

# APPROPRIATE VILLAGE TECHNOLOGY FOR BASIC SERVICES

A catalogue of devices  
displayed at the  
UNICEF/KENYA Government, Village Technology Unit  
NAIROBI, KENYA



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UNICEF/KENYA Government, Village Technology Unit  
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Design: G. McBean

Published by UNICEF  
Eastern Africa Regional Office  
P.O. Box 44145  
Nairobi  
Kenya

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## INTRODUCTION

UNICEF helps governments in developing countries provide for children's basic needs, through the improvement of water supplies, nutrition and health care. UNICEF believes that simple, low cost, indigenously-based technology can contribute to the development of a better quality of life for families and children.

Appropriate technology is a concept that is often talked about but less often practically applied. UNICEF and the Ministry of Housing and Social Services in Kenya decided in 1976 to promote the concept in a practical way by setting up a Village Technology Unit (VTU). Examples are displayed of alternative solutions to problems experienced by mothers and children in rural areas and poorer urban communities.

The VTU has a workshop where new ideas are tried out and traditional ideas improved in the light of experience. Training courses in practical skills are also conducted for craftsmen and artisans selected for rural communities whose people feel a need for technological improvements.

This catalogue covers: food preservation, processing and storage; water collection, pumping and storage; and home improvements and energy conservation.

The designs described in this catalogue may not be the best designs for all situations. They are open to modification to suit local conditions and materials.

The catalogue provides examples of items of appropriate technology which could be used in rural development programmes. It is not intended to be a construction manual although it may provide some basic construction guidelines. Prices have only been provided for devices available on the market.

For most of the items no prices have been given since the cost of materials and labour is bound to vary. Instead, only the materials and the man-days required for the construction of each item have been estimated.

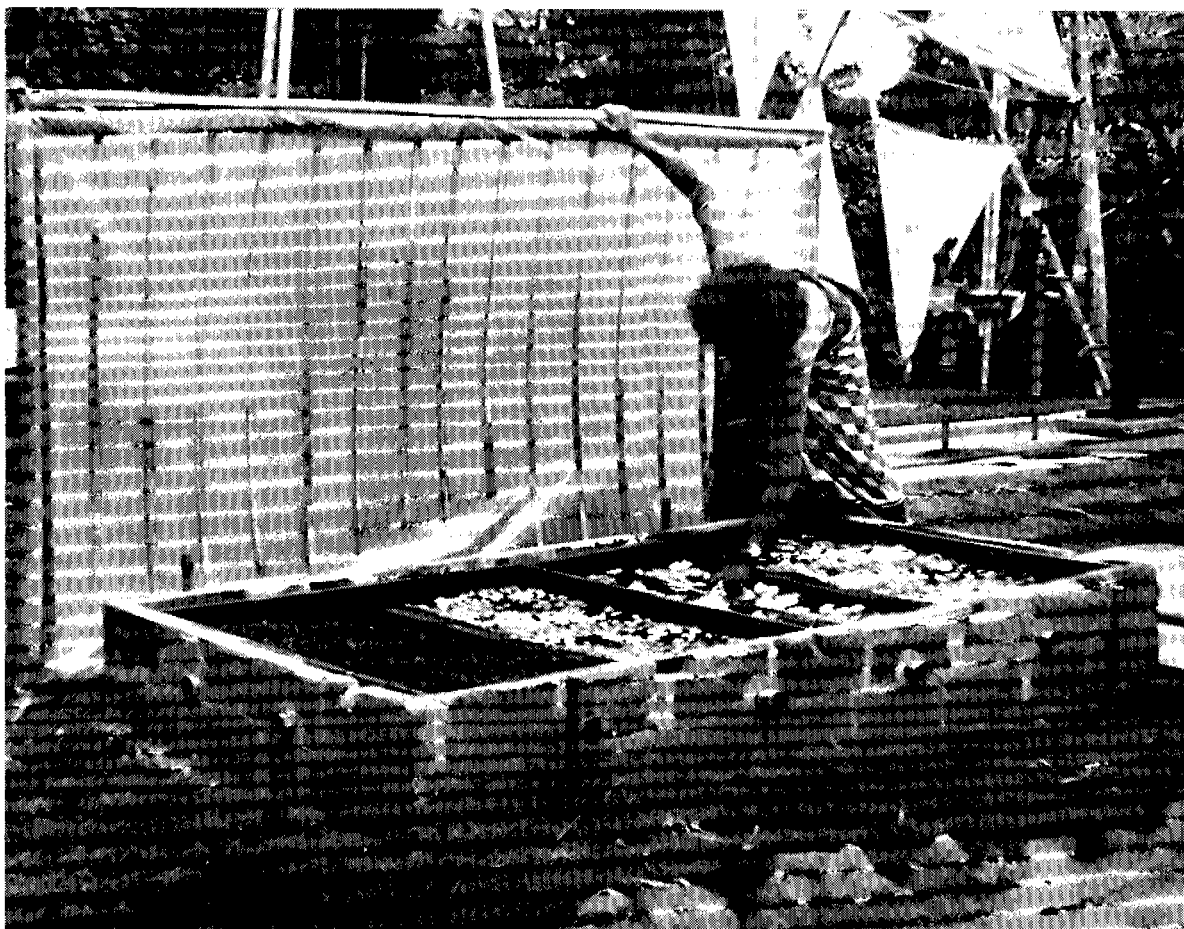
The Village Technology Unit at Karen, Nairobi, welcomes visitors.

For directions and lay-out of the Village Technology Unit, Karen, see page 55.

# SECTION ONE

## FOOD PRESERVATION, PROCESSING AND STORAGE

1. Solar Food and Crop Dryer . . . . . 6
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1. Solar Food and Crop Dryer-- Fixed. Dries and disinfests food and crops prior to storage.

## SOLAR FOOD AND CROP DRYER

**Description:** The dryer consists of a shallow rectangular open box-shaped structure built directly on to the ground using mud and wattle, mud bricks, or cinva-ram bricks. External dimensions of the "box" are usually 2.4m long, 1.2m wide and 22cm deep. The box is provided with four hollow bamboo air-inlet tubes (7.5cm dia) equally spaced along the bottom of each long wall. Air outlet ports are provided by four slots (5cm x 5cm) cut along the upper surface of each long wall.

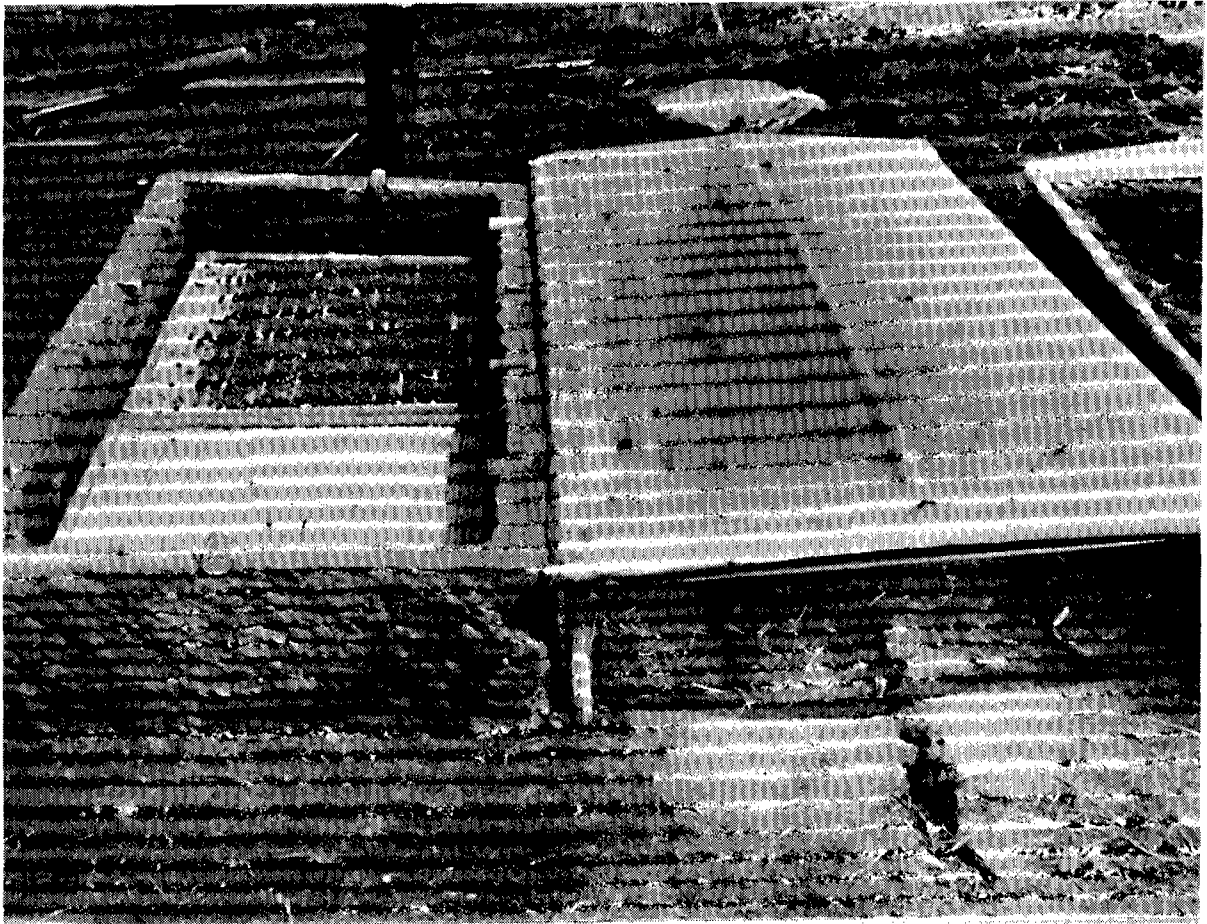
The dryer is provided with simply-made perforated drying trays made from wire gauze, hessian or reeds on wooden or bamboo frames. These trays rest on the protruding inner ends of the lower air inlets. The dryer is covered with a "double-glazed" cover of clear polythene film stretched over

a simple wooden or bamboo framework.

In use the air heated by the sun rises and passes out through the upper air outlets carrying away moisture from the drying crop. This induces an inward flow of air through the lower air inlets which passes up through the crop on the drying tray, thus maintaining a continuous circulation of air.

**Function:** Drying and disinfestation of crops prior to storage; drying of vegetables, fruit, spices, meat and fish; and drying of commercial crops such as coffee, cocoa, copra, or pyrethrum.

**Specific Advantages:** Construction is simple using inexpensive materials and can be taught to unskilled people. The dryer provides an effective means for necessary pre-storage drying of crops, for preservation of perishable foods and for enhancing the



2. Crops Placed on Trays and Cover Replaced.

quality and marketability of commercial crops.

**Disadvantages:** The polythene used for the cover is susceptible to damage and needs careful handling.

**Durability:** A well-built and well cared-for dryer should last for several years. The polythene cover will weather and deteriorate. Depending upon climatic conditions it will need replacement every one or two years.

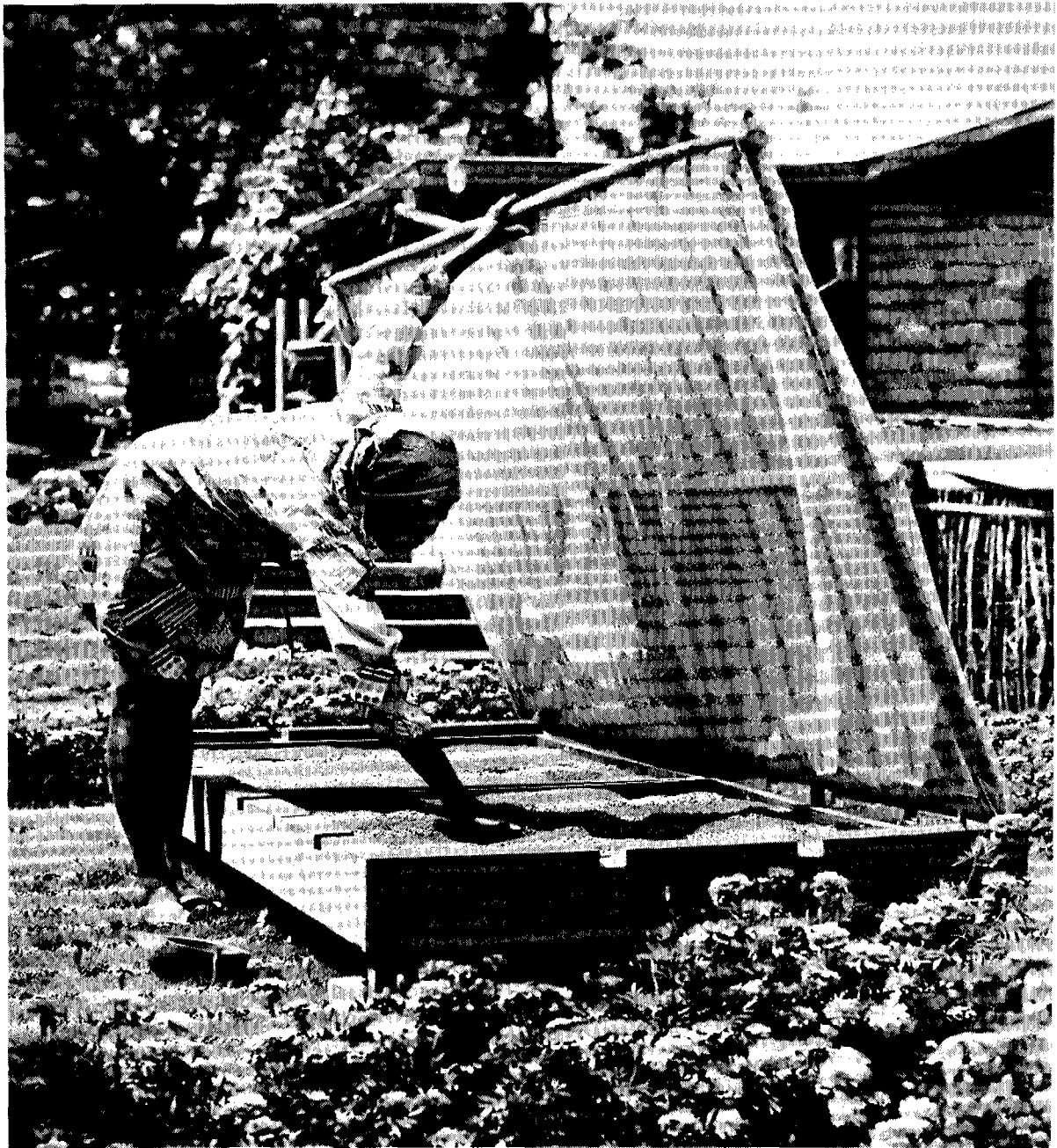
**Labour for Construction:** 4 man-days.

**Tools Needed:** Machete (panga), hoe, trowel, float, saw, knife.

**Materials Needed:** 1) 12 stakes 40cm long by 7.5cm dia.

- 2) A sufficient amount of clay soil
- 3) ½-bag cement
- 4) 100kg sand
- 5) Bamboo poles for polythene frame and air inlets
- 6) Polythene
- 7) 210cm x 80cm perforated material for trays
- 8) Nails 5cm
- 9) Sisal string - 10m
- 10) Bamboo poles for air vents and trays
- 11) Sufficient quantity of long sticks 1-2cm dia

N.B. Dimensions can be increased up to 360cm x 180cm x 22cm, depending upon width of polythene cover sheets available.



3. *Portable Solar Food and Crop Dryer. Dries and disinfects food and crops prior to storage.*

### **PORTABLE SOLAR FOOD AND CROP DRYER**

**Description:** This is a portable version of the SOLAR FOOD AND CROP DRYER described on page 6. It consists of a double-walled box structure of wooden construction, literally a box within a box. The 6cm. annular space between the outer and inner walls and the 6cm. double bottom space

is packed with suitable insulating material such as dried grass, kapok, or coconut fibre. External dimensions are 2.6m x 1.2m x 0.20m. The dryer is supported 15cm. above ground on four legs. Air inlet holes are provided in the bottom by drilling through battens which support the inner box. Air outlet slots are cut in the upper edges of the long sides of the box. The cover and drying trays used are similar to those described on page 6.





