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Expert Group Meeting on Design, Development and Manufacture of Simple Food Processing and Preserving Equipment*

Lusaka, Zambia, 9-13 January 1989

DESIGN, DEVELOPMENT AND MANUFACTURE OF SIMPLE FOOD EQUIPMENT**

Prepared by

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* Organized by UNIDO in co-operation with the Government of Zambia and the Village Industry Service

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V.89-54013

INTRODUCTION:

There are about 700,000 women in Lesotho. Most of these women remain at home when their husbands have left their rural homes to obtain jobs in towns in Lesotho and the mines of the Republic of South Africa. Mine remittances are source of income for most of the families in Lesotho. Women receive income from husbands periodically and at irregular intervals. At this juncture the audience should be reminded that women are minors by legislation and depend heavily on the decisions of husbands (heads of households) on utilization of family assets. Wives receive a fair share of the husbands' wages if the relationship between the spouses is healthy. Natural energy sources are depleted and women rely heavily on buying sources of energy for food processing and food preservation. Husbands' wages are needed to purchase energy sources besides other household items.

Lesotho is an agriculturally based economy. It is very disturbing to realize that married women have no right to own land as individuals. These women cannot have security in terms of land in order to get loans from Banks, nor could women obtain land to grow trees as individuals. Lesotho is so eroded that natural fauna is depleted. There is lack of natural woods for preservation and processing. Lesotho has a severe winter and special steps have to be undertaken to produce crops or preserve food because during spring and summer, a lot of food crops grow (maize, beans,

vegetables, fruits). In winter vegetables, winter wheat, fodder and peas grow. Food preservation techniques have to be devised to solve problems related to seasonal production of crops. Food has to be prepared in such a way that it will be edible and acceptable to taste. Technological devices have been developed for food processing and food preservation. These will be classified into traditional and modern or appropriate technologies.

A. SIMPLE FOOD PROCESSING TECHNIQUES:

i) Grinding Stone:

Granite stone is used with a small stone for grinding grain against the larger stone. The surfaces of both stones are roughened up. The texture of flour is varied depending on whether flour will be used to make soft/hard porridge or weaning foods for the baby. All grains are processed by this technique.

ii) The hammer mills and dehuller for sorghum.

iii) Soaking and grinding on the stone-grinder.

iv) Cooking in clay pots. This is obsolete and three-legged pots are utilized.

v) Source of energy is wood, cow dung or plant remains after harvest.

B. APPROPRIATE TECHNOLOGY FOR FOOD PROCESING:

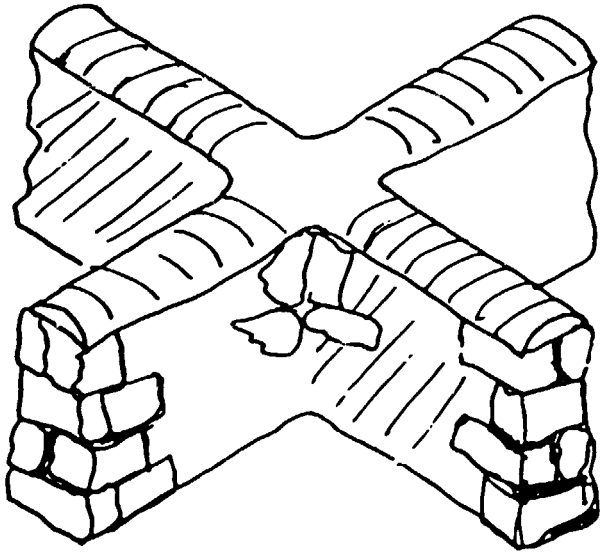
In the Ministry of Interior, Chieftainship Affairs and Rural Development, there is the Appropriate Technology Section (ATS). The main objective of the Section is development of new technologies, trials, publicity and dissemination of information and sale of developed appropriate technologies which are useful to Basotho especially in the rural areas. The following devices have been developed and tested.

i) Wind Protection Fireplace (Leifo):

This device is used to protect fire from wind effects. Mud and stone is used to build four walls attached to each other at 90° angles. The height and length of the device depends on choice of the user.

LEIFO - WIND PROTECTION FIREPLACE

Figure 1



ii) Mud-Stoves/Earthern Stoves:

Materials needed are: water, sand, clay, wooden planks, two pots, meshed wire, chimney, corrugated iron sheet, ash pan, stones or bricks. Dimensions depend on the size of stove to be built.

Method:

Start by placing two pots by side on the ground where the device is to be constructed. Leave space about palm's length between pots and the edge of of the stove. The distance between the last pot and the chimney is also as broad as the palm. Draw a line around the pots and chimney. Remove the pots and build a rectangular wall around the line. The wall constructed should be about the length of a fish-oil tin and half the fish-oil tin (one and half fish-oil tin). (5 litres)

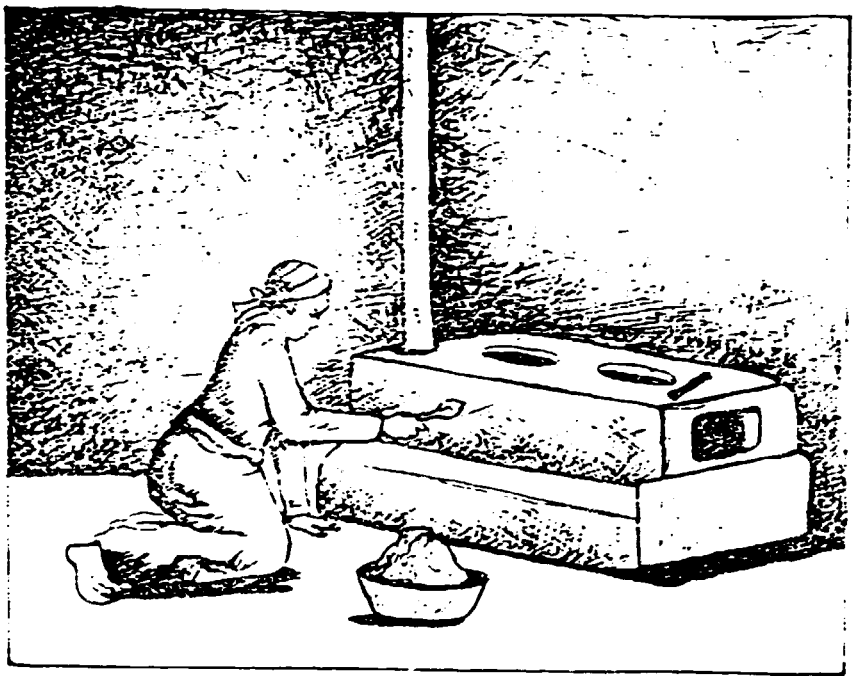
The inside of the wall should be filled with a mixture made in the following manner.

- Three buckets (liemere) of rough sand.
- One bucket of clay.
- Water.

Mix the ingredients to make a good moist mixture of requisite consistency. Fill the wall structure with the mixture and make holes for pots and the chimney, the ash tray, device to control the heat/ flame and provide space for the grate.

Cover the stone structure with mud and smooth the smeared walls so that the device appear clean.

Figure 2



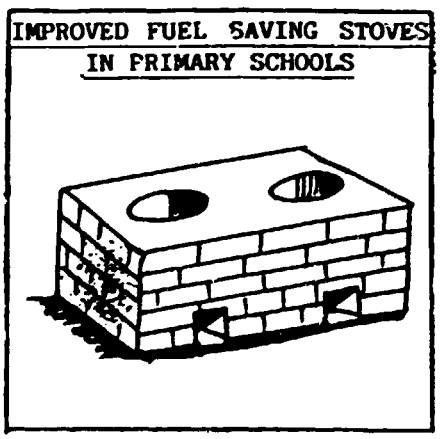
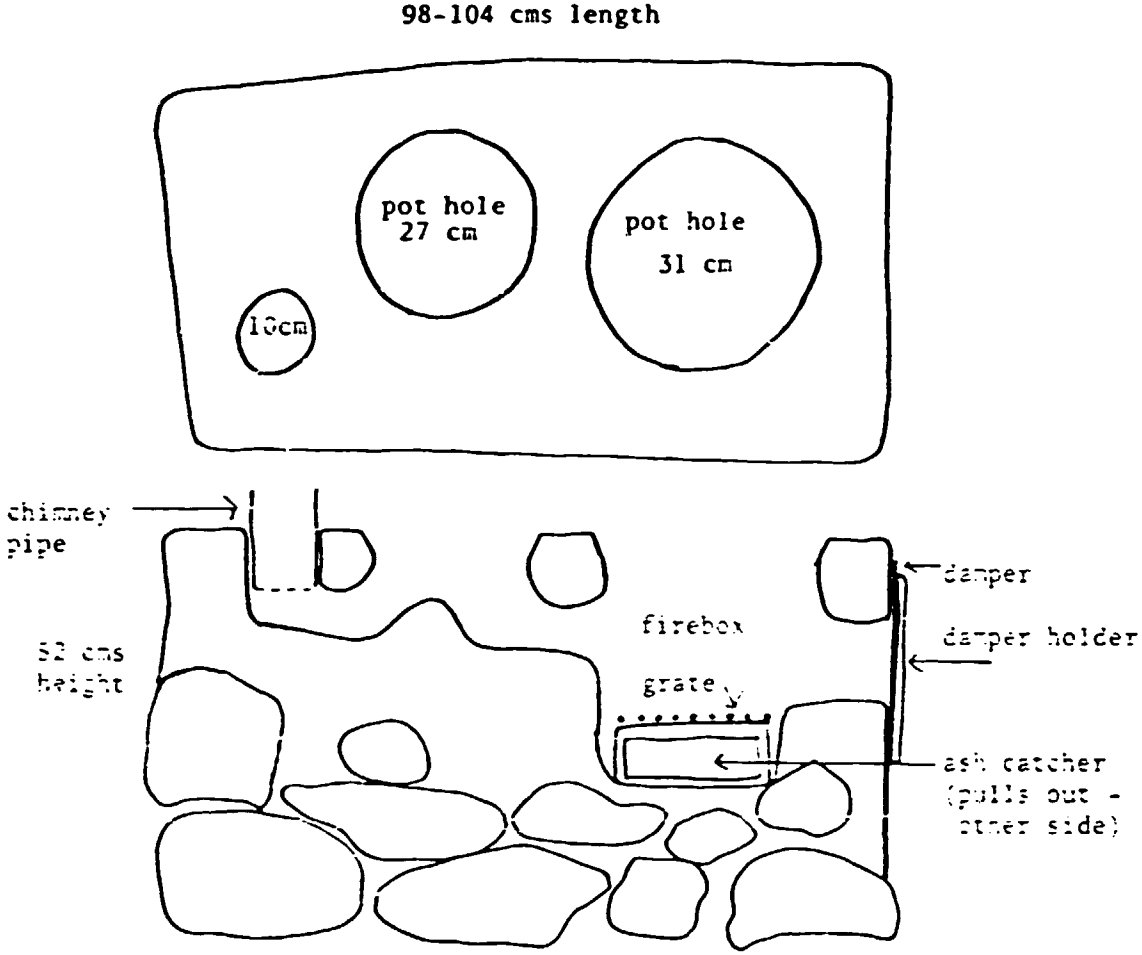


Figure 2A RET Earthen Stove Model 3 (Scale 1:10, cm)



A Rock Base Mud Stove with Grate and Ash Catcher

iii) Paolas:

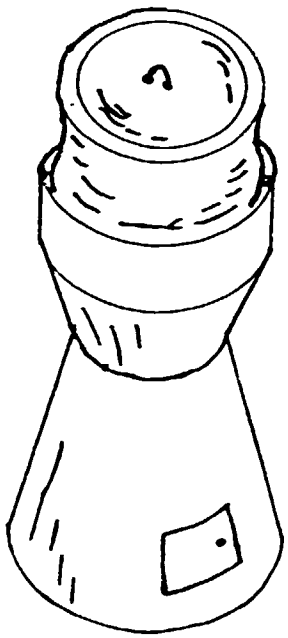
Traditional paolas can be constructed from buckets by making holes all over the surface of the bucket or one hole on one side of the bucket. The device is good for cooking outside, but dangerous to leave overnight in a closed room.

