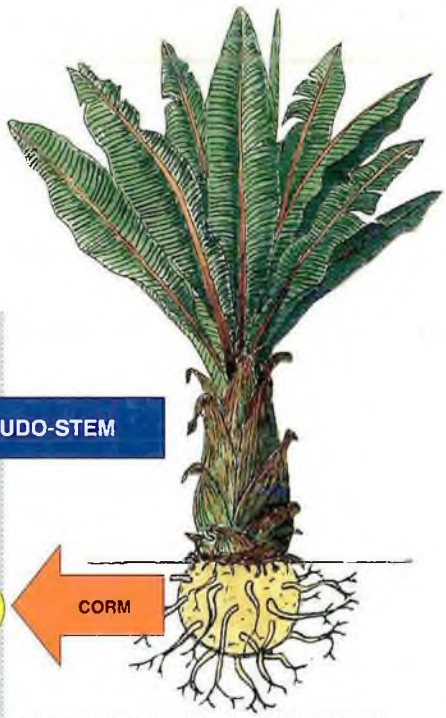
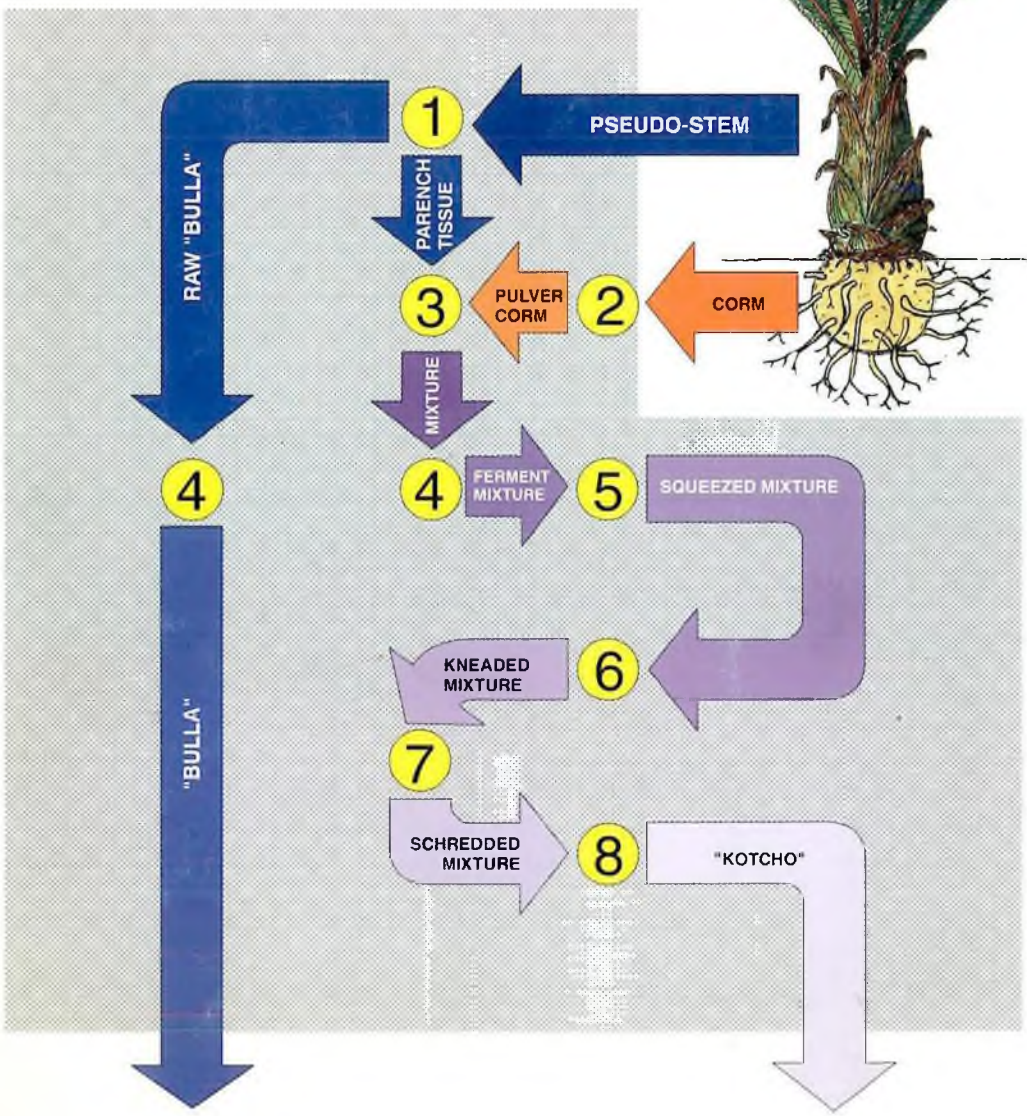
# STUDY OF "ENSET" PROCESSING AND DEVELOPMENT OF "ENSET" PROCESSING TOOLS IN THE SOUTHERN REGIONS OF ETHIOPIA

Mehtzun Tedla and Yewelsew Abebe

ACA/NORAGRIC Research Collaboration Project
October, 1994





# Study of "Enset" Processing and Development of "Enset" Processing Tools in the Southern Region of Ethiopia

**Mehtzun Tedla[1] (BSc.) and Yewelsew Abebe[2] (MSc.)**

[1] Department of Agricultural Engineering and Mechanization; and

[2] Department of Home Science and Technology

Awassa College of Agriculture

P.O.Box 5, Awassa, Ethiopia

Acknowledgement:
The project is part of the ACA/Noragric programme funded by The Norwegian Universities' Committee for Development Research and Education (NUFU)

October, 1994

## PREFACE

Women in rural Ethiopia, like other women in developing nations, are responsible for household and agricultural activities. They are responsible for activities such as planting, weeding, food preparation and processing; water and fuel wood collection, rearing children etc. In general rural women carry the social and economic responsibilities of the family.

Looking into the heavy work load of women, the need for developing appropriate technologies (labour-saving devices) is acknowledged by many writers. When one looks the division of labour in many rural areas, there is a clear demarcation between a man's and woman's work. In general the division of labour is based on gender (9).

If men and women perform different activities most of the time, then any given labour saving device or technology results will have different impact on men and women. For instance the enset plant, which is a staple food for 8 - 10 million of people, requires intensive processing stages in order to produce edible products. The planting of enset is the sole responsibility of men. On the other hand, enset processing and household food preparation (from products of enset plant) is the responsibility of women (8). Thus, any technology to improve the production of enset plant has also to include the processing aspect. Based on this idea we proposed a research project on "Study of Enset Processing and Development of Enset Processing Tools in the Southern Region of Ethiopia" in 1992. The research project was set-up to study the traditional methods of enset processing, and come up with a device to eventually reduce the work load of women in enset culture areas of Ethiopia. The total cost of the research project was covered by the ACA-NORAGRIC research collaboration project.

It is hoped that this trial will contribute to strengthen the existing interest and direction of involving womens' concern in applied researchs.

## ACKNOWLEDGEMENT

Investigators of this research project would like to express their sincere thanks and appreciation to the following individuals and organizations, without whose contributions and encouragement it would have been difficult to complete this project. Organizations and individuals in alphabetical order are as follows:

Organizations

- Institute of Agricultural Research, Nazareth
- NORAGRIC (Norweigan Center For International Agricultural Development, Agricultural University of Norway)
- Research and Extension Office, Awassa College of Agriculture (ACA)
- Sodo Appropriate Technology Center

Individuals

- Mr. Altaye G/Medhin
- Mr. Betato's family
- Mr. Mekete Mekonnen
- Dr. Mogessie Ashenafi
- Mr. Seyoum Muluneh
- Dr. Trygve Berg
- Mr. Wako's family

## CONTENTS

## LIST OF TABLES

## ILLUSTRATIONS

## ANNEXES

## BACKGROUND

"Enset" (*Enset ventricosum*) is a tall fibrous plant which resembles the banana plant. For this reason, it is sometimes known as false banana (11). In the non-"enset" culture areas "enset" is named "koba". There are about eight recognised species of "enset". However, *Enset ventricosum* and probably *Enset edulis* are economically important (10). The size of "enset" plant depends on variety, spacing in between plants, soil fertility, rain fall, etc. Based on these factors, the "enset" plant at maturity reaches a total height of 2 - 10 meters, and a base circumference of up to 3.5 meters (10).

Wild type of *Enset ventricosum* is available in countries such as Cameroon, Kenya, Uganda and Zaire (12). However, Ethiopia is the only country where "enset" plant is cultivated for human consumption. "Enset" serves as the main food source for about 8 to 10 million people inhabiting the densely populated areas of South-Western Ethiopia i.e, Sidamo, North-Western Bale, Gamo-Gofa, Keffa, Wollega and some parts of South-Western Shoa (12).

The propagation of "enset" is done vegetatively by suckers. Seeds could also be used (6). Farmers dig out a mother "enset" plant of about 1 - 2 years old, and split the corm into two or four equal parts. Then the splitted corm is buried diagonally in the ground and covered with cow-dung. New seedlings up to 10 - 50 sprout from each corm after a planting period of 4 - 6 weeks (1,6). When the seedling are ready, they are again transplanted in another prepared land. After each year, transplanting is done two or three times. If the "enset" plant is needed soon for consumption, it is left on where it was transplanted and can be harvested. This bridges the gap between times of food shortage and relative period of food availability (6). However, if the farmer needs the plant for longer duration, it again has to be transplanted for a fourth time near the household yard, and could stay up to 12 to 13 years (Figures 1 and 2 ). The "enset" plant which has reached full maturity is more productive than the one harvested before full maturity. An average yield of the pseudostem and corm was found to be 26 - 42 kg. of food per plant (6).

**Figure 1** **"ENSET" PLANTING FLOW CHART***

Corm of a 1 - 2 years old "enset" plant

▽

Splitted in two or four equal parts

▽

Diagonally planted in different areas and covered with cow-dung

▽

10 - 50 new seedling (suckers) sprout from each after 4 - 6 week

▽

Transplanting on a well prepared ground

▽

3 - 4 years of consecutive replanting

▽ ▽

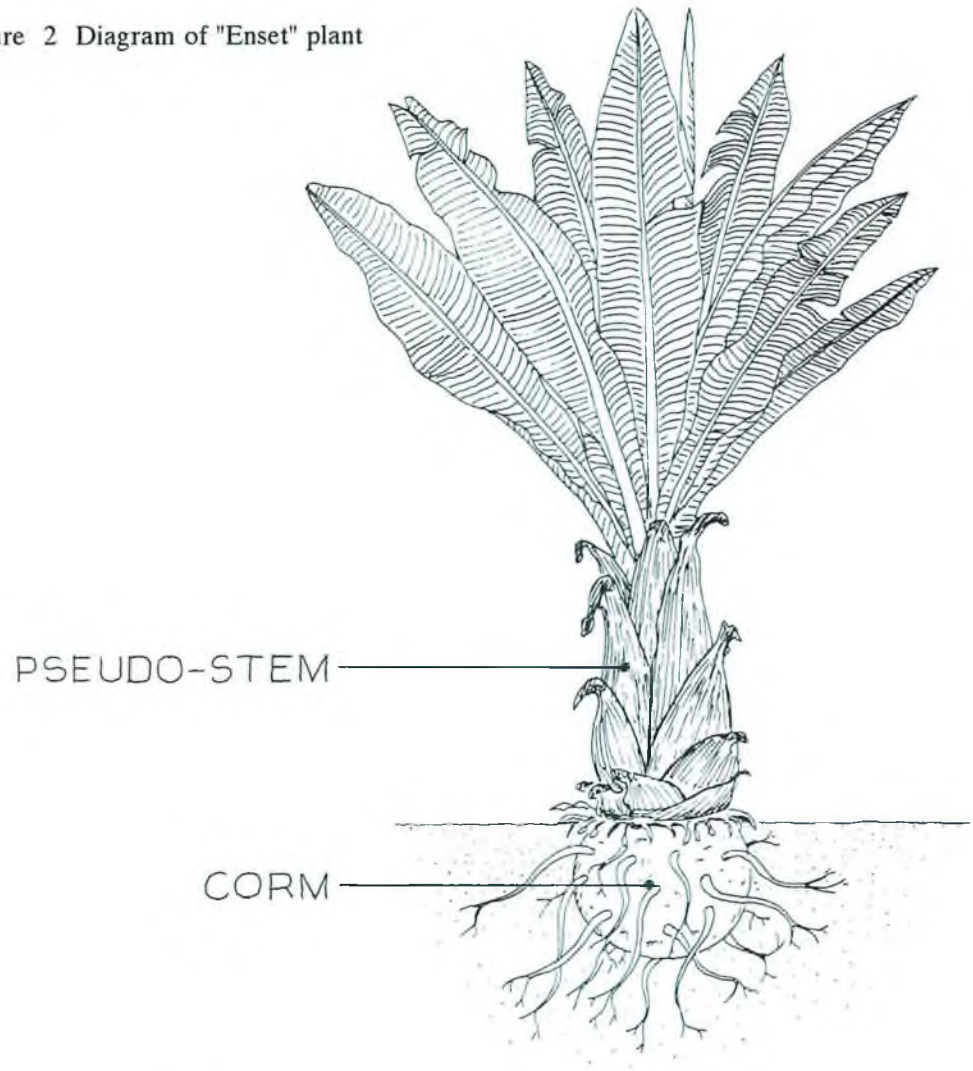
If needed for consumption soon, it stays on the same ground, and can be harvested

the plant could be ready after 3 - 6 years of replanting

- "Enset" plant could stay 12 - 13 years
- Full maturity of "enset" gives high production

* **Adapted from a paper by Deckers J., et al (6)**

Figure 2 Diagram of "Enset" plant




**Uses of "Enset" Plant**

"Enset" is a multi purpose crop. It is used for human consumption, animal feed and for extraction of long fibers ("Kacha") used for making bags, rags, robe, gunny bag, etc. The leaves are used to form the inner lining for the pit in which the decorticated corm and pseudostem are burried for fermentation (4). Some varieties of "enset" and food from these varieties are also considered to have medical value (7). The following are examples of medical uses of the "enset" plant:

- food prepared from immature corm of "enset" plant is fed for healing broken bones.
- gruel or porridge made of bulla is fed to new mothers to clean out the uterus, for milk production, and for strength.
- bulla gruel or porridge is given for newly circumcised children.
- highly fermented "kotcho" in its dry form is also given for treating amoebiasis and for stomach cramps.

Edible parts of the "enset" plant are the corm (root part) and the pseudostem (inner bark). The parts of the "enset" plant used for human consumption are "kotcho", "Bulla" and "Amicho". These products of the "enset" plant are used to make different dishes such as the following:

- Kocho Kita (thin, unleavened bread)
- Bulla Genfo (porridge type)
- Bulla Atmit (gruel type)
- Bulla or Kotcho Ferfer (shredded flake)
- Amicho - Located at the base of the pseudostem and is eaten after boiling like potatoes.

The nutritional value of dishes prepared from "bulla", "kotcho", or "amicho" are high in carbohydrate and low in protein (Table 1). Products of the "enset" plant are often blamed for causing protein deficiency disease when eaten alone as a staple food. It is true that kotcho or bulla contain very little protein (0.5 gm in 100 gm of edible portion). However it should be mentioned that dishes made out of "enset" products are traditionally served with good alternative protein sources. Information gathered in Wolayta and Sidama areas indicate that dishes prepared from these products (kotcho, bulla, etc.) are supplemented either with milk, meat, or legume which enrich the protein value of the prepared food (Table 2).

Table 1 Nutritional Value of Kotcho and Bulla/100gm of Edible Protein

| | Bulla | Kotcho |
|---|---|---|
| Food energy (Kcal) | 200 | 186 |
| Moisture (%) | 48.7 | 53.5 |
| Protein (g) | 0.6 | 0.5 |
| Fat (g) | 0.3 | 0.4 |
| Carbohydrates (g) | 49.0 | 44.8 |
| Calcium (mg) | 82.0 | 70 |
| Phospherous (mg) | 36.0 | 45 |
| Iron (mg) | 3.7 | 7.9 |

Source: Food Composition Table for use in Ethiopia, 1968 (2).

Table 2 Kotcho/Bulla Dishes of Wolayta and Sidama Areas and Types of Protein Sources

| Area | Name of Dish | Type | Protein and Other Nutrient Supplements |
|---|---|---|---|
| **Wolayta** | Bachira | Stif porridge | Milk, butter |
| | Mucho | Shredded, flake | Milk, butter, fenugreek |
| | Godetta | Thin bread | Cheese, meat, milk, butter |
| | Bulla Genfo | Porridge | Milk, butter |
| **Sidama** | Chuka | Flake type | Butter, milk, kale, meat |
| | Shirko | Porridge | Butter, milk |
| | Omolcho | Sandwich type | Beans, meat, kale |
| | Duame | Wrapped and baked | Butter, beans, meat, kale |
| | Torocho | Dry thin bread | Meat, milk, beans, kale |
| | Buluko | Gruel | Milk, butter, fenugreek |

## THE PROCESSING OF "ENSET"

The planting and transplanting of "enset" is carried out by men. "Enset" harvesting and processing is the responsibility of women. The harvesting and processing of "enset" for extracting edible and non-edible parts is probably one of the most cumbersome household responsibilities women in enset-culture areas have to carry out. Information gathered from women in two "enset" culture areas of Wolayta and Sidama indicates that the processing of "enset" is the most laborious household activity. The strategy used by women in these areas to reduce the work load is to have a labour pool support system which they call Hasa. Small groups of women assist a fellow woman in processing her "enset". The assistance could be free, with payment or in return of labour whenever the woman processes her "enset" (7). Though the house wife gets assistance from the neighbours, the entire responsibility relies on her. The survey done in Wolayta area indicates that 86% of the household "enset" processing is done by the wife and another 14% is contributed by neighbours.

Figure 3 Share of Labour in "Enset" Processing in Wolayta Area

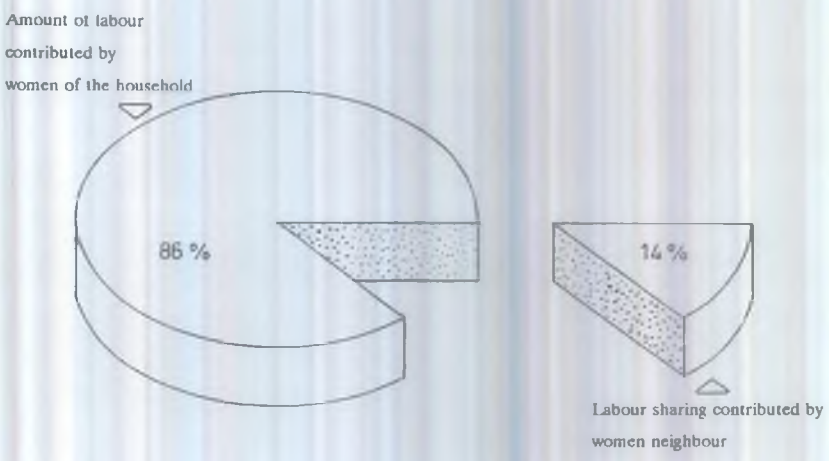
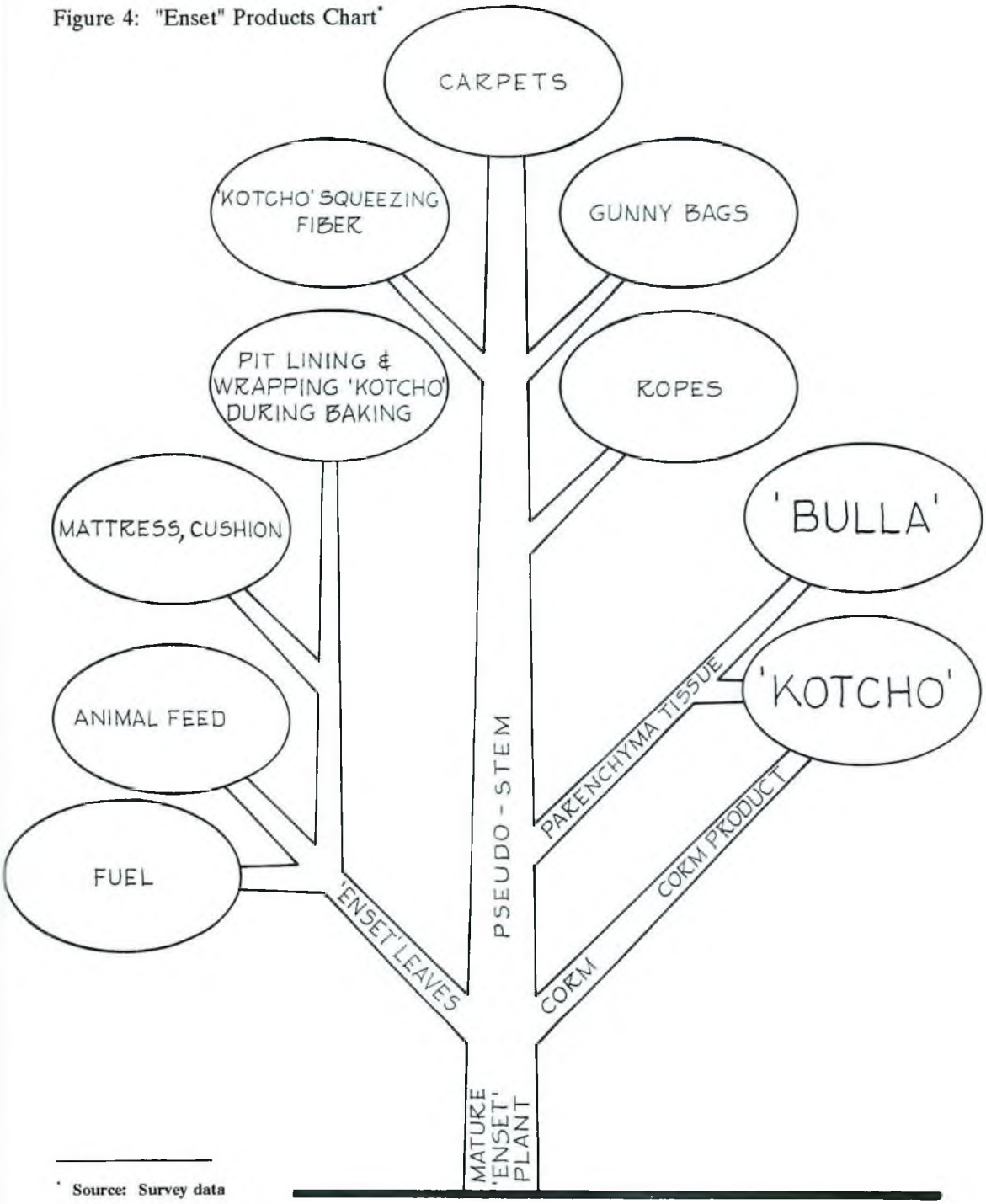


Figure 4: "Enset" Products Chart*




* Source: Survey data

## OBJECTIVES

Lack of labour and time-saving device is one of the major difficulties which especially rural women are facing in performing their day to day activities (3). The non-availability of improved devices, which contribute for saving time and energy does not affect agricultural production only, but also the well-being and health of family members too. Bosurp, cited by Wudnesh has also stated that when women's time and energy is devoted to heavy work load, less attention is given to child care and family feeding responsibilities (13).