4. The Fuel-Fired Dryer. Dries 300kgs of grain in 24 hours.

### THE FUEL-FIRED DRYER

**Description:** A 2.3 x 3m drying platform situated over a pit 1.4m deep. Three open-ended oil drums are joined together and laid in the bottom of the pit to act as a firebox. A cover with an adjustable air intake vent at the front of the firebox and a chimney at the rear regulate fuel consumption and heat output. The drying chamber wall, 0.75m high made from sun dried mud bricks, surrounds the pit, and is supported by concrete or wooden lintels where it crosses over the firebox. The drying platform is made from bamboo strips laid over support beams above the firebox. The firebox is served by a 2.1 x 2 x 1.4m deep stoking pit with an access stairway. Flue gases are carried away by the chimney;

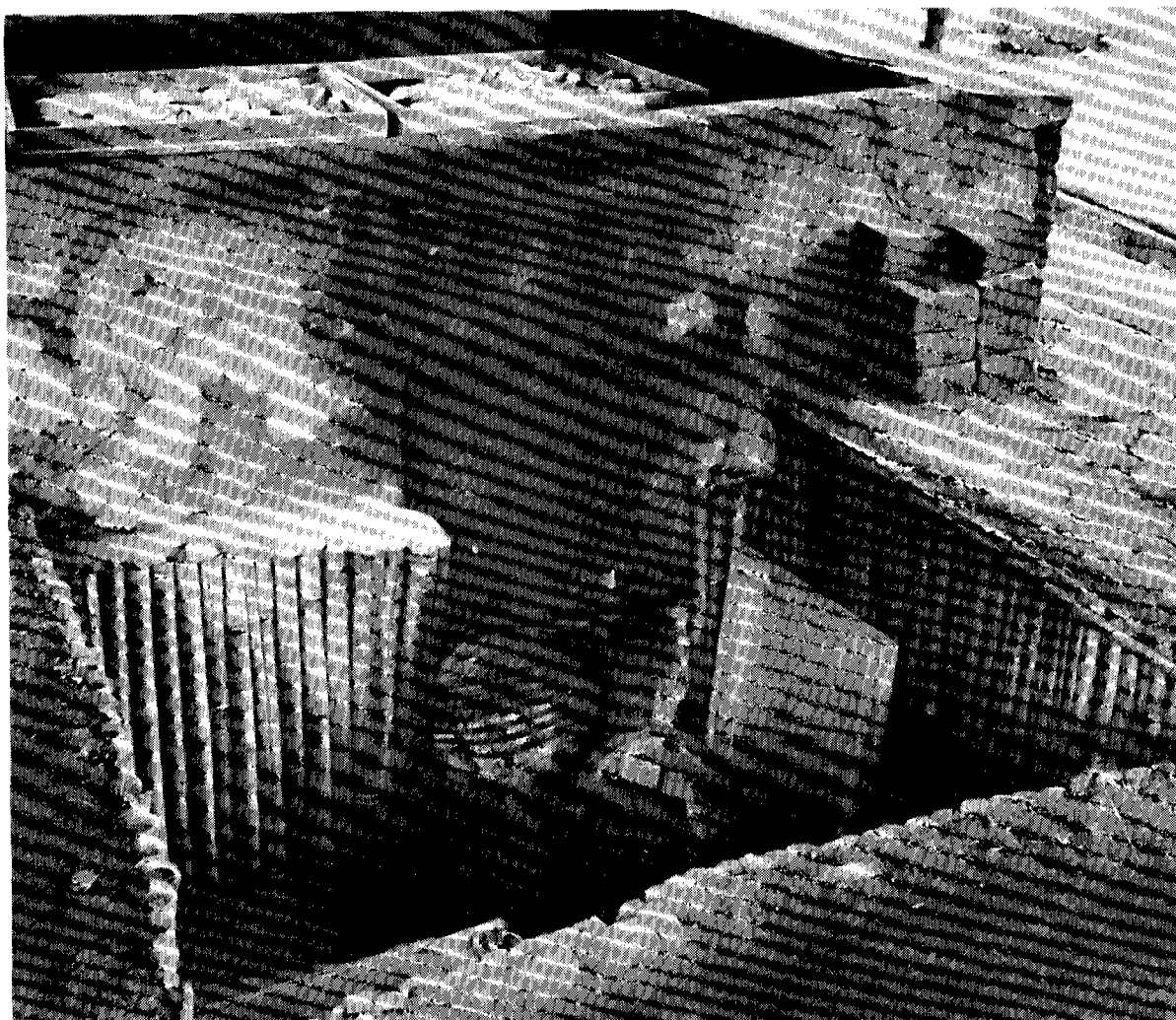
air heated by the firebox rises and dries the crop.

**Function:** Dries up to 3 bags of grain, pyrethrum or other crops in a 24-hour period.

**Specific Advantages:** Construction materials are commonly available and purchased inputs are minimal. Rural people can contribute a large amount of the necessary labour. The dryer is particularly useful in areas where crops must be harvested during cloudy seasons when solar driers cannot be used.

**Disadvantages:** The dryer requires fuel which may be a constraint in a number of places. The dryer is most effective for drying

*CONTINUED OVERLEAF*



5. An interior view of the fuel-fired dryer

large amounts of grain but is uneconomical for smaller amounts.

**Durability:** The dryer pit should be dug on high ground to prevent dampness and covered with a free standing thatched roof. It will last for years if well constructed and periodically maintained.

**Labour Content:** 12 man-days to dig pits, 6 man-days to make mud bricks and 6 man-days to construct dryer.

**Tools Needed:** shovels, hoes, machetes, trowel, karai, spirit level, metal cutters, hammer.

**Materials Needed:** 1) 3 oil drums--220 litres. Each one with

a separate lid fixed with a clamp ring

- 2) 10 poles 3m x 5cm dia
- 3) 1 bag cement
- 4) 100 kgs sand
- 5) 4 - 1m x 6mm dia reinforcing rod
- 6) 2-pieces timber 120 x 8 x 1.75cm
- 7) 2-pieces timber 30 x 8 x 1.75cm or 2 pieces 120 x 30 x 8cm dia. hardwood.
- 8) sufficient bamboo or small dia stocks or loose woven mats for drying platform
- 9) 1kg. 2.5cm nails



6. Maize Crib. Temporary storage and post-harvest drying for maize on-the-cob.

## MAIZE CRIB

**Description:** A large rectangular store 3.8 x 1.2m x 1.6m high constructed of bamboo or wooden poles and covered by a thatched grass or hessian/cement roof in which a 3:1 sand/cement mortar is used. Two hinged doors 1.5m wide are located at the front. The crib is supported 1.25m off the ground on stilts, fitted near the top with rat guards in the form of inverted tin cones or thorn branches.

**Function:** To provide temporary storage and allow post-harvest drying for maize on the cob.

**Specific Advantages:** The store is constructed almost entirely from locally available materials. No special skills are required to build the store thereby minimizing labour costs. The store protects the maize from rain and rats and allows cool ventilation. An alternative hessian/cement roof can be constructed under skilled direction.

**Disadvantages:** The crib may be useful for temporary storage prior to effective drying and enclosed storage. It is not recommended for long term storage.

**Durability:** The maize crib will last for several years depending on climatic conditions and maintenance. The thatching will require renewal after about 5 years but the hessian/cement roof should last the life of the crib. The stilts can be protected from insect damage by using cedar posts or by coating them with oil or bitumen.

**Labour Content:** 10 man-days

**Tools Needed:** machete (panga), hammer for cement roof, trowel, float, scissors, knife.

**Materials Needed:**

- 1) sufficient amount of bamboo or wooden poles
- 2) string or wire
- 3) 8 kerosene tin tops
- 4) 1 used car tyre for door hinges.
- 5) Grass for thatching or:  
3 bags cement;  
250kg sand; 16 metres hessian cloth; 1 kg 2.5cm nails



7. Improved Traditional Silo. Dry and pest-proof storage for threshed grains.

## IMPROVED TRADITIONAL SILO

**Description:** A traditional wicker granary covered by a thatched roof and raised 1 metre on wooden poles fitted with tin sleeves or thorn branches as rat guards. The silo is thickly mudded inside and out and has a final outside layer of plaster consisting of a mixture of mud, cow dung, and ashes. A discharge spout made from a gourd with a plug or small tin with a tightly fitting lid is located at the base of the silo wall. The spout can be fitted with a padlock. A wicker or wooden lid, sealed down with clay, covers the top filling opening once the silo is full.

**Function:** To provide dry pestproof storage for up to 1.25 tons of threshed grain.

**Specific Advantages:** The silo basket and other construction materials are easily obtained locally at low cost. The silo can be built by unskilled village labour thereby reducing labour costs.

The improvements over the traditional silo are as follows:

- 1) By raising the silo on poles with metal guard sleeves or thorn branches directly beneath the silo, the silo is made rat proof.
- 2) The outside plaster of mud, cow dung, and ash and the sealed lid effectively make the silo insect proof.
- 3) The discharge spout allows easy grain removal without unsealing the silo.

**Durability:** The structure should last 6-7 years but the mudding, plaster, and thatching will require more frequent periodic attention.

**Labour Content:** 8 man-days.

**Tools Required:** Machete (panga), hammer, saw.

**Materials Needed:** 1) wicker granary

- 2) Poles and grass for thatching
- 3) 'debbes' (kerosene tins) for tin sleeves
- 4) 1 gourd or tin for discharge spout
- 5) Suitable amount of mud, ash and cow dung for plaster
- 6) Sisal twine (one roll) for tying on thatch and poles
- 7) 1 kilo 10cm nails for framework
- 8) 12 poles 5cm x 2m for basket support
- 9) 5 poles 10cm x 1.5m for base
- 10) 4 poles - 10cm x 4m for uprights to roof

## 1.5 TON MUD BRICK SILO

**Description:** A cylindrical structure of 1 metre inside diameter, 2 metres height, built of sun-dried mud bricks 15cm x 10cm x 10cm size. The bricks are cemented together with a 5:1 sand/cement mortar and built on a concrete base which is cast on top of large loosely packed stones to raise the floor above ground level and prevent damp rising from the ground into the silo. The walls are coated inside and out with a cement plaster. The silo is fitted with a concrete top cover slab (with filling manhole) and an insect-proof discharge spout made of wood.

**Function:** Providing dry, pest-proof storage for up to 1.5 tons of dry threshed grain.

**Specific Advantages:** The major constructional material can usually be obtained at no cost, and the total cost of purchased inputs is low. The silo can be built under skilled guidance, by village people who have no previous training. If labour is provided free on a self-help basis, the only cost incurred will be the cost of materials.

**Durability:** This silo should last for many years depending upon climatic conditions. It should be provided with a free standing grass or palm thatched roof to protect it from rain, and to provide shade to keep the grain at an even and cool temperature.

**Labour Content:** 12 man-days for making mud bricks and 8 man-days for building the silo.

**Tools Needed:** hoe, shovel, trowel, plumb bob, saw, hammer, spirit level.

**Materials Needed:**

- 1) Supply of clay sufficient to make 350 mud bricks. Allow for 10% breakage
- 2) 500 kg rough large (30cm) stones
- 3) 500 kg fine sand
- 4) 4 bags cement
- 5) Timber 2.5m x

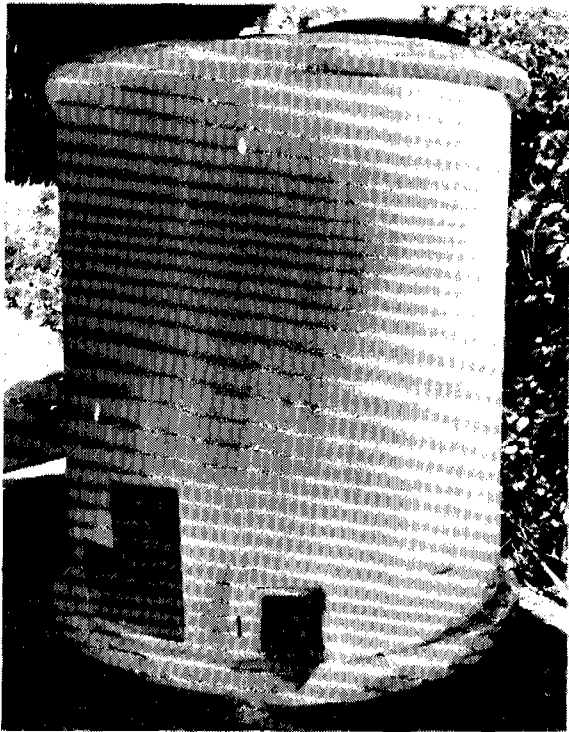
10cm x 2.5cm for mud brick moulds\*

- 6) Reinforcing rod 3.3m x 6mm dia. for cover slab
- 7) Timber 3.3m of 5cm x 2.5cm for top cover mould\*
- 8) 4cm nails—½kg for moulds

\* Items marked can, of course, be re-used many times to construct additional silos.



8. 1.5 Ton Mud Brick Silo. Dry and pest-proof storage for threshed grains.



9. 4.5 Ton Cement Stave Silo. Dry and pest-proof storage of threshed grains.

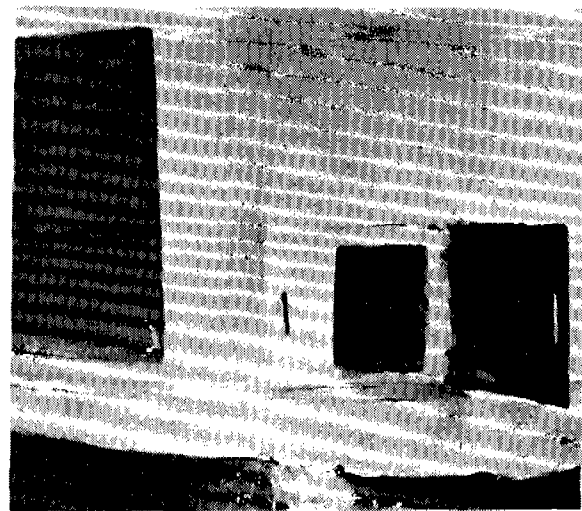
#### THE 4.5 TON CEMENT STAVE SILO

**Description:** A cylindrical structure 180cm inside diameter and 2m in height built of bevelled-edged concrete slabs (staves) arranged in circular courses on a precast reinforced concrete base. The staves are held together by circles of wire on the outside of the silo which are tightened with turnbuckles. The top slab is similar to the base but with an access manhole and cover. The entire outside wall surface is covered with a 1cm thickness of 2:1 sand/cement plaster. A discharge hole covered with a lockable insectproof metal plate is located at the base.

**Function:** Providing dry, pest-proof storage for 4.5 tons of dry threshed grain.

**Specific Advantages:** The silo can be constructed at a reasonable cost and is very strong. It is able to store much greater amounts of grains than traditional silos with greater protection from pests and dampness.

**Durability:** The silo should last for many years but can be further protected by build-



10. Showing Staves and Discharge Hole

ing a free standing thatched roof.

**Labour Content:** 20-25 man-days to construct the silo and 7 man-days to cast the staves (assuming 15 stave moulds).

**Tools Needed:** hoe, trowel, plumb bob, wire cutters, saw, hammer, spirit level, float, karais, shovel.

**Materials Needed:**

- 1) 12 sacks cement
- 2) 2 tons sand
- 3) 2 tons crushed stone
- 4) 24m of 6mm reinforcing rod
- 5) 1 roll 3mm G.I. wire - 12 gauge
- 6) Wire tighteners - 10-7.5cm long
- 7) Timber for moulds 20m-5 x 2cm
- 8) 1 metal plate for door 22 x 30cm
- 9) (91 large staves and 26 small staves are cast from the above materials)



11. Groundnut Sheller. 20-30kg of groundnut can be shelled per hour by one person.

## GROUNDNUT SHELLER

**Description:** A hand-operated groundnut shelling machine consisting of a semi-cylindrical trough of 60cm dia and 25cm wide. The bottom of the trough is made from rigid 1.25cm square weld mesh. An adjustable paddle, which can be raised or lowered in relation to the weld mesh is rotated radially within the trough, pivoting on a 1.24cm dia pipe. The machine is operated by loading groundnuts into the

trough and moving the paddle backwards and forwards cracking the groundnut shells against the weld mesh wire. The shelled nuts fall through the weld mesh into a receptacle placed underneath.

**Function:** Enables one person to produce 20 to 30 kgs of shelled groundnuts per hour.

**Specific Advantages:** The sheller can be constructed from ordinary cut timber by any village carpenter. The unit has been field tested and proved to be 3 times more efficient than hand shelling. The percentage of broken kernels produced varies between 10% and 20% depending on moisture content of nuts and accuracy of the paddle setting.