"TRADITIONAL" PAOLAS TESTED

Figure 3

CONFIGURATION		
HOLES ALL OVER	1/3 HOLES	ONE HOLE
BUCKET		
CYLINDER		
SQUARE		

Figure 3



The improved Paola

245 X 123 GI SHEET CUTTING LAYOUT FOR FIVE PAOLAS
(in centimeters)

Figure: 3A

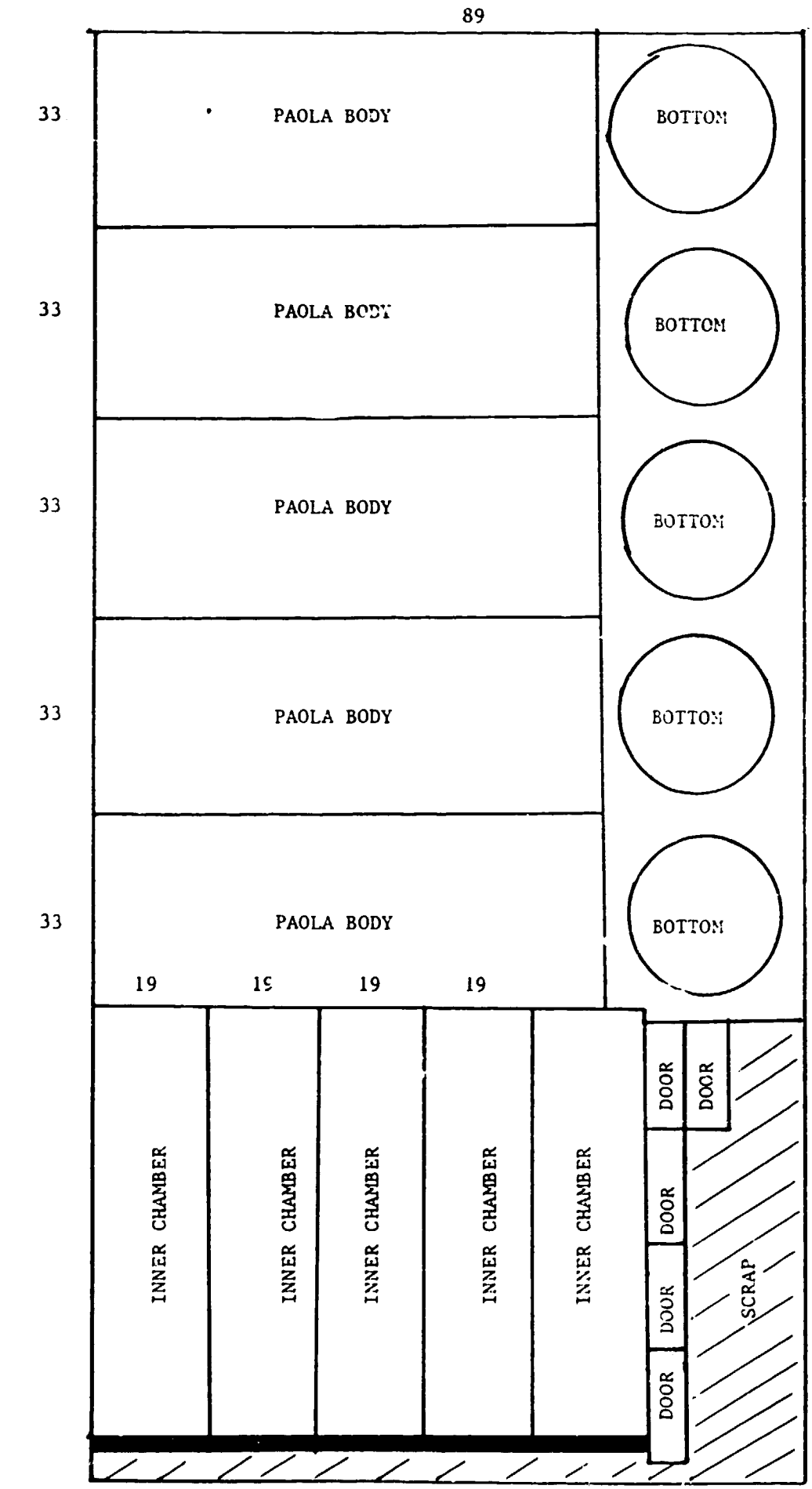
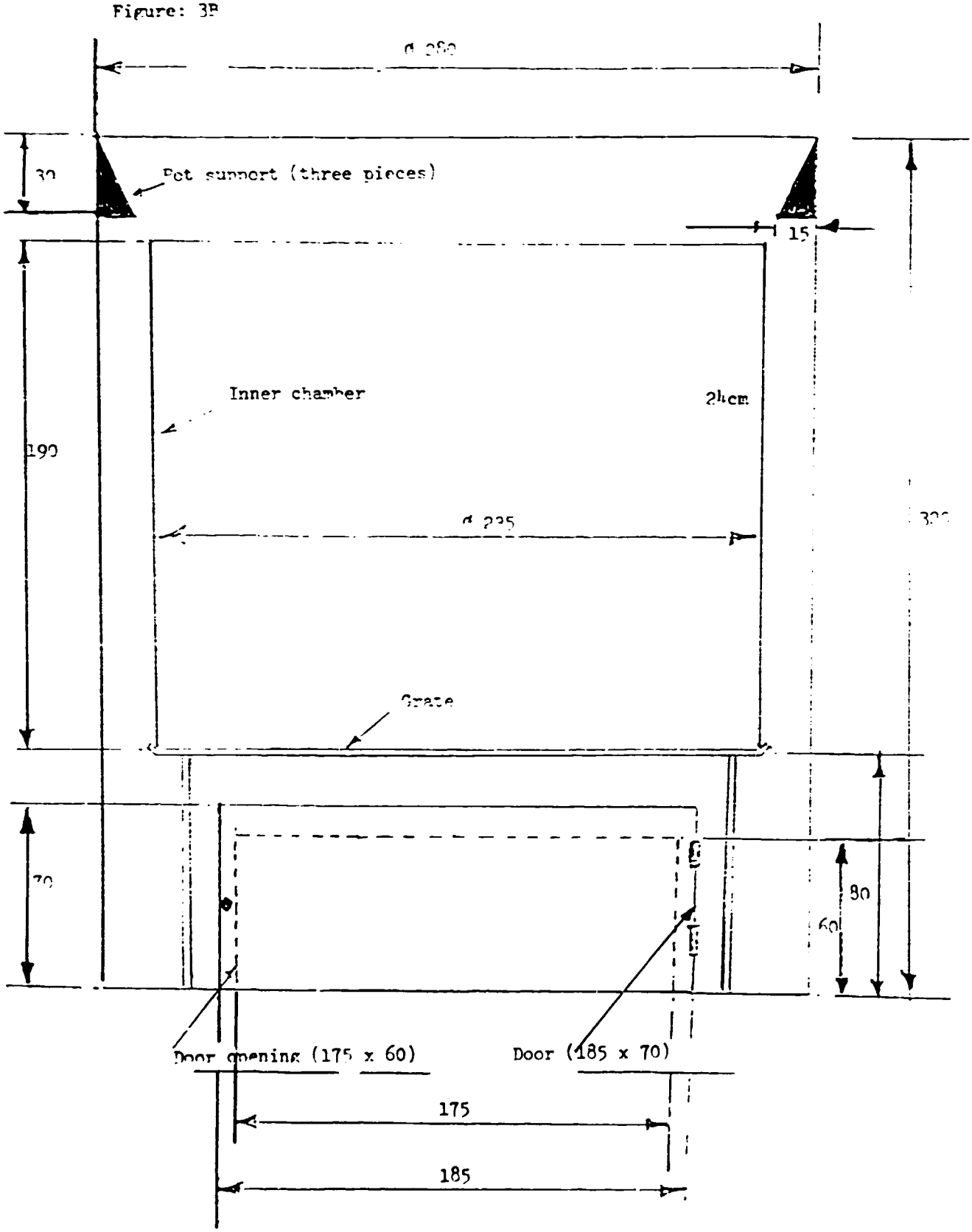


Figure: 3B



METAL PAOLA (USING GI SHEET)