"Enset" (Enset vetricosum), which is the main source of food for densely populated areas of Sidamo, Illubabor, Keffa and some parts of Shoa is also a type of food source which demands labour intensive processing carried out by women. Unlike the milling of cereals, "enset" has to pass though different processing stages (decortication, pulverization, shredding, fermentation and squeezing) to be ready for human consumption. In addition, the few studies conducted on "enset" plant are directed to its production aspect only, and does not integrate the processing aspect which adds heavy work load on women beside other household and social responsibilities. Thus the project on the study of "enset" processing and development of processing tools needed to decorticate, pulverise, squeeze, knead and shred, was started with the main objectives of producing equipments that are:

a. Integrated in one device to the extent possible
b. Relatively compact and long lasting
c. Convenient and easy to operate
d. Efficient
e. Safe and hygienic
f. Not affecting the traditional "Kotcho" taste and consistency
g. Inexpensive and simple to manufacture locally

## MATERIALS AND METHODS

Considering these objectives the aim was to find and adopt an acceptable technical solution that deals with the multi-operational nature of the processing of "enset" based on the outlined parameters. The quality of the end result in the attainment of these objectives,

however, is dependent on the following conditions:

i. Existing skill of local operators in the processing of "enset".

ii. Extent of the availability of local raw materials needed for the construction of equipments.

iii. Existing local craftsmanship which can be employed in carrying out the proposed project using local materials.

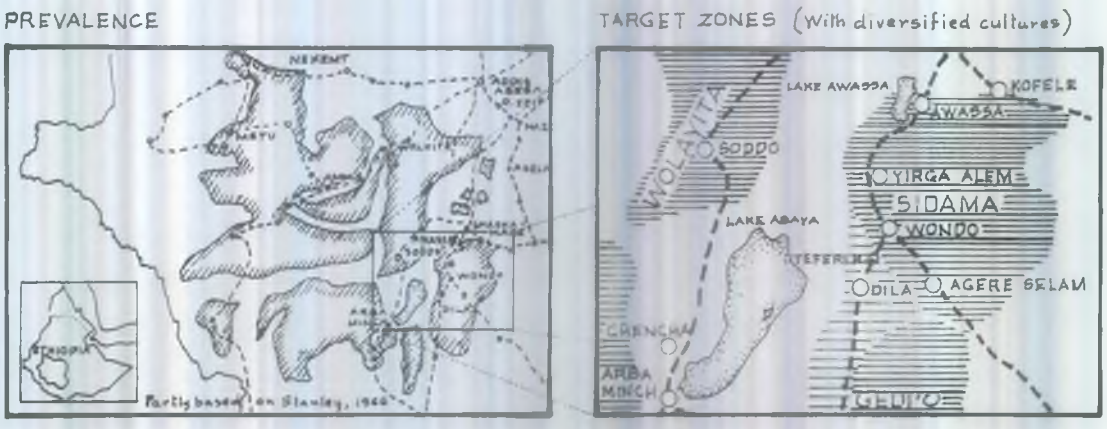
As mentioned in the first pre-condition, it would be counter productive to introduce changes in the established processing customs of the women operators at this stage, unless it is clearly recognized that part or all of the existing practices were found not to conform with the outlined objectives. Therefore, where traditional methods were known to be effective, no effort would be made to improve them. Besides, such changes could be rarely applied without incurring additional expenses and thus undermining one of the basic objectives of keeping the costs of the equipments within the range of affordability.

**AREAS OF INVESTIGATION**

Owing to the time and budget constraints, it was decided to confine the investigation sites within a radius of less than two hundred Km. from Awassa, from where trips could be made to inspect, evaluate and test the traditional as well as the improved methods of "enset" processing.

To the extent possible, the outcome of the research was also intended to benefit more than one "enset" tradition tribes with diversified cultures. Within the "enset" producing zones (Fig 5), it was possible to identify two major tribal areas that are easily accessible from the main highways and are near to Awassa town. These are, the sidāma tribe, extending from Awassa to the South and up to Teferikela and the Wolayta tribe west of Awassa, whose settlement zone is spread around Sodo town.

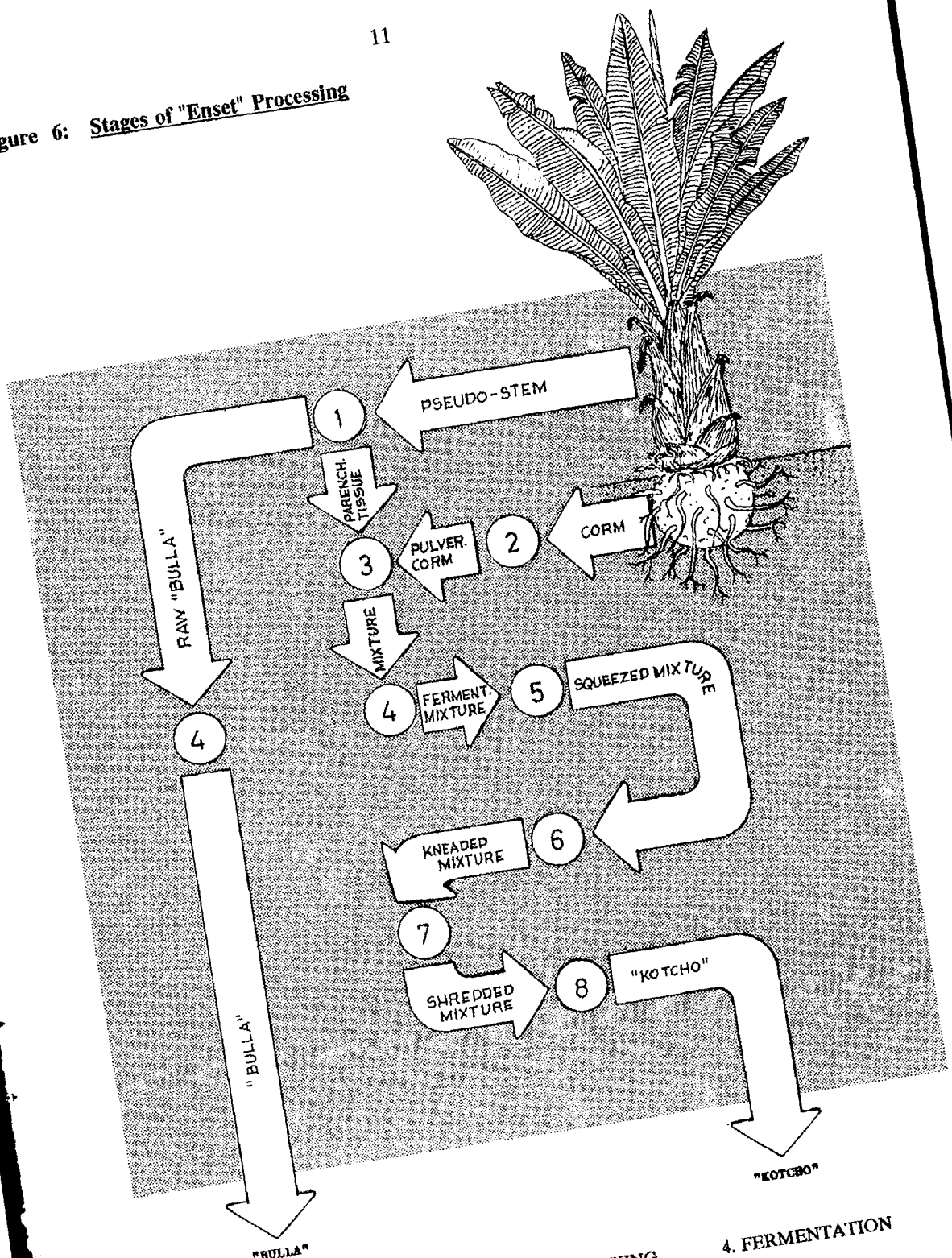
Figure 5: Location Maps of "Enset" Growing Zones




## PRELIMINARY OBSERVATIONS

In this project, it was necessary for the investigators to get a first hand information of "enset" processing activities that employ the local traditional processing tools. Thus, arrangements were made to visit some households in the two different "enset" growing zones. In both the Sidama and Wolayta zones "enset" processing involves decortication of the pseudostem to extract parenchyma tissues and the liquid, pulverization of the corm, and fermentation of the mixture of both the parenchyma tissues and corm product (Fig 6). Squeezing of the fermented mixture follows to get rid of excess liquid and to produce the moist "kotcho" powder.

**Figure 6: Stages of "Enset" Processing**




1. DECORTICATION
2. PULVERIZATION
3. MIXING
4. FERMENTATION
5. SQUEEZING
6. KNEADING
7. SHREDDING
8. SIFTING

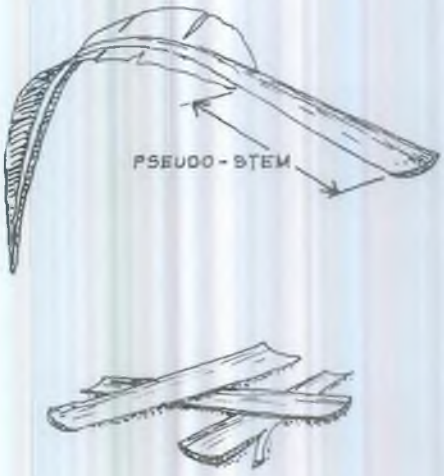
## TRADITIONAL "ENSET" PROCESSING IN THE SIDAMA AREA

### Pit Preparation

Fig. 7 "Enset" decortication pit

The primary job of "enset" food product preparation in the Sidama area starts with the digging of a pit in the ground near a sturdy tree, then a flexible pseudostem of the "enset" plant is placed to cover the soil. Broad "enset" leaves are lined in the pit over the flexible "enset" bark (Fig 7). The purpose of the leaves is to collect and prevent the juicy part from leaking into the ground while keeping scraped pseudostem clean. Using the same pit, half of it is arranged in a way to allow the juicy part to flow down gently and accumulate separately. A long rectangular board is placed on the leaves in the pit and is secured with "woficho" string.

Fig. 8 Edible pseudostem ready for decortication




### Cutting and digging out of "enset" plant

The thick dry outer bark of the "enset" plant are removed. After the first thin lining of the bark are discarded, layers of the pseudostem are removed and readied for scraping (Fig. 8).

### Decortication

A single pseudostem is secured on the wooden pole with "woficho" string. Using a bamboo split, the woman from a strenuous sitting position scrapes the fleshy part of the pseudostem down towards the pit. She secures the pseudostem on the board by raising one leg and pressing it with her heel so that the stem will not slip down (Fig. 9). This process leaves the fiber in the stem.

Fig. 9 Decortication practice in Sidama


The other half of the scrapped pseudostem is also turned upside down, and the stem is secured with the fiber extracted from the first scraping.

This processing separates the fleshy part of the pseudostem from the fiber (about 1 meter and 10 cm in length) while letting the juice flow down in the pit lined with "enset" leaves. After a short while the juicy part sediments into a moist sticky substance known as "bulla". Usually the clear solution on the "bulla" sediment is discarded. The remaining thick sticky white substance, "bulla", is spread in order to be dehydrated. Later on, a handful of "bulla" is wrapped with fresh "enset" leaves and tied with "woficho" string in order to be fermented. Care is taken not to expose the "bulla" to air and light in order to avoid an unwanted color change, i.e., white "bulla" has more market value than non-white "bulla".

Fig. 10 Pulverization practice in Sidama


**Pulverization**

Using a local digging hoe, the corm (root part) is dug out and transported to where the pseudostem is processed. A serrated animal bone (scapula) is used to pulverize the corm (Fig. 10). This process turns the corm into smaller grated pieces which have to be kept aside in order to be mixed with the fleshy scraped pseudostem.

Fig. 11 Burying the mixture of Parenchyma tissue and corm mixture for fermentation


Fig. 12 "Kotcho" squeezing practice in Sidama


**Burying**

The squeezed mixture (pulverized corm and decorticated stem) is buried in a pit lined with "enset" leaves (Fig. 11). A pre-fermented pseudostem base us also added as a starterto initiate the fermentation of the mixture. Just as possession of cattle represents wealth for the pastoral people, having more fermented "kotcho" pits is also taken as a symbol of wealth in the "enset" culture areas.

**Squeezing, Shredding and Sifting**

A handful of the fermented pseudostem and the pulverized corm mixture is wrapped with "enset" fiber (katcha). The wrapped mixture is placed on a pointed cone-shape piece of wood, and the woman presses it with her knees by rotating the wrapped mixture into different directions ( Fig. 12). This process squeezes out the unwanted liquid part. The semi-dry food mixture is finely chopped on a wooden board with a local knife. The purpose of this process is to chop the remaining fiber in the feed mixture as finely as possible. Finally the "kotcho" is sifted using a local sieve. This method allows the "kotcho" powder to pass through the sieve separating it from unwanted fibrous part.

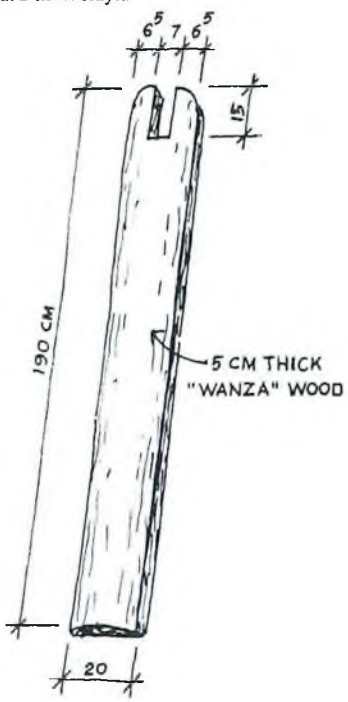
## "ENSET" PROCESSING IN THE WOLAYITA AREA

**Selection of "enset" tree for food processing**

To be considered for processing the "enset" tree must be mature. The sign of its maturity is usually the flowering stage. In addition, when the height of the stem reaches about 190 cm and the diameter at the base is around 65 cm, the tree is said to be mature enough for the processing (Fig. 13)

Fig. 13 Decortication pit

Fig. 14 "Wanza" decortication board in Wolayta




**Preparation and fixing of the stem processing equipments**

Because there are normally no vertical structures in the "enset" yard where the food processing takes place, one of the "enset" trees is used as a support for the decortication board during the removal of the parenchyma tissues from the pseudostem. At the foot of this tree a pit with a diameter of 80 cm and a depth of about 25 cm is dug by first chopping all the soft roots that sprout from the tree, using a local forked hoe and knife. Semi-dry "enset" leaves are gently folded and curved around the lateral side of the hole, totally covering the surface and extending about 20 cm above the ground. The leaves are tied together at intervals to form a bottomless cylinder. The bare bottom ground as well as the side of the pit is then entirely covered by criss-crossing fresh leaves. Another layer of mature, tougher and brownish leaves is finally laid on top of all the previous leaves.

In the Wolayta zone, it is customary to use a decorticating board of roughly 20 x 190 cm "Cordia Africana" ("wanza") wood with a 15 cm forked end (Fig. 14). This board is placed in the leaf covered pit on one end and made to rest on its forked end on the upper part of the tree. The inclination of the board (20 - 25$^0$) thus created is generally acceptable for the operation. Its upper end is then securely tied to the tree using strips of the semi-dry stem fibers known as "woficho".

Fig. 15: Bamboo scraper in Wolayta

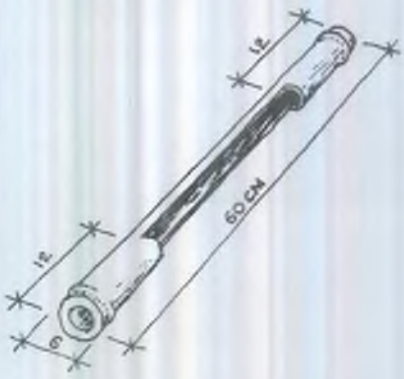



Fig. 16: Pseudostem being prepared for decortication

Fig. 17: Decortication practice in Wolayta

For scraping the parenchyma tissues from the plant's pseudostems, a devised bamboo rod of 5 - 6 cm in diameter and 50 - 60 cm in length is used. Half of the middle section of the hollow rod is removed leaving two end handles and a scraper in the middle (Fig. 15).

**Pseudostem Processing Operation**

The outer semi-dry stems of the selected trees to be processed are cut at their bases and disposed of. The fresh light green and fleshy stems that are immediately visible are served from the tree and their leaves cut to leave about 100 cm long stems ready for decortication (Fig 16).

Decortication of the "enset", through the local method, in principle requires scraping of the fleshy part of the plant while resting the stem against the wooden board and securing its upper end with fibers. About 30 cm of the upper part of the stem folds over the fiber string to ensure tightness during decortication.

The removal of the parenchyma tissues begins when the operator, customarily a woman, who while standing (Fig. 17) holds the bamboo scraper with her hands on each end, presses the sharp edge on the stem and drags it downwards scraping off the fleshy part of plant into the pit. The process is repeated until the soft tissue is completely removed from the lower half of the stem leaving the white fibers only. By exchanging the position of the unprocessed and that of the scraped end of the stem and using its fibers to tie it to the board string, this opposite end of the stem is then decorticated in the

same manner as the first half. The last greenish layer of the scraped tissue, which is markedly different from the upper white tissue, does not seem to be favored by the operator and is normally discarded from the fermentable portion each time a stem is decorticated. In fact, its removal is necessary only to make use of the freed fibers.

The operation continues until all the pseudostems of the tree are decorticated (Fig. 18). To facilitate easy scraping of the tissue from the fiber, the lower part of the stem resting on the board is slashed along the narrow side with a series of cuts using the bamboo scraper. The fibers that are severed along with the parenchyma tissue into the pit are then picked out and disposed of.

Fig. 18: Decorticated parencyma tissue

When the operator feels that the accumulated parenchyma tissue in the leaf covered pit below is too chunky, she chops the stuff with a stick until it is satisfactorily broken down into tiny pieces.

The operator is frequently observed sharpening the bamboo scraper during the entire operation.

The average time required to pick a stem of usually about 100 cm length, twice tie and untie it to the board, provide a series of notches, decorticate it and pick out the undesirable fibers from the accumulated tissue in the pit is about 2 minutes and 50 seconds.

Fig. 19 Extraction of "Itma" in Wolayta

**Extraction of the liquid food from the parenchyma tissue**

"Itma", by which the milky liquid food is known in Wolayta, is extracted by sqeezing it out from the accumulated mass of parenchyma tissue. With bare cleaned feet, the operator repeatedly steps on the juicy food stuff placed under "enset" leaves to squeeze out the liquid. During the operation, the "itma" iq channelled from the fleshy tissue to a collection pot through an inclined "enset" leaf resting on the ground (Fig. 19).

When the "itma" is for some time left in the pot, its fine and slimy white substance settles to the bottom of the container. The white stuff, which is considered as an "enset" food specialty is separated from the clear liquid above it and left wrapped from one to four days to ferment before it is ready for consumption.

**"Enset" corm processing operation**

Once all the psudostems are cut from the tree and decorticated, the operator proceeds with the task of pulverizing the chunky root of the tree known as the corm.

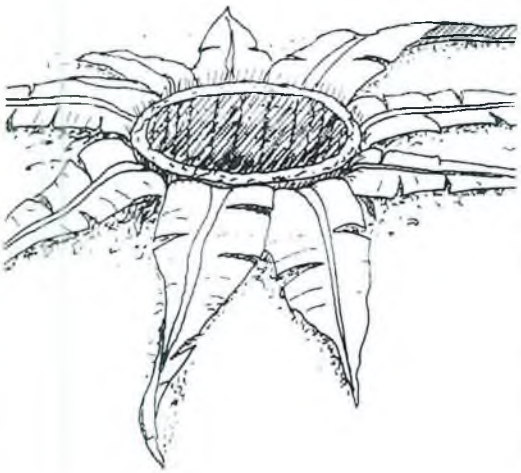
The tree, now left only with the core stem and some leaves on top, is cut and reduced to a height of about 120 cm. Some outer semi-dry stems not yet severed from the lower part of the tree are spread out in all directions without being detached from their bases and the remaining part of the stems are cut right above the corm.

Fig. 20: Pulverization of corm in Wolayta

With its roots still in the ground, the corm is pounded on its top (Fig. 20) using a wooden pole of 8cm (dia) x 100cm (length). With each pounding, the teeth of the serrated end of the pole chops the substance in the middle of the corm. As pulverization advances, a cavity is skillfully created with the outer walls of the corm still intact. Under these circumstances the operator continues to pound until she reaches the bottom of the edible root.

The mouth of the corm cavity is further enlarged by cutting its rim and placing the material inside the hollow space to be pounded along with the already chopped material.

Fig. 21: Preparation of corm cavity before spices are applied



When the desired quality is achieved, the cavity is emptied of the pulverized corm, which is temporarily placed in a clay pot. Some of the pseudostems (excluding the core stem), that are cut last to give way for pulverizing the corm, are shredded and put in the cavity. Pounding follows until the material is finely ground.

Once again the product is removed and the empty corm cavity is serrated from inside with a local knife (Fig. 21).

Operators say that a cavity is more hygienic for meshing the "enset" food than a wooden mortar, which often requires thorough cleaning before use.

The healthy parts of twelve local spices are shredded, placed inside the cavity, pounded and rubbed with a hand against the internal serrated wall.

In the Wolayta area, the local names of these starter spices are: "shuko", "hireyo", "waro", "dal'isa", "gemako" (king of spices), "zemo", "chechiwa", "setiwa", "ayidame", "koseret", "zeli'amta" and "fura" (rotten "enset" bark).

Some of the processed corm and stem products that were removed earlier are placed back into the cavity. Pounding begins over the small quantity of product and continues as more and more of the materials are poured into the cavity until it is filled to the brim.

Fig. 22: Parenchyma and corm mixture placed and shut inside corm cavity

Since the "enset" food stuff inside the cavity is expected to settle with fermentation, some more of the product is heaped at the top before it is tightly shut off from air and water.

Fresh "enset' are wound on the crown of the overfilled corm cavity to totally cover the protrusion of the food stuff. The semi-dry leaves once left spread on the ground, but still attached to the base of the corm, are lifted and effectively used as a second cover and moreover they firmly tie the first fresh leaf cover to the corm (Fig. 22). As a further precautionary measure, additional "enset" leaves are placed on top of the wound up corm to shed away any rain water that might fall and penetrate into the laboriously produced food product.

**Squeezing of fermented mixture of parenchyma tissue and pulverized corm**

Two to three weeks after it is neatly stored, the food stuff is considered as fermented and ready for the final process.

Fig. 23: Squeezing through fiber band wringing in Wolayta

A batch about 600 g is picked by hand and placed in the middle of a dry "enset" fiber band which is about one meter in length. The fiber is folded lengthwise until it completely covers the food stuff and with two operators at both ends vigorously wringing the strip, the liquid is squeezed out until no more of it comes out (Fig. 23).

As a result of squeezing, a moist fibrous "kotcho" is produced, which, on a wooden tray, is collected, kneaded (Fig. 24) and shredded with the local knife like green 25: vegetables (Fig. 25). The shredding process is believed to cut to tiny pieces the fibers that escape into the food stuff during decortication.