**Durability:** The unit will last for several years if properly constructed and used.

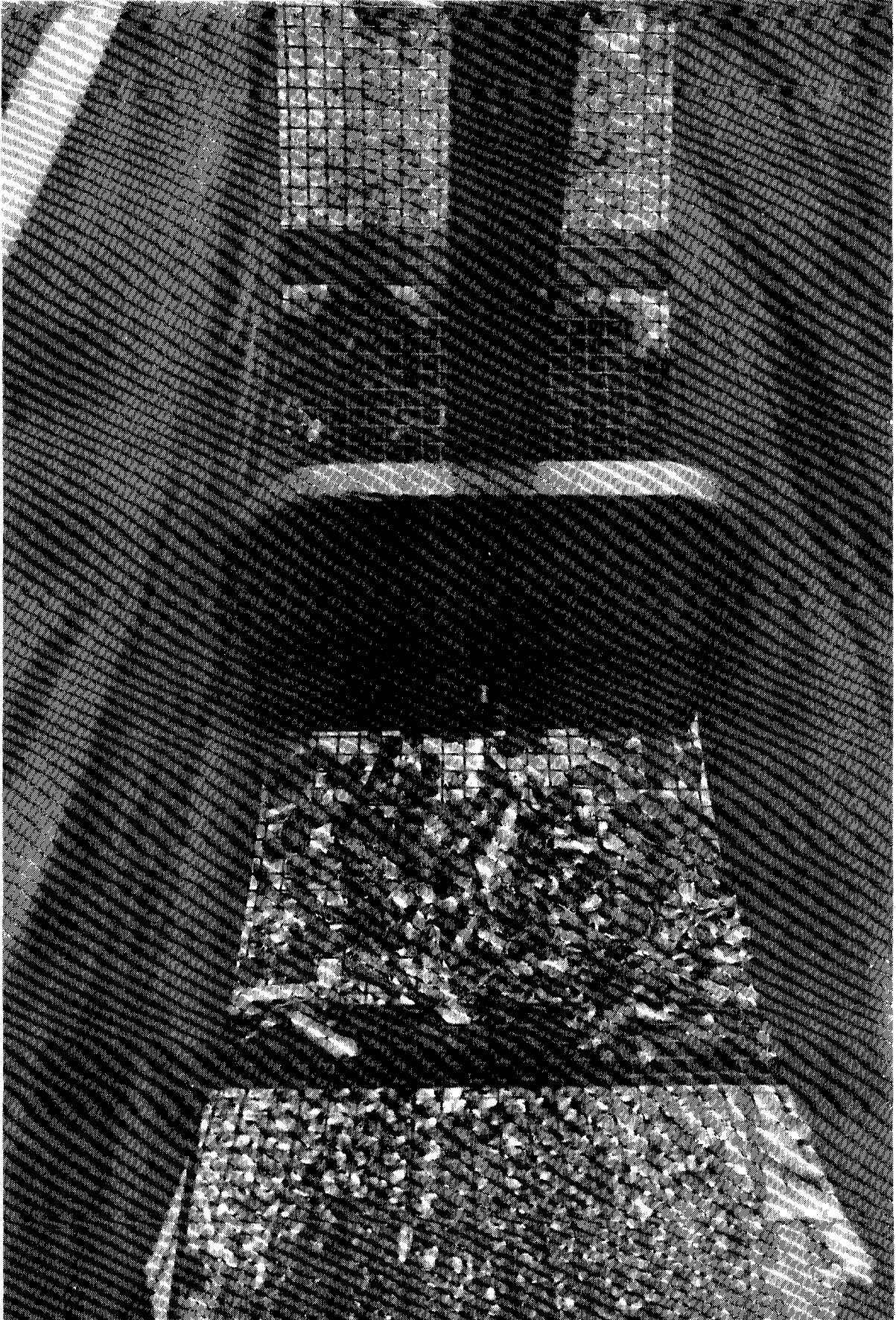
**Labour Content:** 2 man-days

**Tools Needed:** Hammer, saw, screwdriver, wood chisel, spokeshave, 1.75cm wood drill bit, 4mm metal drill bit, plane.

**Materials Needed:**

- 1) 1-piece 20cm x 1m x 1.25cm square weld mesh
- 2) 2-pieces 2cm dia x 9cm bolts with wingnuts
- 3) 1-piece 1.25cm x 35cm steel pipe
- 4) 1.75cm fence staples
- 5) 4-pieces 2cm dia steel washers
- 6) 4cm wood screws
- 7) 5 x 5cm by 4.5m timber
- 8) 2.5 x 5cm by 4.8m timber
- 9) 2.5 x 10 x 30cm timber
- 10) 26 x 23 x 2.5cm timber
- 11) 65 x 65 x 2.0cm plywood (or equiv. glued timber)





12. The inside of a Groundnut Sheller



13. Maize Sheller. Shells 120kgs of maize per hour by one person.

### MAIZE SHELLER

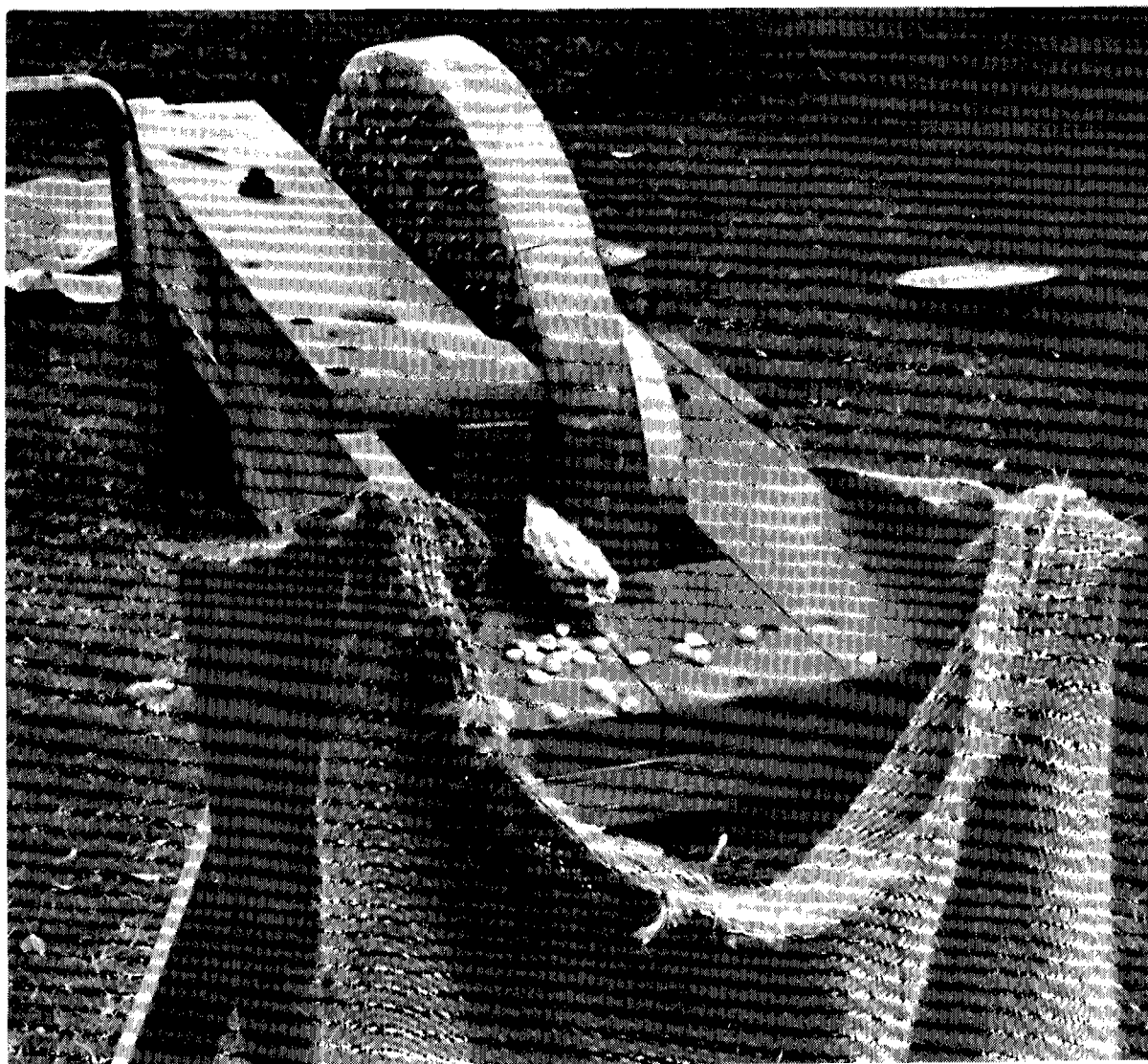
**Description:** A hand-operated machine consisting of a solid wooden wheel, 60cm in diameter, on one side of which 150 fencing staples have been nailed. Adjacent to the wheel is a wooden shute along which the cobs are fed to a spring loaded pressure plate which holds the cobs against the stapled side of the rotating wheel. The action of the stapled wheel, turned by a hand-crank made from 1.24cm dia water pipe, shells the maize kernels from the cob into a receptacle placed below. The shelled cobs are automatically ejected.

**Function:** Provides a more efficient and less laborious method of hand shelling maize.

**Specific Advantages:** Construction materials are obtainable locally at low cost. Building requires one carpenter working for 3 days using hand tools. The machine will produce up to 120 kg. of shelled maize per hour depending on the stamina of the operator.

**Disadvantages:** The spring-loaded pressure plate must be adjusted for small cobs.

**Durability:** As the only moving piece on the machine is the wheel, the bearing blocks may require replacement from time to time. The side of the shute is liable to be worn by the action of the wheel if it is not aligned correctly and protected. However, the machine itself should last for a considerable time if constructed and handled properly.



14. Close-up View of the Maize Sheller

**Labour Content:** 3 man days

**Tools Required:** hammer, saw, metal shears, wood plane, brace and 3cm dia. bit, screwdriver, 4mm metal cutting drill bit.

**Materials Needed:**

- 1) 150 fence staples
- 2) 4 6mm x 12cm steel bolts, washers and nuts
- 3) 1-12mm x 15cm steel bolt, washer and nut
- 4) 1-used kerosene tin or other sheet metal
- 5) Assorted nails or 10 x 5cm wood screws
- 6) 5 x 7.5 x 480cm

timber

- 7) 5 x 5 x 60cm timber
- 8) 2.5 x 7.5 x 240cm timber
- 9) 7.5 x 15 x 80cm timber
- 10) 6 x 6 x 35cm timber
- 11) 2.5 x 30 x 240cm timber
- 12) 0.3 x 14 x 60cm timber
- 13) 7.5 x 7.5 x 15 hardwood
- 14) 2.5 x 12 x 24 hardwood
- 15) 2.5 x 7.5 x 24 hardwood



15. CeCoCo Hand Winnowing Machine Type A-1. Winnows small grains and seeds.

#### CeCoCo HAND WINNOVER TYPE A-1

**Description:** A small manufactured winnowing unit made of steel and consisting of a hopper feeding through a slot into a chamber open at the front and bottom with a hand cranked paddle wheel fan at the rear. The four metal paddles of the fan are mounted on a shaft facing the chamber and are powered from a geared hand-crank located on the side of the unit. Two discharge shutters are fixed beneath the unit on a metal stand and feed to a collecting container. The fan blows air through the falling grains, blowing the chaff away while allowing the heavier grain to be separated and collected.

**Function:** To rapidly winnow seeds and

grains by hand. Designed for small grains and seeds but it cannot deal with maize or beans.

**Specific Advantages:** The unit is efficient and easy to operate. It can be adjusted to winnow varying sizes of seeds and grains.

**Durability:** The winnowing machine is constructed of durable materials and is extremely simple in design having only 2 moving parts. Maintenance is low and the unit should last for years.

**Availability and Cost:** Manufactured by:--

CeCoCo  
Chuo Bocki Goshi Kaisha  
Central Commercial Co.  
Ibaraki  
Osaka, Japan.



16. *Dunia Handmill. Cracks and mills dried grains and seeds.*

### DUNIA HANDMILL

**Description:** A small capacity hand operated grinding mill consisting of a hopper feeding into a milling chamber where two opposing 15cm dia grooved milling plates are housed. The Unit is turned by a handle mounted on the rim of a flywheel which is mounted on the grinding shaft. The grade of flour produced may be changed by adjusting a set-screw which alters the distance between the milling plates.

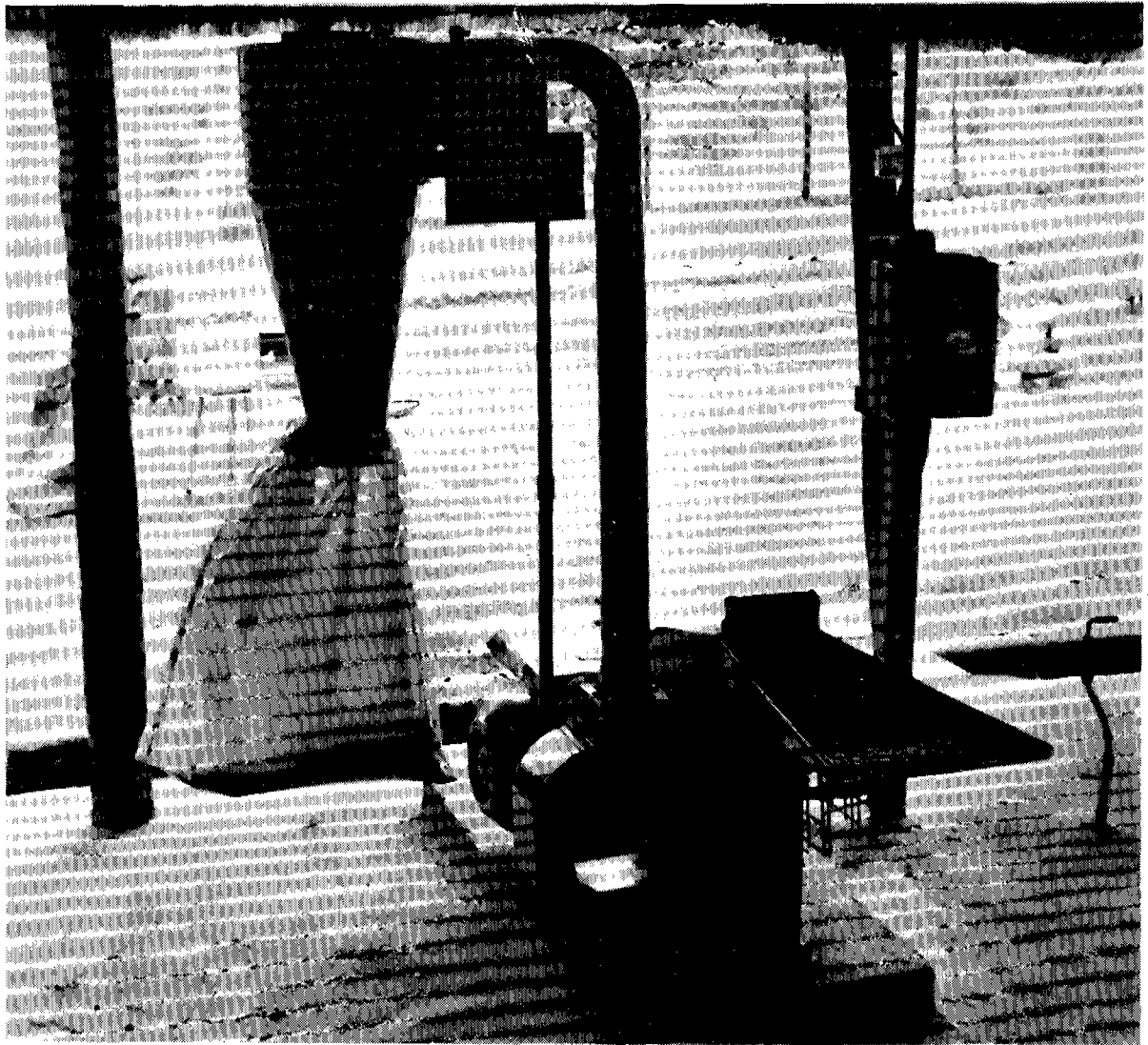
**Function:** To crack and mill dried grains and seeds by hand.

**Disadvantages:** It cannot produce as fine a grade of flour as hammer mills or stone mills but is a valuable machine for grain cracking where this is desirable.

**Durability:** This mill has been used for a number of years and has proved to be reliable and durable.

**Availability:**

Manufactured by: Ndume Products Ltd.  
P.O. Box 62  
Gilgil, Kenya



17. Manik MGM2 Hammer Mill. Grinds dried grains and seeds up to 200-300kg per hour.

### MANIK MGM 2 HAMMER MILL

**Description:** A medium capacity hammer mill that is belt-driven at 4,000 r.p.m. off a 10 h.p. electric or diesel motor. A regulated feed tray leads to a grinding chamber with sixteen reversible hammer blades fixed to a milling shaft. The bottom half of the chamber consists of a milling screen and fan housing leading to a discharge pipe and cyclone chamber.

**Function:** To grind dried grains and seeds at a rate of 200-300 kgs per hour.

**Specific Advantages:** An efficient but expensive hammer mill which produces

good quality flour. The grinding chamber is easily accessible for screen changes or hammer adjustments and the entire unit breaks down easily for transport.

**Durability:** The mill is made of heavy welded steel with few moving parts that are easily maintained. All parts are easily changed and should last for years.

#### Availability and Cost:

Manufactured by:— Manik Engineers  
P.O. Box 1274  
Arusha, Tanzania.

**Total Cost:** 6,525/- complete with motor and switch (1976)

## **SECTION TWO**

### **WATER COLLECTION, PUMPING AND STORAGE**

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1. Small Cement Water Jar. Stores 300 litres of roof water.

### SMALL CEMENT WATER JAR

**Description:** A thin walled container which can be built in various sizes up to 1000 litres. A circular sand/cement mortar base is cast first and a tough, shaped cloth bag is placed on the base. The bag is then packed full of sawdust, dried grass (or other suitable filling material) to form a mould. A circular former to provide a mould for the top opening is placed on top of the bag and a 2:1 sand/cement mixture is then plastered onto the bag in two 0.5cm layers leaving a circular opening at the top. After the cement has set, the stuffing and bag are removed and can be re-used for further jars.

**Function:** To provide an effective roof water catchment container or pest-proof grain storage jar up to 1000 litres capacity.

**Specific Advantages:** All purchased materials for construction are easily obtained in most towns at low cost. The jar can be constructed by a trained worker in a short time with the assistance of one unskilled

labourer. The smaller water jars can be rolled from place to place.