SCALE: 2:1

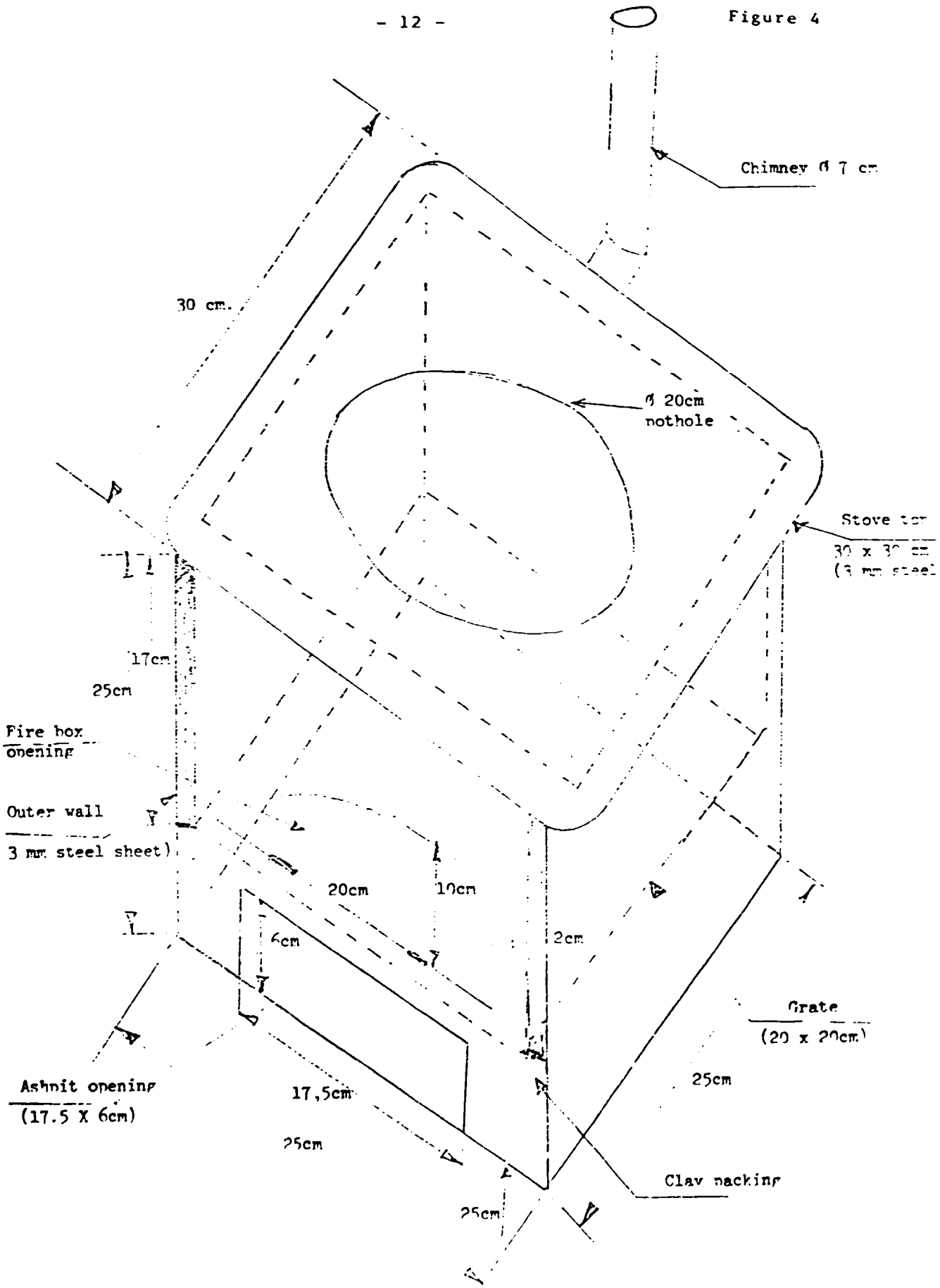
ALL DIMENSIONS ARE IN MM

iv) The Single pot stove:

The structure can be used indoors in winter and outside in summer. The device is made of cooking surface consisting of a double wall of corrugated iron packed with two (2cm) centimeters clay in between the walls. The bottom of the cooking surface is a grate made from pieces of corrugated iron sheet or iron bars.

The stove has a chimney, fire box opening and ash tray.

Figure 4

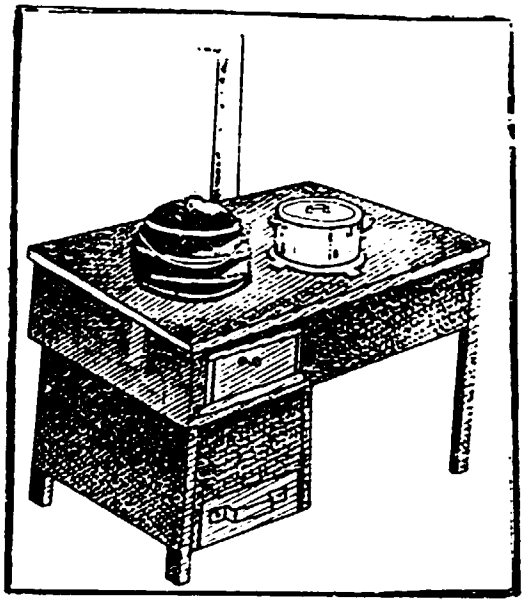


SINGLE POT STOVE (WITH CLAY LINING/PACKING)

v) "Mabotle" stove:

This is a very popular device (instructions as detailed).

Figure 5:

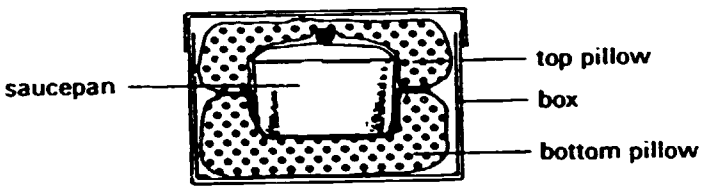


vi) Retained Heat Cookers:

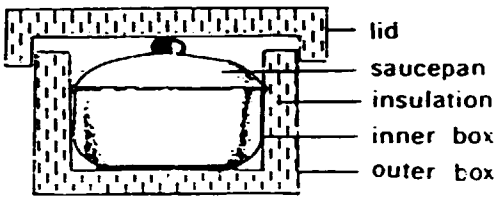
These are becoming popular devices in Lesotho. The retained heat cooker is a cooking structure which is used to finish cooking food that has already been boiled. The cooker consists of a box (bottom and top containers) and insulating materials (pillows).

Figure 6:

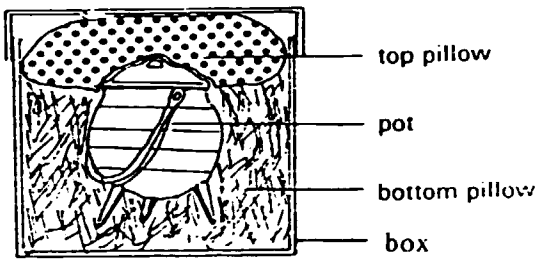
Model 1



Model 2



Model 3



How to make the retained heat cooker:

Most of materials of the Retained Heat Cooker probably can be found somewhere in your own home. All you do is find and assemble the parts. The type which is easy to make and very efficient consists of a cardboard box with a lid, two cushions for the bottom and the top of the containers. The cushions provide most of the isulation and the box is a convenient portable container. The cushions

should be made so as to fill the box completely when used.

How to make the two pillows:

To make the two pillows, cut two rectangles the width and length of the inside of your cooker. Fold each in half and sew up two sides. Turn the cases so that the stitching is on the inside and stuff loosely with your insulating materials. Close the opening with the hem-stitching or a zipper.

Another simple model is made of two boxes, one inside the other, with the space between them filled with insulation. An insulated lid or cushion goes over the top.

Another simple model is made of box layered out with grass/chaff or sawdust at the bottom and covered with the top pillow stuffed with insulation.

A temporary retained heat cooker can be improvised by wrapping the container in blankets, sleeping bags. The possibilities are endless.

Important points to consider in making the retained Heat cooker:

There are a few principles to bear in mind when making any type of the retained heat cooker:

- make sure there is enough insulation on all sides of the container.

- the pot should fit as snugly as possible into the cushions or lining of the box.

- the lid of the box should fit closely to be as nearly air-tight as possible. This minimises heat loss by convection.

Insulating Materials:

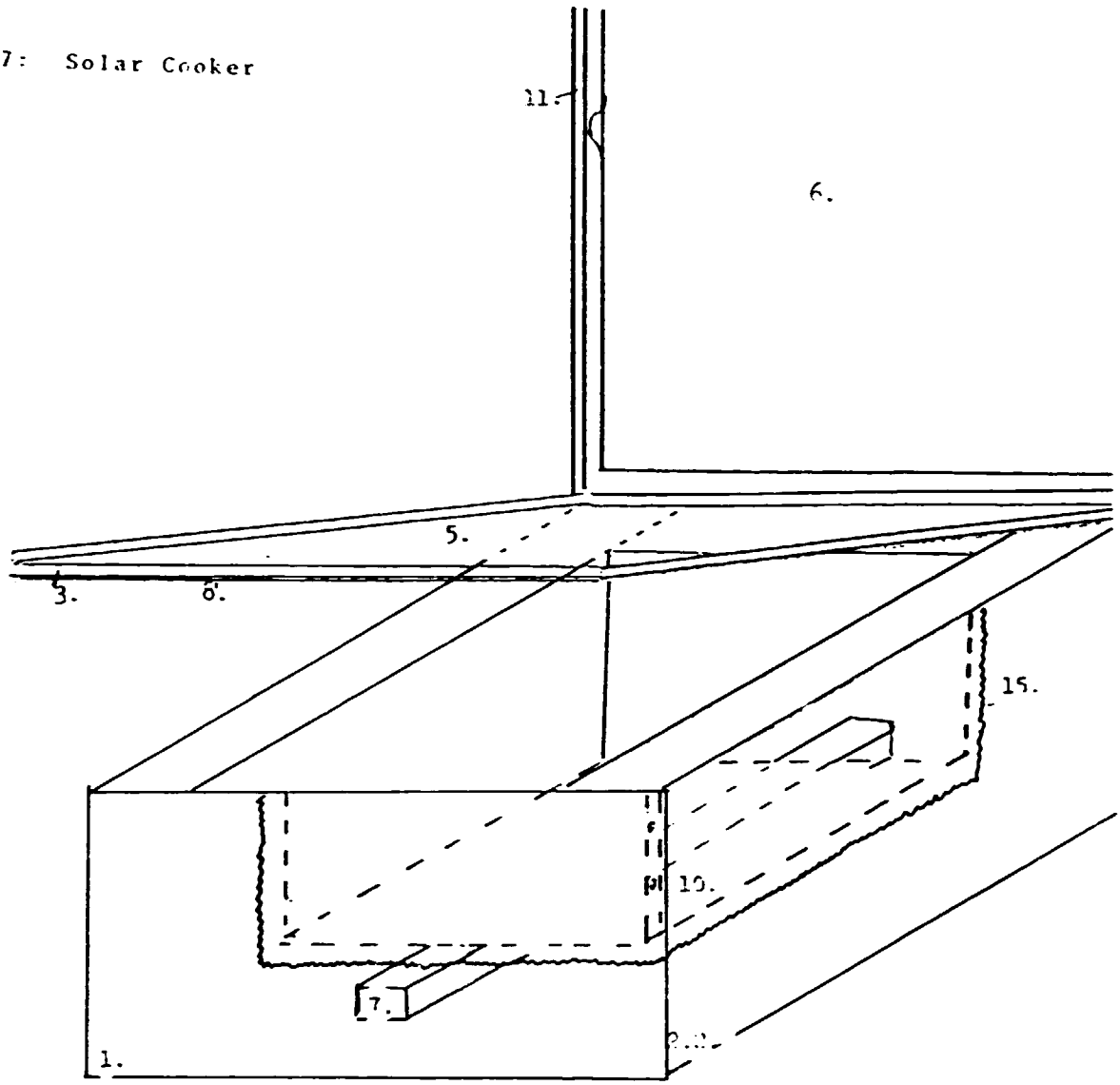
A wide variety of commonly available materials can be used for insulation. Any material which consists largely of small or less isolated air pockets will insulate well. The trapped air acts as a barrier to heat loss by convection and conduction. Examples of insulation materials are hay, straw, chaff, sawdust, shredded cloth, crumpled newspaper, feathers, wool, sponge, fur, fibreglass, and styrofoam beads.