Fig. 24: Kneading of "kotcho"

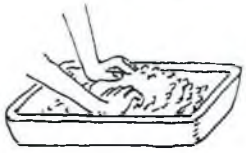
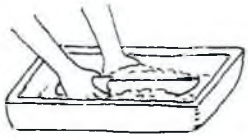


Fig. Shreading of "kotcho"



Following sifting to get rid of the fibers (Fig. 26), a finer powdery substance is produced which is the end result of the series of processes aimed at producing the food.

Fig. 26: Sifting of "kotcho"

**Table: 3:** Name of "Enset" Processing Tools and Estimated Cost

| Name of Tool | Use | Cost (Birr) |
|---|---|---|
| Wooden tray | Tray for kneading, shredding and sifting | 10.00 |
| Kincho (pointed wood) | Squeezing | 3.00 |
| Meta (flat pole) | Decortication | 1.00 |
| Sisicho (saw tootled metal) | Scraping | 3.00 |
| Kem (scapula) | Pulverizing | 0.25 |
| Shole (big knife) | Cutting "enset" plant | 4.00 |
| Worme (smaller knife) | Shredding | 2.00 |
| Memo (sieve) | Sifting | 2.00 |
| Hanticho (fiber) | Squeezing | 0.10 |

## SOME PHYSICAL CHARACTERISTICS OF "KOTCHO"

It was believed that establishing the contents and some physical characteristics of "kotcho" beforehand would facilitate any attempt in improving the design of the processing equipments.

Therefore, the food stuff was subjected to a series of laboratory tests to establish the force required to extract the optimum amount of liquid from a given quantity of fermented "kotcho' and the maximum depression of the dough under such force. The tests carried out in the lab used fermented dough from some localities under investigation.

The equipment used was an arbitrary hollow steel cylinder of 50.7mm in diameter (with a closed bottom) and with 3 mm holes drilled in grid, having distances of 15 mm between centers of holes, on the entire lateral surface. In each test the cylinder was filled with fermented "kotcho". Its volume was 88.8cm$^3$.

A serrated end shaft slightly less in diameter than the cylinder was placed on top of the dough and subjected to a gradually increasing force for two minutes while it was being vigorously rotated clockwise and counter-clockwise by hand as it compressed the "kotcho", to achieve maximum extraction of the liquid. The minimum force required to achieve the maximum depression was 40KN.

Consequently, analysis of the sample to establish some physical characteristics that may be essential for the work was carried out and the results were as tabulated below. For easier reference the volume of the "kotcho" was increased to $1000cm^3$ and the commensurate weight and density were also adopted.

Table 4 Volume, Weight and Density of "Kotcho" Before and After Squeezing

| Food stuff | | Volume ($cm^3$) | Weight (gr) | Density ($gr/cm^3$) | Volume reduced through compression (%) |
|---|---|---|---|---|---|
| "kotcho" fermented for 14 days using traditional method | Before squeezing | 1000.00 | 1136.50 | 1.14 | 0% |
| | After squeezing applying a force of 40KN | 594.50 | 478.60 | 0.81 | 41.5% |

Table 5 Weight Percentage Distribution of 100gr "Kotcho" Elements Before Extraction of Liquid

| "Kotcho" Elements | % |
|---|---|
| Air-dry "kotcho" powder | 32.6% |
| Squeezed liquid extract | 58.0% |
| Moisture in powder before air-drying | 1.2 |
| Dry fiber | 8.2 |

From table 5, two important phenomenon relevant to the investigation were established: The maximum amount of liquid expected to be extracted through a minimum pressure, and the compressibility of the dough expressed in terms of the percentage of the original mass of "kotcho". In Table 2, it can be observed that the amount of liquid extracted is almost twice as heavy as the "kotcho" powder left after squeezing.

It is hoped that the above findings may serve as yardsticks of some of the aspects of the evaluation of the performance as well as the product of any improved "enset" processing equipment

## PAST ATTEMPTS MADE TO IMPROVE "ENSET" PROCESSING EQUIPMENTS

In the late 70s, some institutions initiated improvement of "enset" processing projects in an attempt to up grade or totally change the existing local processing tools in the "enset" culture zones of Ethiopia.

### The Awassa College of Agriculture

The Wood and Metal Workshop of the Agricultural Engineering Technology of the Awassa College of Agriculture made impromptu practical improvements of the decorticating board and its sitting arrangements towards the end of 1978, following some observations of the local tools and processing practices in the immediate rural surroundings of Awassa town.

It was a praiseworthy attempt made to improve the processing tools and ease the extremely straneous processing practices in the rural areas of the Sidama Zone. However, while the decortication board was well placed and its clamping device acceptable, the wooden armchair was not simple enough to be produced by local craftsmen. No attempts were made to produce the remaining equipments that deal with pulverization, squeezing, kneading and shredding.

### Sodo Appropriate Technology Center

The appropriate technology center in Sodo Wolayta has also put its effort for producing tools for "enset" processing. In 1988 the center came up with the first trial "enset" processing tools. A report written in 1992 stated that these devices have advantages and some limitations (5). This indicates the need for continuous improvement of "enset" processing tools.

**Instutute of Agricultural Research (located in the vicinity of Nazareth)**

From the institute's 1984 and 1985 progress report of the Agricultural Implements Research and Improvement Team of the Department of Agricultural Engineering, we understood that the research involved in the improvement of local "enset" processing tools "assumed the national responsibilty for `enset' processing project and attempted in a coordinated manner to develop an appropriate technology that will contribute positively to the problems."

The equipments were being developed by the institute based on the following objectives:

a. "The devices to be developed should be based on locally available row materials."
b. "Rural crftsmen should be able to manufacture, repair and maintain the devices."
c. "Should fulfill the need to individual and community users."
d. "Preserve the usual taste of `kotcho.'
e. "Should be simple and cheap enough to be afforded by `enset' growers."

Accordingly they set out to investigate and produce the following devices:

a. "Enset" stem processing equipment.
    i. Included plank/clamp decorticator
    ii. Horizontal plank/clamp decorticator
    iii. Adjustable rotary blade pulveriser

b. "Enset" corm processing equipment
    i. Gratter/slicer (wood worker jack plane)
    ii. Non-adjustable rotary blade pulveriser
    iii. Adjustable rotary blade pulveriser

c. "Bulla" extraction equipment
    i. Flat board sqeezer
    ii. Bucket type sqeezer

In accessing the performance as well as the practicability of the devices, the IAR maintained in its report that, while the equipment registered some improvements in the convenience of their use, there were some evident draw backs:

a. Decortication
   i. The inclined plank decorticator "was not as efficient as the traditional tool ..."
   ii. The horizontal plank decorticator was causing "very great stresses" "on limited part of the operators' muscles"
   iii. The motorized decrticator was still under development

b. Pulverization
   i. The grater "sliced materials varied in sizes," causing fermentation process to slow followed by some discoloration of food.
   ii. The non-adjustable rotary blade pulverizer "lacked adjustable clamping mechanism to accommodate various sizes and configuration of enset corm."
   iii. The adjustable rotary blade pulverizer needed "extensive field testing for its social and economical suitability." although technically the problem of enset corm processing is more or less solved."

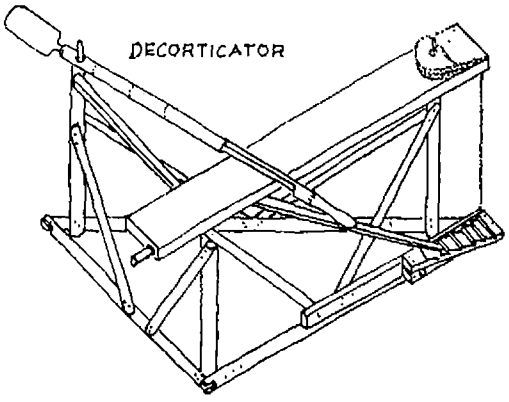
c. "Bulla" extractors
   i. The flat board squeezer "lacked sufficient mechanical strength to do the intended job and as a result it was discarded immediately.
   ii. The bucket type squeezer "was found to be efficient ... but field testing and evaluation will continue for its social and economic soundness."

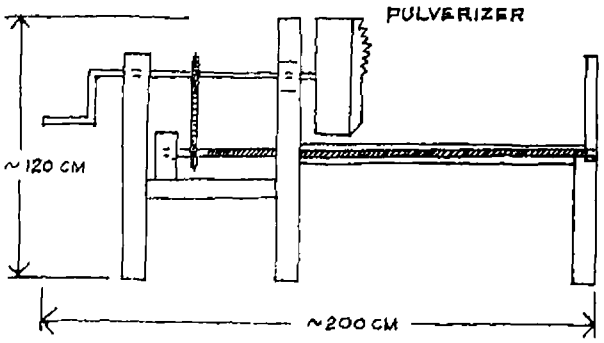
There were no further reports of improvement and evaluation on the devices on the subsequent IAR progress report.

The institute has done a commendable job in figuring out the problems encountered in "enset" processing. It also came up, for the first time, with devices that will deal with the processing of the raw food stuff in an effort to reduce the intensive labour that women in rural area are undertaking.

However in the construction of some of the devices, objectives "a". "b" and "e" do not seem to have been strictly adhered to. For example, the installaion of over one meter of threaded bar the sprocket wheel and chains, the steel cranking shafts and cutting wheel of the "enset" corm pulverizer is far beyond the means of the average peasant to "afford", not to mention the huge space (200 x 60cm) the machine takes in the humble grass hut dwelling, only to perform one of the three major tasks of processing. The materials, therefore, were neither "locally available" nor could the said "Rural craftsmen... manufacture, repair and maintain the devices."

Some of the available illustrations of the devices produced by the IAR are shown below (Fig. 27 - 29).




## BRIEF SURVEY OF POSSIBLE EXISTING MECHANICAL METHODS OF PROCESSING FIBROUS PLANT PSEUDOSTEMS AND CORMS

### Decortication of Pseudostems

In principle the parenchyma tissue can be mechanically removed from the fibrous stem by:

a. scraping through a reciprocating motion
b. scraping through a rotary motion
c. smashing or hammering it against a hard surface

In assessing the above methods, with the aim of employing them in the rural areas, and based on the parameters set out at the beginning of this study, the following pros and cons were identified:

a. **Scraping through a reciprocating motion**

Schematic concept: Resting the stem against a board and scraping. (Fig. 30)

Fig. 30: Scraping through a reciprocating motion

**Advantages:**

i. traditional practice of local population
ii. easy to operate
iii. inexpensive
iv. safe to operate
v. simple to produce the equipment through local craftsmen
vi. local materials can be used to produce the equipment
vii. practically no maintenance is required
viii. simple to store
ix. quality of decortication could easily be checked at any time

**Disadvantages:**

i. too much energy exerted and time wasted to produce comparatively small quantity of end product

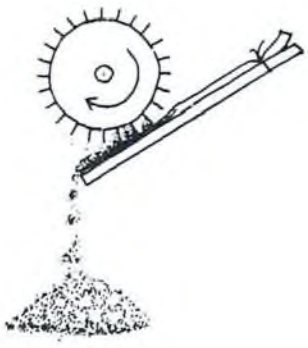
ii. fixing the end of each stem before decortication is found to be cumbersome

iii. hygienic and efficient collectors of product need to be installed

b. **Scraping though a rotary motion**

Schematic concept: Applying a rotating scraper on the fixed stems (Fig. 31).

Fig. 31. Scraping through rotary motion



**Advantages:**

i. may be faster for decortication

ii. time saver and efficient if motorized for large quantities of stem, as already observed in sisal factories.

**Disadvantages**

i. does not conform with local practice

ii. expensive

iii. can not be produced through local artisans

iv. may not be produced using local materials

v. may not be easily maintained by the rural operators

vi. not safe to operate with young children around

vii. requires more power to manually operate

viii. takes more time to clean after and before use

ix. would be more easily damaged or corroded if not properly stored in rural environments

x. would be very difficult to find energy source and operate it in the rural area

c. **Smashing or hammering against a hard surface**

Schematic concept: Fixing several stems to a wheel and letting it rotate at high speed to smash them against a fixed flat surface (Fig. 32).

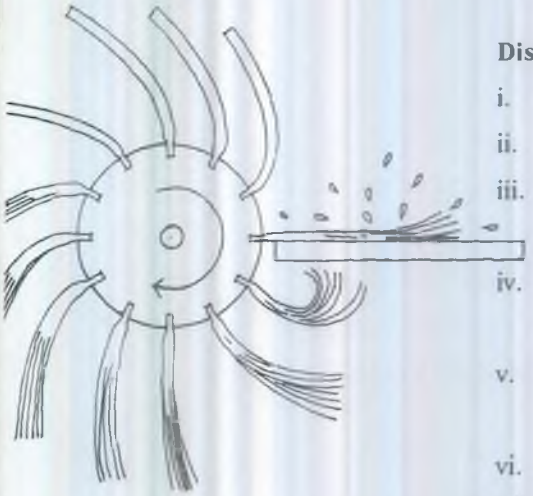


Fig. 32: Smashing against hard surface

**Advantages:**

may be time saver and efficient if motorized

**Disadvantages:**

i. does not conform with local practice
ii. expensive
iii. it may not be possible for the main body, being metal, to be produced by local craftsmen
iv. may not be hygienic if a local material such as wood is used
v. there may be too many moving parts in the device
vi. not easy to maintain
vii. too many stem fixing devices would be needed
viii. takes more time to clean after and before use
ix. too bulky to store

Considering this background information on the possible systems of freeing parenchyma tissue from the fibers, it is all too clear that scraping through reciprocating movement stands out as the most viable method for adoption in equipment design for the rural population at this point in time.

In this connection it is proposed that, during the processing, the parenchyma tissue can be collected on a local grain sieve placed on top of a pot. It can then be pressed by hand to free the white "bulla" from the fleshy substance. The "bulla" collected in the pot and the parenchyma tissue are usually stored separately for a subsequent fermentation process.

**Pulverization of the corm**

Again, there are only two main methods to consider in grating the corm into tiny pieces: Maneuver tools to a) move back and forth or up and down b) rotate.

A reciprocating tool pulveriser was found to be simpler to make, less expensive, safe to operate and in conformity with the local practice. But, if motorized and safety could be observed during operation, a rotary pulveriser would be much more efficient and easier to operate. Of course, the high cost is the one thing that always becomes a hinderance to the acceptability of such a tool by the rural population.

## IMPROVEMENT OR ADOPTION OF EXISTING METHODS OF FERMENTATION, SQUEEZING, KNEADING, SHREDDING AND SIFTING

### Fermentation

Fermentation of the "kotcho", to the satisfaction of the consumer, occurs in no less that 14 days.

The fresh mixture of parenchyma tissue and pulverized corm is thightly covered and is entirely shut away from air and water for the whole period of fermentation. To do this, the investigators recommend the use of some wide mouthed clay pots with lids and small perforations at the bottom to ooze the excess liquids.

The "kotcho" could be wrapped tightly with "enset" leaves and placed in the pots. Care should be exercised so that the pots are filled to the brim to avoid or lessen the air pockets created between the wrapped "kotcho" and the internal surface of the pots and their lids.

The closed pots with their contents could be buried about 20cm below the ground surface or stuffed with leaves, tightly closed and shelved to ensure adequate insulation during the process of fermentation. Similarly, the accumulated "bulla" could also be tightly closed in smaller pots and stored for the designated period of fermentation.

### Squeezing

Traditional practice demands that some of the liquid in the fermented mixture of parenchyma tissue and pulverized corm has to somehow be removed before consumption.

If a mechanical means is employed without drying the dough and also not affecting its traditional taste, one is left with only two alternatives:

a) exposing the "kotcho" to centerfugal force

b) confining the food stuff in a perforated container and applying pressure

Contempleting on the application of centerfugal force as a means of extracting the liquid from the dough, would be too unrealistic to consider at the moment. The cost of the material and the know-how needed to build the machine would make it unaffordable to the peasant population. Besides, the operation, storage and maintenance of a centerfugal liquid extrating mechanism would, at present, be too complicated to be handled by villagers. The lack of hygienic handling of the equipment in the rural environment could not also be underrated.

Therefore, the investigators were left with the option of using the principle of compression as a viable solution of freeing the liquid from the dough.

Two types of squeezers were selected for adoption, pending the outcome of the assessment of their performance and practicability:

a) confining the sample inside a perforated cup and applying a pressure on the open end.

b) wrapping the food stuff with a loosely knit fiber band and wringing the cloth from the two ends until the liquid is removed to an acceptable degree.

The maximum amout of liquid which could be extracted through a compressive force from a given quantity of "kotcho" has already been established. Consequently, it was realized that the amount of this liquid which can be squeezed out using the traditional method is about 70% of laboratory extracted liquid. Hence, any improved squeezer should not extract more liquid than that of the local devices which are already in use.

**Kneading, shredding and sifting**

Kneading shredding and sifting are subsequent processes in the final stages of the production of the edible part of "enset". Short of motorizing these processes, kneading is done manually on a tray and can be followed by randomly shredding the escaped fibers in the "kotcho" powder against the base of the tray using a sharp knife. Once the fibers are satisfactorily shredded to pieces, the slightly moist "kotcho" can be sifted with a sieve to get rid of the fibers. In the production of simple and inexpensive equipments, the above three traditional practices can be considered for adoption.

## ADOPTION OF A CONFIGURATION OF "ENSET" PROCESSING CONCEPTS

Based on the analysis made earlier on the various methods of processing, equipment concepts were formulated and integrated in some combinations in an effort to arrive at a solution which most conforms with the objectives set out at the beginning of this study.

While the traditional method of removing the parenchyma tissue from the stem was found to be effective, safe and inexpensive and therefore adopted, the inclined board was necessarily elevated to give way for a comfortable sitting arrangement.

Two more processing options can be incorporated on the same board: Corm pulveriser chamber on one side, and a fermented "kotcho" kneading and sifting tray on the other. Shredding of the corm could be performed using a serrated hand grater.

A squeezer designed to extract the fermented "kotcho" dough could be attached to a lever that is connected to and manipulated by the seat. A simpler design that employs wringing of "kotcho" wrapped in fiber band to get rid of the excess moisture (as applied in cloth laundry) could be adopted as an alternative.

A number of configurations of the conceptual components of the equipment, with regards to their formation were first considered (Fig. 33) before one was opted for on the basis of the simplicity of its structure, efficiency and convenience.

**Fig. 33: FOUR CONFIGURATIONS OF THE CONCEPTUAL COMPONENT**

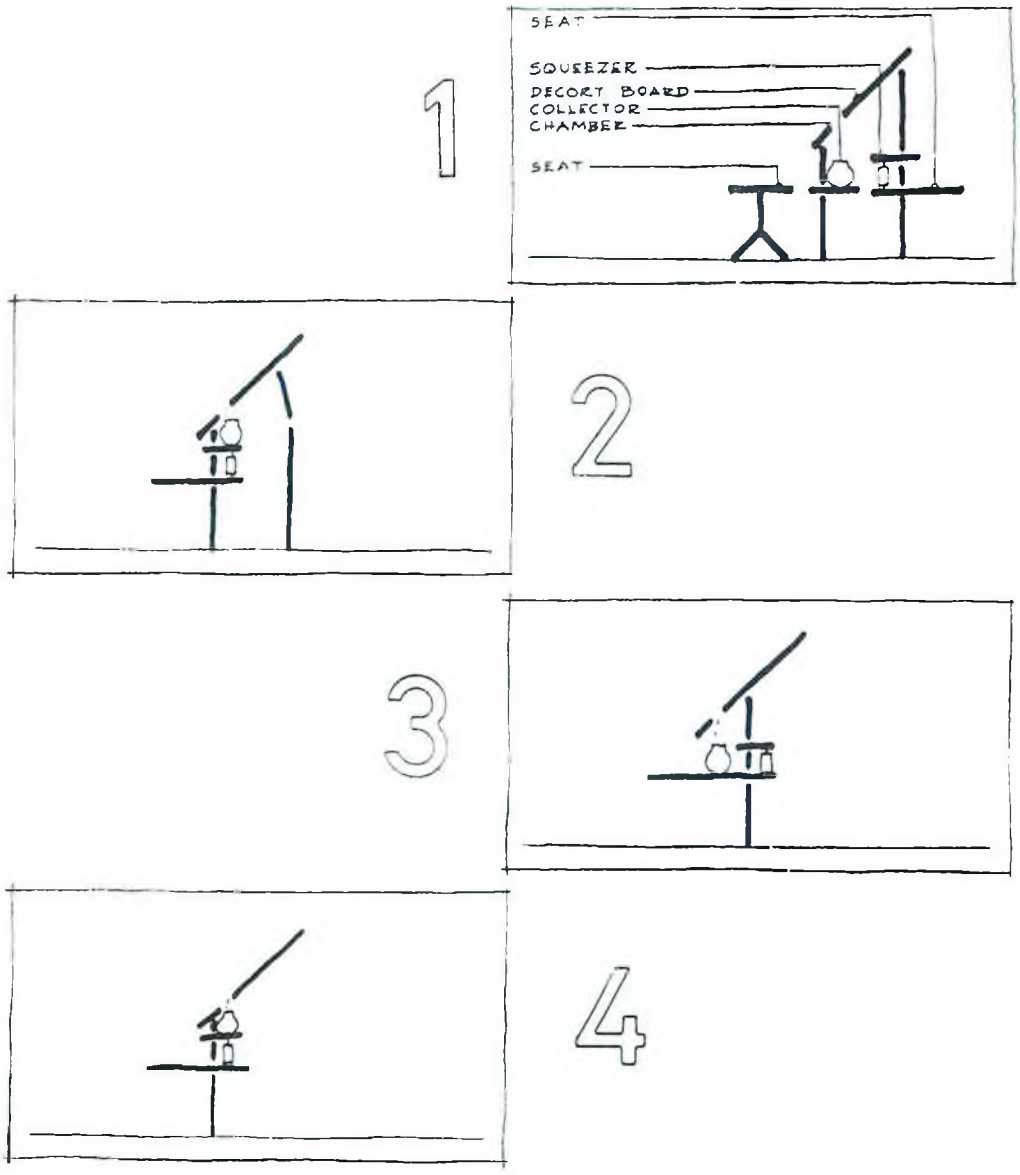


TABLE 6 Analysis of the Suitabilities of the Four Suggested Processing Concepts of "Enset"

| No. | ADJUSTABILITY OF DECORT. BOARD ANGLE | SITTING ARRANGEMENT | POSITION OF PROCESSED PARENCHYMA TISSUE AND CORM COLLECTOR | LOCATION OF PULVERIZING CHAMBER | SQUEEZER LOCATION |
|---|---|---|---|---|---|
| 1. | No possibility to adjust board | Not connected to the main body of the equipment | Ideal location, but requires its own supporting lever | Ideal location | Additional lever seat required |
| 2. | Can be adjusted, but requires additional support system | Fore-post can be used as the only support for the board and the seat | Same as in No. 1 | Same as in No. 1 | Leverage of seat ideally utilized for squeezing |
| 3. | Can be adjusted and needs only one vertical supporting structure but design of connection detail may be complicated | Same as in No. 2, but requires longer seat lever to connect to the post | Ideal location, seat lever can also be used as supporting structure of collector | Same as in No. 1 | Same as in No. 2 |
| 4. | Can be adjusted and needs only one vertical supporting structure. One more advantage: design of connection detail could be simpler | Same as in No. 2 | Same as in No. 1 | Same as in No. 1 | Same as in No. 2 |

Assuming the adoption of the above concepts and, if squeezing is to be performed through the seat lever pressure on the "kotcho" filled cup attached to the end of the rod, (Fig. 33) concept No. 3 would be opted for pending the successful outcome of the board and the fore-post design connection detail.