**Durability:** If properly made and cared for the jar should last for at least 10 years.

**Labour Content:** 3 man-days

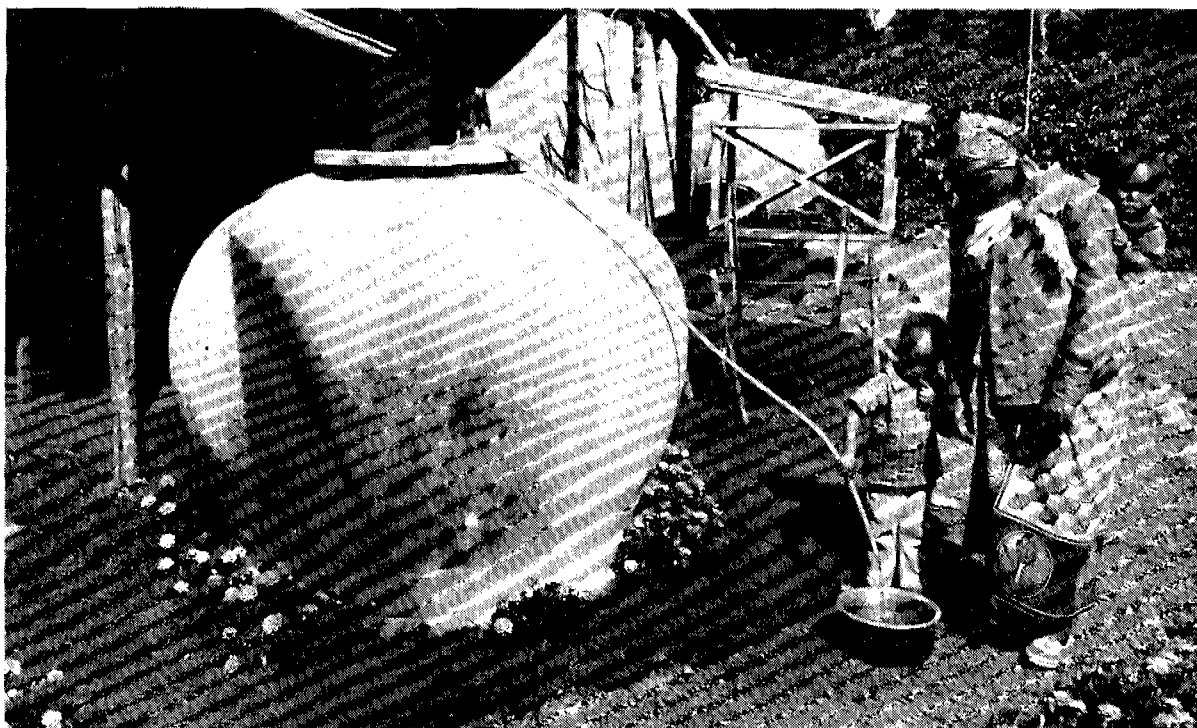
**Tools Required:** Shovel, trowel and float.

**Materials Needed:**

- 1) \*4 metres of hessian or Amerikani cloth for bag
- 2) ½-bag cement
- 3) \*Strong Twine
- 4) 1 bag riverbed sand (as fine as possible)
- 5) \*Needle and thread for sewing bag together
- 6) Handful of motor grease or soap
- 7) \*1m of 3cm wide galvanised metal strip
- 8) 40cm heavy wire for jar lid handle

\* can be used repeatedly.





2. Large Cement Water Jar. Stores 2,500 litres of roof water.

## LARGE CEMENT WATER JAR

**Description:** A thin walled container which can be built in various sizes up to 10,000 litres. A 30cm deep foundation is filled with crushed rock and a 5cm concrete slab is cast on top. A tough, shaped cloth or hessian bag is placed on the base and filled with sawdust, dried chopped grass (or other suitable material) to form a mould. A circular wooden former as a mould for the top opening is placed on the top of the bag. A 2:1 sand/cement mixture is then plastered onto the bag in two layers with chicken wire reinforcement between them. Total wall thickness for a 2,500 litre jar will be approximately 3cm. When the cement is set (i.e. 24 hours later) the stuffing and bag are removed and can be re-used.

**Function:** To provide an effective roof-water storage container up to 10,000 litres capacity.

**Specific Advantages:** The construction costs of a large water jar are much lower than a comparably sized metal tank, particularly

if several are built in the same locality.

**Disadvantages:** Unless large quantities of stuffing material are easily available it has been found that a size of 2,500 litres is a practical maximum.

**Durability:** If properly made and cared for the jar should out-last the average galvanised iron tank.

**Labour Content:** 7 man-days.

**Tools Needed:** shovel, hoe, trowel, wire cutters and float.

**Materials Needed:**

- 1) 5 bags cement
- (2,500 litre tank) 2) 500kgs sand.
- 3) 12sq. metres 2.5cm wire mesh reinforcing
- 4) 600kg crushed rocks
- 5) 10.5 metres strong cloth 1.22m wide
- 6) Needle and thread
- 7) 200kg ballast 2.5cm

(NOTE: The bag may be used again to manufacture additional jars)



3. Granary Basket Water Tank (Ghala Tank). Stores 2,500 litres of roof water.

### GRANARY BASKET WATER TANK (GHALA TANK)

**Description:** A structure 180cm in dia. and 145cm high built using a large traditional granary basket of woven sticks plastered with a 2:1 sand/cement mortar on the inside to a thickness of 2.5cm. It is set in a previously cast 2 metre dia. concrete foundation. The tank is provided with a 1.25cm dia. G.I. draw off pipe cast into the foundation.

**Function:** To provide an effective roof water storage container of up to 3500 litres capacity.

**Specific Advantages:** All construction materials are easily obtained and are relatively

inexpensive. The tank can be built under skilled supervision by rural people.

**Durability:** Unknown. This technique is a new development. The prototype has lasted 2 years without serious deterioration.

**Labour Content:** 5 man-days

**Tools Required:** Hoe, shovel, trowel, spirit level, float.

**Materials Needed:**

- 1) Woven stick granary basket
- 2) 5-bags cement
- 3) 500kg. of sand
- 4) 200kgs gravel 2.5cm for foundation
- 5) 2.5m x 1.25cm. dia. G.I. pipe



4. Flap Valve Pump. Raises water up to 3 metres.

#### FLAP VALVE PUMP

**Description:** A simple low lift water pump consisting of a 3cm dia. PVC pipe extending below the surface of the water and attached at the top to a pump handle. A discharge hole, located 25cm below the sealed top, is fitted with a wooden valve seat and a flap valve made of motor car inner tubing. Over the valve seat is a tin splash guard and spout for directing the discharge. The pump handle is pivoted at the mid-point on a support which is of a convenient height for pumping.

**Function:** To raise water from depths up to 3 metres.

**Specific Advantages:** The pump is very simple as there is only one moving part. Materials are available locally at low cost and the skills required for construction are within the scope of any village carpenter. The pump can lift 35-litres/minute from a depth of 1.5m at 1800m altitude. Further

studies are being made to increase pumping depth.

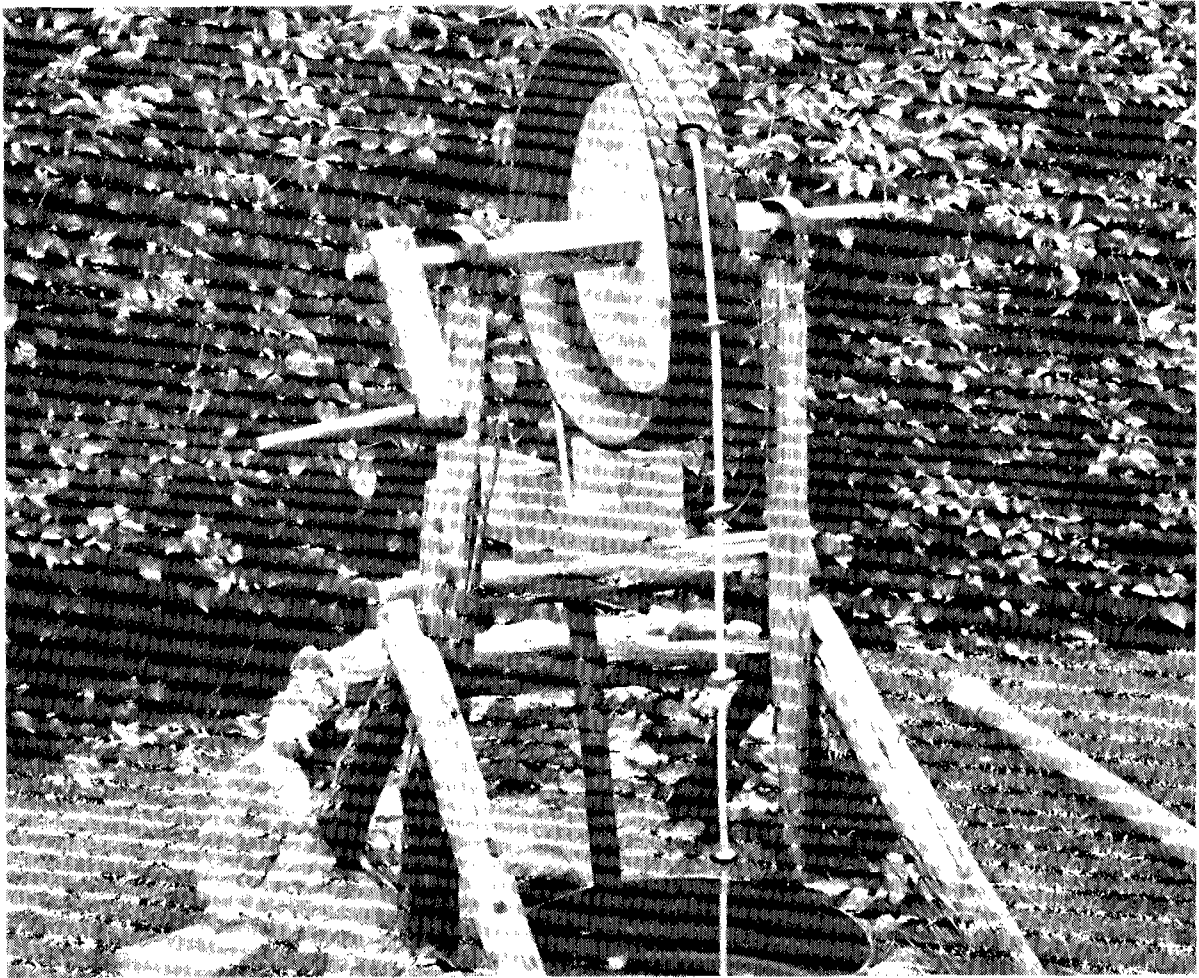
**Durability:** Because of the flap valve pump's simplicity and material strength, there is no reason that it should not last several years. Little or no maintenance is required.

**Labour Content:** 2 man-days

**Tools Needed:** hammer, saw, wood chisel, brace drill and 2.5cm bit, tin shears, soldering iron, pliers, round wood file.

**Materials Needed:**

- 1) 3cm dia PVC pipe up to 3.5m in length
- 2) 3-pieces cypress 5 x 10 x 15cm
- 3) 1-piece camphor 2.5x10x80cm
- 4) ¼ 'Debbe' (Kerosene tin)
- 5) Solder
- 6) 1-piece 10x10cm rubber inner tubing



5. Rope and Washer Pump. Raises water up to 10 metres.

## ROPE AND WASHER PUMP

**Description:** A shallow well pump consisting of a continuous loop of 7mm nylon rope with 4.0cm dia. rubber washers (stiffened with metal washers) threaded on to it. The rope is pulled up inside a 4.5 cm dia. PVC pipe which has one end submerged and the other at the required discharge level. The rope passes over a hand turned windlass and down again to the bottom of the pipe. The 64cm dia. windlass consists of two rings of car tyre sidewall attached back to back to a 56cm dia. wooden disc.

The two pieces of rubber tyre grip the washers and draw the rope upward and around the windlass.

**Function:** Raising water from depths of

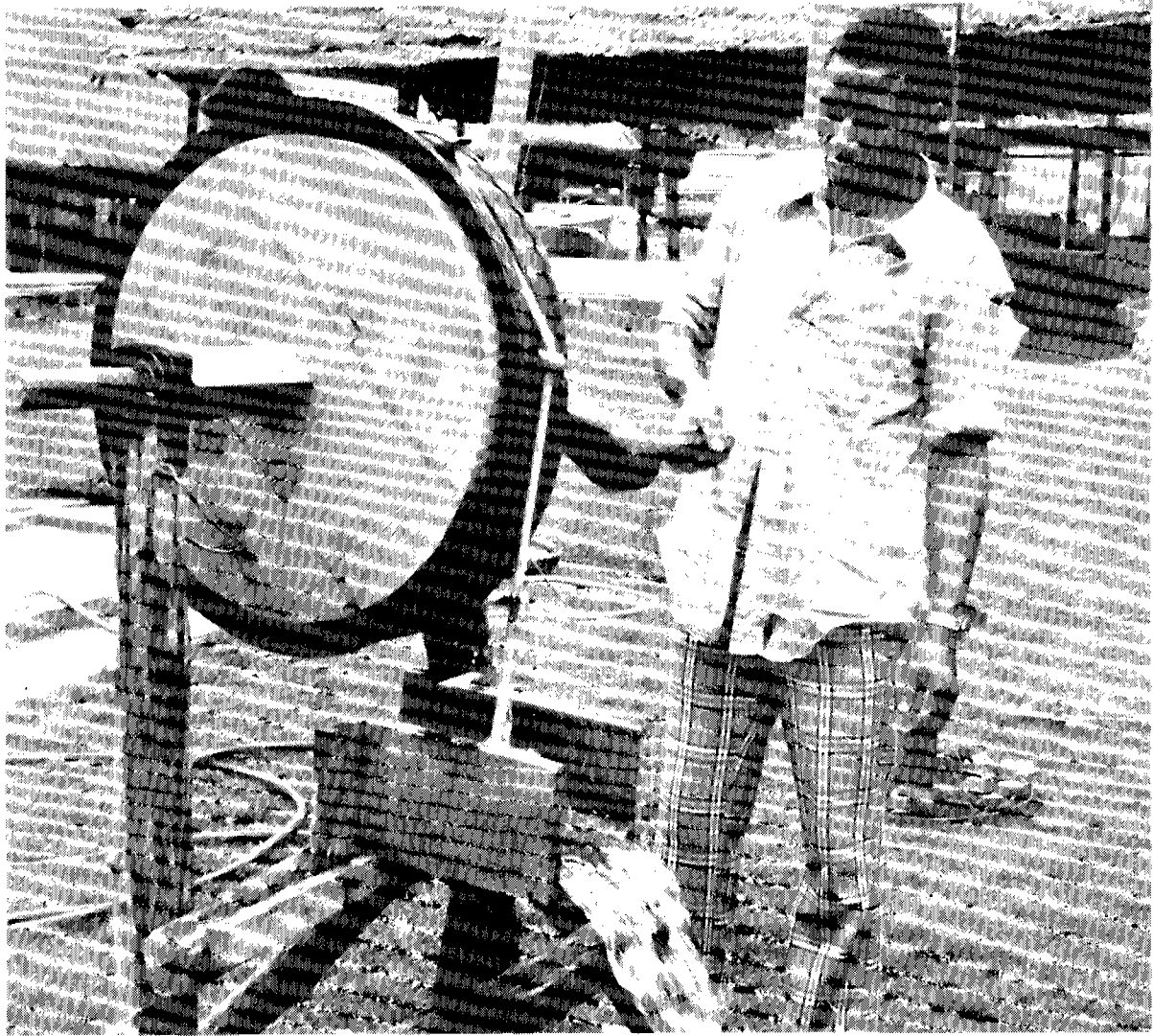
up to 10 metres.

**Specific Advantages:** All purchased materials are inexpensive and available in most areas while construction can be done by any village carpenter. Maintenance and repairs are accomplished easily and inexpensively.

**Durability:** The pump stresses are low and consequently wear is little. The washers and rope wear more rapidly than other parts and will require periodic replacement. The pump should last for years if properly constructed and maintained.

**Labour Content:** 6 man-days.

**Tools Required:** Hammer, Saw, hacksaw, hand-drill, woodfile, spanner, gas welding equipment.



6. Close-up View of the Rope and Washer Pump.

**Materials Required:** (for 3m deep well)  
(N.B. To raise water from greater depths a smaller diameter pipe and washers should be used e.g. 2.5cm or 1.25cm diameter).

- 1) 7mm nylon rope  
— cut to desired length
- 2) 4.5cm dia. PVC pipe cut to desired length
- 3) 1 used 15 inch tyre
- 4) 1.2m G.I. pipe 1.25cm dia
- 5) 3 7.5cm x 0.5cm bolts and nuts
- 6) 2 U-bolts 15cm x 1cm with nuts
- 7) Sufficient 4.5cm dia. rubber washers cut from old tyre
- 8) 2 pieces 7.5cm x 7.5cm x 20cm oil soaked wooden bearings
- 9) 7m 7.5cm dia. poles.
- 10) 1.8m 20cm x 5cm cypress timber
- 11) Sufficient 2.5cm dia. metal washers.
- 12) Nails as required



7. Bangladesh Shallow Well Pump. Lifts water from up to 8 metres deep.

### BANGLADESH SHALLOW WELL PUMP

**Description:** A factory made cast iron handpump. Water is sucked to the surface by a piston and suction valves which are located in the pump chamber.

**Function:** To raise water from a well or borehole. The maximum depth from which the pump can lift is 8 metres. Pump lift and capacity decreases as site altitude increases.

**Specific Advantages:** The installation of a handpump allows a well head to be covered

and hence protected from contamination and provides a simple and relatively inexpensive way of raising water.