vii) The Solar Cooker and the Solar Oven:

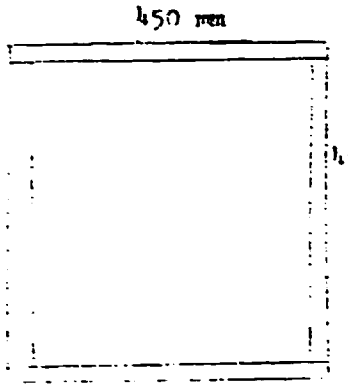
Solar cooker and solar oven trap sun's energy to cook food or bake bread or cakes. The devices consists of two boxed of different sizes which fit into one another so there is an inner box and an

outer box; space between the boxes insulated. The inner box is painted with black paint. The boxes have a glass lid mounted on wooden frames. The rays of the sun are reflected into the inner box by two mirrors supported by wooden frame in such a manner that the mirrors can be tilted to direct the reflected rays so the focal point lies in the centre of the inner box. The boxes are made of corrugated iron sheets. The frames are supported by wooden frames. The solar oven is constructed from corrugated iron sheet (boxes - outer and inner as with the cooker). Reflective surfaces are made from corrugated iron flaps - petal - like which are lined with tin foil. When the petal like flaps are opened, the rays of the sun are concentrated towards the inner box which is covered with a glass lid. Both cookers are provided with locking devices and can be securely left to cook outside while the cook is attending to other duties at home or in the field.

Figure 7: Solar Cooker



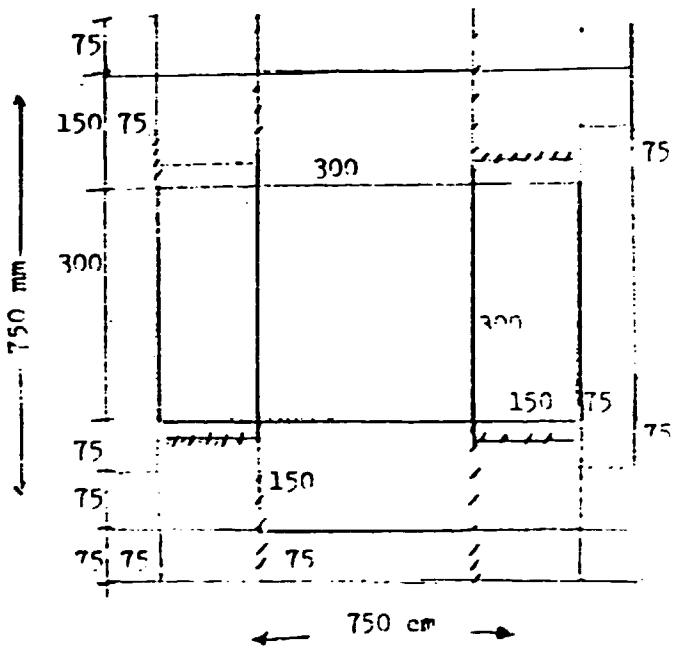
1. 2 x focia board	450 mm x ± 220 mm	) outer box
2. 2 x focia board	(450 mm - (2 x width)) x 220 mm)	
3. SAP 18 x 18 mm	12 x 450 mm	mirror and lid frames
4. flat iron	750 x 750 mm	inner box
5. glass	445 x 445 mm	lid
6. mirror	450 x 450 mm and mirror clamps	
7. SAP 18 x 18 mm	450 mm - 2 x width	to support inner box
8. foam	h x 450 mm	
9. silicone rubber		
10. nonrivet		
12. 2 x hinges		
13. 1 lock		
14. screws		
15. aluminium foil shiny side up		
16. isolation material - fibre glass		
17. wood or so 450 mm x 450 mm to close the box		



OUTER BOX

Figure 7a.

flat iron - inner box

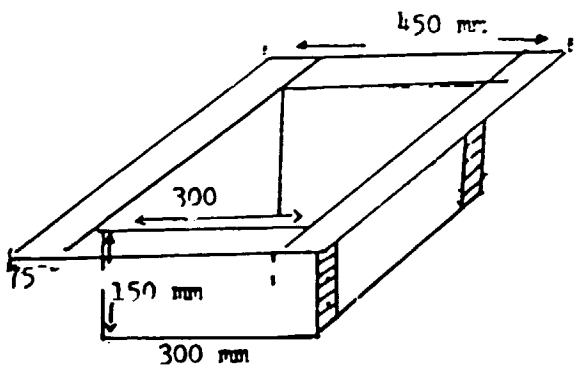


0 overlap

- where to cut

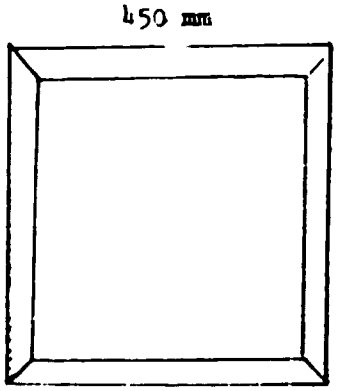
- what you must have after dutting

where to bend



- overlap

• • - pop rivets



x 3

1x lid
2x mirror frame

FOOD PRESERVATION TECHNIQUES:

a. Food Drying:

This method was used to preserve vegetables, fruits meat. The materials were dried in the sun. Meat was salted before drying.

b. Bottling:

This is the most popular food preservation method used by Lesotho women. Vegetables and fruits are usually preserved. Items can be kept in bottles for more than fi years.

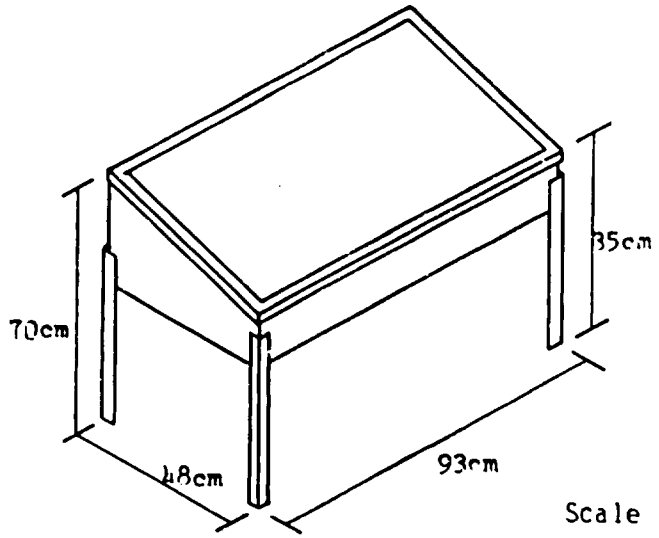
c. Solar Dryers:

These devices have been developed by the Appropriate Technology Section (ATS).

Figure 8:

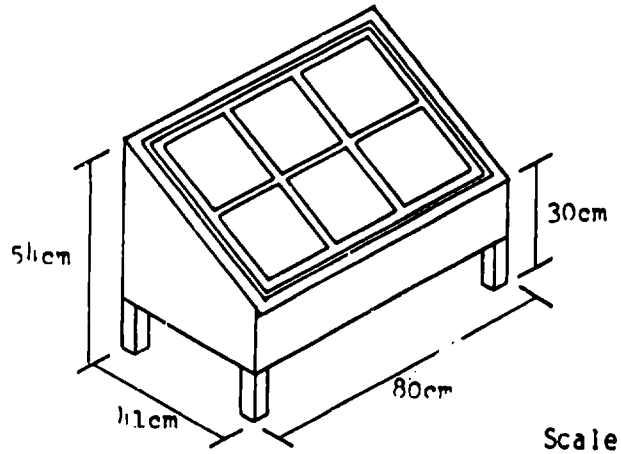
Figure 8: Solar Dryers

Figure 1: Metal Fiberglass Dryer



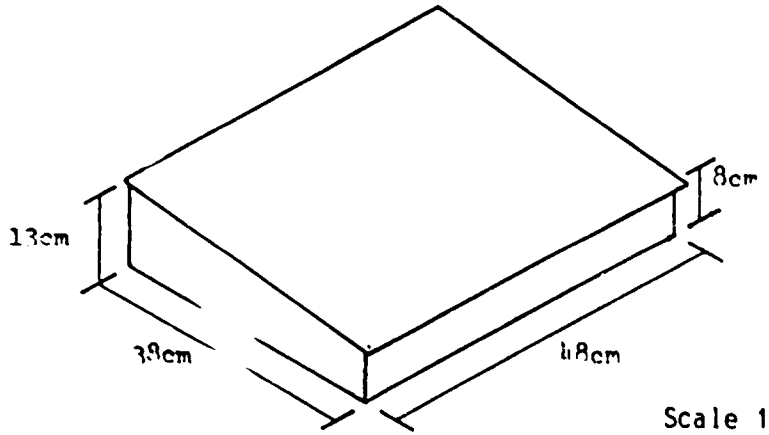
Scale 1:20

Figure 2: Window Dryer



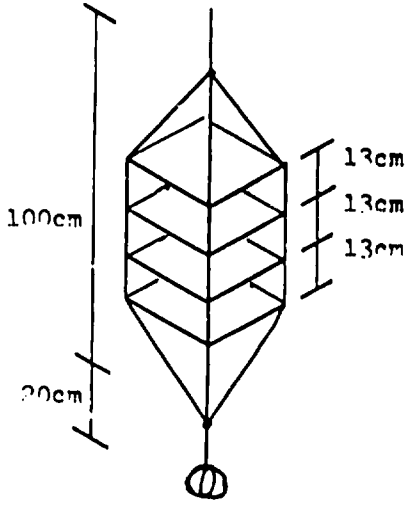
Scale 1:20

Figure 3: Cardboard Box Dryer



Scale 1:10

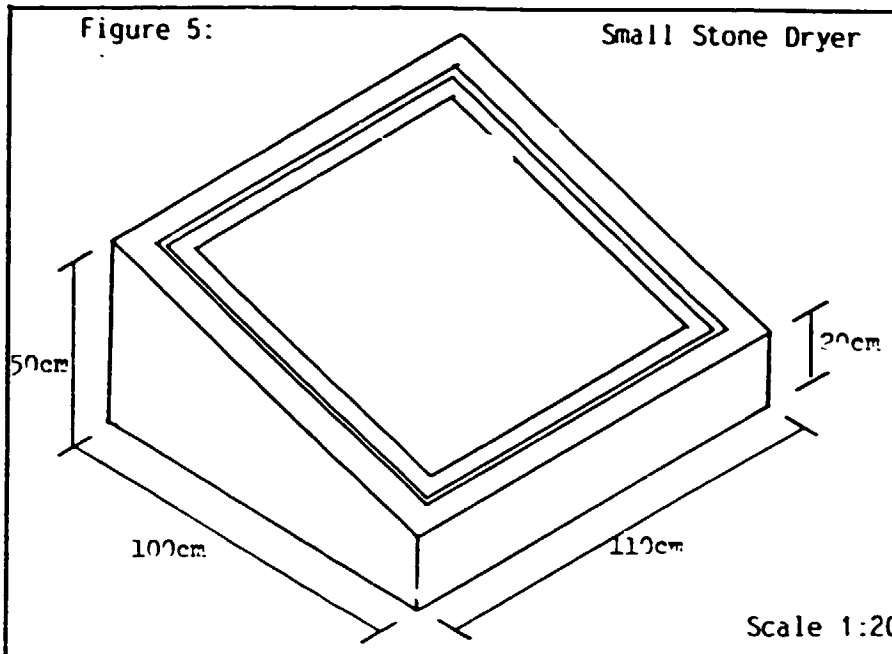
Figure 4: Cabbage Bag Dryer



Scale 1:20

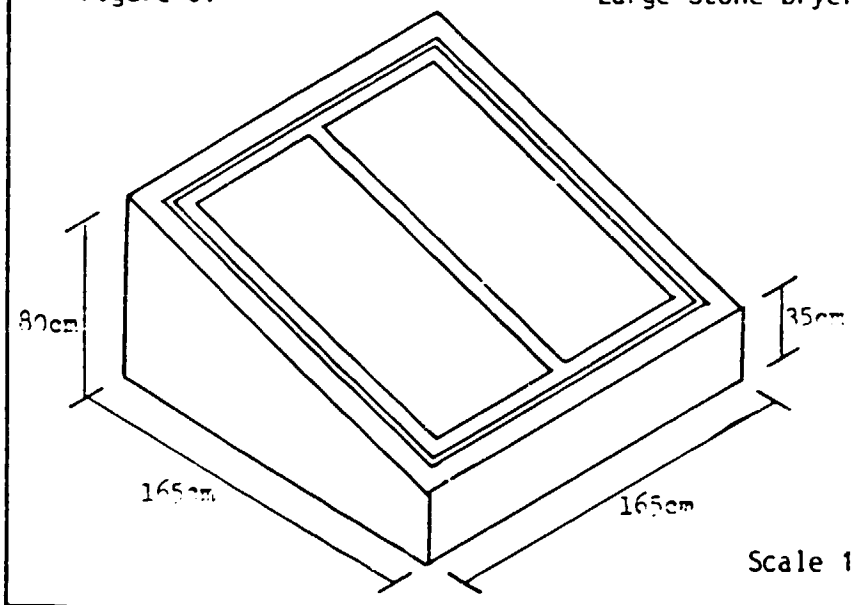
Figure 8A

Figure 5: Small Stone Dryer



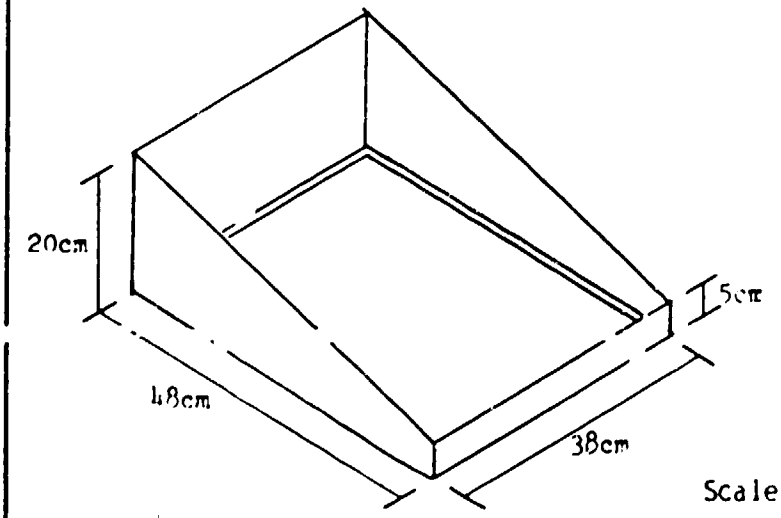
Scale 1:20

Figure 6: Large Stone Dryer



Scale 1:33 1/3

Figure 7: Traditional Dryer



Scale 1:20

SOLAR DRYER

Figure: 8B

MATERIALS REQUIRED FOR THE FRAMEWORK

a). Top Frames

970 mm x 32 mm x 32 mm (4 pieces)
555 mm x 32 mm x 32 mm (4 pieces)

b). Legs

660 mm x 32 mm x 32 mm (2 pieces)
390 mm x 32 mm x 32 mm (2 pieces)

c). Botton Frames

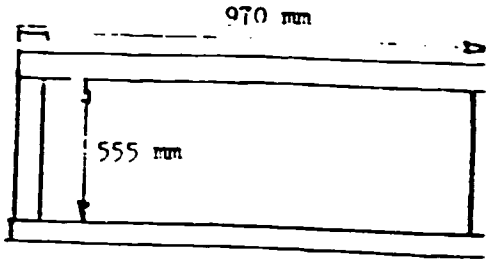
890 mm x 32 mm x 32 mm (2 pieces)
500 mm x 32 mm x 32 mm (3 pieces)

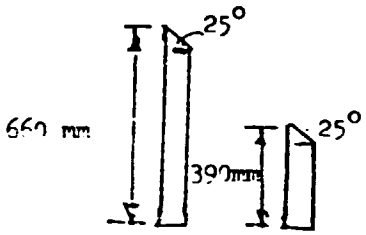
d). Tray

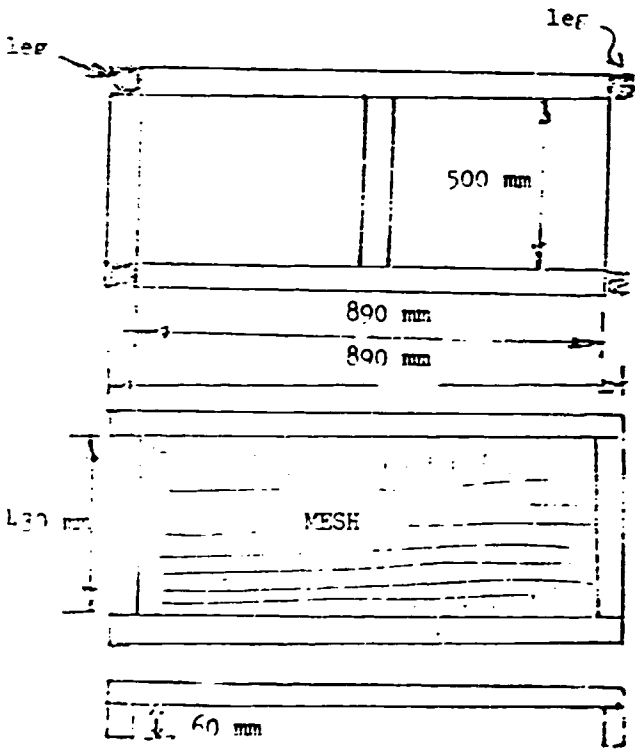
890 mm x 32 mm x 32 mm (2 pieces)
630 mm x 32 mm x 32 mm (2 pieces)
60 mm x 32 mm x 32 mm (4 pieces)

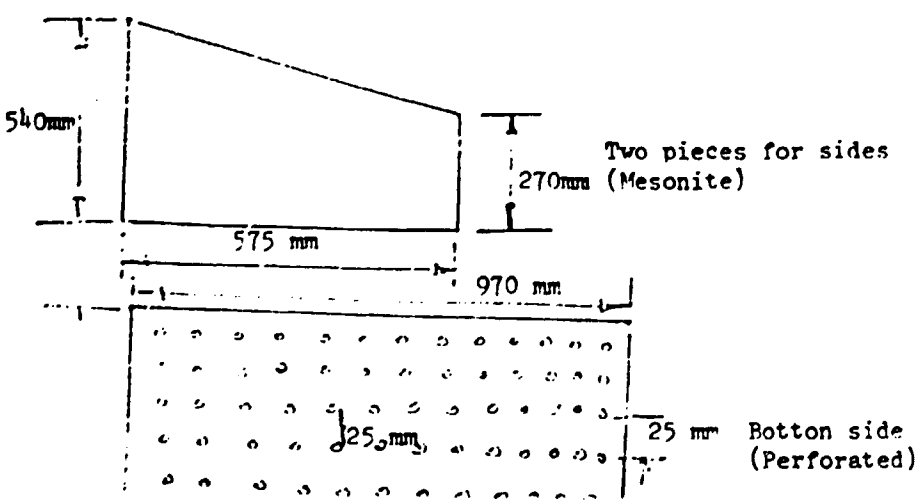
e). Materials for body

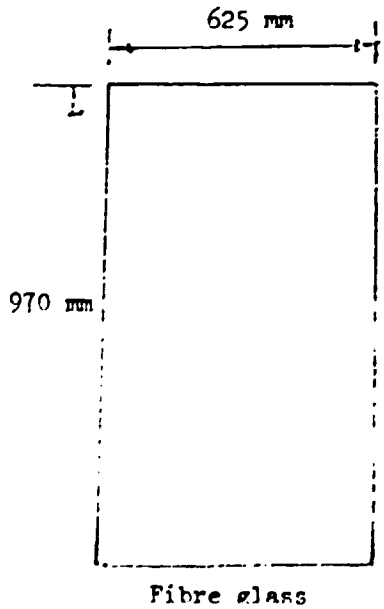
970 mm x 500 mm Mesonite for Rear
970 mm x 230 mm Mesonite for Front