If, however, fiber wrapping and wringing of the "kotcho" is to be adopted, concept No. 4 would be more viable since the "kotcho" cup squeezer would be eliminated. This facilitates the planned attachment of the parenchyma tissue and pulverized corm collector to sit on the projected seat lever without requiring its own supporting structure.

## PREPARATION OF PRE-DESIGN MEASURING EQUIPMENTS FOR FIELD TESTS

### Adjustable "enset" decortication board

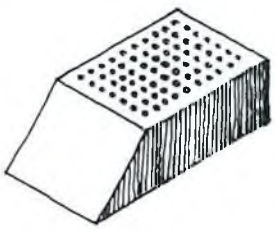
Concept No. 4 being adopted, the length, angle, elevation of the decortication board and the height of the seat from the ground had to be based on the outcome of field tests. Therefore, an adjustable "enset" decortication board and seat (Annex 1) were developed in order to measure the preferred dimensions of each operator of the site. The collection of related information using the form (Annex 2) was planned to help settle the acceptable size of the anticipated improved equipment.

### Corm Pulverizers

Box grater

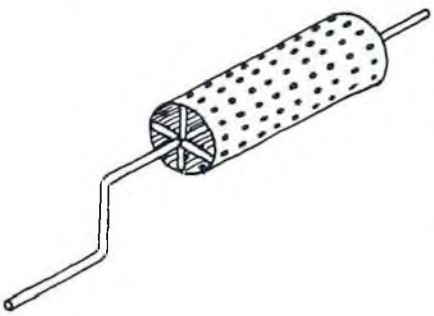
A nail perforated sheet metal box, with the open end facing down (Fig. 34) was used as a grater.

Fig. 34: Box pulverizer



The corm was moved back and forth rubbing against the perforated rough surface. The corm was, however, too heavy to manipulate for rubbing and corm product was darker as a result of staining by the metal. An attempt was also made to use the box as a rubbing tool while holding the corm on a wooden board. It required too much force to rub the corm and at the same time to hold it firmly on one fixed position.

Fig. 35: Cylinderical pulverizer



Rotary Cylinder Grater

A revolving hollow cylinder, made out of nail perforated sheet metal (like a cheese grater) with both ends open and mounted, through its spokes, on a steel shaft (Fig. 35) was made and manually tried if it could pulverize the corm.

It did grate the corm finely as desired, but was immediately clogged and this was followed by metal staining of the slimy substance as a result of trying to force cutting on the corm.

Fig. 36: Rectangular pulverizer

Rectangular Plate Grater

A flat rectangular sheet metal with toothed strips fixed at interval and parallel to the short side and with a handle on the other side (Fig. 36) was tried for pulverization.

It was applied the way a shoe brush would be used. It was too difficult to rub against the corm as there were too many cutting edges. With a few movements the toothed strips were leveled with clogging. When more rubbibg was attempted discoloration began to appear.

Fig. 37: Disc pulverizer

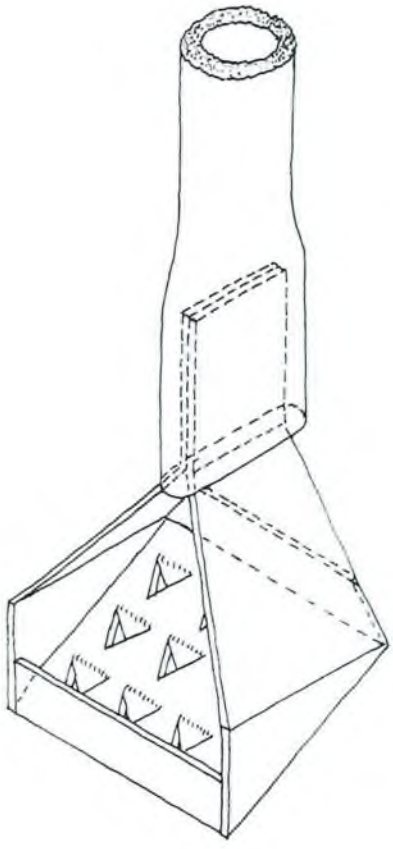
Rotary Disc Grater

A number of toothed strips radially fixed on a horizontal axis rotating sheet metal disc (Fig. 37) were found to be more effective in grating than the three above mentioned devices. However, pulverization was observed to be frequently stopped when the corm was fed into the manually rotating plate beyond the depth of the grating teeth.

When the toothed disc was driven forcefully, resisting the stoppage caused by the corm. discoloration of the product soon became apparent.

The problem of the slimy corm sticking to the disc's saw was still not avoided. The disc size was also observed to determine the strength required to perform the task.

Fig. 38: Vertical handle pulverizer



Vertical Handled Coarse Toothed Grater

It was observed that the hammering action of the local pulverizers on the corm considerably increases the power of grating.

In trying to implement this phenomenon and improve the traditional pulverizers version, a vertical handled grater was devised (Fig. 38). Each triangular tooth on the tool was punched out of the sheet metal base and bent, while still attached to its base. This left a triangular hole on the base which was expected to effectively discharge the slimy and fibery product during the processing.

Although the tool's effectiveness was realized, the draw back was that punching out the coarse teeth out of the sheet metal was not easily carried out in an ordinary metal shop.

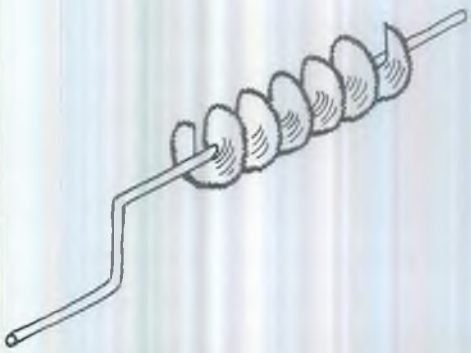
As the product of the above process was much coarser than the corm ground through the traditional method, the production of a pulverizer with finer teeth as a substitute, was attempted in the shop. But it was soon learnt that unless this was made with a special metal punch, it may not be realizable through the ordinary metal shop process.

Nevertheless, this particular tool was later tentatively selected as a field testing pulverizer until a less expensive and equally effective device was produced.

Helical Saw Toothed Grater

In order to avoid frequent contact between the corm and the metal that are not directly involved in the cutting action, which was the cause of discoloration, a toothed helical strip was welded to a shaft and attached to the underside of the decortication board (Fig. 39). It was manually rotated through its crank.

Fig. 39: Helical pulverizer



Consequently, the results were encouraging in that it has succeded in smoothly scraping the corm and producing an acceptable shredded product. At times, non-homogenous lumps originating from inside the corm could be seen escaping the pulverization. This was improved by narrowing the gap between the helical blades in a subsequent trial.

In the last version it was observed that scraping was effctive. But there were two distinct disadvantages:

a) The corm had to be sliced in sizes equal to the small openning at the lower end of the decortication board.

b) A tremendous side pressure was generated, as a result of the helical blade rotating and driving the corm to the side of the wooden openning. This had tended to split the lower end of the decortication board.

## INFORMATION GATHERING ON THE PERFORMANCE OF "ENSET" PROCESSING EQUIPMENTS AND OPERATORS

A randomly selected five households, with well developed "enset" yards, in each of the zones, were made to be involved in assessing the performance of the testing device.

The equipments consisted mainly of an adjustable decortication board and stool (Annex 1). An improved pseudostem scraper, corm pulverizer, "bulla" and "kotcho" fermentation clay pots and squeezer were also included.

In the two trips that were made to each zone, a comparative study of the performance of the local and improved "enset" processing equipments was conducted using a form (Annex 2) which was especially prepared for the purpose. The results of the findings were as follows:

**Decortication of pseudostem**

In both the Wolayta and Sidama Zones, the time the operators took to decorticate pseudostems using the improved testing device was, on the average, lower by 20% than when using the local equipments. But the very great advantage 80% of the operators appreciated was the provision of a comfortable seat. By this arrangement all the women interviewed in Sidama expressed relief of not having to sit on the ground and pressing, with one of their stretched legs, the upper part of the pseudostem against the decortication board until all the stems were decorticated. The instant stem clamping device was also an added advantage in the processing. In like manner, the women in Wolayta, were obliged to stand and lean forward to decorticate during the whole operation. But when interviewed, only 60% supported the provision of seating arrangements.

**Pulverization of corm**

As stated in the preliminary observation, there is a great difference in the local practice of corm pulverization between the two zones. Each of these practices has no doubt, its own advantages over the other. However the investigators used the already improved metalic corm pulverizer, (Annex 3-4) as a viable option. This tool can fairly well be accepted in the zones inspite of their diversified cultures.

A woman operator that favour customary practice such as pounding with a serrated stick in pulverization of corm, rather than using any less expensive and improved pulverizer was encountered once. A few were even expecting factory produced metallic machineries to replace the local equipments. However, the researchers attempted to explain to them the need and advantages of having improved tools which can be made of locally available materials, capable of being produced by local craftsmen, simple to use and economically affordable.

**Preparation of "kotcho" and "bulla" for Fermentation**

There were no fundamental differences between the "kotcho" fermentation method of local and improved method. The problem considered though was whether the households could afford to purchase several huge bottom perforated clay pots only for the purpose of storing "kotcho" during fermentation. But for sanitary consideration, the investigators felt that it was necessary to completely isolate the substance from the foreign materials that tend to penetrate it from the surrounding soil. The dirt in the "enset" yard is largely untidy and frequently observed to be as a natural habitat for various insects. For this reason to place the "kotcho" in the perforated pots was the only alternative found hygienic and feasible by the researchers at the time. There was no change proposed to the cultural practice of placing "bulla" in small pots for fermentation.

**Squeezing of "Kotcho"**

After a two weeks period, all the sites were revisited to evaluate the fermented "kotcho" and carry out the final process of squeezing, kneading, shredding and sifting of the substance.

There were considerable reduction in volume of all the "kotcho" placed in the pits and pots. They were measured to be 40 - 58% of the original "kotcho" stored. The variations in volume reduction may have been caused by the variety, maturity and moisture content of the "enset" plants; porosity of storage facilities and thoroughness in the stem, corm and "bulla" extraction processing.

Throughout the sites the "kotcho" fermented through the local method was found to be drier. On the other hand, those stored to ferment in perforated clay pots had pleasant odour

and whiter appearances, which are desirable qualities of the "kotcho" in both zones.

The improved method of squeezing in Wolayta had reduced the time by an average of 21% of what was required to squeeze through the traditional practice. Although no time was saved with the use of the improved equipment in several sites of the Sidama Zone, the performance of two operators showed a very significant reduction of 53% in squeezing time.

If some lady operators have not gained squeezing process time through the use of the new equipment, it may be due to their lack of adaptability with fiber band squeezer. It is expected that through more experience they will overcome the obstacle. Two women complained that the fiber band squeezer was not letting out enough liquid as the local one. When field test results were later compared, the performance of the improved squeezer in letting out the unwanted liquid was found to be less by about an average of 12% than the traditional squeezer.

The researchers realized that the impermeability of the fiber band was due to the tightly knit fiber band which was employed in the improved squeezer. After some strands were randomly removed from the fabric and the sqeezer used again, some of the "kotcho" itself was tending to come out through the material towards the end of the process.

The application of the concept is the most inexpensive, effective safe and hygienic and therefore very difficult to find a replacement at this time. However, more has to be done to improve it so that the element of porosity in the band would not be compromised by its inability to hold back the "kotcho" during processing.

No problems were encountered in kneading, shredding and sifting of the semi-dry "kotcho", as methods similar to those of the traditional practice were applied.

**Processing and Operators Information**

The information on the "enset" processing operators, status conditions, experiences, performances and views as tabulated below, was considered to be very valuable factor that would contribute towards the improvement of the existing processing equipments.

Table 7: Related Data and Preferences of 10 Household Ladies from the Sidama and Wolayta Zones.

| Locality | Women operators in the sites | Operator's physical status | | | Years of experience in "enset" processing | If operator satisfied with tradiional method of processing | If not satisfied suggest improvement (for all the numbers listed below refer to Table 6 ) | When operating the person prefers to: | | | Prefered height of lower end of decort. board (cm) | Prefered angle of decorti-cation board | Max. distance operator can stretch during decortication (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Height (cm) | Weight (kg) | Age (Yr) | | | | Sit on ground | Sit on stool | Stand | | | |
| Sidama | 1. | 150 | 40 | 40 | 28 | NO | 1° | | X | | 52 | 60° | 57 |
| | 2. | 152 | 70 | 57 | 41 | NO | 2° | | X | | 49 | 47° | 57 |
| | 3. | 154 | 58 | 40 | 30 | NO | 3° | | X | | 49 | 49° | 55 |
| | 4. | 156 | 50 | 32 | 17 | NO | 4° | | X | | 59 | 45° | 59 |
| | 5. | 157 | 50 | 24 | 10 | NO | 5° | | X | | 50 | 62° | 64 |
| Wolayta | 6. | 149 | 43 | 40 | 28 | YES | -- | | | X | 57 | 53° | 57 |
| | 7. | 155 | 52 | 30 | 16 | NO | 7° | | X | | 40 | 59° | 55 |
| | 8. | 148 | 45 | 40 | 28 | YES | -- | | | X | 55 | 55° | 60 |
| | 9. | 155 | 52 | 30 | 20 | NO | 9° | | X | | 40 | 59° | 55 |
| | 10. | 142 | 45 | 30 | 15 | NO | 10° | | X | | 46 | 60° | 58 |

From the above table it is understood that all the ladies interviewed were very familiar and thorough with their jobs. They were mostly in their middle ages and had many years of experience in "enset" processing. Eight out of ten had expressed their desire to see some kind of improvement made on the traditional equipments. Sitting arrangement is one of the almost unanimously requested provisions to be included in the equipment design.

As observed, their preference in size and location dimension of the improved equipment, based on measurements made on the testing device were:

| | | |
|---|---|---|
| a. | Preferred height of lower end of decortication board | 40 - 59cm |
| b. | Preferred angle of decortication board | 45 - $62^0$ |
| c. | Maximum distance operator can stretch hand during decortication | 55 - 64cm |

Below are the tabulated remarks given by the operators (identified by site no.) expressing their dissatisfaction of the traditional practices and some features of the proposed equipment.

Table 8: Remarks of Operators on "Enset" Decortication

| Type of Process | Zones | |
|---|---|---|
| | Sidama | Wolayta |
| **Decortication** | 1* a. The women in Sidama sit on the ground and lift their feet to hold one end of the stem against the board during decortication. Hence, they requested that a better way be found so that they can sit properly and decorticate after being trained on how to use the equipment. | 7* a. Because it hurts our backs when we decorticate (the stem), we will appreciate if ways could be found for us to decorticate while sitting after being trained. |
| | | b. Our bamboo made stem scraper wears out quickly, we would appreciate therefore, if it could be replaced by a metal scraper. |
| | 2* a. It would be preferable if the decortication equipment is provided with a back support for its seat, (the lady's height, weight and age is: 152, 70kg and 57 Yrs.) | 9* a. Same as in no. (7a)<br>b. Same as in no. (7b) |
| | b. Similar to no. (1a) | 10* a. Same as in (7b), but handle to be provided so that it does not bruise the hands during use. |
| | 3* a. While the young educated ladies reject the traditional practice of raising their legs to clamp the "enset" stem, the veteran operators prefer the traditional way (to any other). | b. Same as in no. (7a) |
| | 3* b. The improved decortication board should be further improved (the board to be crowned along its center line) | |
| | 4* a. The "enset" scraper and decortication board should be corrected (with regards to the testing decortication board) | |
| | 5* a. Same as in (4a)<br>b. Same as in (1a)<br>c. Same as in (3d) | |

Table 9: Remarks of Operators on Pulverization of "Enset"

| Type of Process | Zones | |
|---|---|---|
| | Sidama | Wolayta |
| **Pulverization** | 1* b. The traditional bone pulverizer is found to be inefficient and moreover wears out quickly. They request, therefore, that this be replaced with metal pulverizer.<br>2* c. Similar to no. (1b)<br>4* b. The improved corn pulverizer should be provided with sharper teeth.<br>5* Same as in (4b) | 7* c. Because pulverization with our local tools is found to be tedious and time consuming, we appreciate if a better way of pulverization is improvised.<br>9* c. Same as in no. (7c) |

Table 10: Remarks of Operators on Squeezing of "Enset"

| **Type of Process** | **Zones** | |
|---|---|---|
| | **Sidama** | **Wolayta** |
| **Squeezing** | 3* d. The traditional vertical squeezing wood is slippery and can cause injury, Therefore it would be welcomed if the equipment could be changed.<br>4* d. Same as in (3d)<br>e. The improved method of squeezing had its draw backs:<br>i. The grain sack was too thick to allow sufficient liquid to flow out<br>ii. When the sack was thinned some "kotcho" started to come out from the big openings and rendered squeezing inconvenient.<br>5* e. Same as in (4e) | |

Table 11: Summary of the Remarks

| Traditional equipments | | Improved equipments (testing equipments) | |
|---|---|---|---|
| No. of operators Suggesting | Suggested improvement from female operators | No. of operators suggesting | Suggested improvement from female operators |
| 7 | Include sitting arrangements in the new equipment design. | 7 | Avoid very coarse or very fine teeth in metal corm pulverizer. |
| 1 | Provide back support for the seats. | 2 | A more loosely woven material, that allows the liquid to freely flow under pressure and at the same time does not let the "kotcho" come out with the liquid, to be considered for squeezing. |
| 3 | Replace bamboo with steel "enset" scraper. | | |
| 4 | Improve performances of local pulverizers. | 1 | Decortication board (used for testing) to be crowned in the middle, so that the scraper will not scratch the edges of the board during operation. |
| 3 | Hazardous Sidama traditional "enset" squeezer to be radically improved. | | |
| | | 2 | The equipments used, for testing operators' performance on decortication, to be improved. (the testing equipment was vibrating during operation, due to its unsteady structure) |

## ADOPTION OF APPROPRIATE "ENSET" PROCESSING EQUIPMENTS

### General Implementation of Design Concept No. 4

Based on design concept No. 4 with the cup squeezer attachment eliminated and substituted by the folded fiber band method, the prototype of three piece "enset" processing equipment was made, following the size dimension preferences acquired from the sites.

The decortication board was tentatively made to incline at $45^0$ angle which was within the range of acceptable slop as realized through the survey in the areas of investigation.

The creation of the simple inexpensive, safe and effective pseudostem clamping device continued to occupy the investigators. Clamping of the stem is done on the upper part of the board and is not supposed to be time consuming to operate.

A round wooden stick eccentrically mounted on two metal hooks was tried and was found to be very effective. The design of yet another wooden clamp that does not require any metal accessories was also devised and prefered.

In practice, the integration of the three main parts of the wooden processing equipment, as demonstrated in the conceptual sketch, was successfully implemented. These three main wooden parts can fit into one another and be dismantled safely with very little effort.

The main vertical post on which the decortication board and the seat rests will be made to stand on the ground with its base inserted in a precisely cut rectangular cavity of a large stone buried in the ground. The idea of burying the large stone, with a rectangular cavity on top and level with the ground, was to hold the cantilevered equipment firmly and prevent it from falling during operation. Stone was prefered for this purpose, as it does not rot or weather under outdoor climatic conditions. With this arrangement, the base of the post can be easily taken out and the whole equipment be stored in the house when not in use.

**Prototype of Improved "Enset" Processing Equipment Type "A"**

In implementing the general concept outlined above, the first attempt was made to produce a realistic equipment capable of fulfilling the full function of the anticipated "enset" food processor.

The three parts of the body of prototype "A" (Annex 5, 6 & 7) were made out of wood using nails to fix the components.

Decortication board (1), with clamp hooks at the upper end, pulverization chamber at the lower end and kneading tray on the other side, was fitted at $45^0$ angle in slots made on both sides of the main stand (3).

A round wooden stick clamp provided, with two eccentric necks to slide in and fit the side hooks, was found to be effective in holding the stem firmly to the board during decortication. A vertical handled toothed grater can be used for pulverization by resting the corm on the horizontally mounted tray to collect the grated food stuff.

In principle, the traditional scraper is adopted as one of the proposed processing equipments. But the middle portion of the scraper, if affordable, can be replaced by a saw toothed strip of sheet metal, curved on the shorter side to provide rigidity, and forming

tubes on both sides to accommodate some portions of two wooden handles.

A comfortable horizontal working seat (2) is held in position by its extended beam fitted in a single slot made in the main stand.

The kneading tray suppot beam (4) is made with appropriate slot and protrusions to fit at right angle to the extended parts of the seat and hold the tray horizontally when in use. It can also serve as a seat for clay pots that collect parenchyma tissue and "bulla" during decortication.

One of the features of the main stand is that a rectangular through hole is extracted on its upper middle portion to facilitate the entry of a handled fiber band squeezer. With this arrangement the operator is able to lock one end of the folded band in the stand and twist the other through its wooden clamp handle until the liquid in the "kotcho" is satisfactorily squeezed out.

The squeezer is a traditionally accepted method already in use in the Wolayta area. Hence, its adoption was recommended with the additional installation of wooden clamp handle at each end of the folded fiber band (Annex 20).

After a day's operation, the band should be washed thoroughly and dried in the sun, lest mildew would spoil the taste of the food in the subsequent use of the equipment.

Installation of the large stone (preferably trachyt) in the ground with a rectangular hole chiselled out on the top to a depth of 15cm, is necessary to accommodate the base of the main stand during the processing operation (Annex 19).

**Prototype of Improved "Enset" Processing Equipment Type "B1" and "B2".**

The design of type "B1" (Annex 8 & 9) and "B2" (Annex 10, 11, 12, 13 & 14) processing equipment is basically the same except that "B1" is made at a modern carpentry shop and "B2" is hewn out of wooden trunk by local craftsmen, using their own traditional tools, following the prescribed design and dimensions.

These equipments are considered as improvements of type "A". In addition, there were no nails used in "B2" and curvatures on the wood that can not easily be implemented by the rural craftsmen were avoided. Both of the improved types of equipments were sturdier than type "A", since the decortication board and the seat were fitted to the main stand in double side slots.

The kneading and sifting tray was placed undeneath the seat instead of the original idea of placing it on the other side of the decortication board. In "B2", moreover, the tray was further improved by considerably increasing its width, without necessarily compromising the appropriateness and comfort of the seat on the other side. In this arrangement, the two sides of the tray were extended to provide a) much needed, reliably strong beams that can easily support the expected weight of the operator and b) a stable seat for the parenchyma tissue collector, without involving any extra support beam as applied in type "A".

Collection access to parenchyma tissue or the pulverization chamber was still maintained at its original position.