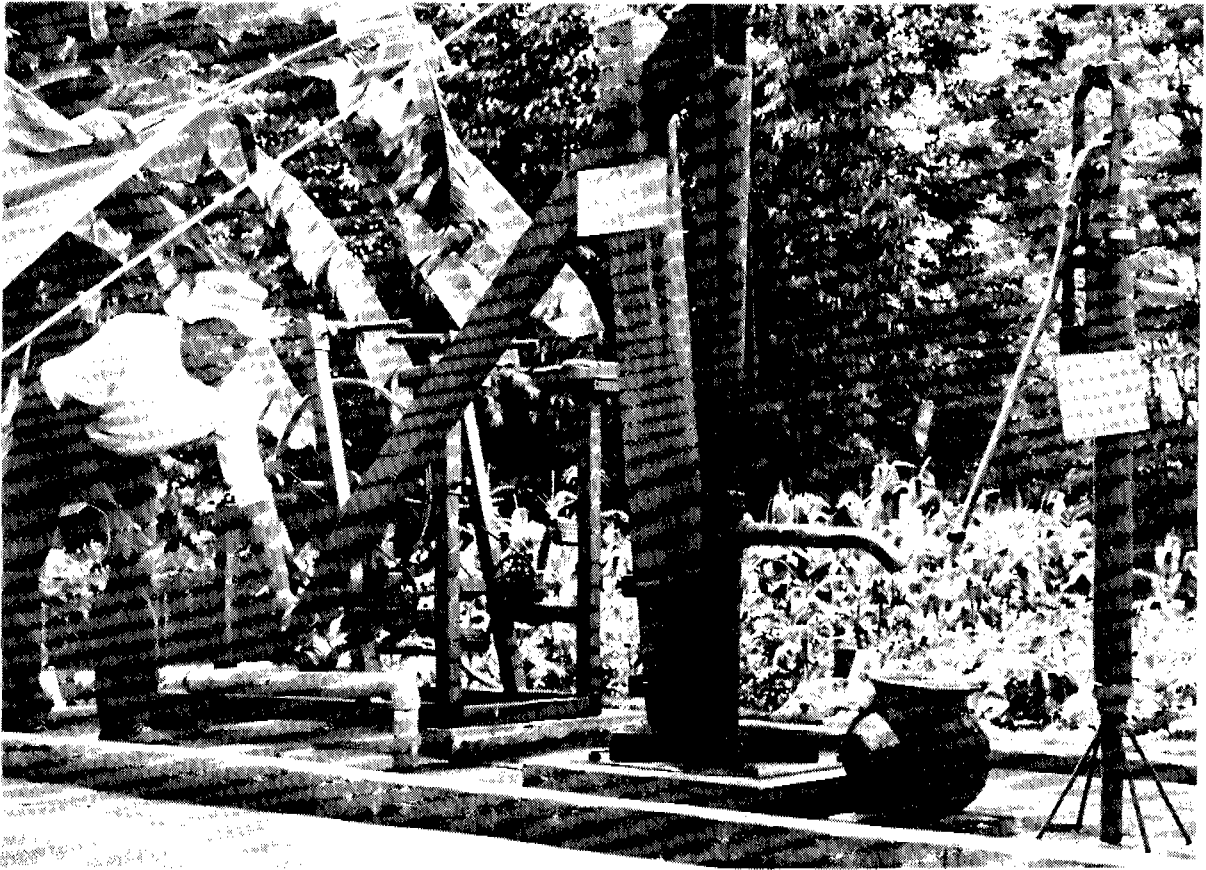
**Durability:** The piston sealing washers will require periodic replacement. The pump will operate for many years with little other maintenance. Pivots need greasing, and pivot pins require periodic replacement.

**Availability:**

Available from:

DACCA (Contact UNICEF Office)

Price: FOB DACCA Approx. US\$20.00



8. Deep Well Pump. Lifts water from up to 65 metres deep.

**DEEP WELL PUMP (Uganda Pump)**

**Description:** A hand-operated pump consisting of a heavy duty pump head and a piston and valve at the bottom of the pipe, below water level. The piston is connected to the pump head by lengths of steel or wood rod.

**Function:** To pump water from depths up to 65 metres.

**Specific Advantages:** (See Shallow Well Pumps leaflet). Maintenance costs are very low and spare parts should be readily available. The pump capacities are as follows:—

**Durability:** The pump is constructed of rugged and durable materials and requires little maintenance other than washer replacement. Pivots must be greased and pivot pins require period replacement.

**Availability and Cost:**

Uganda Pump (6.3 cms dia piston)  
 Available from: Craclius Terratest  
 Nairobi, Kenya — Kshs. 4,600 (1978)

**NOTE:** Price does not include casing, well rods, or piston as this varies with desired diameters.

Pump Piston dia (cm)	Strokes per/min.	Stroke length (cm)	Capacity (litres per hour)	Depth (m)
10.0	20	18	1520	15
7.0	22	18	840	25
4.5	22	18	260	65

## HYDRAULIC RAM PUMP

**Description:** A water pumping device whose sole source of power is water dropping 1-metre or more, with a flow greater than 5-litres per minute, to pump a smaller volume of water (approximately 10% of drive pipe flow) to a height of up to 10 times the drop of the drive pipe. The ram operates by the flow of the drive pipe escaping through an impulse valve which shuts suddenly when the flow becomes sufficiently fast. The momentum of the column of water forces the water through a non-return valve and up a delivery pipe to a holding tank.

**Function:** For pumping a small continuous flow of water to a height of up to 150 metres above the pump using flowing water as a power source.

**Specific Advantages:** The ram requires no power supply other than the flow of water and will work constantly with minimal attention. The unit is made entirely of water pipe and easily available pipe fittings and has only two moving parts which may require occasional replacement. The ram can be constructed in any local metal workshop by local skilled labour.

**Durability:** The ram will work for many years with only occasional tuning and valve maintenance.

**Labour Content:** 2 man-days to construct. Installation depends on the site and the amount of work required to install a pump foundation and piping.

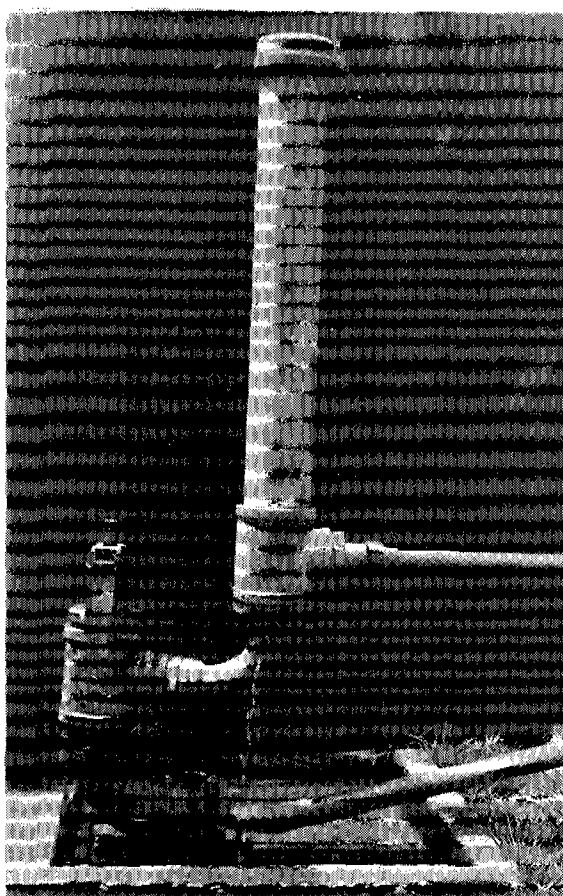
**Tools Needed:** Hacksaw, pipe spanner, adjustable spanner, vice, file, drill, bits.

**Materials Needed:**

- 1) 1-piece 61 x 6.5cm dia pipe, threaded both ends
- 2) 1-piece 6.5cm dia steel cap
- 3) 1-piece "T" 6.5cm dia

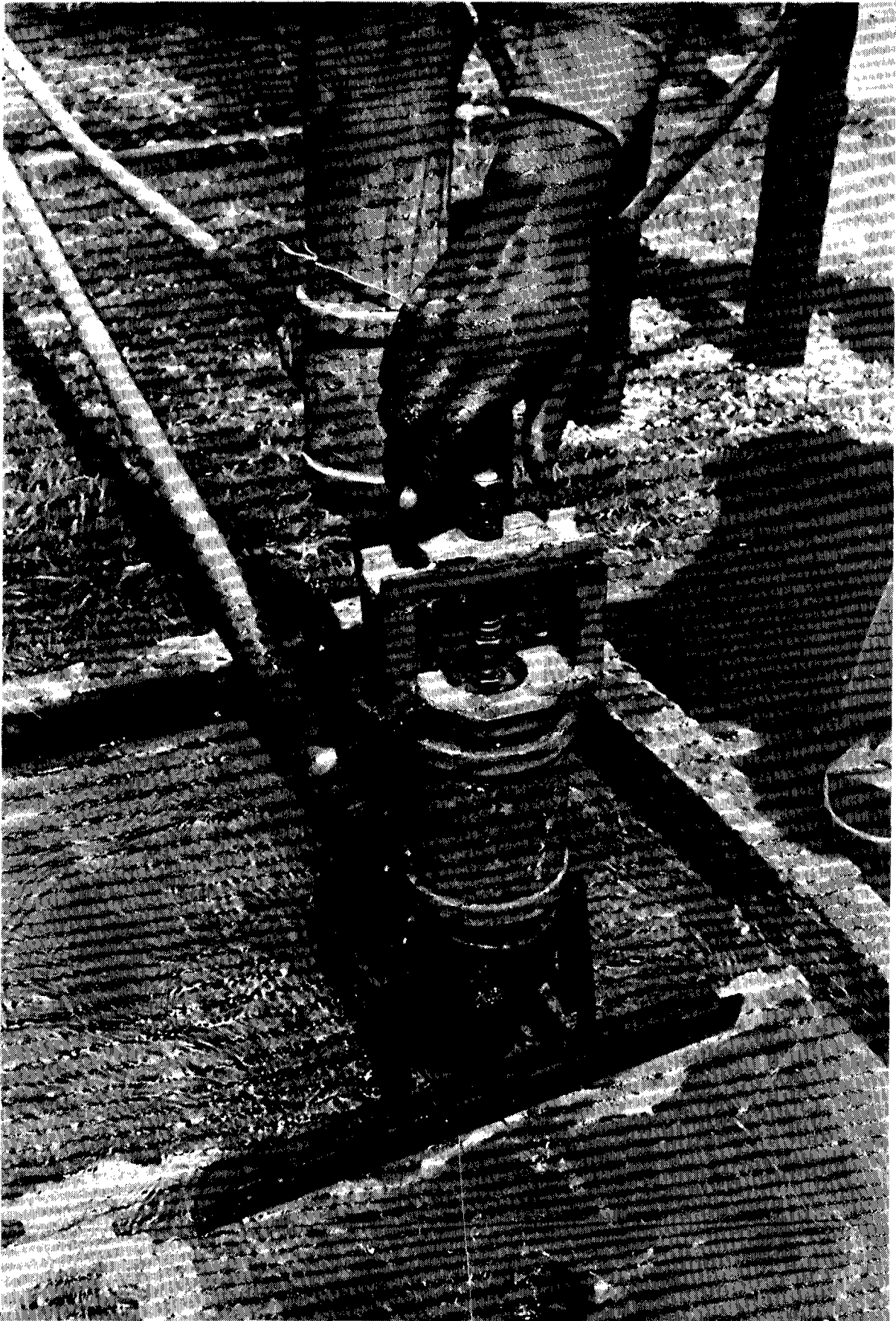
- 4) 1-piece reducing "T" 6.5 to 2.5cm dia
- 5) 3-pieces reducing bush 6.5 to 3.75cm dia
- 6) 1-piece 90° bend 3.75cm dia
- 7) 1-piece bolt 7.5 x 1cm
- 8) 1-piece coil spring
- 9) 1-piece steel strip -- 2.5cm
- 10) 1-piece 13x4cm channel mild steel
- 11) 2-pieces 8 x 4cm channel mild steel

**NOTE:** Detailed plans for constructing a hydraulic ram pump are available from Intermediate Technology Publications Ltd., U.K., and from Volunteers in Technical Assistance (VITA), USA.



9. Hydraulic Ram Pump. Continuously pumps water up to 150 metres high.





10. Impulse valve of the Hydraulic Ram Pump.



11. Prototype Bicycle Pump. Discharges 60 litres of water per minute up to 7 metres high.

**PROTOTYPE BICYCLE PUMP** — developed by the University of Dar es Salaam, Tanzania

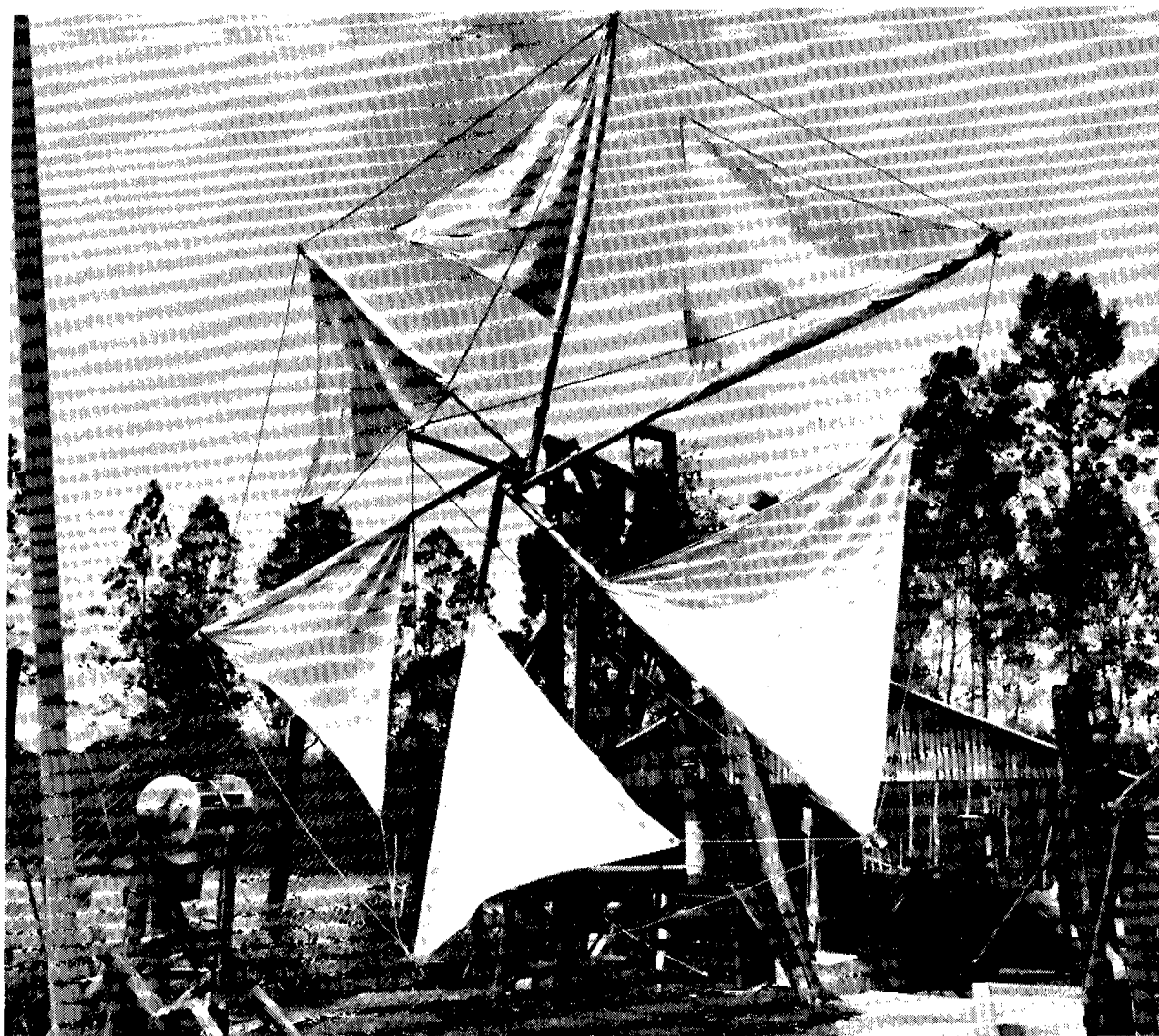
**Description:** A low lift pump consisting of two bicycle pedal drives, mounted on a metal frame, driving a small centrifugal pump. A belt gear is employed to produce a suitably high speed for the pump.

**Function:** For two people to pump a maximum of 60-litre per min. of water from depths of up to 7 metres to a height

of 7 metres at 35 r.p.m (pedal speed).

**Specific Advantages:** This prototype pump has the advantage of being able to raise water above the pump outlet, (which lift pumps cannot do), e.g. to a water tank. Pedal power is the most efficient way to use human energy but this idea requires further development before a cheap and efficient unit is obtained.

**Cost:** Kshs. 1,000 (1976).



12. Cretan Windmill Pump. Can lift water to a height of 5 metres.

### CRETAN WINDMILL PUMP

**Description:** A fixed hand windpump useful in areas of strong prevailing winds from one direction. The windpump is supported by a timber frame; it has canvas sails, a metal transmission drive and is connected to a low lift diaphragm pump. The pump is made from an old car tyre and two metal plates with non-return valves in the suction and delivery pipes.

**Function:** To lift water from a pond or lake a maximum of five meters.

**Specific Advantages:** In strong winds 2 or 4 of the six sails can be furled to reduce stresses on the drive and pump. Components

can be locally made or obtained.

**Durability:** This model is an early prototype after which several modifications have been made to strengthen the design. The final design (1978) is still under observation.

#### Availability and Cost:

Manufactured by CITC (Christian Industrial Training Centre)  
P.O. Box 72935  
Nairobi, Kenya

The current design incorporates a swivel head arrangement and metal tower—and usually uses a more conventional reciprocating pump. Total Cost from Kshs. 7,000 to Kshs. 12,000 depending on the tower design.