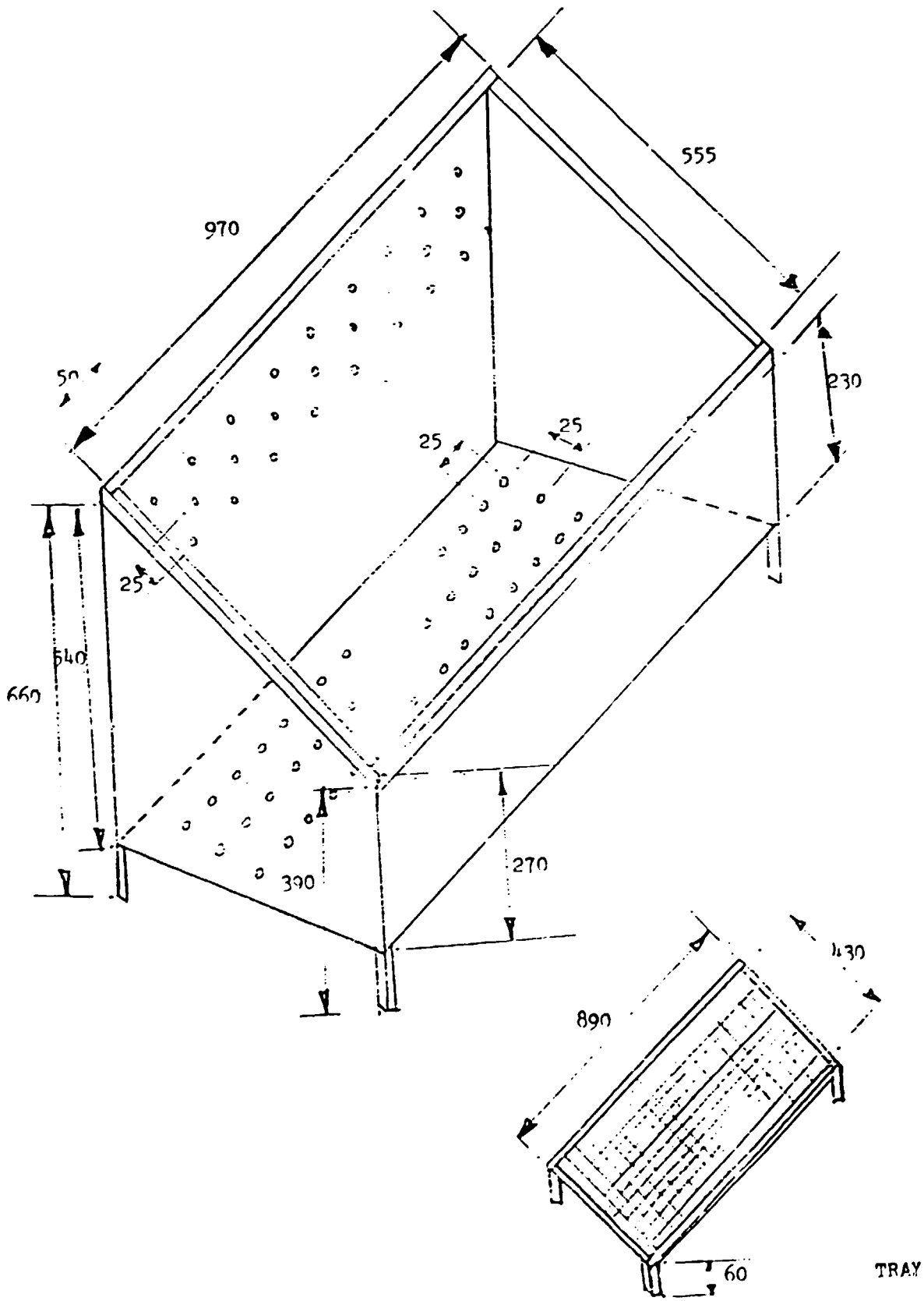






A.T.S. Solar Dryer

Figure 8C



d. Storing Grains:

The brick silo/stone silo:

This is a structure constructed of brick or stone.

Figure 9: Brick Silo

Brick Silo

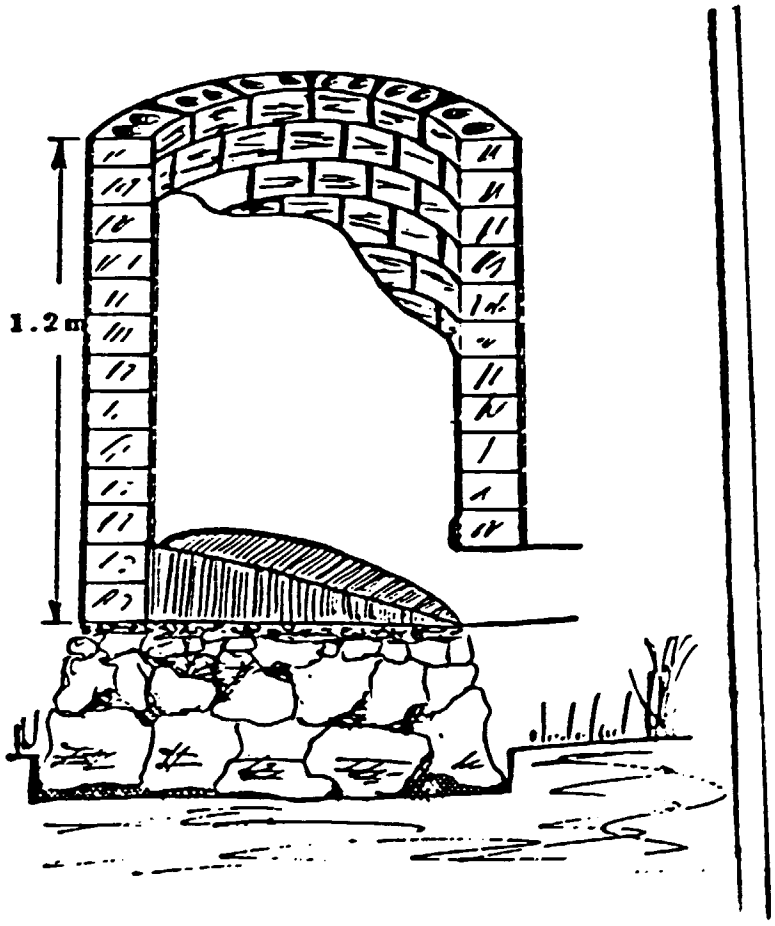


Figure: 9A

Brick Silo

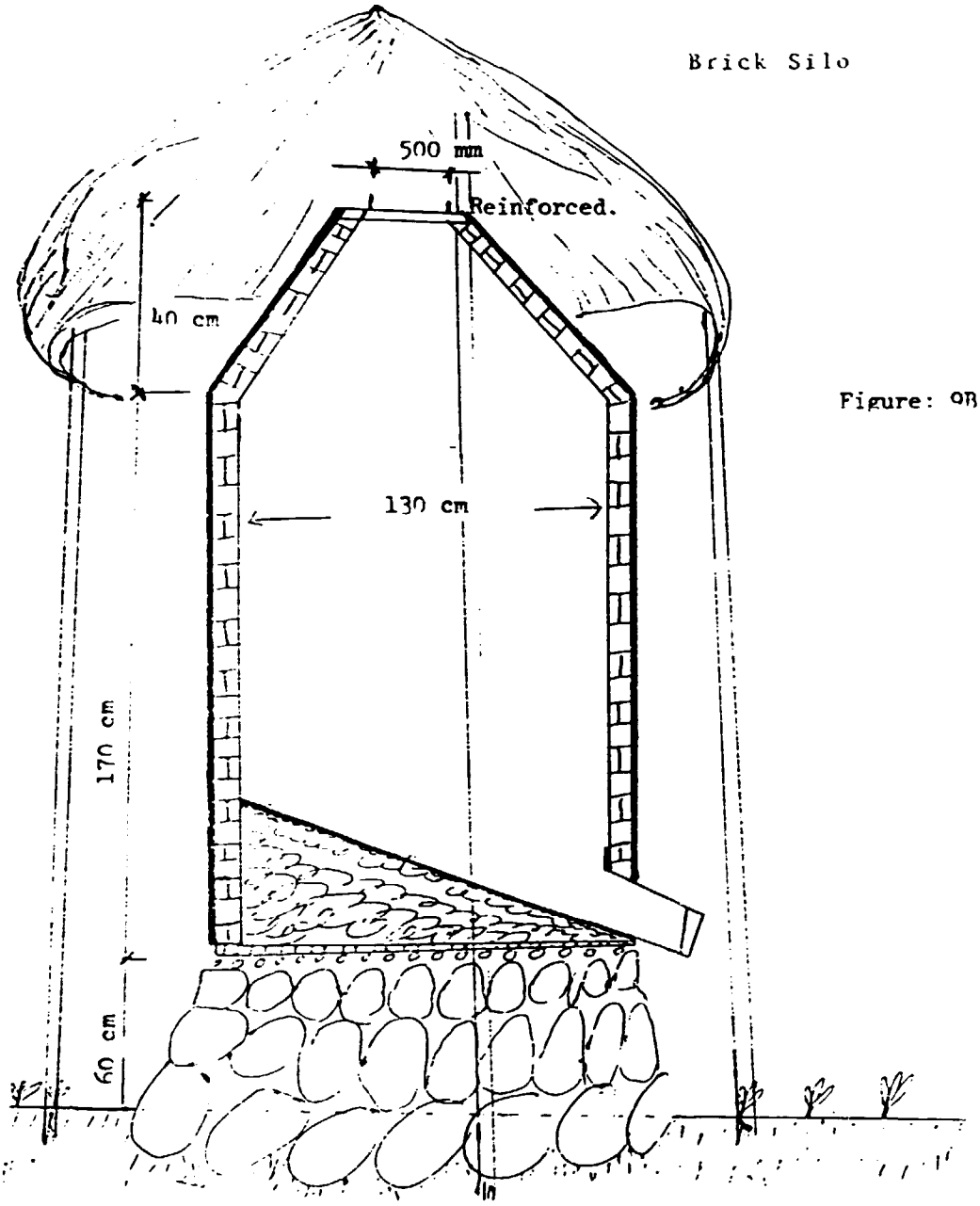
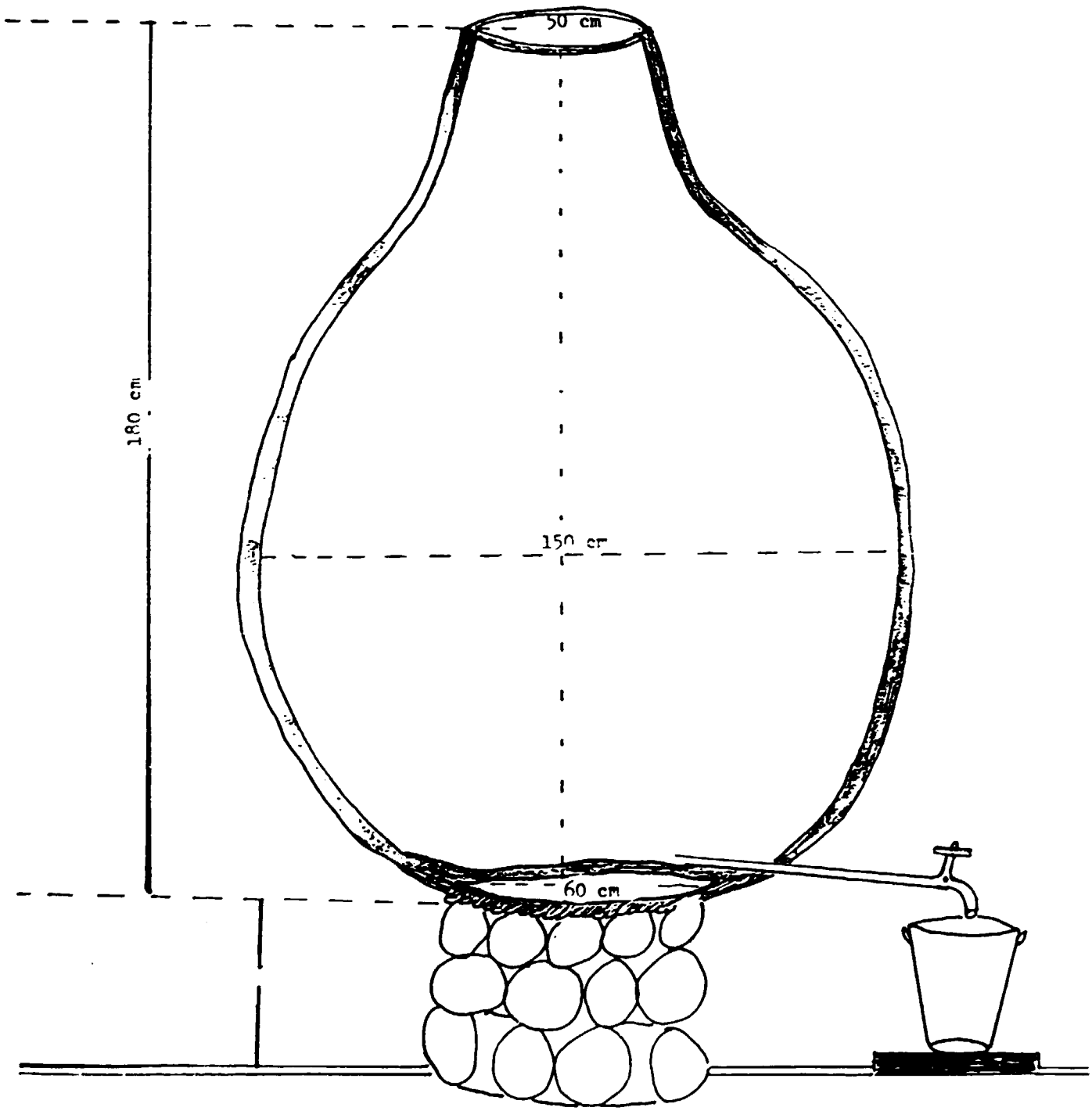