A wooden clamping device for the decortication board was designed and implemented. The device required the use of heavy counter-weight to clamp the end of the parenchyma tissue during decortication (Annex 19).

There is no change for the squeezer locking hole arrangement. The lower end of the main stand is shaped in the same way as in type "A" to fit the stone cavity in the ground.

Type "B1" and "B2" were decorated on their non-utilizable surfaces with straight line grooves criss-crossing to form squared patterns. The lines on "B2" were branded with hot iron after the wood was painted with plain wood oil. This type of motife has proven to create a sense of straightness and unity of component parts on the simple equipment. On the locally curved wood the decoration showed a visible effect in arresting the rough surface, which for the most part was done without the use of a straight edge.

Though there was an advantage for the local craftsmen to use a freshly cut trunk and easily transform the soft wood, with their local axes, into boards of the desired sizes, the draw back was that the fitting parts of the equipment shrank significantly as it dried. As a result loose connections were created that would obviously cause vibration during the processing operation.

Therefore, well dried wood should be prefered to the wood that was hewn out of a newly cut tree for the construction of the equipments.

**Prototype of improved corn pulverizers**

**Horn corn pulverizer**

The simplest and most inexpensive pulverizer that was totaly made out of the available local materials was the serrated cattle horn (Annex 20). It was found to be very effective in grating the corn, although it was used in the same way as the scapula pulverizer in the Sidama zone.

**Pivoted Lever Pulverizer**

This optional device was the last of the attempts made in the production of the series of pulverizer attachments to the decortication equipment (Annex 15, 16, 17 & 18).

Its main parts are the grater arm and the corn box. The grater, which is made of a number of scrapers and toothed blades placed at certain angle, is fixed to a pivoted lever. Thanks to the studies made by the IAR in the last decade, the very idea of combining toothed blades and scrapers, positioned alternatively, was found to be very helpful in producing an effective lever pulverizer. The corn box, which is open on both sides, confines the corn while being pressed by a wooden lever on one end and pulverized by the scraping arm on the opposite open end.

## RESULTS OF THE INVESTIGATION

### Prototype "B2" adopted

The researchers settled on adopting "B2" as the most viable basic equipment for the processing of the edible part of the "enset".

This last integrated equipment in the series, seemed to fulfill all the requirements considered as essential to its functions and performances.

When tested, it was found to be:

a. Multi functional
b. Relatively compact and long lasting
c. Convenient and easy to operate
d. Efficient
e. Safe and hygienic
f. Not affecting the traditional "kotcho" taste and consistency
g. In the long run inexpensive and simple to locally manufacture

To assert the above findings and assumptions , however, plans were made for further test of the equipments in the rural sites.

### Costs of the equipment

The cost of the materials such as the stone base, the cattle horn and squeezer band along with their labour cost could be eliminated, since they are easily available and can be made by the would be owners of the equipments. Hence, the total cost of the equipments could be reduced to Birr 139. There can still be significant reduction of the costs if the farmers are able to provide the craftsmen with the needed wood for the construction of the three main parts of the equipment.

Another way of lessening the burden of the expenses for the purchase of such equipment is to share the cost of one complete set of wooden equipment among residents in a cluster of huts. But each household would have to install its own permanent stone base in its "enset" yard. With this arrangement only the equipment would rotate among households during the

"enset" processing seasons without necessarily removing the stone base. The use of the clay pots however, would be too inconvenient to share by the processors.

It should be noted that while the above basic equipments are made without involving ***a single nail or metal accessories***, the optional pivoted lever corm pulverizer, tailored as an attachment to this equipment, was not intended to be metal-less device. Therefore whenever required, nails, steel blades and structural reinforcement steel profiles can be applied. This device was designed and constructed for those farmers who are economically in a much better position to afford the purchase of equipments with greater mechanical advantages.

The equipments regarded as basic can be produced using local materials, tools and craftsmen. But a modern wood and metal shop would be involved to build the pivoted lever grater. Consequently, the material and labour needed to produce the attachment was estimated to cost about Birr 200:-

Table 12: Cost Breakdown of the Equipments and Accessories

| Item | Description | Material cost (Birr) | Labour cost (Birr) | Sum (Birr) |
|---|---|---|---|---|
| 1. | About 40 x 40 x 25cm trachytic stone base | 4.00 | 10.00 | 14.00 |
| 2. | Main wooden stand | 8.00 | 15.00 | 23.00 |
| 3. | Wooden decorticating board (pseudostem clamping device included) | 8.00 | 15.00 | 23.00 |
| 4. | Wooden seat and tray combination | 20.00 | 25.00 | 45.00 |
| 5. | Bamboo scraper | -- | -- | 2.00 |
| 6. | Serrated, cattle horn pulverizer | -- | -- | 1.00 |
| 7. | Parenchyma tissue collector clay pot | -- | -- | 6.00 |
| 8. | "Bulla" collector clay pot | -- | -- | 4.00 |
| 9. | Local grain sieve | -- | -- | 6.00 |
| 10. | "Kotcho" squeezer fiber band with wooden handles | -- | -- | 3.00 |
| 11. | Fermentation clay pot | -- | -- | 30.00 |
| **Total (Birr)** | | | | **157.00** |

## INTRODUCTION OF THE DEVELOPED EQUIPMENT "B2" AND ITS ACCESSORIES IN THE TARGETED ZONES

The assessment and reactions of the women operators, with regards to the viability of the basic equipment were considered to be crucial to the success of the project. Therefore, trips were made to the two target zones once again for on the site equipment appraisals.

The new device was set up in the two zones by ladies themselves following brief instructions from the investigators. In all cases, the equipment was easily set up, manoeuvred and dismantled with very little effort.

Since its dimensions were within the prefered measurement range of the operators, as expressed in the previous interview, the ladies felt comfortable to sit and operate the equipment. They were advised that when the seat needed to be slightly adjusted to the required height, the ground under it could be lowered or raised to suit each operator.

Once they set up the equipment, decortication, pulverization, squeezing, shredding and sifting were performed smoothly and with no major obstacles.

Some vibration of the equipment was, however, noticed during the operations. This was caused by some loose joints created as a result of shrinkage of the wood. The draw back was not unexpected, since a recommendation was passed earlier to correct it. In the future, while the wood should be curved from freshly cut tree, the slots and forks should be extracted after it is thoroughly dried.

The operators are to be advised that the equipment, once used should be stored indoors and on higher shelves to prevent any abuse and misuse.

By and large, almost all the women operators have expressed their fascination and satisfaction with the nail-less four piece wooden device innovated to provide comfort and ease during the entire cumbersome process.

One of the seasonsed lady operator who is about 150cm in height from the Wolayta Zone, was briefly instructed on how to assemble and operate the equipments. The following illustrations and captions explain the sequence of her putting up and using the newly proposed equipments in the actual rural environment.

1

A household member digs a hole on the ground to place natural stone base for the processing equipment.

2

The stone base is placed in the ground with its slot facing upwards.

3

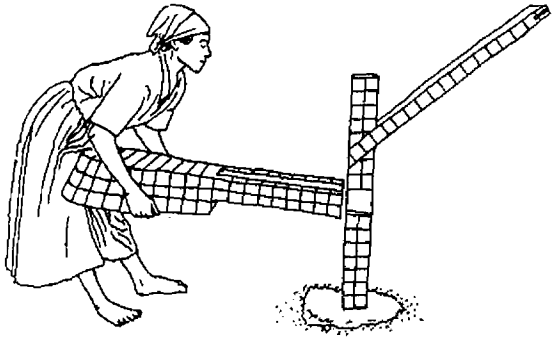
The woman operator inserts the main wooden support post into the stone slot.

4

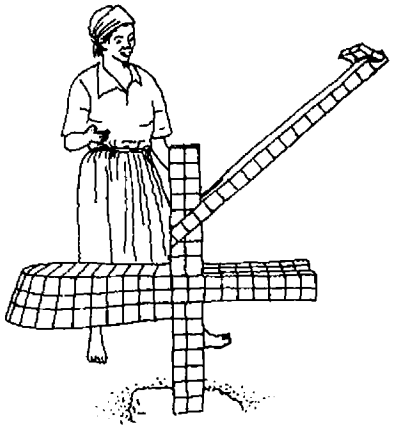
The operator slides the decortication board on the sides of the main post.

The operator slides the seat and tray combination on the sides of the main post.

5



6



The pseud-stem clamp is already fixed at the upper end of the decortication board.

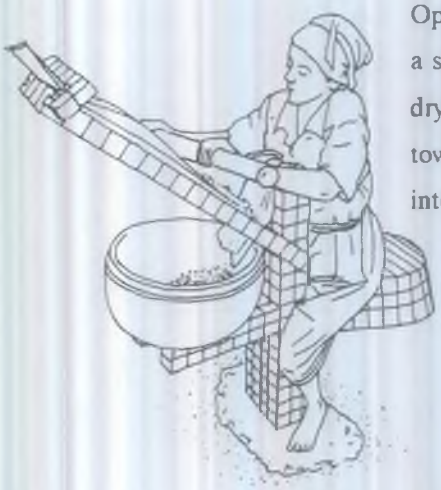
7

Positioning of the clay pot under the decortication board close to the outlet hole.

8

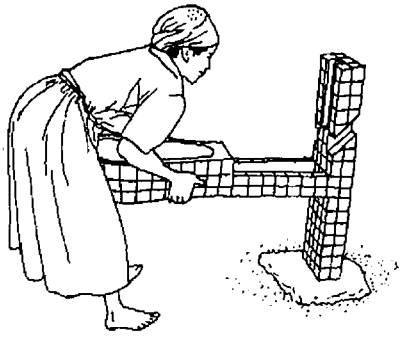
Operator seated and posing to test the new equipment.

9



Operator in pseudo-stem processing action using a split bamboo stem. (Notice the piece of semi-dry stem placed on top of the main post and bent towards the hole to direct the parenchyma tissue into the clay pot below).

10

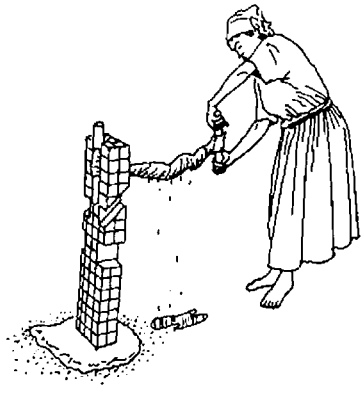


Operator rearranges equipments for pulverization process. The tray is made to face upwards.

11

Operator pulverizes the corm using improvised pulverizer.

12



Squeezing by wringing the fiber bag wrapped fermented "kotcho".

13

Kneading the squeezed "kotcho" on the tray.

14

Shredding the kneaded "kotcho" with a local knife.

15

This shows the type and size of dwelling ordinary farmers own in relation to the proposed processing equipments.

## CONCLUSION AND RECOMMENDATIONS

The saying "A man works from sun to sun but a woman's work is never done" is not more evident than in the heart rendering day to day activities of the women in the rural areas. A village woman has to plan ahead on how to extend the meager resources made available to her so that all members of the family can be properly sustained. On the designated day of the week, she has to travel a considerable distance to reach a village market and carry out her market duties. The milking of goats or cows, the fetching of fire wood and water, preparing meals, taking care of the young ones, cleaning the house, removing and disposing the animal litter and working in the "enset" yard are among the tasks which are normally left for her to perform from dawn to dusk. It is unfortunate that all these responsibilities are traditionally assigned to the women.

The present study confined to "enset" processing and development of "enset" processing tools does not address the general socio-economic problems affflicting the women in "enset"-culture areas. The researchers, however, are of the opinion that one way of resolving these problems is for the male population to take steps toward and thoughtfully consider sharing with the women the responsibilities of the household activities. Though highly improbable to achieve at this stage, this would greatly tip the workload balance in favour of women carrying less burden in the homes.

Be as it may, under existing village circumstances, no single solution, that can possibly relieve the woman from her burdensome domestic chore, is in sight. However, if materials and means of processing and cooking food needed for sustaining the family can be brought closer to the household and processing equipments simplified through studies, research projects such as the improvement of "enset" processing tools will have undoubtedly attained their intended goals.

It was in this context that the research project of "enset" processing equipments was identified as one of those requiring urgent attention. The final outcome of this study was the development of "enset" processing equipment which is capable of fulfilling the parameters set out at the beginning of the research. In the process of producing the

equipment considerable time had been devoted to simplify the initial concept of processing. The task was to minimize or all together do away with the need for any nonlocal materials involved in the building up of the equipments. Finally, an equipment entirely produced from local wood, free from even the most rudimentary fixing materials, such as nails, was developed as embodied in prototype "B2".

The production of the "enset" processing equipment "B2" may not serve as an ultimate solution to the "enset" processing problem millions of women are facing in the southern regions of Ethiopia. Nevertheless, the researchers believe that the creation of such a handy equipment made from local materials and using local skills may further contribute towards the series of improvement attempts made by various agencies in the past.

Many observers may feel perplexed by the simplicity of the newly developed "enset" processing equipments. They may be eager to see the rural population acquire more mechanized equipments. The present investigators unquestionably share their concerns. But, it must be remembered that the chief constraint which prevailed during the development of the equipment was the actual living conditions of those farmers, whose destitution has caused them to barely afford the acquisition of crooked decortication boards and simple bamboo scrapers.

It goes without saying, therefore, that it would be futile to develop devices that are far beyond the purchasing power of the rural population and the skill of their craftsmen, if done in the hope that some day welfare agencies would subsidize the project.

The equipments are desperately needed now!

When a male member of a family, residing on the outskirts of Sodo town in Wolayta, was asked if the villagers were aware of the existence of improved "enset" processing equipments produced by government agencies in the town. he said that they had not seen nor heard of any such devices. This was an unexpected remark coming out of the very peasants whose quality of lives many researchers in the past were toiling to improve.

Although the investigators have not travelled extensively in the rural areas so as to assess the extent of dissemination and impact of any earlier improved equipments, in those areas visited non were found.

The question then arises: Might not the same fate befall to the "enset" processing equipments being developed in this research once it is completed?

It is evident that once found viable, a project of this nature could only be considered as successful if its product finds its way to the rural homes as easily as the traditional implements that are made available by the local craftsmen in many village markets.

However, there seem to be yet unresolved obstacles towards the introduction of an improved equipment in the rural areas, which stands in the way of effectively committing the population to its continuous utilization and in the prepetuation of its production.

It is towards this objective that the researchers, following the valuable suggestions made by NORAGRIC and the Research and Extension Office of the Awassaa College of Agriculture, are recommending to carry out the project into the next stage of study - a study that would probe into the various possible approaches of product introduction including the task of winning the commitments of the rural population to take advantage of the newly developed "enset" processing equipment and its accessories.

**REFERENCES**

1. A Diagnostic Survey of Ezo Tula Peasant Association in Chencha, North Omo (1994), FARM AFRICA, p 59.

2. Agren, G. and R. Gibson (1975). Food Composition Table For Use in Ethiopia. Stockholm: Almaqvist and Wiskall.

3. Alasebu Gebreselassie (1983). Women on Settlement. National Workshop on Women in agriculture Development. Awassa.

4. Hanna Kebede (1978). Improving Village Water Supplies in Ethiopia: A Case Study of Socio-Economic Implications. United Nations, Economic commission for Africa.

5. Chaka, W. and Kifle, D. (1992). A Report on Improved Enset Food Preparation. Sodo, (unpublished).

6. Deckers J., Kefale A., Sandford S. and Swennen R. Paper on Interdisciplinary Ecological Research Effort for Enset in Ethiopia (unpublished). FARM AFRICA

7. ILCA (Information Center for Low-Extended Input and Sustainable Agriculture (1993). Enset - a multipurpose crop, Volume 9 no. 3, pp 9 - 10. ETC Foundation, Netherlands.

8. Judit S. and Hellen Kassa. Paper on the Effects of Gender on Resource Contributions, Decision Making And Influence; A Comparison Between Enset, Teff And Maize (unpublished). FARM AFRICA

9. Overholt, C., Anderson Mary B., Cloud, K., Austin James E. (1991). Gender Roles in Development Projects. Kumarian Press, Inc. Connecticut, U.S.A.

10. Sandford S., and Alemu K. (1991). Enset in North Omo. FRP Technical Phamplet 1, pp. 8 - 10 FARM AFRICA.

11. Taye Bizuneh (1984). Evaluation of Some "Enset" ventricosum clones for Food Yield with Emphasis on the effects of Length of Fermentation on carbohydrate and calcium Content. Journal of tropical agriculture (Trinidad). 61(2) 111-116.

12. Westphal E. (1975). Agricultural Systems in Ethiopia. Center for Agricultural Publishing and Documentation. Wageningen, the Netherlands 123-125.

13. Wudnesh Hailu (1991). Rural Family of Ethiopia: Economic activities, Household Analysis, and Standard Household Type comparisons. Hamburg: Verl. Weltarechiv.

**Glossary**

| | |
|---|---|
| Amich (Hamicho) | -Corm of immature "enset" plant (root part). It is sectioned into large chunks boiled and consumed. |
| Bulla | -Milky liquid produced from scrapped pseudostem. It turns into a paste or powder after dehydration. |
| Bulla genfo | -Porridge made out of bulla. |
| Bulla ferfer | -Shredded flake made out of bulla |
| Corm | -The root part of enset plant |
| Enset | -A tall fibrous plant which resembles the banana plant |
| Hasa | -A labour-pool system used by women in Wolayta area |
| Itima | -A Wolayta term used for bulla |
| Karta | -A low quality squeezed out liquid from fermented kocho. It is mixed with other food items and consumed |
| Kocho | -Fermented mixture of decorticated pseudostem and pounded corm |
| Kocho Kitta | -A flat thin bread made out of kocho dough |
| Kancha | -Enset fiber produced after scrapping the pseudostem. It is used for making strings, and gunny bags |
| Koba | -A name given for enset in the non-enset culture areas |
| Woficho | -Dehydrated, leaf sheath and petiole |

ZONE & SITE NO..... HOUSE OF..... PERSON CONTACTED..... DATE.....

## PSEUDO STEM

| METH. OD | NO | PRE-DECORTICATION (AVE. MEASUR.) | | | | AFTER DECORTICATION (TOTAL AMT.) | | | | | | TIME SPENT FOR DECORT. (MIN) | JUICE LOSS ON THE GROUND | | REMARK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | LENGTH (CM) | WIDTH (CM) | THICK. (CM) | WEIGHT (GR.) | NO. OF PCS. | PARANCHYMA TISSUE WEIGHT (GR) | PARANCHYMA TISSUE VOLUME ($CM^3$) | JUICE RETAINED WEIGHT (GR) | JUICE RETAINED VOLUME ($CM^3$) | JUICE DISPOSE ($CM^3$) | FIBER WEIGHT (GR) | | VALUABL. | DISPOS. | |
| LOCAL METH. | 1 | | | | | | | | | | | | | | | |
| LOCAL METH. | 2 | | | | | | | | | | | | | | | |
| SUGG. METH. | 1 | | | | | | | | | | | | | | | |
| SUGG. METH. | 2 | | | | | | | | | | | | | | | |

## CORM

| METH. OD | NO | PRE-PULVERIZATION | | AFTER PULVERIZATION | | TIME SPENT FOR PULVERIZATION (MIN.) |
|---|---|---|---|---|---|---|
| | | VOLUME ($CM^3$) | WEIGHT (GR) | VOLUME ($CM^2$) | WEIGHT (GR) | |
| LOCAL METH. | 1 | | | | | |
| LOCAL METH. | 2 | | | | | |
| SUGG. METH. | 1 | | | | | |
| SUGG. METH. | 2 | | | | | |

## MIXTURE

| PSEUDO-STEM AND CORM MIXTURE | | | REMARK |
|---|---|---|---|
| VOLUME ($CM^3$) | WEIGHT (GR) | FERMENTATION STORAGE CONDITION | |
| | | | |
| | | | |
| | | | |
| | | | |

## OPERATOR

| HEIGHT (CM) | WEIGHT (KG) | AGE (YR) | YEARS OF EXPERIENCE ON 'INSET' PROCESSING | IS OPERATOR SATISFIED WITH TRADITIONAL METHOD OF PROCESSING? | IF NOT SATISFIED SUGGEST IMPROVEMENT | WHEN OPERATING, THE PERSON PREFERS TO: SIT ON GROUND | SIT ON STOOL | STAND | PREFERED HEIGHT OF LOWER END OF DECORT. BOARD (CM) | PREFERED ANGLE OF DECORT. BOARD | MAX. DISTANCE OPERATOR CAN STRETCH DURING DECO. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |

## SQUEEZING (AFTER FERMENTATION)

PERSON CONTACTED..... DATE.....