13. VITA Windmill Pump. Pumps 3,000 litres of water from up to 7.5 metres deep.

### VITA WINDMILL PUMP

**Description:** A swivel headed wind driven pump constructed mainly of G.I. piping and using corrugated G.I. roofing sheets for sails. Mounted on a tower pivoted at the bottom to allow easy field installation with ground assembly of major components.

**Function:** To pump water from depths of up to 7.5 metres using wind power. It can pump 3,000 litres ph in a 20 kmph wind with a 5.4 metres head and a 5 cm dia. cylinder.

**Specific Advantages:** The components can all be made locally. The pump is convertible to hand operation in periods of no wind. A large tail vane and light-weight blades enable the wind pump to pivot quickly in changeable winds and to operate with windspeeds as low as 10 kmph.

**Durability:** Since the design is a relatively

recent one (1976) no long term data on durability is available. The latest design incorporates a self-governing device to reduce the danger of damage in high winds.

### Availability and Cost:

Manufactured by: Ujuzi Leo Industries  
P.O. Box 764, Arusha  
Tanzania.

The unassembled kit is available at Tanzania Shs. 15,000 (or US\$ 1,925).

A compatible pump unit is available at Tanzania Shs. 1,500 (or US\$193).

"The Arusha Windmill: A construction Handbook", is published by VITA (Volunteers in Technical Assistance) 3706 Rhode Island Avenue, Mt. Rainier, Maryland, U.S.A. 20822 or is available from J.S. Moore Bookshop, P.O. Box 30162, Nairobi, Kenya.

## **SECTION THREE**

### **HOME IMPROVEMENTS**

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1. *Cinva Ram Block Press. For making rammed earth building blocks.*

## CINVA RAM BLOCK PRESS

**Description:** A locally manufactured portable block-making machine made entirely of steel. The block moulding box has an upward moving base plate connected to a lever which is operated by hand to compress a slightly moistened mixture of soil and stabiliser.

**Function:** For making rammed earth building blocks (14 x 10 x 29cm) and tiles from a wide variety of common soils mixed with a small amount of cement or lime.

**Specific Advantages:** The soils suitable for block making can often be found on the building site reducing transport costs since the blocks only require a small percentage of cement or lime stabilizer. The material cost inputs are very low. The blocks can be removed immediately from the press and cure naturally on site in 5 to 7 days. A variety of block and tile sizes and shapes can be made by inserting wooden moulds into the mould box. The entire procedure can be carried out by two to four unskilled labourers after a brief guidance period.

**Durability:** The press is of sturdy construction and with a minimum amount of maintenance, should last many years.

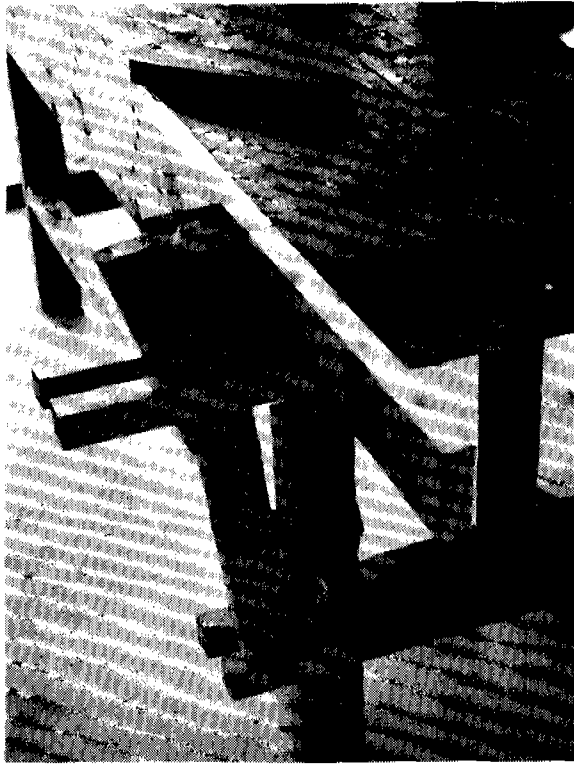
**Labour Content:** Four labourers can in one day produce 300 blocks. An average two-roomed house requires approximately 2,500 blocks.

**Tools Required:** The machine is sold complete with sifting and measuring equipment. A shovel is also required.

**Materials Needed:**

- 1) Desired amount of soil containing a small amount of clay  
1 cubic metre of earth can make about 110 bricks
- 2) 1 bag cement can produce 120 blocks at 5% cement content
- 3) Some sand may be needed depending on the type of soil available

**Obtainable at:** R.I.D.C., Kenya Industrial Estates, P.O. Box 275  
Machakos



2. All Wooden Bench Vice. To hold wood in place for carpenter to work on.

## ALL WOODEN BENCH VICE

**Description:** A simple carpenter's vice. The moving jaw is attached to the upper end of a 50cm. arm pivoted at its lower end. This arm moves towards and away from the bench between two rigid horizontal arms which are secured to the upper part of the bench. These horizontal arms are drilled to take a wooden dowel pin. A workpiece is placed between the wooden jaw and the bench and gripped tightly by tapping a wooden wedge between the moving jaw and the dowel pin. Long pieces of work are stabilized by wooden pins or dowels which fit into holes drilled along the side of the work bench.

**Function:** To hold wood in place for a carpenter to work on.

**Specific Advantages:** The vice is constructed using no metal parts. No special skills beyond a rudimentary knowledge of woodwork are required, and materials are easily and inexpensively available. The vice can be

scaled up or down to suit the size needed.

**Durability:** The vice will last for a considerable time if properly constructed and handled. The wedge and locking dowels will require periodic replacement.

**Labour Content:** 1 man-day

**Tools Required:** saw, hand-drill – 1.75 and 2cm wood bits. Plane useful but not necessary.

**Materials Needed:**

- 1) 5 x 5 x 120cm timber
- 2) 5 x 7.5 x 97cm. timber.
- 3) 3.75 x 10 x 30cm. camphor timber
- 4) 3.75 x 7.5 x 30cm timber
- 5) 40cm of 2cm dia. doweling
- 6) 10cm of 1.75cm dia. doweling
- 7) 2.5 x 50cm tyre tube rubber



3 Oil Drum Forge. An easy-to-operate blacksmiths' forge.

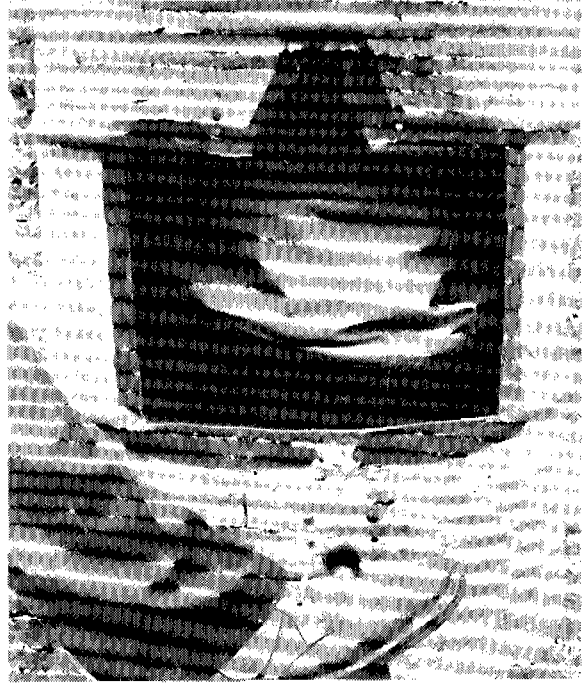
### OIL DRUM FORGE

**Description:** A used 220 litre oil drum which has had the top dished inward for a fire hearth and a section of the side cut to fit in a simple foot-operated bellows. The bellows consists of two 35cm. dia wooden discs joined by a 30cm. canvas skirt with 3 intake flap valves at the bottom, 2 outlet flap valves at the top and a 2.5cm. air pipe leading from the bellows to the hearth above. A foot pedal linkage is connected to the base of the bellows through a pivot on the side of the drum. The dished top is insulated and protected from heat by a 3cm. thick layer of clay.

**Function:** Provides an efficient and easy-to-operate blacksmith's forge.

**Specific Advantages:** The forge can be easily operated by a single person. Construction materials are available at low cost in most towns and can be fabricated by a blacksmith with an assistant familiar with carpentry.

**Durability:** The forge is constructed of



4. A close-up view of bellows mechanism.

rugged materials and should last for several years with proper handling. The hearth insulation and the bellows skirt will require occasional maintenance and replacement.

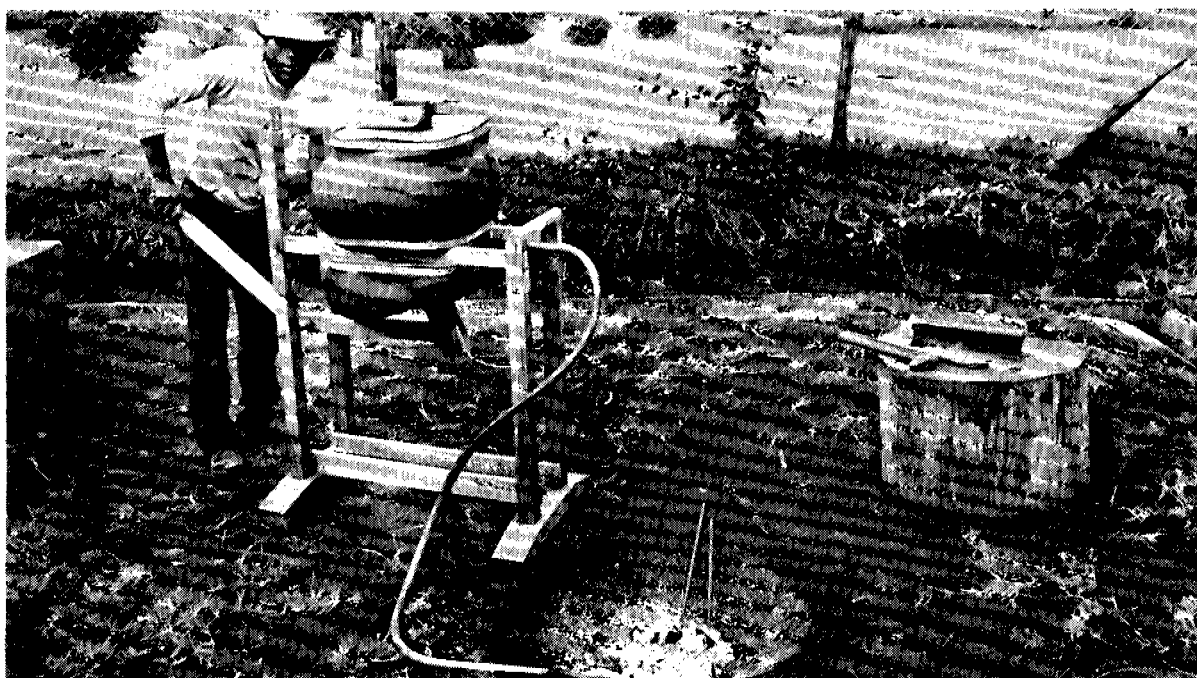
**Labour Content:** 4 man-days

**Tools Needed:** Hammer, file, screw driver, metal punch, hacksaw, woodsaw, cold chisel, wood drill or chisel.

**Materials Needed:**

- 1) 1-220 litre oil drum
- 2) 2-Wooden discs  
35cm dia. x 2.5cm.  
thickness
- 3) Canvas 30 x  
120cm
- 4) Piece of used inner-  
tubing
- 5) 30cm of 2.5cm. dia  
pipe
- 6) 1 metre of 38mm x  
6.3mm flat iron or  
1.25cm. pipe
- 7) Assorted nuts, bolts,  
screws, nails
- 8) 45cm. of 5cm x  
5cm x 3mm angle  
iron





5. Inner Tube Bellows. Provides continuous air flow to a forge.

## INNER TUBE BELLOWS

**Description:** A simple bellows having an active lower pumping chamber and an upper storage and discharge chamber. The chambers are made from discarded car tyre inner tubes slit and tacked on the top and bottom to 40cm square wooden plates with rounded corners. The lower chamber has holes through both the top and bottom wooden plates with inner tube flap valves fixed to the upper side of each hole. The upper chamber has only holes through the bottom plate and has no valves. The lower chamber is pumped by a handle attached to the bottom plate and pivoted on the bellows stand. The alignment of the upper chamber is maintained by a pivoted wooden guide arm. A 2.5cm dia discharge pipe is connected in the space between the two chambers and leads to the working forge.

**Function:** To provide a continuous flow of pumped air to a working forge.

**Specific Advantages:** The bellows are able to provide a continuous air flow by means of the upper storage chamber, which when filled by the lower chamber, deflates slowly due to the weight of the upper plate and

guide arm. The unit is simple in design and only requires simple carpentry skills to be fabricated.

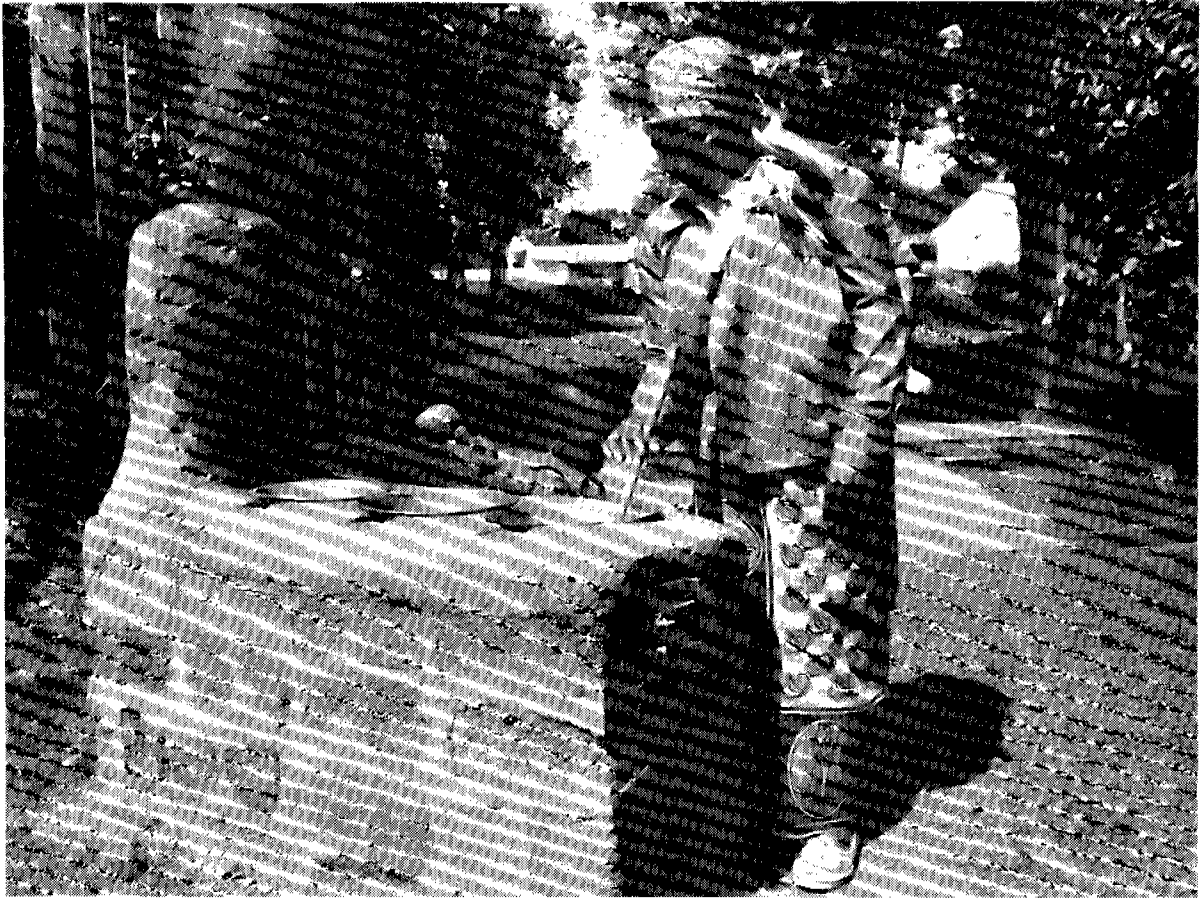
**Durability:** The bellows is sturdy and simple and provided it is properly constructed, it should last for many years. It is suggested that the unit be mounted on a strong stand. The handle and pivot pins should be made of hardwood and may require occasional replacement.

**Labour Content:** 2 man-days

**Tools Needed:** hammer, chisel, saw, tin shears, hacksaw, knife.

**Materials Needed:**

- 1) 2-discarded inner tubes
- 2) Nails, tacks
- 3) 20cm — 2.5cm dia pipe
- 4) 5.7m of 5 x 5cm timber
- 5) 80cm — 5 x 10cm timber
- 6) 3.6m — 5 x 7.5cm timber
- 7) 4-pieces — 40 x 40 x 2.5cm timber



6. Raised Cooking Platform. A safe energy saving device.

### RAISED COOKING PLATFORM

**Description:** A rectangular cooking stove 50cm x 120cm x 55cm high built of rammed earth/cement bricks with a 22cm x 17cm high open slot down the middle. The slot is mudded over with a 1:2 cement/earth mixture leaving 3 holes in the top just the right size for cooking pots. At the front of the firebox slot is a fitted tin air-intake control vent while at the rear is a cement/earth chimney.