Figure: 08

d. <u>The Water Jar</u>:

This is used to harvest rain water from the roof-top. It consists of a cement pot with a mouth spout with a tap and stone base.

Figure 10: Water Jar



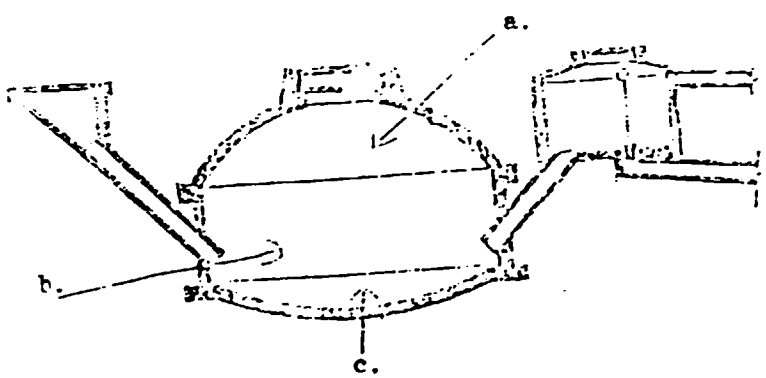
BIOGAS GENERATION PLANTS:

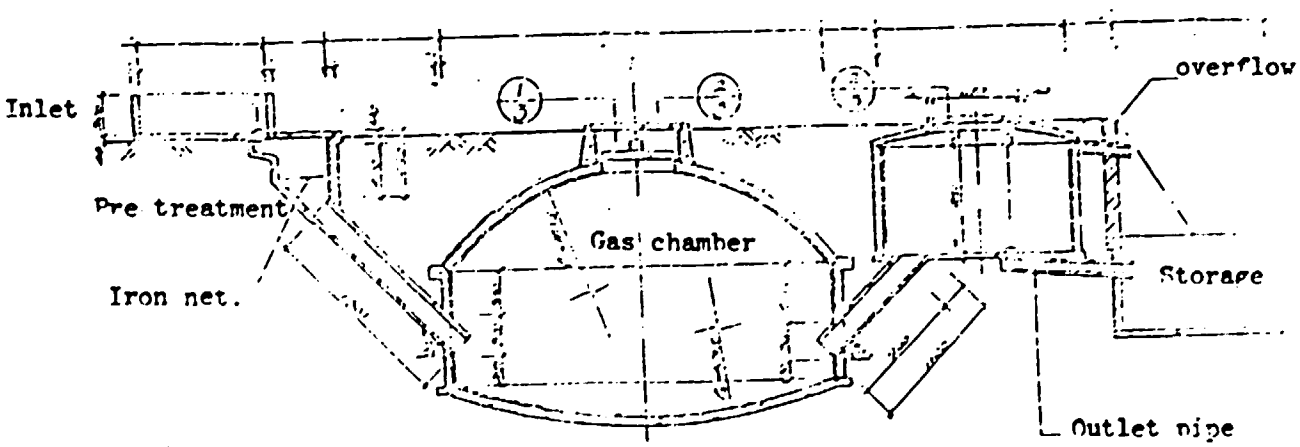
Biogas is used as fuel for food processing. In Lesotho the technique is gradually gaining popularity. There is about twenty-six (26) plants in the whole country, with every district having at least two plants. Maseru district has six (6) and Mohale's Hoek has four (4) plants.

The biogas plant consist of basically three parts i.e.

- Top dome where gas is accumulated.
- The cylinder where cow dung is kept for fermentation.
- Bottom-dome - keeps dung before fermentation.
- Inlet - letting in cow dung.
- Outlet - letting out slurry after fermentation.
- Sherry chamber.

Figure 11





Section 1 1

OTHER FOOD PROCESSING TECHNOLOGIES:

1. Soy Bean Processing Project in Quthing (Plenty Lesotho)

Technology used here involves traditional and modern methods. The major activities are extraction of milk from the beans, roasting the beans, and grinding the roasted beans into popular powder (lipabi) and fat cakes. Technical devices used in the soy bean dairy for extraction of milk/tofu/soy yoghurt include the following:

- traditional grinding stone (Leloala la Sesotho).
- casseroles
- buckets for soaking beans overnight.
- cloths for sieving
- press for making soy cheese/tofu.
- vinegar/lemon juice
- refrigerator for storing food
- clock for timing the operations involved
- Solar dryer

Extraction of milk from soy beans involves soaking beans overnight in a bucket. This procedure is followed by grinding the beans finely on the grinding stone, boiling the ground matter mixed with water for 20 minutes. The mixture is then sieved and the liquid is ready for drinking. Residue can be used to mix with wheat, flour or maize flour to improve the nutritional status of maize and wheat meal.

- Keep food covered.

- Wash dishes before placing food in the dish.

- Don't eat discoloured food or smelling food.

- Soy milk and soy yoghurt should be kept for a day during cool weather. After a day boil them for 15 minutes. They will turn into cheese which should not be kept for too long.

- Tofu should be kept in cold water. Tofu can be kept for a day or further if the weather is cool.

The milk can be mixed with vinegar or lemon to curdle the milk. The curd can be passed through the press to turn it into cheese.

Soy bean flour (from ground beans) is mixed with wheat/ maize/sorghum meal to improve the nutritional status of the grains.

The most common practice at Plenty Lesotho is the use of soy bean powder to make fat cakes (makoenya) which are very popular. The beans are soaked overnight, ground finely, then the powder added to brown wheat flour and kneaded into dough which is fried as fat cakes.

Another popular item is powder from roasted beans. The beans are soaked overnight, then ground roughly, dried in a solar dryer for six hours, then roasted in oil and ground into fine powder. Powder is mixed with fine salt and sugar to good taste, packaged and sold as "lipabi".

Another delicacy is roasted beans. Beans are soaked overnight, then roasted in oil.

Proper Storage for soy bean products:

- keep food for short time if it is hot.
- Keep food in shady, cool place (refrigerator) or in a hole in the ground.

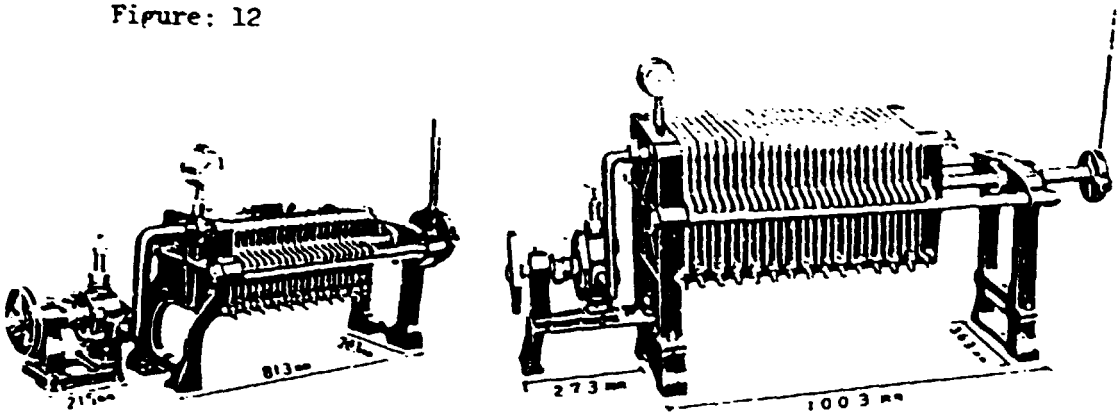
EXTRATION OF OIL FROM SUNFLOWER:

The Catholic Relief Services has introduced sunflower production programmes around the clinics. The major aim is income generation for participants. Technology used include:

- Power husker "LO"
- Hand grain winnower "B"
- "Cecoco" Oil Expeller
- "Cecoco" filter press

FILTER PRESSES

Figure: 12



L 1028mm x W 203mm

L 1276mm x W 363mm

The "HANDER" Filter Presses (Types A,B&C) can be run being connected with "Hander" Oil Expellers. Therefore, the users need not buy separate motive power to run them. The V-Belt Pulleys are furnished and fitted on the shafts of their Pump. In case it is necessary to run a "Hander" Filter Press separately, then use 1/2 H.P. Motor.

The above Photos illustrate "HANDER" Filter Presses Type A & B, to which raw oil is pumped by means of Pump.

SPECIFICATION

Type	Chamber Size & Number	Power Required	Pulley		Filtering Area	Hourly Capacity	Packing		
			Dia.	R.P.M.			N/W	G/W	Meas't
A	7" x 7" x 10	½ H.P.	9"	170	7.4 sq. ft.	12 gallons	126 kgs.	176 kgs.	10.0 Cft.
B	12" x 12" x 14	1 H.P.	11"	200	30 sq. ft.	40 gallons	343 kgs.	502 kgs.	25.0 Cft.