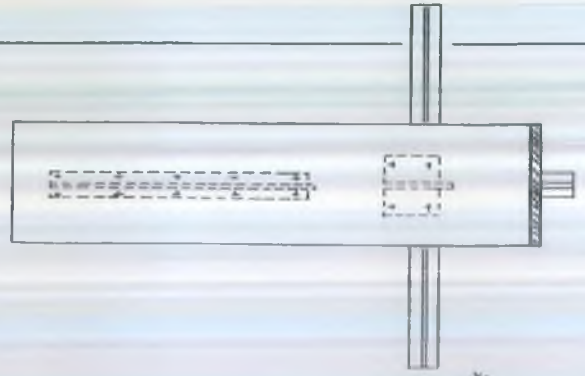
| USING TRADITIONAL SQUEEZER | OPERATOR'S STATUS HEIGHT (CM) | WEIGHT (KG) | AGE (YR) | DURATION OF FERMENTATION (DAYS) | VOLUME OF MIXTURE ($CM^3$) | WEIGHT OF MIXTURE (GR) | LOSS OF WEIGHT (GR) | LOSS OF VOLUME ($CM^3$) | WEIGHT RATIO OF EXTRACTED JUICE | VOLUME RATIO OF EXTRACTED JUICE | PALM GRIP FORCE GRIP | TWIST | TIME SPENT FOR SQUEEZING | NO. OF PERSONS INJURED IN THE USE OF LOC. SQU. | 'KOCHO' TASTE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

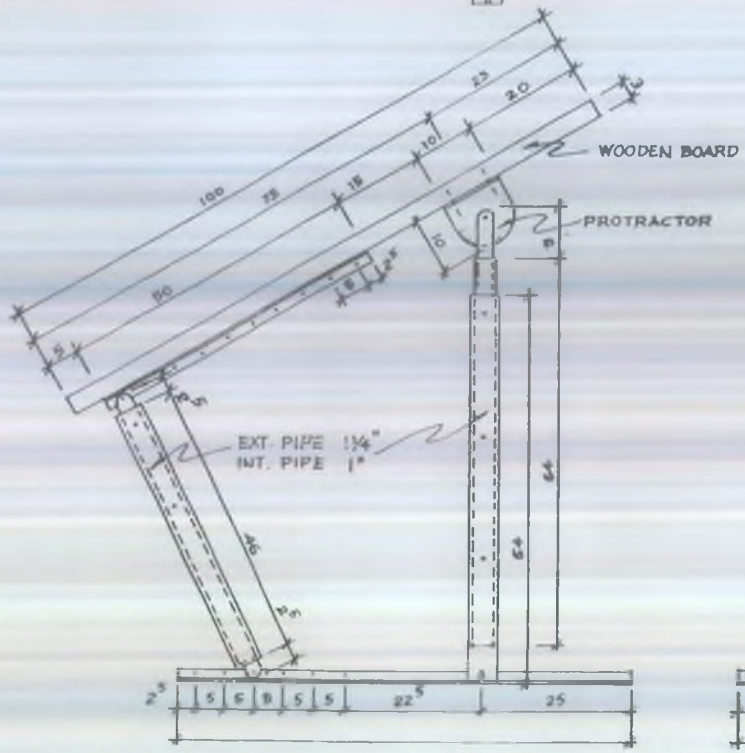
| USING PROPOSED SQUEEZER | DURATION OF FERMENTATION (DAYS) | VOLUME OF MIXTURE ($CM^3$) | WEIGHT OF MIXTURE (GR) | LOSS OF VOLUME ($CM^3$) | LOSS OF WEIGHT (GR) | WEIGHT RATIO OF EXTRACTED JUICE | VOLUME RATIO OF EXTRACTED JUICE | FORCE APPLIED TO EXTRACT JUICE (KG/CM) | TIME SPENT IN JUICE EXTRACTION (MIN) | 'KOCHO' TASTE |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| | | | | | | | | | | |

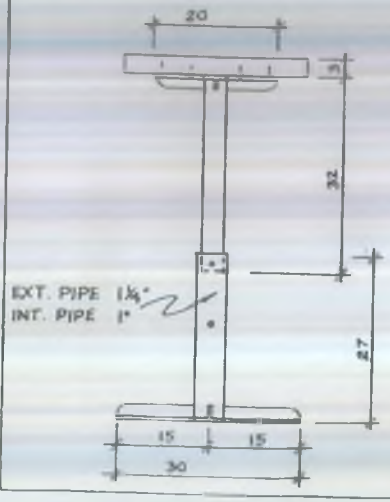
G = GOOD
T = TOLERABLE
B = BAD

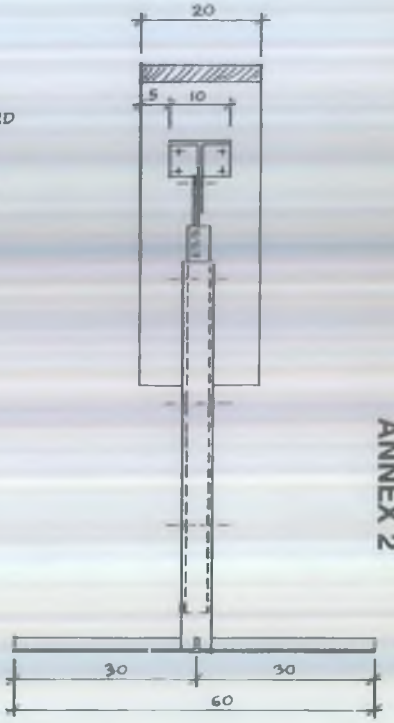
ANNEX 1

ADJUSTABLE 'INSET'
DECORTICATION BOARD
& STOOL, SCALE 1:10

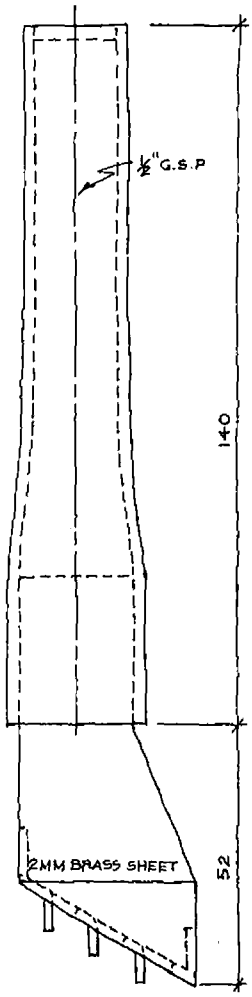


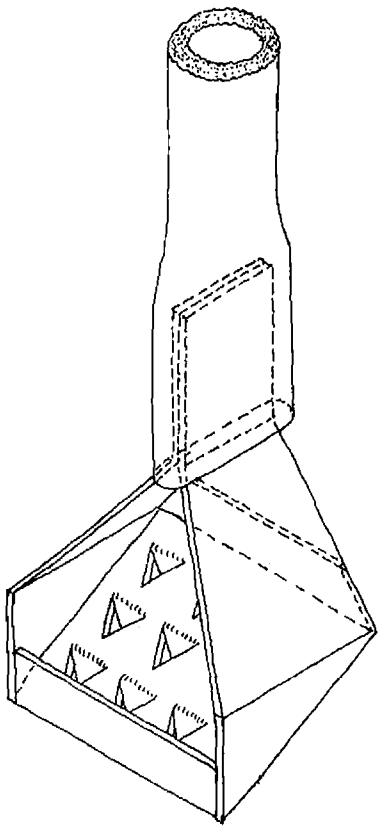



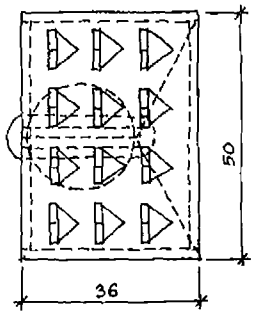



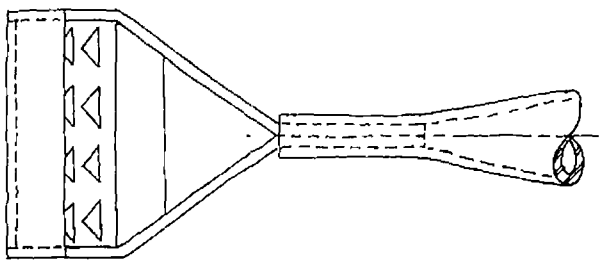
ANNEX 2

**ANNEX 3**



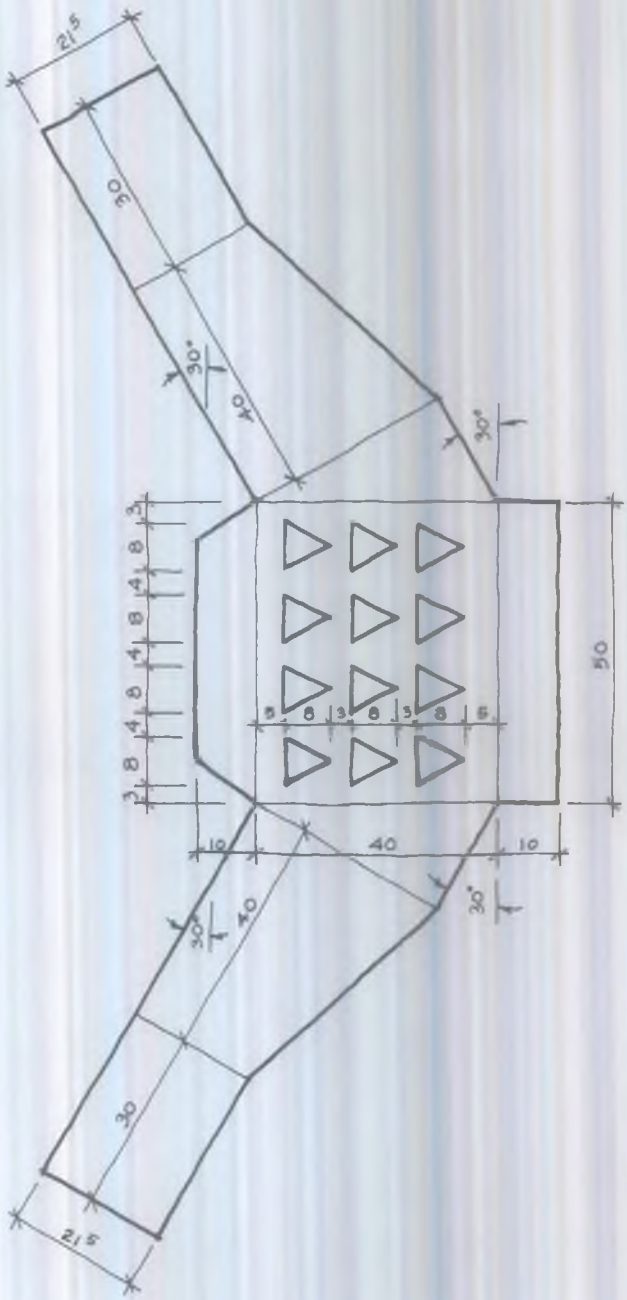





| | | |
|---|---|---|
| AWASSA COLLEGE OF AGRICULTURE<br>DEPARTMENT OF AGRICULTURAL ENGINEERING & MECHANIZATION | | |
| NORAGRIC PROJECT ON "ENSET" PROCESSING EQUIPMENTS | | |
| VERTICAL HANDLE PULVERIZER | | |
| DESIGNED: M.T. | DATE: 31ST AUG., 1994 | SCALE: |

ANNEX 4



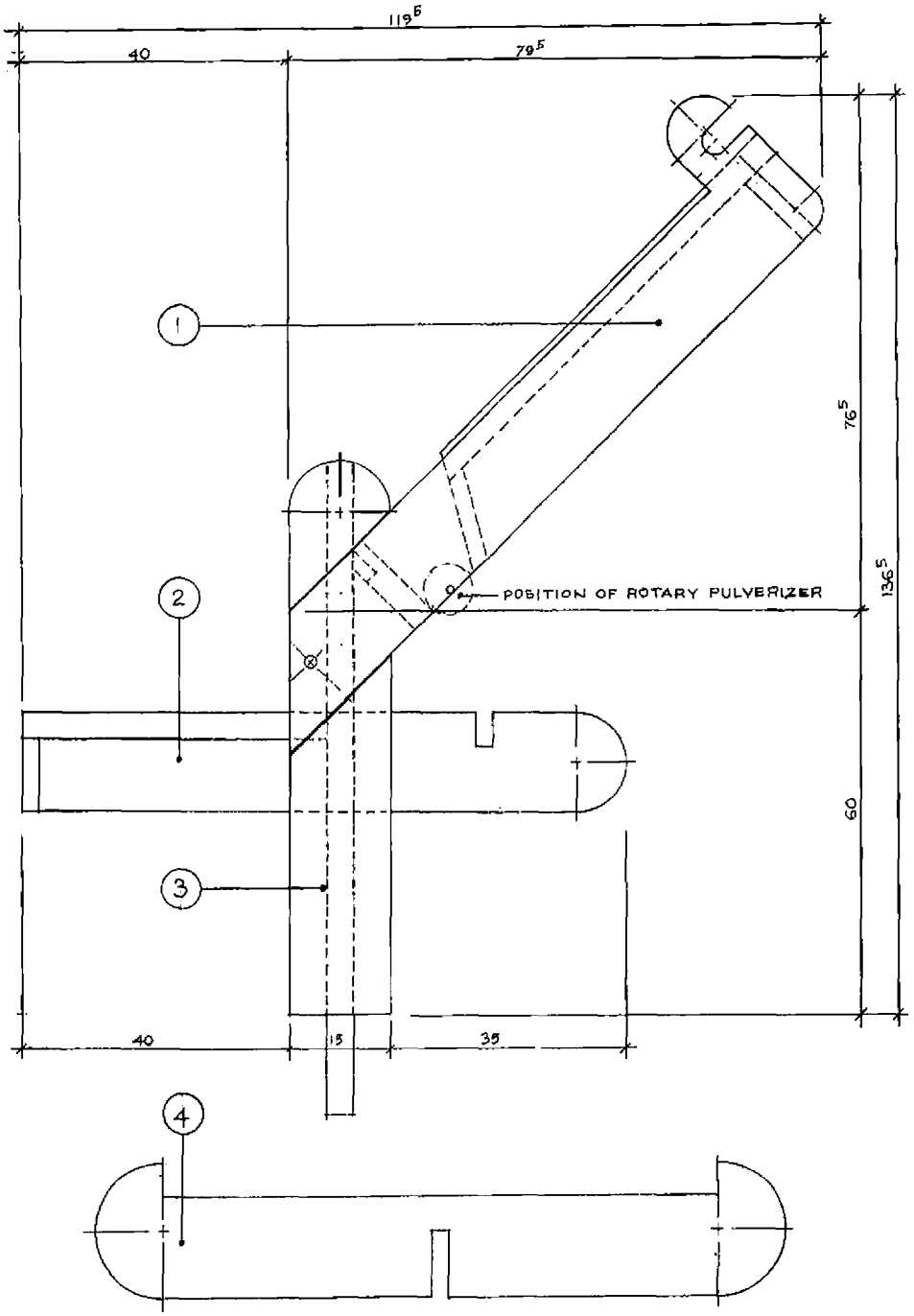

AWASSA COLLEGE OF AGRICULTURE
DEPARTMENT OF AGRICULTURAL ENGINEERING & MECHANIZATION

NORAGRIC PROJECT ON "ENSET" PROCESSING EQUIPMENTS

BRASS SHEET PATERN OF GRATER FOR VERTICAL HANDLE PULVERIZER

| DESIGNED: M. T. | DATE: 31ST AUG., 1994 | SCALE: 1:1 |
|---|---|---|

**ANNEX 5**



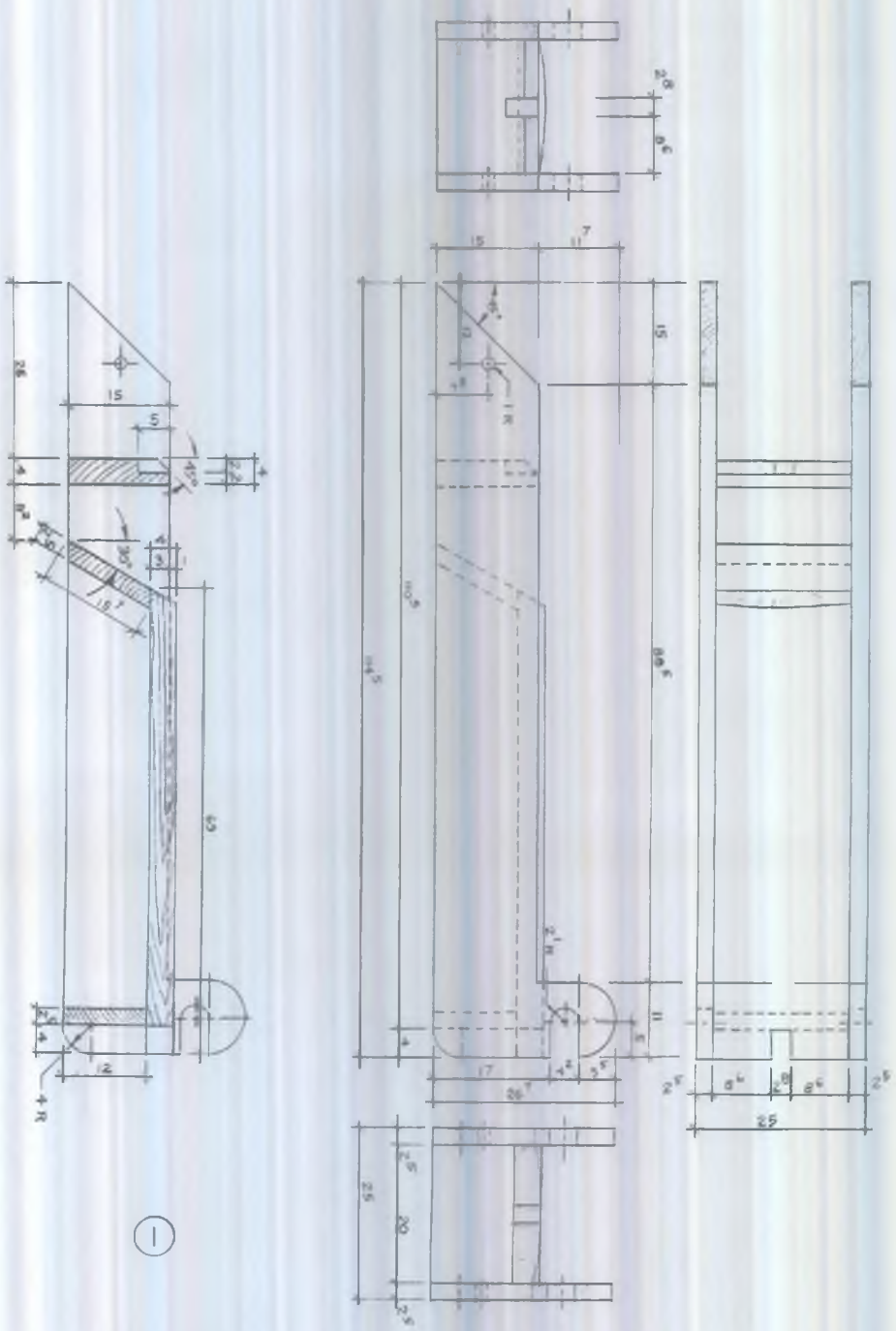

AWASSA COLLEGE OF AGRICULTURE
DEPARTMENT OF AGRICULTURAL ENGINEERING & MECHANIZATION

NORAGRIC PROJECT ON "ENSET" PROCESSING EQUIPMENTS

PROTO-TYPE "A" — ASSEMBLY DRAWING

| DESIGNED : M.T. | DATE : 31ST AUG. 1994 | SCALE : |
|---|---|---|

ANNEX 6



AWASSA COLLEGE OF AGRICULTURE

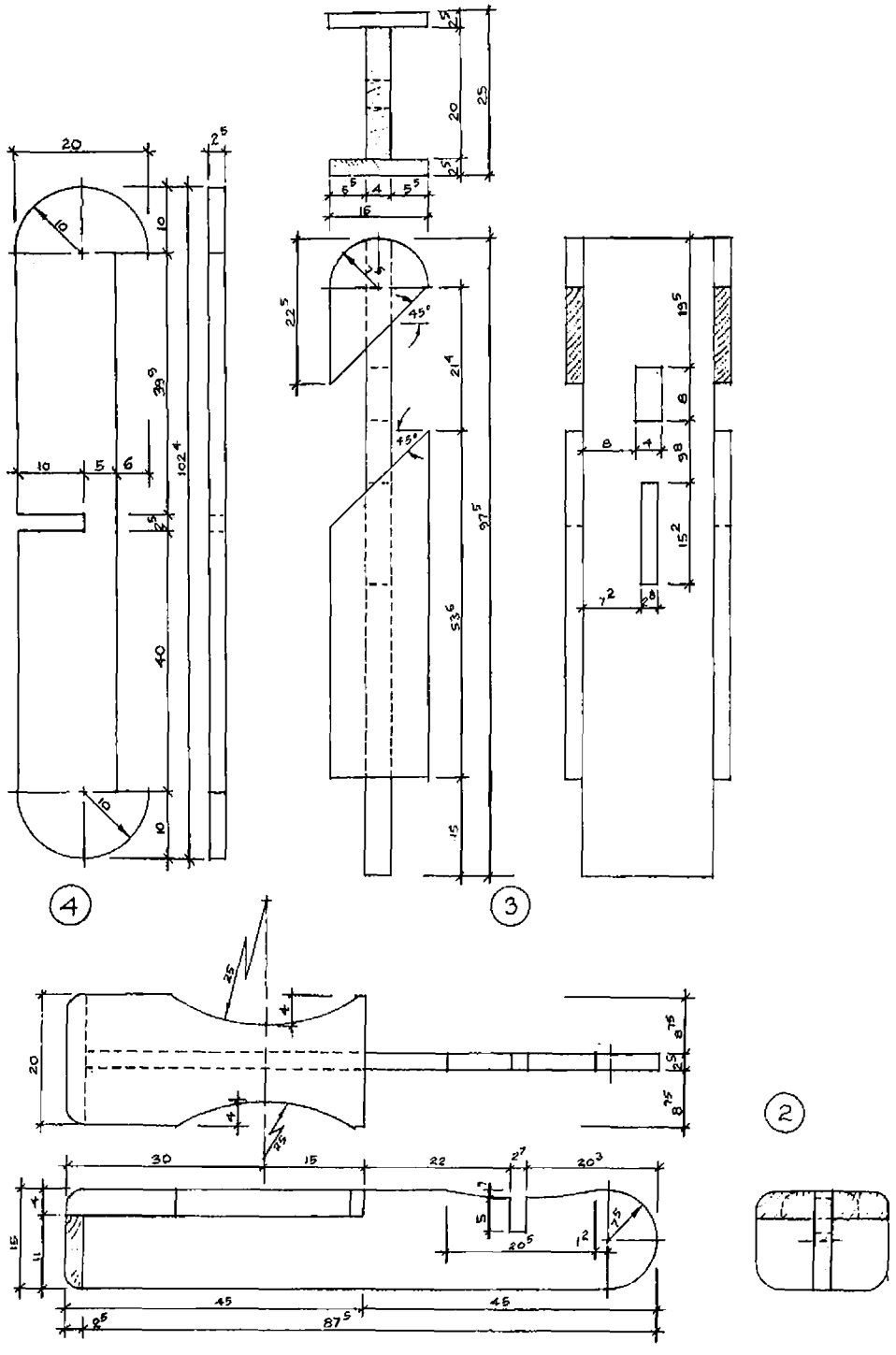
DEPARTMENT OF AGRICULTURAL ENGINEERING & MECHANIZATION

NORAGRIC PROJECT ON "ENSET" PROCESSING EQUIPMENTS

DECORTICATION BOARD AND TRAY COMBINATION FOR PROTO-TYPE "A"

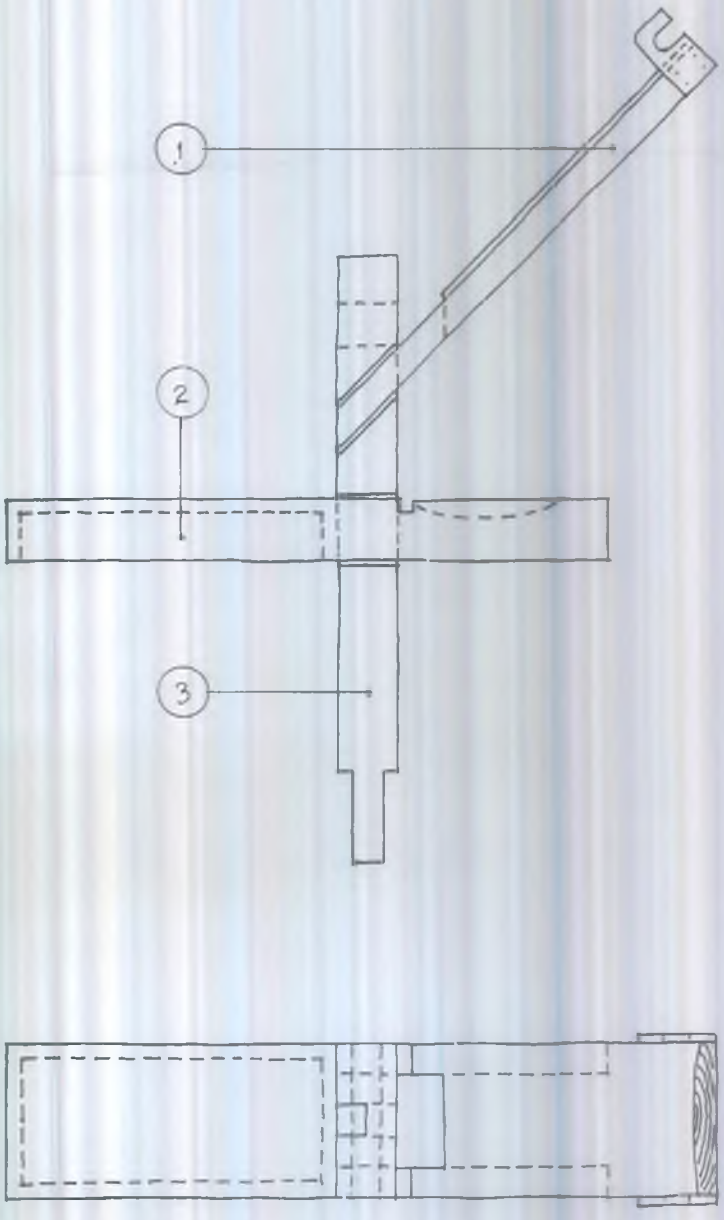
| DESIGNED: M.T. | DATE: 31ST AUG., 1994 | SCALE: |
|---|---|---|

