The dried chilli slices are then ground in a disintegrator to the desired fineness.

(f) Packing. The product can be packed in polythene-lined gunny bags for bulk and/or packed into smaller tins.

If the chilli powder is intended for export, special care has to be taken to: a) keep the content of pesticides low, and b) observe hygiene all through the process, starting with harvesting. It is mandatory that a bacterial infection by escheriaia coli be avoided. To ensure this, a microbiologist and an analytical chemist will be needed.

4. Technical data:

The required equipment for the process is:

Slicers
Dehydrators
Grinders
Homogeniser

Capacity:

Raw material	400 tonnes/year
Finished product	60 tonnes/year
Working days	300 days/year

<u>UNIDO - Technology Profile No. 120</u>

5. <u>Financial data</u>: (all figures in US dollars, 1983 prices)

Investment cost:

Land	**510**
Building	**8,500**
Plant & machinery	**10,000**
TOTAL	**19,010**
Working capital	**2,300**
Production cost	**0.9 per kg**
Selling price	**1.0 per kg**

6. <u>Transfer of technology</u>

Free of charge

UNIDO - Technology Profile No. 121

1. Technology: Small-scale bakers' yeast production

2. Final products and use: Culinary purposes

3. Process:

Bakers' yeast is obtained by fermenting a sugar solution with a selected yeast strain. In order to stimulate the yeast growth, air (oxygen) and nutrients must be added. Without them the yeast would ferment the carbon source (sugar) into alcohol and not assimilate it for growth.

In order to obtain bakers' yeast of the required quality (see annex) and with reasonable yield from the raw material, nutrients and air have to be specially prepared and added following a detailed programme, internationally known as "Zulauf". The conditions of fermentation, such as pH, temperature, etc., are also controlled continuously.

The equipment and machinery must be suitable to match the requirements of the process and also be adapted to locally available raw materials, chemicals and utilities.

Normally, bakers' yeast production consists of the following stages:

3.1 Preparation of raw materials

The purpose of the preparation is to transform the substances, which are necessary for the yeast growth, into a form and concentration that can be assimilated by the yeast. This means from solid into a low concentration liquid. Furthermore, toxic substances which impede yeast growth and reduce quality, must be eliminated.

The principal raw material is molasses. The molasses are diluted in a tank with hot water, sterilized with steam, cooled and finally the sludge is sedimented. This can be done batch-wise (cooling tank, sedimentation tank) or continuously using a jet cooler for pasteurization of molasses and a centrifuge for the sedimentation. A plate heat exchanger is used for cooling. In cases of a very fine sludge, molasses can also be filtered through a disk filter.

3.2 Nutrient preparation

As nitrogen source, ammonia, urea and diaminonsulphate or diaminonphosphate can be used. Usually a combination of the two products is used. As a phosphate source, diaminonphosphate or phosphoric acid should be used. The nutrients are diluted with hot water, the sludge is sedimented (in some cases washed) and the clear liquid is used in the fermentation. When chemicals with high purity are used, they can be added to the fermentation without dilution. The pH of the fermentation is controlled with sulphuric acid, which should always be diluted to approximately 10 %.

3.3 Fermentation and centrifugation

The yeast is grown in various stages (pure culture, pre-fermentation, seed yeast. and main fermentation) in several fermentation tanks. The fermenters are equipped with a highly efficient aeration system, a cooling system and a dosification and instrumentation system. Normally bakers' yeast is grown at a temperature of 30°C, while the raw material and nutrients are dosified automatically in accordance with yeast growth. Bakers' yeast is fermented batch-wise. After the batch has been completed, the yeast cells are separated from the mash by centrifuges. The result is yeast cream which is washed with water and again passed through the centrifuge.

3.4 Yeast cream storage and pressing

The yeast cream, which contains about 16-18% total solids is stored at +7°C. It is dehydrated t 28-30% total solids for easier transportation and handling. A continuous vacuum filter is used for capacities over 12 tonnes/day, a batch-wise working filter for lower capacities.

Now the pressed yeast can either be packed and delivered as fresh bakers' yeast to the bakeries, or dried to obtain Active Dry Yeast (ADY). In some countries where big bakeries are close to the yeast factory, yeast cream can also be used. It is delivered daily to the bakery and added directly to the dough.

3.5 Active dry yeast production

The fermentation process is similar to that of the fresh yeast production. After filtration, the yeast is granulated and carefully dried in a continuous or discontinuous process. The dried yeast granulate, i.e. the active dry yeast is the packed under vacuum or protective gas and can be stored up to one year without substantial loss in activity. The instant character of the active dry yeast is obtained by certain additions (emulgators) as well as by a special drying process. Compared to the conventional active dry yeast, the instant dry yeast has the advantage that it can be worked directly into the dough without any previous water addition. The drying of the yeast is carried out in a fluid bed drier. The drying conditions depend on the process applied, however, the drier should be equipped with a device for air conditioning (temperature and humidity control) and another to regulate the air quantity. By regulating the air quantity and air conditioner, the yeast is dried under optimal conditions in order to maintain high activity or raising power.

4. Technical data:

Utility supply

- Steam supply at a maximum of 8 bar.

- Water of drinking quality is required for the process and cooling water with max. 24°C for cooling of the fermentation tanks. Where cooling water is not available, a cooling tower must be installed.

- Electricity at locally available voltage must be guaranteed for 24 hours/day.

Waste water

Large amounts of waste water result from bakers' yeast production (12 m^3 for i ton of fresh yeast). Waste water can either be concentrated through evaporation and used as animal feed stuff or treated by anaerobic digestion, by which methane gas is produced.

Equipment

A small-scale unit for the production of 100 tonnes of ADY/year normally consists of:

- Molasses tanks for storage, diluting and cooling
- Fermentation equipment with one 2 m^3 propagator and one 25 m^3 main fermenter
- One or two centrifuges and one filter press (300 kg fresh/batch)
- 3 yeast cream tanks, 5 m^3 each
- Yeast drier for 30 kg ADY/hour

- Utility supply including boiler, cooling tower or cooling machine, air conditioning equipment and storage for chemicals

- Laboratory equipment

- Simple instrumentation

Consumption figures

Molasses	4,700 kg
Urea	60 kg
Diaminonphosphate	50 kg
Anti-foam agent	5 kg
Sulphuric acid	50 kg
Electric energy*	2,100 kWh
Process water	80 m^3
Cooling water (24°C)	950 m^3
Steam 2.5 bar	900 kg
Steam 7.0 bar	4,500 kg

*) only for the production line

Quality standard for Active Dry Yeast

Total solids	min. 92%
P_2O_5	2.2-2.4%
Protein	40-44%
Colour	light
Raising power	1,000 ml CO_2
Stability**	650 ml CO_2

**) after 24 hours storage at 35°C

5. Financial data: (all figures in US dollars, 1987 prices)

Estimate of investment costs

Molasses preparation	25,000
Fermentation	110,000
Separation/filtration	130,000
Yeast storage	30,000
Yeast drying	150,000
Chemical preparation	15,000
Laboratory equipment	30,000
Utility machinery*** (compressor, cooling machine)	60,000
Boiler water treatment	60,000

Installation material and installation	200,000

	810,000
Assistance for design and engineering	300,000

	1,110,000

***) may be partly or totally available locally.

6. Transfer of technology

Free of charge