POWER HUSKER "LO"

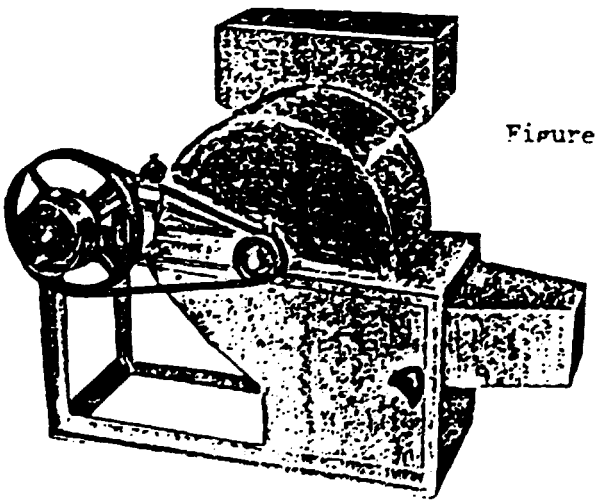
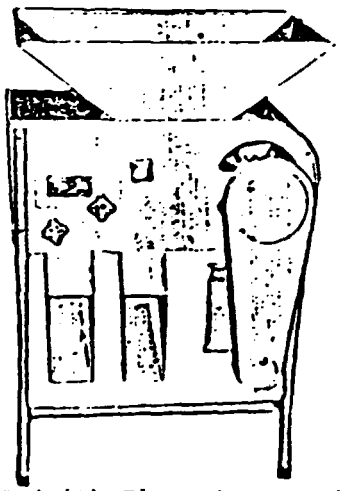


Figure: 13

HAND GRAIN WINNOWER "B"



SPECIFICATION OF POWER HUSKER FOR SUNFLOWER (with Electric Motor):

Type	Power Req'd	Capacity/hr. in Materials	Pulley R.P.M.	Dimension(mm)	Packing Spec.(Approx.)		
					N/W	G/W	Meas't
LO	2.2KW	800 kgs	1000-1200	H850 x W770 x L1150	150kgs	250kgs	1.5M3

SPECIFICATION OF HAND GRAIN WINNOWER FOR SUNFLOWER:
20-watt single-phase motor drive available with extra cost

Type	Power Req'd	Capacity/hr. in Materials	Handle R.P.M.	Dimension(mm)	Packing Spec.(Approx.)		
					N/W	G/W	Meas't
B	Hand	max. 650kgs	Approx.100	H1020 x W500 x L790	17kgs	35kgs	0.23M3

PEANUT HUSKER "150-D","100-D" SUPER DELINTER "B"

OIL EPELLER TYPE 52

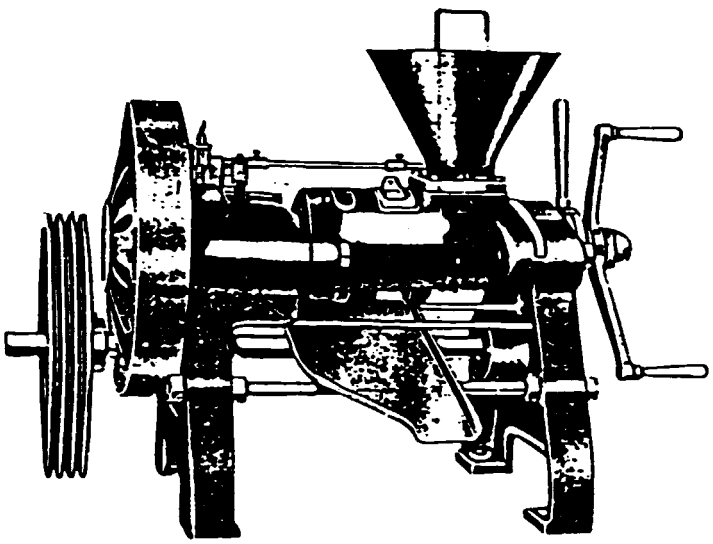


Figure · 14

SPECIAL FEATURES

1. AUTOMATIC & CONTINUOUS EXTRACTION.
2. SMALL SIZE & STURDY CONSTRUCTION. REQUIRES MINIMUM FLOOR SPACE.
3. VERY HIGH OIL-EXTRACTION EFFICIENCY & PROCESSING CAPACITY.
4. LOWEST INITIAL COST & SUBSEQUENT OPERATING/MAINTENANCE EXPENSES.
5. ANY WORKER WITHOUT SPESIAL TRAINING CAN BECOME SKILLED OIL-EXPELLERMAN IN SHORT TIME.

SPECIFICATION

Size of Main Parts:

Dia. of Drum (inside)	2⅝"
" " (outside)	6¼"
Length of Drum	12"
Length of Worm Shaft	21"
Pitch of Worm Shaft	1"
Dia. of Large Gear (Pitch circle)	12½"
Dia. of Pinion Gear (Pitch circle)	3½"
Gear Ratio	21 : 75
Dia. of Pulley (V or Flat)	14"

Accessories & Spare Consumption Parts:

① Worm Shaft	1 pc.
② Cage Bar	1 set.
③ Ring	2 pcs.
④ Spacer	3 pcs.
⑤ Ring Turning Lever	1 pc.
⑥ Monkey-Wrench	1 pc.
⑦ Spanner	1 pc.
⑧ Machine Setting Bolt	4 pcs.

Material of Main Parts:

① Worm Shaft	Manganese Steel
② Cage Bars	Tool Steel
③ Ring	High Tensile Cast Iron
④ Large Gear	Cast Iron
⑤ Pinion Gear	High Tensile Steel

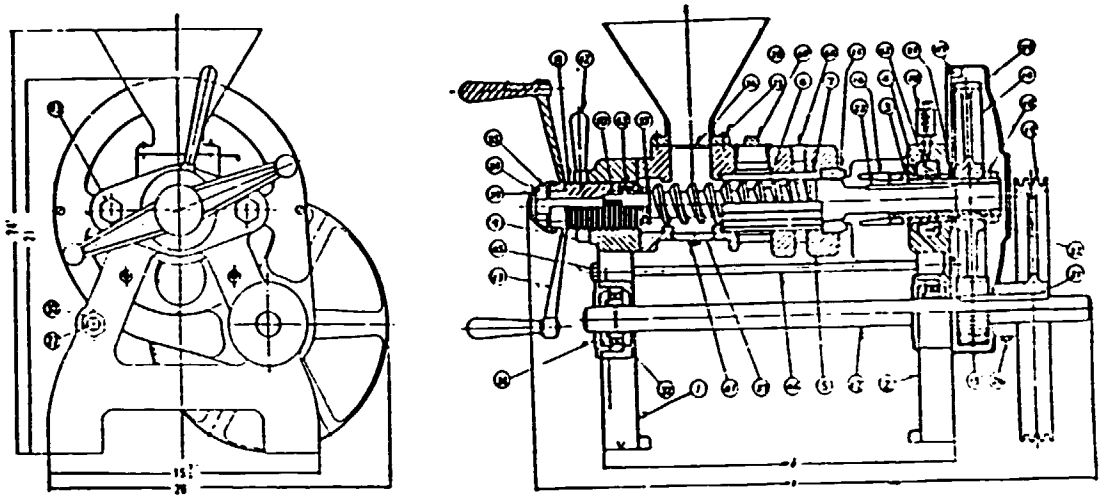
Power Required	Pulley		Expelling Capacity per hour (seeds)
	Dia.	R.P.M.	
3~5 H. P.	14"	300~350	30 - 50 kg.

Remarks:

In case of tough Copra or the like, 5 H. P. Motor or Engine is required.

DESIGN OF OIL EXPELLER TYPE 52

Figure: 15



① Hopper Side Frame
② Gear Side Frame
③ Sleeve
④ Large Gunmetal Journal Bearing
⑤ Drum
⑥ Worm Shaft (Dia. 59mm : 2⅜ inch)
⑦ Cage Bars
⑧ Adjusting Screw
⑨ Round Locking Nut
⑩ Small Gunmetal Journal Bearing
⑪ Ring
⑫ Locking Handle
⑬ Adjusting Handle
⑭ Large Gear
⑮ Pinion Gear
⑯ Oil Cake Cutter
⑰ Driving Shaft
⑱ Round Sleeve Nut
⑲ Pulley 14" Dia
⑳ Hopper
㉑ Withdrawing Bolt
㉒ Hopper-Attaching Screw
㉓ Pulley Locking Screw
㉗ Stay Bolt ¾"
㉙ Oil Cup
㉗-A Gear Cover
㉘-B Inside Gear Back Plate
㉚ Nut ¾"
㉛ Sleave Ring
㉜ Radial Ball Bearing
㉝ Thrust Ball Bearing
㉞ Bearing Cup
㉟ Ring Washer
㊱ Raw Materials Feed-Regulating Plate
㊲ Raw Materials Removal Plate
㊳ Handle Cap
㊴ Raw Materials Removal Plate Screw
㊵ Attaching Bolt ⅜"
㊶ Stay Bolt ⅜"
㊷ Nut ⅜"
㊸ Gear-Cover Screw
㊹ Drum Cover
㊺ Felt (large)
㊻ " (small)
㊼ Name Plate

CONCLUSIONS AND RECOMMENDATIONS:

There are a lot of appropriate technology devices developed in Lesotho for food processing and food preservation. The devices range from basic traditional devices, improved traditional techniques to modern techniques (referred to as appropriate technological devices). Devices for food processing range from traditional grinding stone, hammer mills, dehullers for sorghum and cooking devices ranging from paolas (stone and metal) to sophisticated single-pot metal stove and complex "Mabotle" metal stove with about 24% energy efficiency utilization. Solar heaters and cookers are constructed. The retained heat cookers are very efficient cooking devices.

Food preservation has undergone great development with the old traditional systems to sophisticated achievements. Food preservation techniques range from simple drying in the sun to use a solar dryers. Grain storage can now be provided by the brick silo.

RECOMMENDATIONS:

1. A regional institution to train technicians on appropriate/ relevant technology to be built for SADCC Member States.

2. Exchange of technology by a regional magazine on appropriate technology on food processing and food preservation.

3. Selection of a country of SADCC as the Co-ordinator of appropriate technology development.

4. Each Member State to draw a clear policy on appropriate technology i.e. objectives, strategy, dissemination, publicity, training, education, industrial development/ commercialization of devices etc.

5. Data collection on appropriate technology with emphasis on construction of devices.

6. Emphasis to be laid on technologies that supplement or complement food processing and food preservation e.g. water provision and storage, health issues, sanitation, washing technologies, provision of clean but cheap and healthy housing.

7. Member States to provide civic centres at strategic points in the rural areas where women can go for exchange of experience, learning and skill training on appropriate/relevant technologies for improvement of life in their homes.

REFERENCES

1. Appropriate Technology Section of the Ministry of Interior, Chieftainship Affairs and Rural Development.

2. Extension Section of the Department of Extension, Research and Education of the Ministry of Agriculture.

3. Plenty Lesotho.