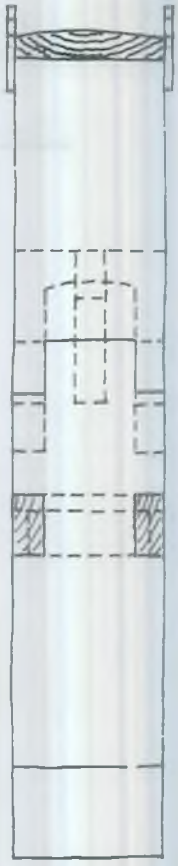
**ANNEX 7**




| | | |
|---|---|---|
| AWASSA COLLEGE OF AGRICULTURE<br>DEPARTMENT OF AGRICULTURAL ENGINEERING & MECHANIZATION | | |
| NORAGRIC PROJECT ON "ENSET" PROCESSING EQUIPMENTS | | |
| PROTO-TYPE "A" — MAIN STAND, SEAT AND TRAY SUPPORT BEAM | | |
| DESIGNED: M.T. | DATE: 31ST AUG., 1994 | SCALE: |

ANNEX 8





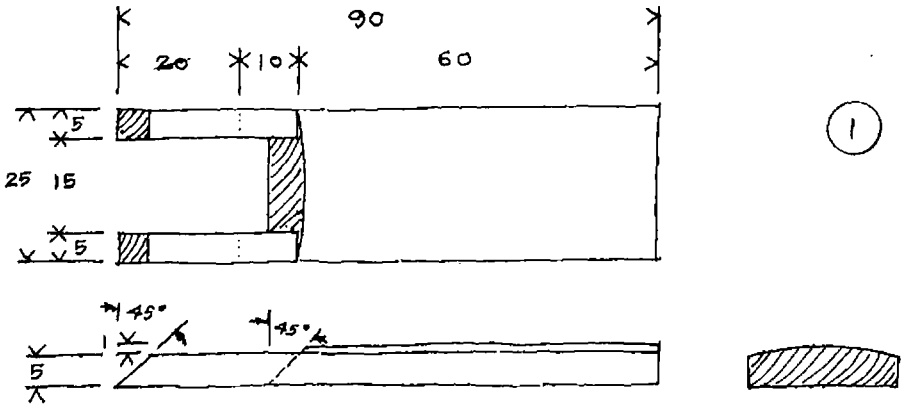
AWASSA COLLEGE OF AGRICULTURE
DEPARTMENT OF AGRICULTURAL ENGINEERING & MECHANIZATION

NORAGRIC PROJECT ON "ENSET" PROCESSING EQUIPMENTS

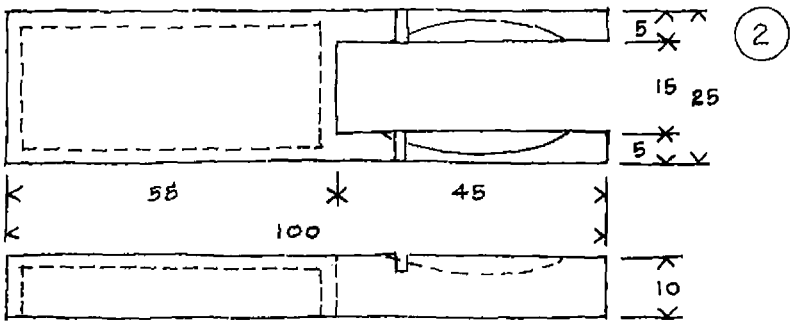
PROTO-TYPE "B1" — ASSEMBLY DRAWING

| DESIGNED: M.T. | DATE: 31ST AUG., 1994 | SCALE 1:10 |
|---|---|---|

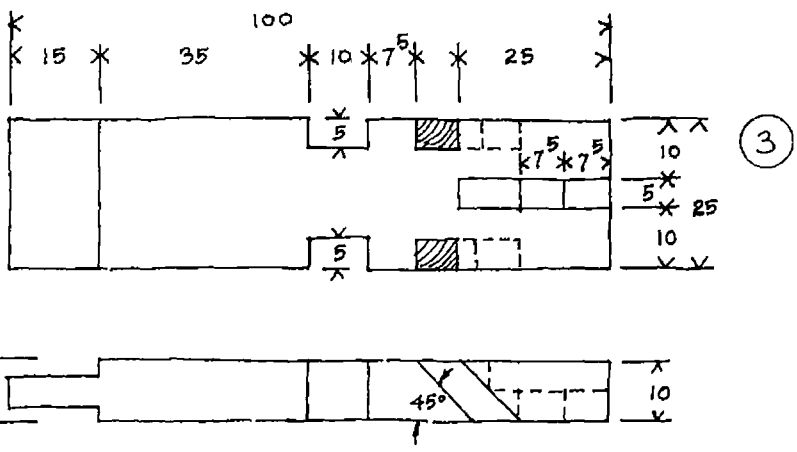
**ANNEX 9**




(1)




(2)

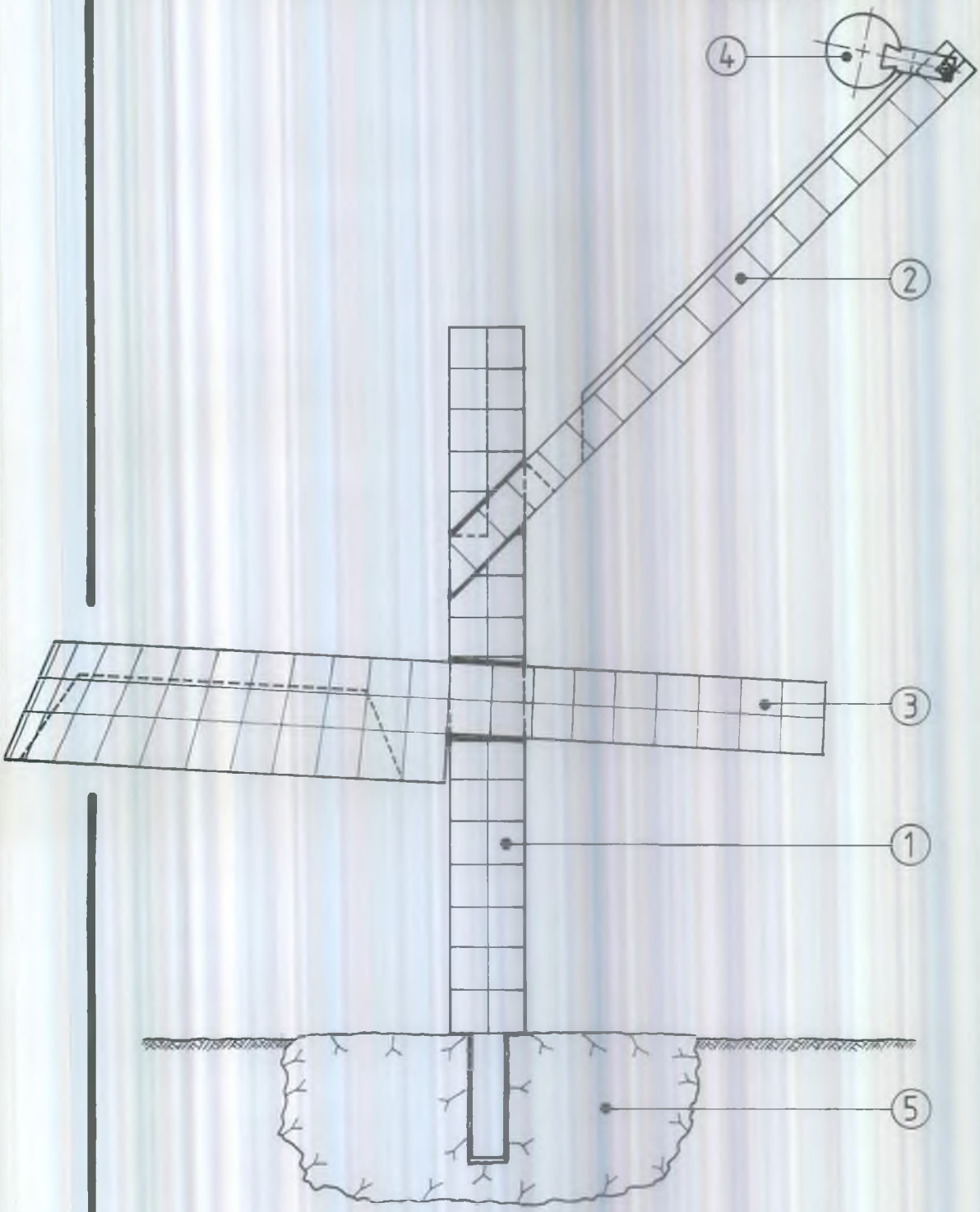



(3)




| | | |
|---|---|---|
| AWASSA COLLEGE OF AGRICULTURE<br>DEPARTMENT OF AGRICULTURAL ENGINEERING & MECHANIZATION | | |
| NORAGRIC PROJECT ON "ENSET" PROCESSING EQUIPMENTS | | |
| PROTO-TYPE "B1" — DECORTICATION BOARD, SEAT & TRAY COMBINATION AND MAIN STAND | | |
| DESIGNED: M.T. | DATE: 31ST AUG., 1994 | SCALE: 1:10 |

ANNEX 10

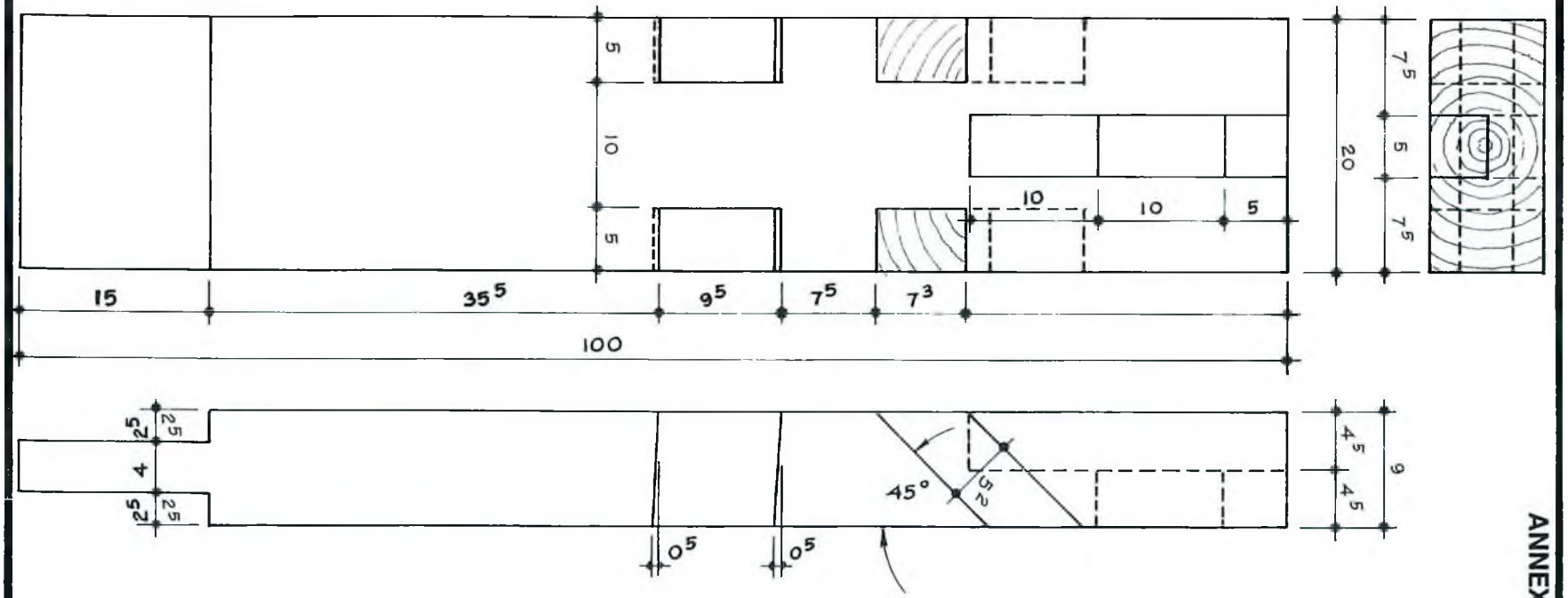



AWASSA COLLEGE OF AGRICULTURE
DEPARTMENT OF AGRICULTURAL ENGINEERING & MECHANIZATION

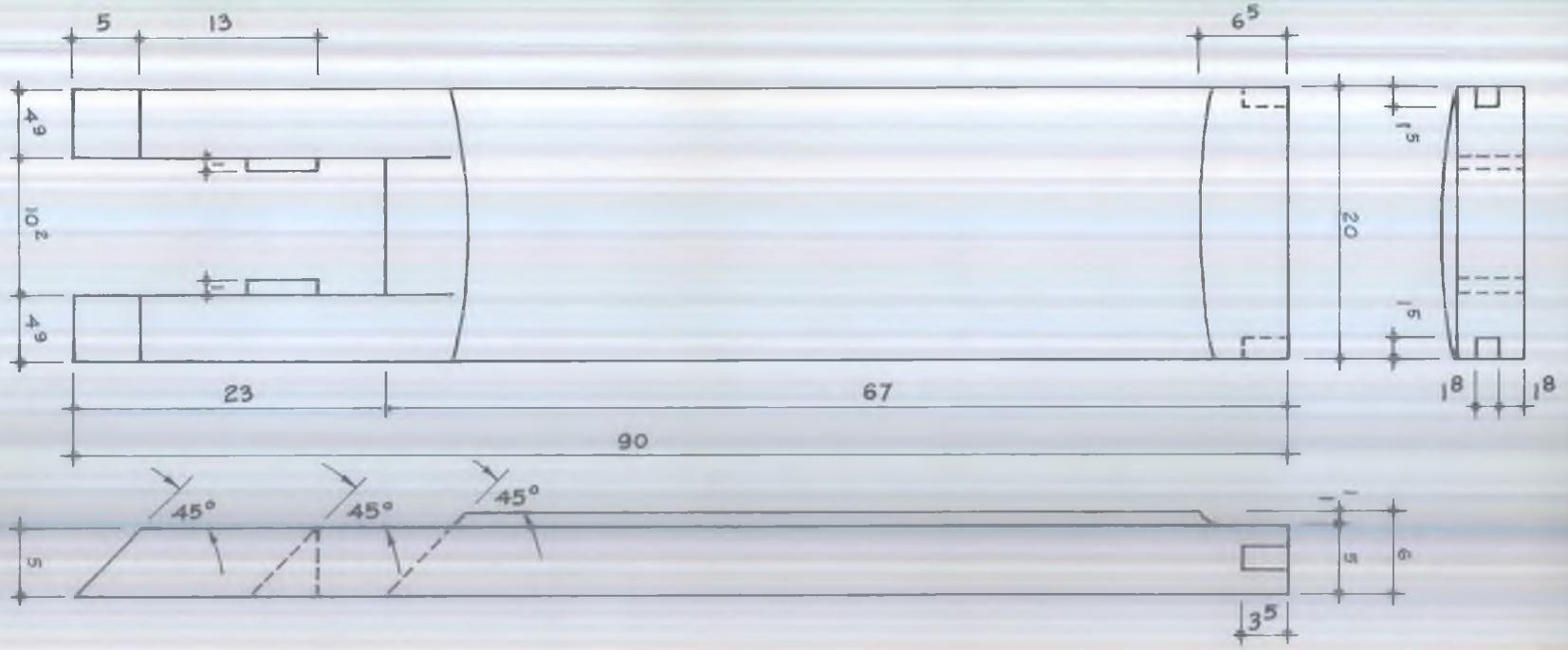
NORAGRIC PROJECT ON "ENSET" PROCESSING EQUIPMENTS

1. MAIN STAND 2. DECORTICATING BOARD 3. SEAT & TRAY COMBINATION 4. CLAMP AND 5. STONE BASE ASSEMBLY

| DESIGNED: M.T. | DATE: 31ST AUG., 1994 | SCALE: 0 10 20 CM |
|---|---|---|

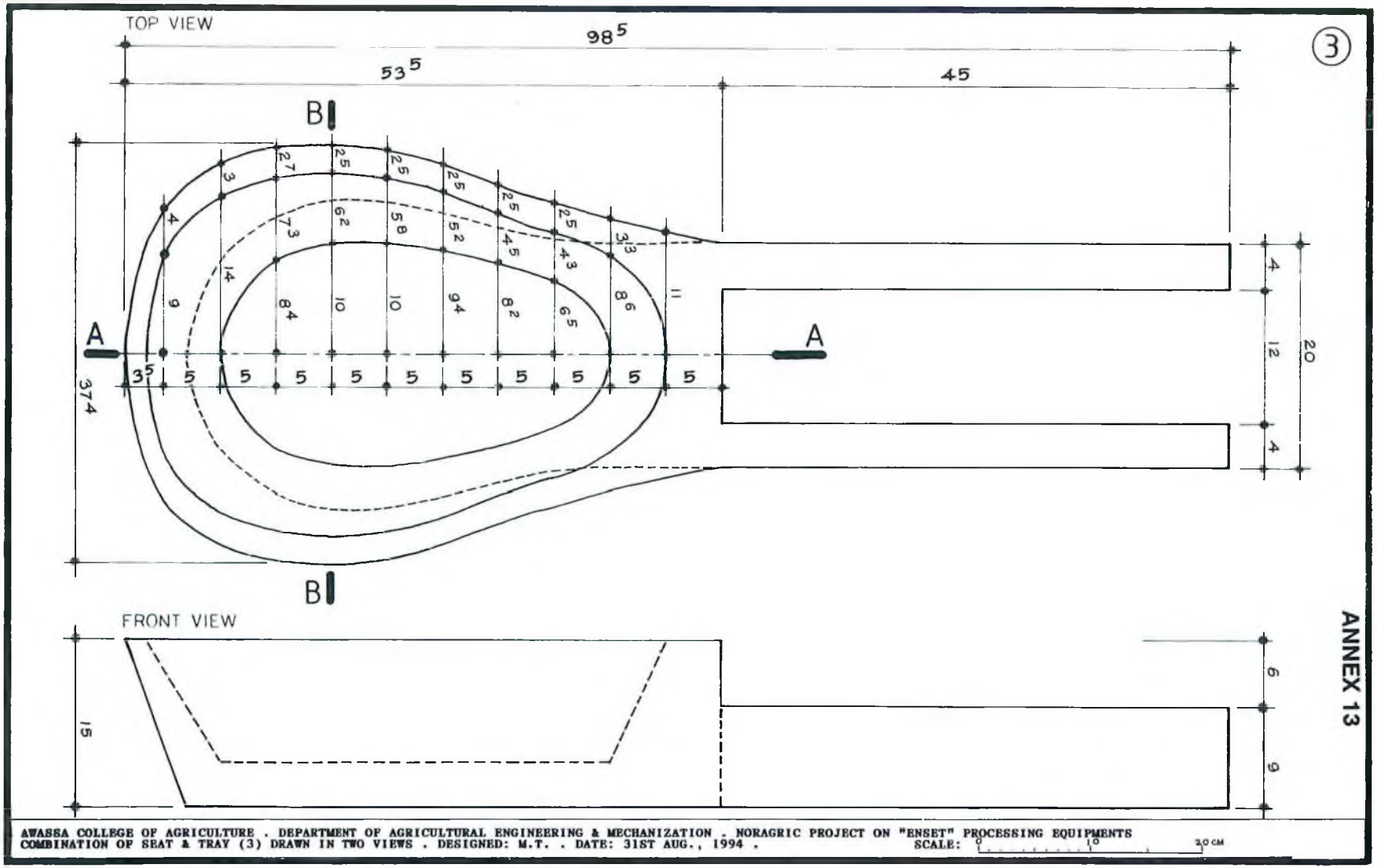


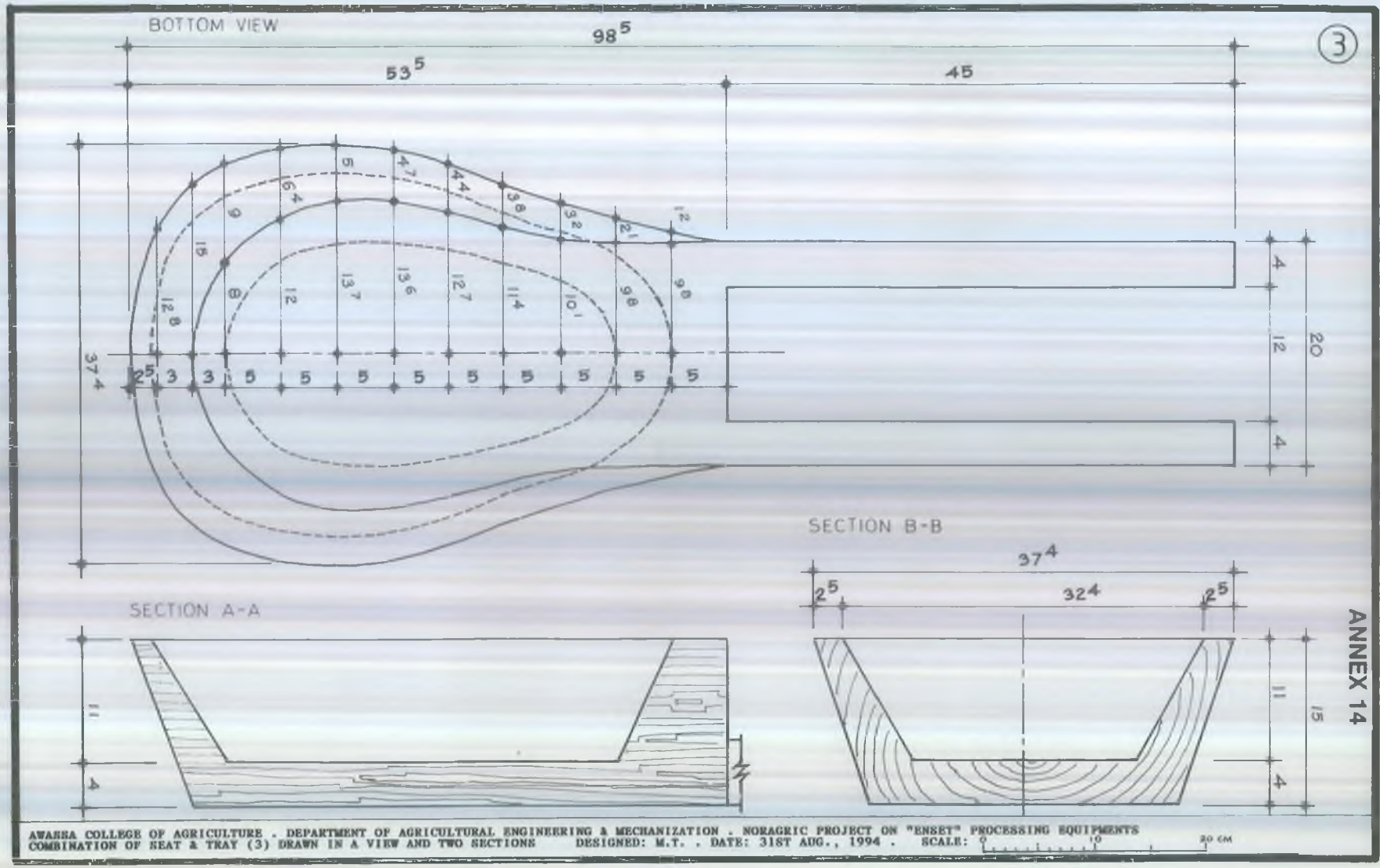

| | | |
|---|---|---|
| AWASSA COLLEGE OF AGRICULTURE<br>DEPARTMENT OF AGRICULTURAL ENGINEERING & MECHANIZATION | | |
| NORAGRIC PROJECT ON "ENSET" PROCESSING EQUIPMENTS | | |
| MAIN STAND (1) DRAWN IN THREE VIEWS | | |
| DESIGNED: M.T. | DATE: 31ST AUG., 1994 | SCALE: 0 10 CM |