**Function:** A cooking stove on which three pots can be heated at the same time.

**Specific Advantages:** The stove can easily and cheaply be built from Cinva-ram\* bricks by unskilled labour. An alternative and even less expensive method of construction utilizes sun-dried bricks with a sand/cement plaster for protection. If three pots are used, the stove is more economical

than an open fire. It eliminates the continual need for bending over the fire, the danger of burn injuries to children, and the irritation from smoke.

**Durability:** The stove will last for years if given periodic maintenance.

**Labour Content:** 1 man-day to make bricks and one man-day for construction.

**Tools Needed:**

- 1) 36 cinva-ram bricks or sufficient 2.5cm x 10cm timber for mud brick moulds or sufficient burnt bricks
- 2) 1/3-bag cement
- 3) 3-karais of sand
- 4) 1-piece 20cm x 30cm tin from discarded kerosene tin

\*(See Cinva Ram leaflet)



7. Kerosene Tin Oven. For baking using an open fire.

### KEROSENE TIN OVEN

**Description:** A small oven constructed from two 4-gallon rectangular kerosene tins riveted together after removing their common side. Two hinged doors at the front give access to a raised tin baking shelf. A shallow layer of sand over the oven floor allows even heating which can be controlled by two air vents at the top. The outside walls are covered with a wire mesh and plastered with a clay-sand mixture for insulation.

**Function:** For baking foods using an open fire.

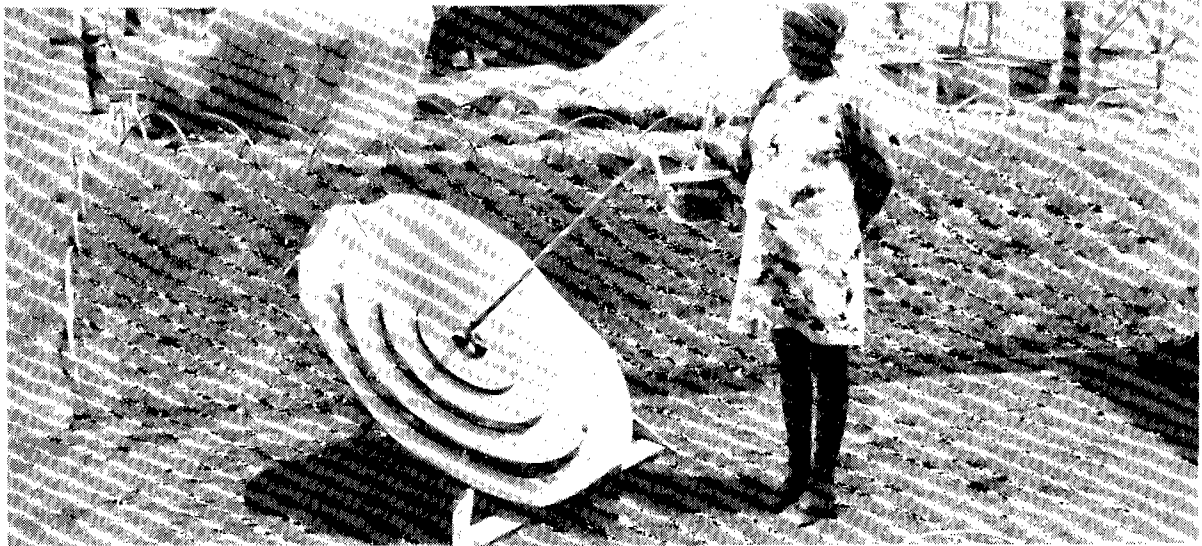
**Specific Advantages:** The oven is cheap and can be constructed by a local tinsmith out of two discarded kerosene tins. The heat source can be any open fire and increased heating can be achieved by placing hot coals on top of the oven.

**Labour Content:** 2 man-days

**Tools Needed:** Hammer, tin shears, pliers, anvil, riveting tool.

**Materials Needed:**

- 1) 2 kerosene tins
- 2) Rivets (or nails)
- 3) 5kg. fine sand



8. Solar Reflector Cooker. Concentrates sunlight heat for cooking purposes.

### SOLAR REFLECTOR COOKER

**Description:** A stepped parabolic reflector 120cm in diameter consisting of four Mylar\* or kitchen foil-covered concentric hardboard rings, attached to two cross members and supported by one of two hinged legs 70cm and 45cm long respectively. A 1-metre long support rod with a metal vessel holder at one end is fixed perpendicularly to the reflector at the centre of the rings.

**Function:** To concentrate sunlight for cooking purposes.

**Specific Advantages:** The cooker uses only the sun's energy to heat a cooking vessel. Materials are both relatively inexpensive and easily available and construction can be carried out by a village carpenter.

**Disadvantages:** The unit is not practical on cloudy days or in areas of weak sunshine. Because of the sun's movement the cooker will require frequent adjustment (every 15-20 minutes) to keep the cooking vessel in the focal region. Mylar is more durable and a more efficient reflector than kitchen foil but it is more expensive and more difficult to obtain.

**Durability:** The unit is simple and reasonably strong and should last for several years. The reflecting surface requires special

handling and may need replacement after one year of continuous exposure to the weather.

**Labour Content:** 3 man-days

**Tools Needed:** Hammer, saw, coping saw, screwdriver, pliers, metal drill, 6mm bit, paint brush, hacksaw, sandpaper.

**Materials Needed:**

- 1) ½-sheet hardboard 3.5mm thick
- 2) 1 roll of aluminium kitchen foil or Mylar plastic
- 3) 3 metres of 2.5cm x 7.5cm timber
- 4) 1-1 metre broom handle
- 5) 1-tin epoxy cement and hardener (For sticking the Mylar) (For kitchen foil use white wood glue which is waterproof when dry)
- 6) 25 mm hinges and screws
- 7) Nails as required
- 8) 50cm length of flat iron strip, 2cm wide by 3mm thick

\*Mylar is aluminised plastic foil



9. To save labour and conserve firewood.

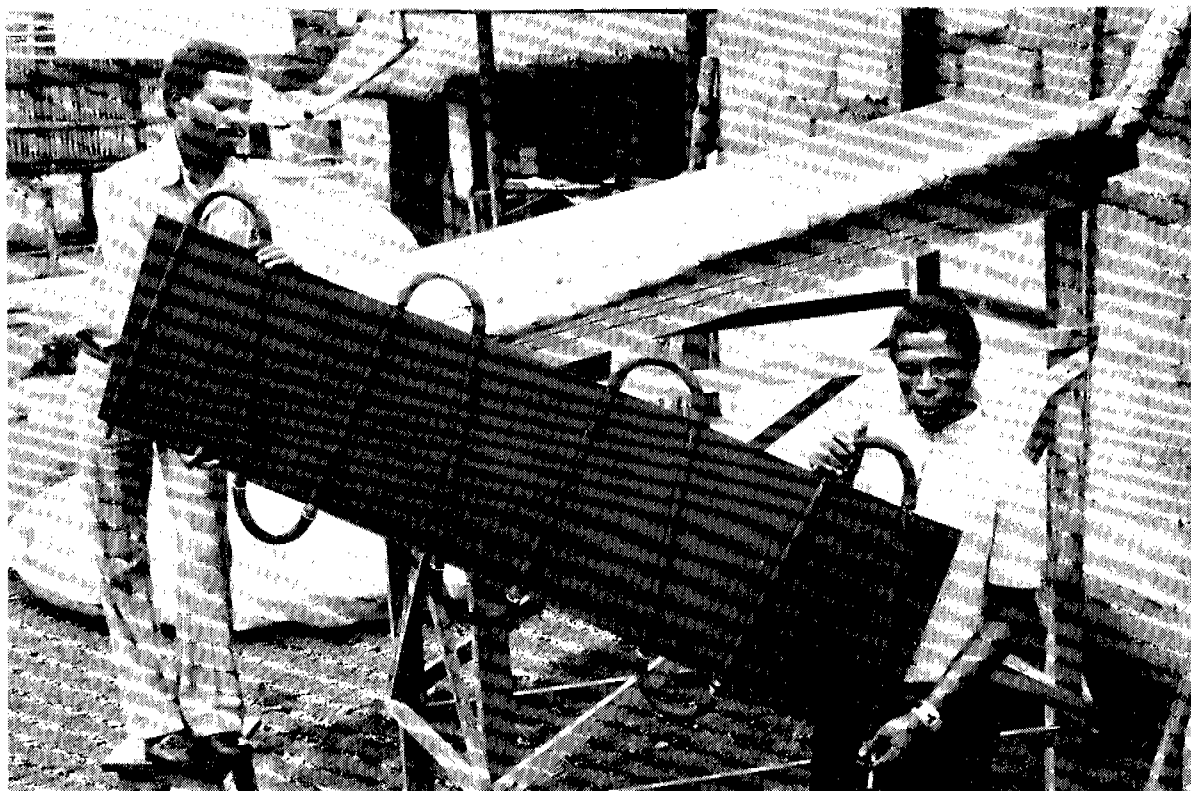
### HOT BOX COOKER

**Description:** This is a basket with a tight fitting lid both made of local fibres or sticks. The inside wall is insulated with a 7.5-10 cms layer of wood shavings, straw, or any other alternative material covered with cloth. A pillow made out of a cloth bag packed with wood shavings is prepared to fit the inside top of the basket. A stone which fits the bottom inside diameter of the insulated basket is needed.

**Function:** To reduce fuel required for cooking food. Food is brought to the boil in a covered cooking pot and placed on a pre-heated stone inside the basket. The basket is then covered with the pillow and lid.

**Specific Advantages:** The cooker can be prepared by any unskilled person. The materials needed are local and cheap. It limits fire accidents, reduces fuel requirements and does not require attention during cooking period. Cooking will be completed within 1-2 hours and food will keep warm for a long period.

**Materials:** Fibres, sticks, a stone, wood shavings and sack material.



10. Solar Water Heater. Heats water up to 60°C.

### SOLAR WATER HEATER

**Description:** The system consists of a solar collector unit connected directly to an insulated hot water tank. The collector consists of a zig-zag arrangement of 1.35cm G.I. piping laid transversely in grooves on a 45 x 190cm 26 gauge G.I. sheet. To simplify construction the piping is fastened to the collector sheet in eight 50cm pieces and the ends of the pipe sections are joined by U-bends of heavy duty rubber hose. This forms a continuous zig-zag of approx. 6 meters total length. The collector unit is painted matt-black and is housed in a shallow 200 x 75 x 15cm wooden box where it lies on a 6 cm deep bed of wood shavings which provide insulation. The top of the box is covered by a double glazing of transparent polythene sheet.

The collector box is tilted at an angle of 15° to the horizontal and is located at a slightly lower level than the storage tank. The lower end of the collector pipe is

connected to the bottom of the hot water storage tank and the upper end to an inlet about 2/3 of the way up the side of this tank. All connecting pipes and the storage tank are insulated with sisal pith. In operation water heated by the sun decreases in density and rises up the collector and into the upper section of the storage tank. This induces a convection flow with continuous cycling of water from the storage tank through the collector resulting in a continuous heating of the water in the storage tank.

**Specific Advantages:** This heater can provide a good supply of hot water at a temperature of 60°C. It is therefore very useful as a fuel saver in any situation where hot water is needed. Its construction is such that no welding or brazing is required and only simple readily available components are used.

**Durability:** The unit will last for many years although the polythene double glazing will need to be replaced after every one or

two years depending upon the extent of weathering.

**Tools Needed:** hacksaw, hammer, saw, wood chisel, pipewrenches, pipe die.

- Materials Needed:**
- 1) 2-60 litre drums or tanks
  - 2) 2-1.25cm dia gate valve
  - 3) 2-1.25cm dia unions
  - 4) 4-1.25cm dia bends
  - 5) 4-1.25cm dia nipples
  - 6) 1-piece 45 x 190cm metal sheet
  - 7) 16-pieces 30cm long x 1.75cm dia hose
  - 8) 1-litre matt-black paint
  - 9) Insulation - grass, wood shavings, etc.
  - 10) 2-pieces 1.75 x 1.75 x 200cm timber
  - 11) 2-pieces polythene sheeting 85 x 210cm
  - 12) 2-pieces 1.75 x 1.75 x 75cm timber
  - 13) 2-pieces 2.5 x 12 x 75 cm timber
  - 14) 2-pieces 2.5 x 12 x 200cm timber
  - 15) 1-piece 3.5mm x 200 x 75cm hard-board
  - 16) sufficient 5cm nails or screws
  - 17) 1 box tacks
  - 18) 12m of 1.25cm dia G.I. pipe



11. Charcoal Water Filter. Extracts suspended solids and germs from water.

### CHARCOAL WATER FILTER

**Description:** A locally made 20-litre clay pot fitted with a 1.25cm dia discharge tap at its base and containing graded layers of stones, gravel, sand and broken charcoal.

**Function:** To filter out suspended solids and biological pollutants.

**Specific Advantages:** The filter is effective in the removal of solids and other pollutants and can filter sufficient drinking water for one family. All materials are locally obtained apart from the tap which costs little.

**Durability:** The pot and tap will last for a long time. The filter does, however, require cleaning or renewal of the beds when these become clogged and this can occur frequent-

ly (every 3 months) in the instance of a very dirty water source. Larger versions (200-litre size) of this type of filter are more practical and efficient and require less frequent washing.

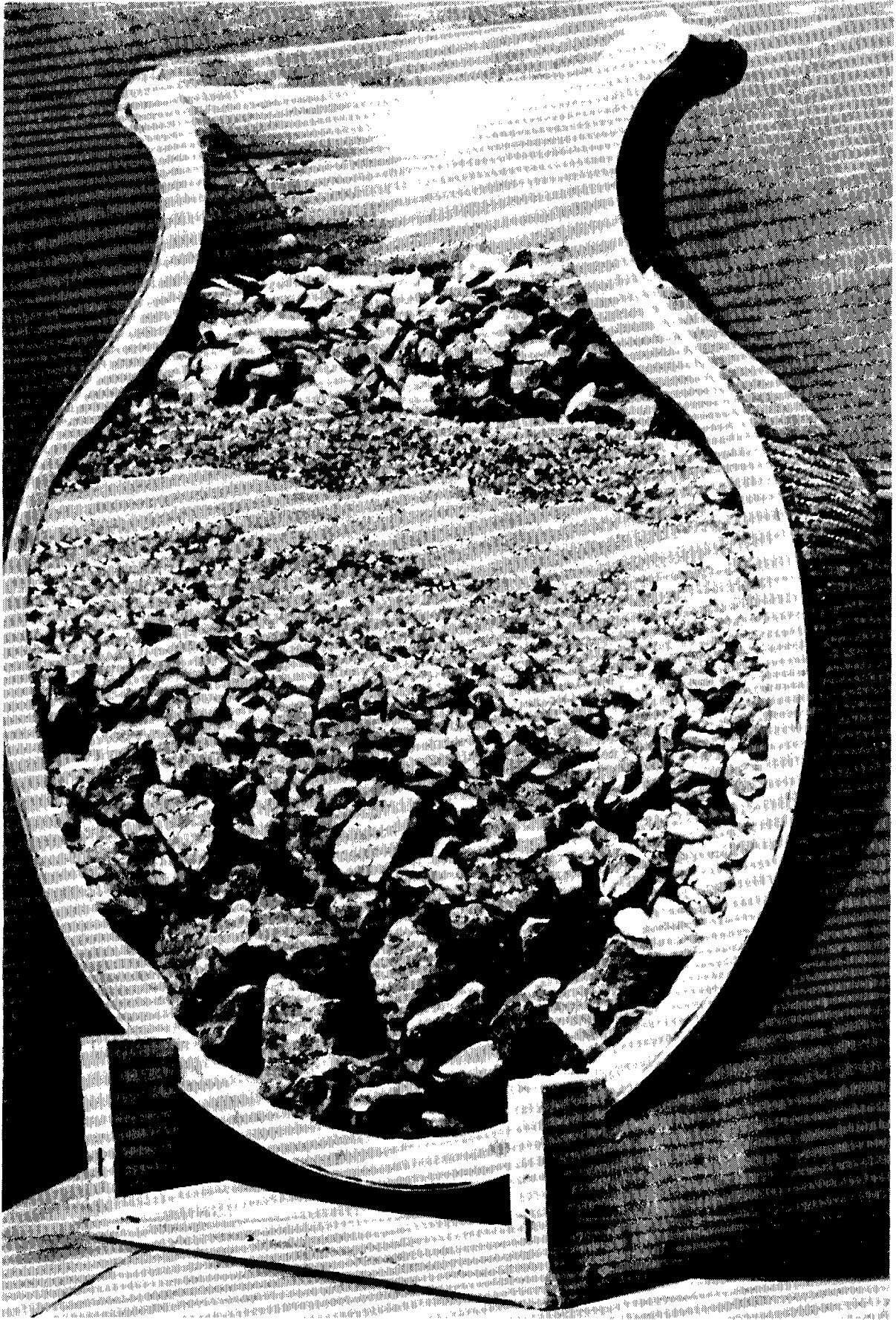
**Labour Content:** 1 man-day

**Tools Needed:** Drill, 2cm bit.

**Materials Needed:**

- 1) 1-20 litre clay pot
- 2) 1-1.25cm water tap
- 3) 1 kg. small stones 1.75cm
- 4) 1 kg. large stones 2.5cm
- 5) 1 kg. gravel 1cm
- 6) 1 kg. broken charcoal 1.75cm
- 7) 1 kg. fine sand





12. Details of Filter Medium.



13. *Evaporative Charcoal Cooler. To provide cool storage.*

### EVAPORATIVE CHARCOAL COOLER

**Description:** A box 40 x 40 x 60cm covered by a galvanised iron water tray from which cloth strips or 'wicks' drip water down onto side frames consisting of a 5cm thickness of broken charcoal sandwiched between 1.25cm chicken wire mesh. A hinged and latched door constructed similarly to the sides allows easy access.

**Function:** The action of water evaporating from the charcoal cools the interior of the box providing cool storage for meats and vegetables.

**Specific Advantages:** The cooler is made from inexpensive and easily obtainable materials and can be constructed by a village carpenter. The cooler can prolong the storage life of meats and vegetables beyond normal periods in areas where other refrigeration is not available. Optimum cooling is obtained in arid windy areas where evaporation is highest.

**Durability:** The cooler should last for several years if rot-resistant wood is used in the frame. The wick rags will require replacement about every four months.

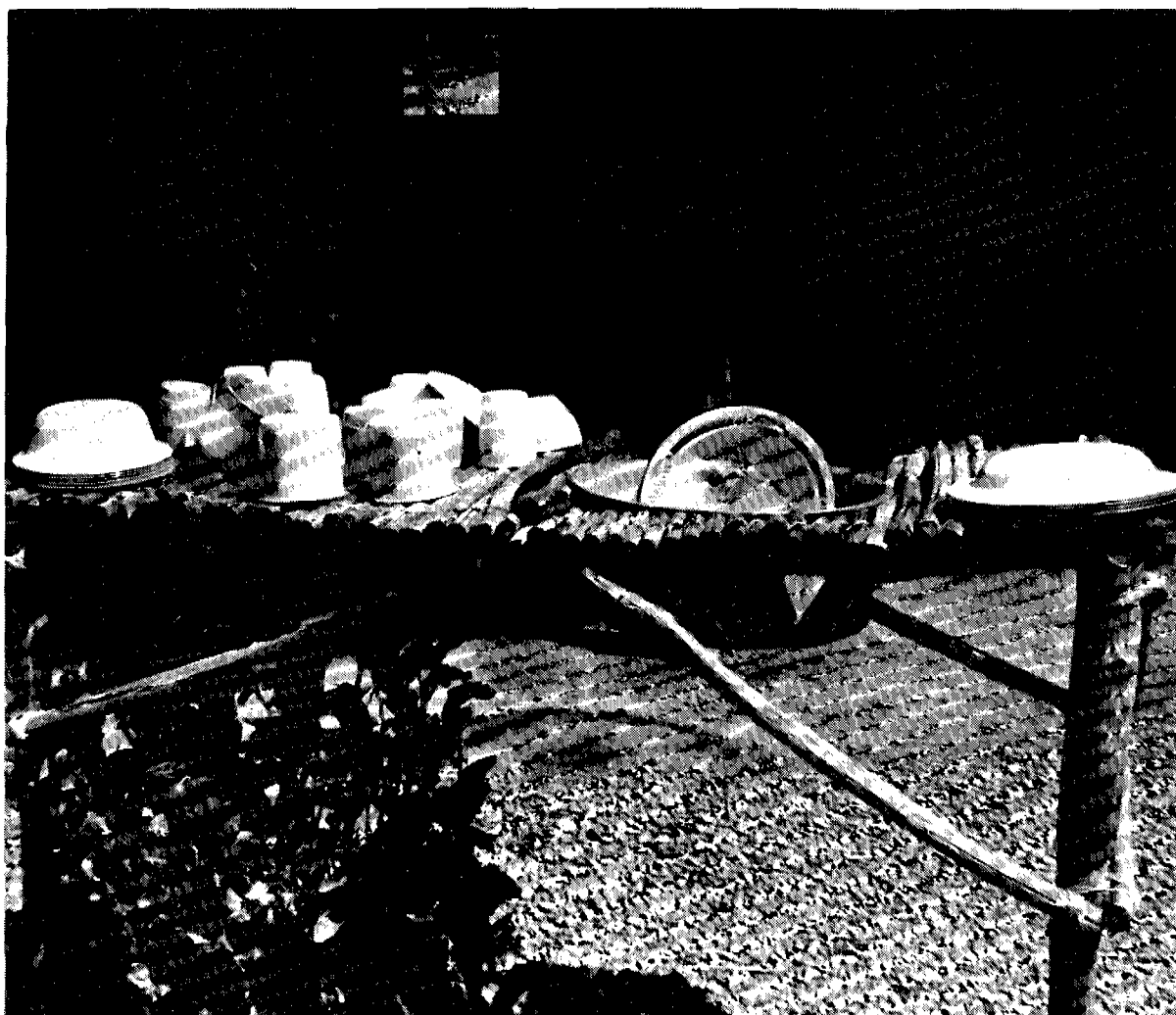
Note that heavy cloth works best as a 'wick' because of increased capillary action.

**Labour Content:** 2 man-days

**Tools Needed:** hammer, saw, screwdriver, soldering iron.

**Materials Needed:**

- 1) 8-pieces 43x63cm of 1.25 chicken wire
- 2) 1-piece 5x60 x 60cm tin water tray
- 3) 2-pieces 5cm steel hinges and screws
- 4) ¼kg small fencing staples or small nails
- 5) 6.8m of 2.5 x 10cm rough timber
- 6) 8m of 2.5 x 2.5cm rough timber
- 7) 5-pieces 5cm x 6cm x 40cm rough wood
- 8) scrap cloth strips
- 9) ¼-bag broken charcoal
- 10) 5cm nails



14. Raised Sink and Drying Table. Practical way of keeping home utensils clean.

#### RAISED SINK AND DRYING TABLE

**Description:** A small table 50 x 120 x 90cm high constructed with a hole in the centre for a 'sufuria' washing basin. The table is made entirely of wooden sticks bound together with string or vines. A hole 50 x 50 x 80cm deep is dug beneath the table and filled with stones to act as a soakaway pit for the waste water.

**Function:** Providing a raised working surface for washing and drying dishes, preparing foods etc.

**Specific Advantages:** The table enables a person to conveniently wash and sun-dry items away from ground dirt. The wash basin easily lifts out for emptying.

All materials are found locally and the table is easily constructed by unskilled labour. The only cost will be that of the wash basin.

**Durability:** The table may last several years but the binding may require replacement.

**Labour Content:** 1 man-day |

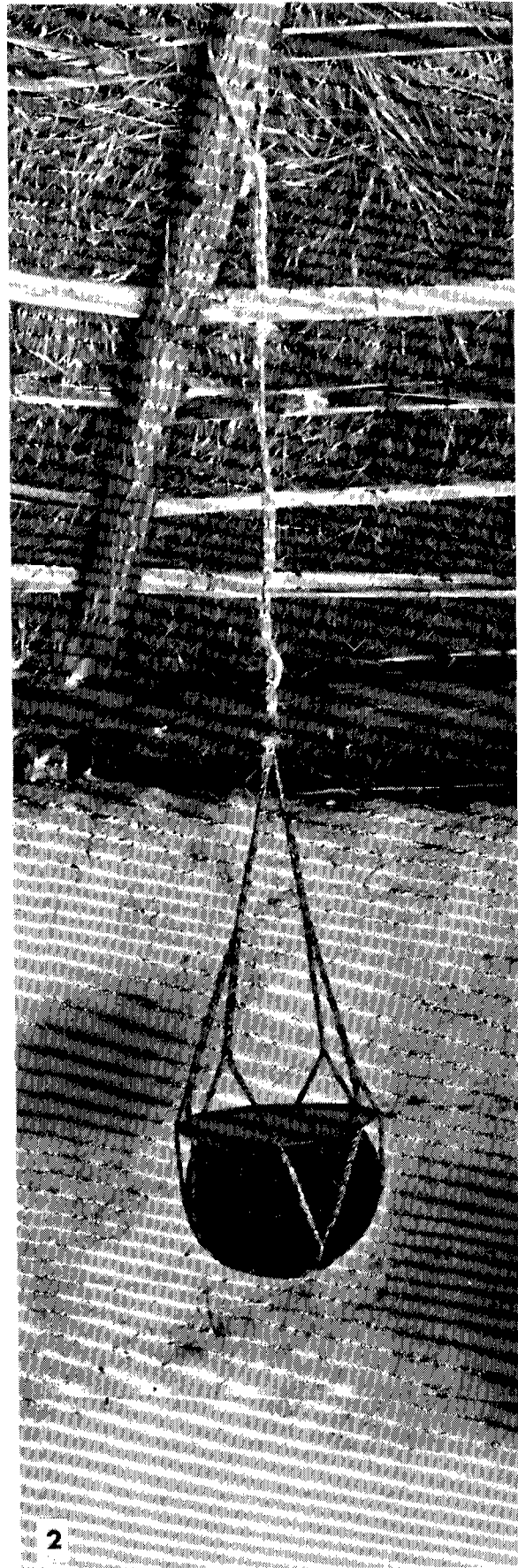
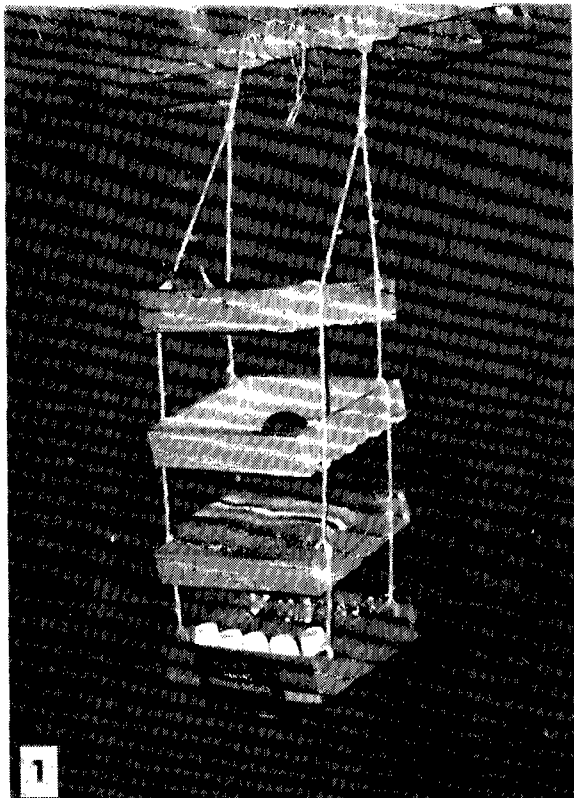
**Tools Needed:** Machete (panga)

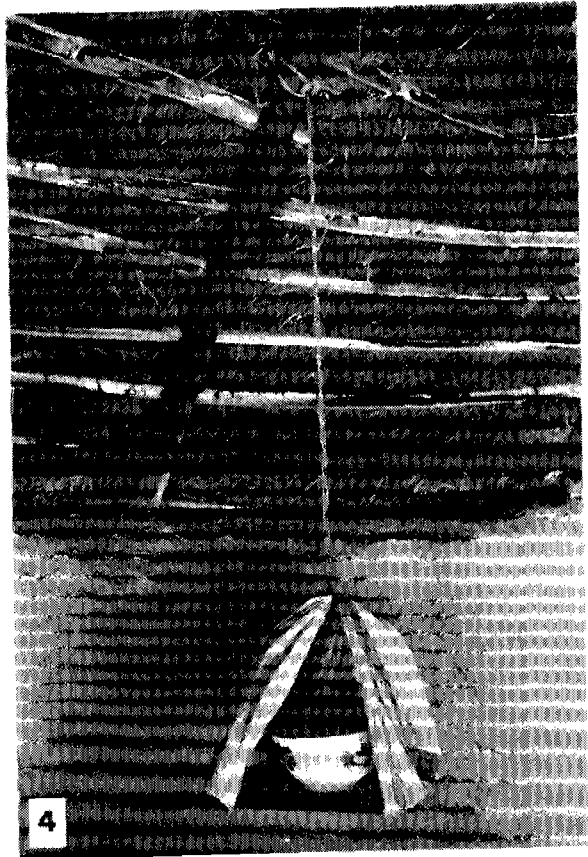
**Materials Needed:**

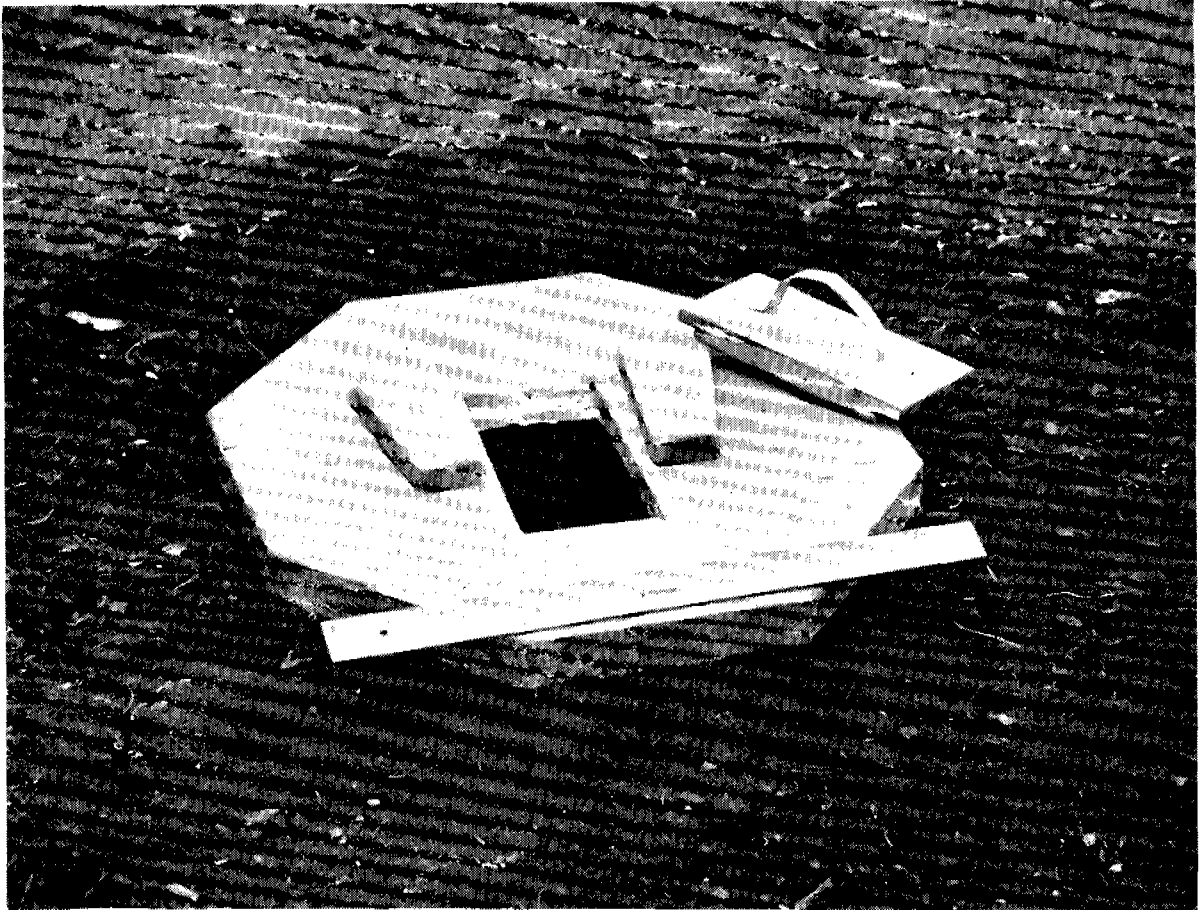
- 1) Sufficient supply of straight wood sticks or branches
- 2) String or vines
- 3) Wash basin (30cm dia sufuria)

## SOME HOME IMPROVEMENT ITEMS

- 1) **Hanging Storage Shelves:**  
A series of shallow 35cm x 45cm boxes suspended from each other by ropes. The ropes are hung from the roof or the top of the wall.
- 2) **Hanging Pot:**  
A traditional clay pot for food storage suspended from the roof by a rope out of reach of pests.
- 3) **Coconut Shredder:**  
A traditional tool consisting of a seat with a sharp serrated blade fixed at the front for shredding the white meat of a coconut.
- 4) **Hanging Fly-Proof Food Safe:**  
A 30cm x 30cm piece of timber with a net or cloth cover stretched over a domed bentwood framework and hung from the ceiling by a rope. It protects food from insects, and dirt and can be provided with a rat guard to keep out rodents.







15. To provide Toilet Training for the Young Child and Keep the Compound Clean.

#### CHILD'S SQUATTING PLATE

**Description:** Reinforced concrete plate 48 x 48 cm and 4 cm thick on the outside sloping inward to a thickness of 2.5 cm around the hole at the centre. Footplates on either side of the hole are raised 1.75 cm and cast in tin molds at the same time as the plate is cast. A beveled wooden hole cover 2.5 cm thick is provided to seal off the hole.

**Function:** To train children in proper habits of hygiene, to prevent pollution of immediate environment and the spread of parasites.

**Specific Advantages:** The plate is simple, inexpensive and easily constructed. It enables children to be toilet-trained in their immediate environment and is easily relocated as necessary.

**Materials:** Cement, sand, chicken wire and a small board.









Published by **UNICEF**  
Eastern Africa Regional Office  
PO Box 44145  
Nairobi  
Kenya