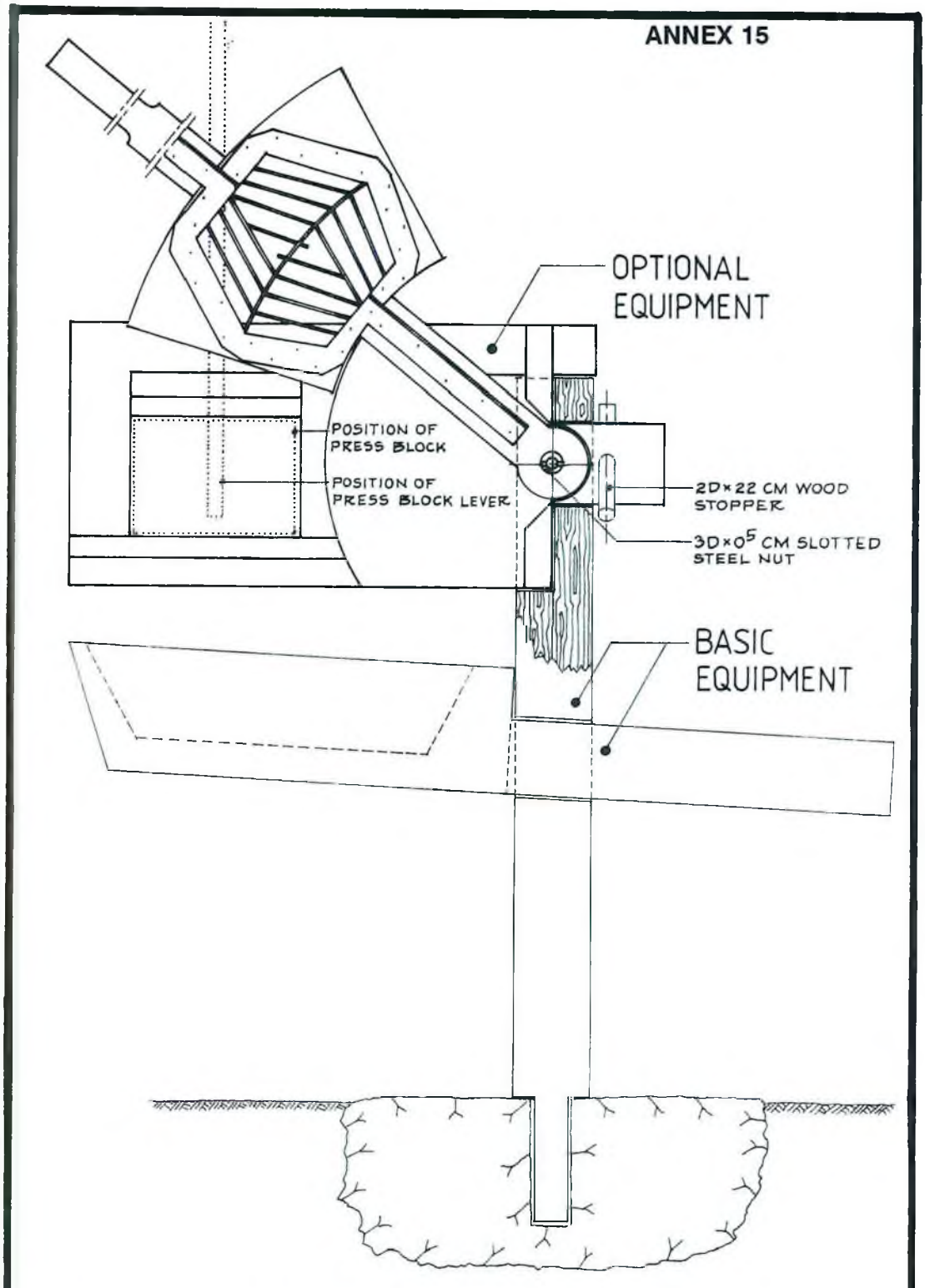

ANNEX 12

AWASSA COLLEGE OF AGRICULTURE . DEPARTMENT OF AGRICULTURAL ENGINEERING & MECHANIZATION . NORAGRIC PROJECT ON "ENSET" PROCESSING EQUIPMENTS
DECORTICATION BOARD (2) DRAWN IN THREE VIEWS DESIGNED: M.T. . DATE: 31ST AUG., 1994 . SCALE: 0 10 20 CM


TOP VIEW
98 5
53 5
45
B
A
A
B
374
35
5
5
5
5
5
5
5
5
5
5
5
5
9
14
27
3
4
25
25
25
25
25
25
25
31 3
73
62
58
52
45
43
84
10
10
94
82
65
86
11
4
12
20
4
FRONT VIEW
15
6
9
3
ANNEX 13
AWASSA COLLEGE OF AGRICULTURE . DEPARTMENT OF AGRICULTURAL ENGINEERING & MECHANIZATION . NORAGRIC PROJECT ON "ENSET" PROCESSING EQUIPMENTS
COMBINATION OF SEAT & TRAY (3) DRAWN IN TWO VIEWS . DESIGNED: M.T. . DATE: 31ST AUG., 1994 .
SCALE: 0 10 30 CM


BOTTOM VIEW
98.5
53.5
45
3
37.4
2.5
3
3
5
5
5
5
5
5
5
5
5
5
5
16.4
12.8
9
15
8
12
13.7
13.6
12.7
11.4
10.1
9.8
9.8
4.7
4.4
3.8
3.2
2.1
1.2
4
12
4
20
SECTION A-A
11
4
SECTION B-B
37.4
2.5
32.4
2.5
11
4
15
ANNEX 14
AWASSA COLLEGE OF AGRICULTURE . DEPARTMENT OF AGRICULTURAL ENGINEERING & MECHANIZATION . NORAGRIC PROJECT ON "ENSET" PROCESSING EQUIPMENTS
COMBINATION OF SEAT & TRAY (3) DRAWN IN A VIEW AND TWO SECTIONS
DESIGNED: M.T. . DATE: 31ST AUG., 1994 . SCALE: 0 10 20 CM

**ANNEX 15**



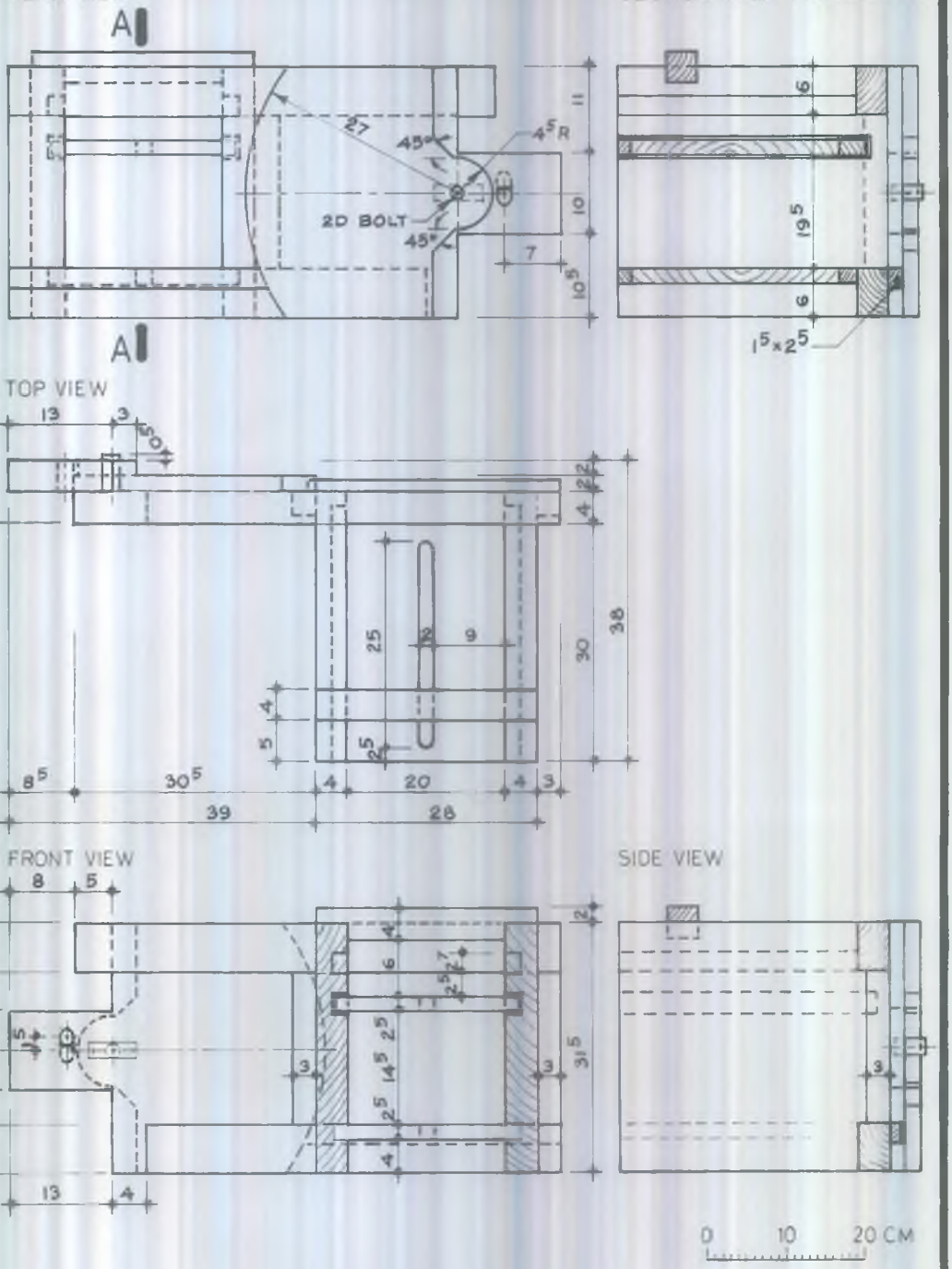

AWASSA COLLEGE OF AGRICULTURE
DEPARTMENT OF AGRICULTURAL ENGINEERING & MECHANIZATION

NORAGRIC PROJECT ON "ENSET" PROCESSING EQUIPMENTS

BASIC AND OPTIONAL EQUIPMENTS ASSEMBLY

| DESIGNED: M.T. | DATE: 31ST AUG., 1994 | SCALE: 0 10 20CM |
|---|---|---|

**ANNEX 16**

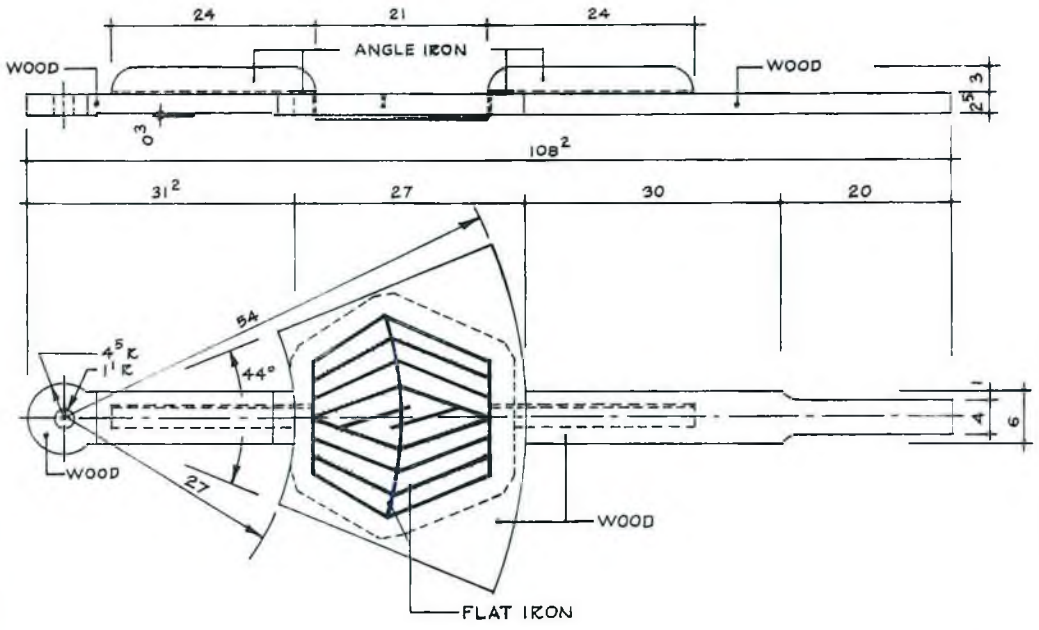


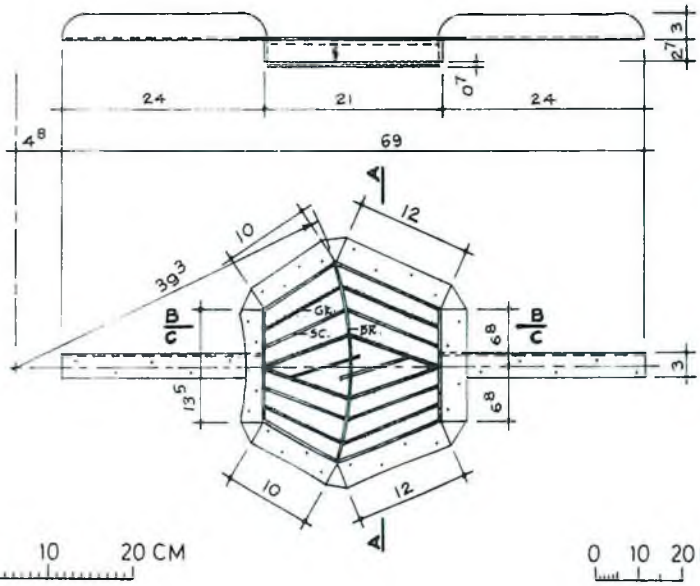

AWANSA COLLEGE OF AGRICULTURE
DEPARTMENT OF AGRICULTURAL ENGINEERING & MECHANIZATION

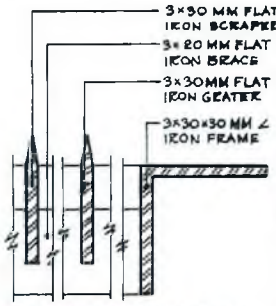
NORAGRIC PROJECT ON "ENSET" PROCESSING EQUIPMENTS

PIVOTED LEVER PULVERIZER – CORM BOX

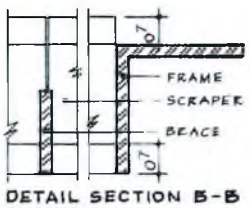
| DESIGNED: M.T. | DATE: 31ST AUG., 1994 | SCALE: |
|---|---|---|



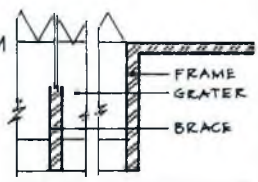




DETAIL SECTION A-A




DETAIL SECTION B-B




DETAIL SECTION C-C

0 10 20 CM

0 10 20 MM

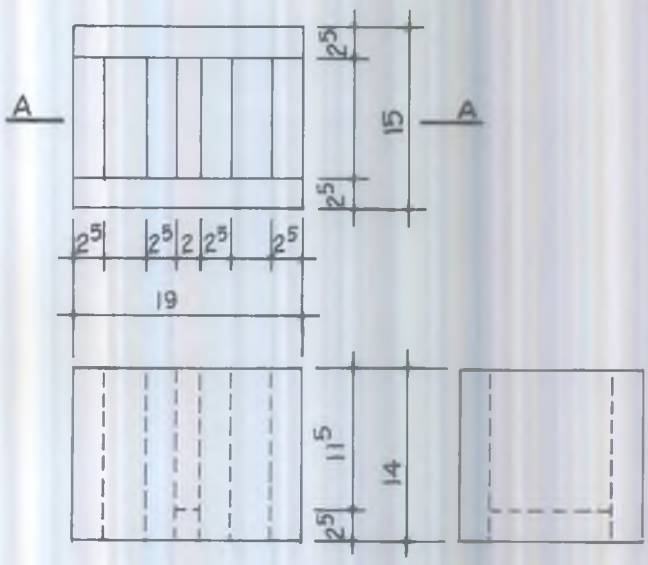
AWASSA COLLEGE OF AGRICULTURE
DEPARTMENT OF AGRICULTURAL ENGINEERING & MECHANIZATION

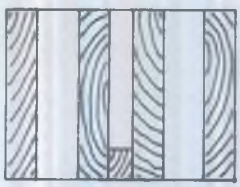
NORAGRIC PROJECT ON "ENSET" PROCESSING EQUIPMENTS

PIVOTED LEVER PULVERIZER - GRATER ARM

| DESIGNED: M.T. | DATE: 31ST AUG., 1994 | SCALE: |
|---|---|---|

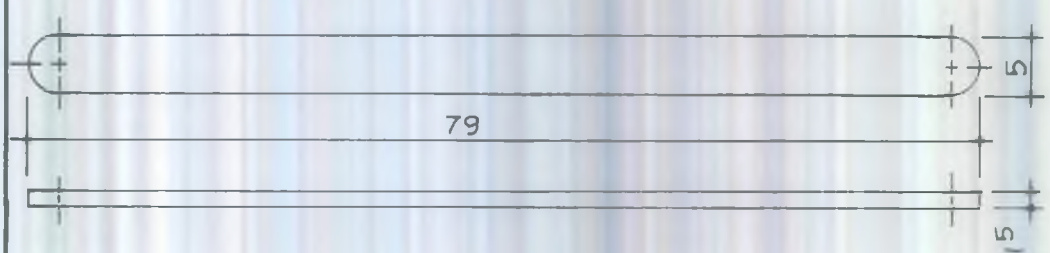
# 'CORM' PRESS BLOCK



SECTION A-A

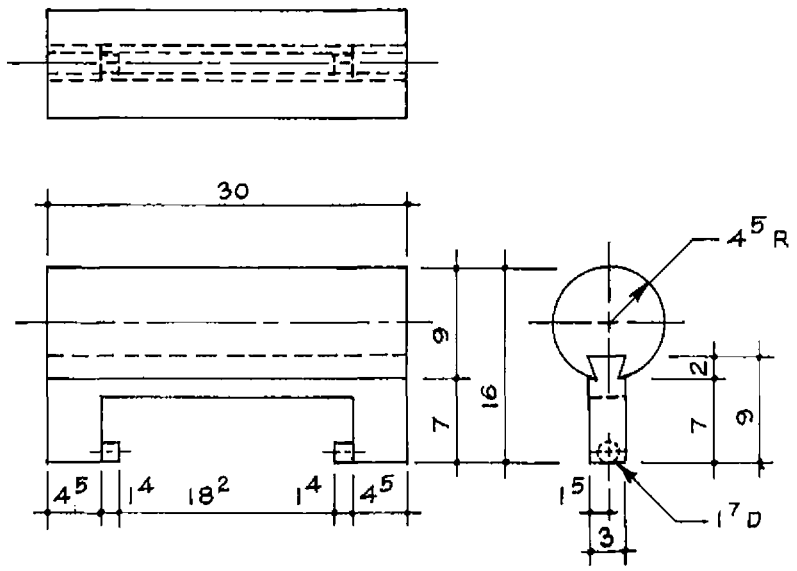
# PRESS BLOCK LEVER




| | | |
|---|---|---|
| AWASSA COLLEGE OF AGRICULTURE<br>DEPARTMENT OF AGRICULTURAL ENGINEERING & MECHANIZATION | | |
| NORAGRIC PROJECT ON "ENSET" PROCESSING EQUIPMENTS | | |
| CORM PRESS BLOCK AND PRESS BLOCK LEVER | | |
| DESIGNED: M.T. | DATE: 31ST AUG., 1994 | SCALE: 1:5 |

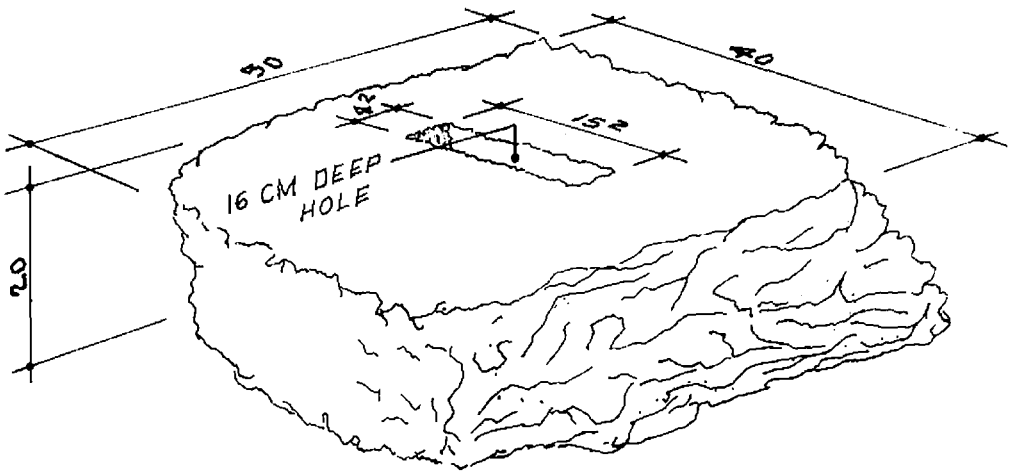
4

## CLAMP (SCALE: 1:5)




5

## STONE BASE



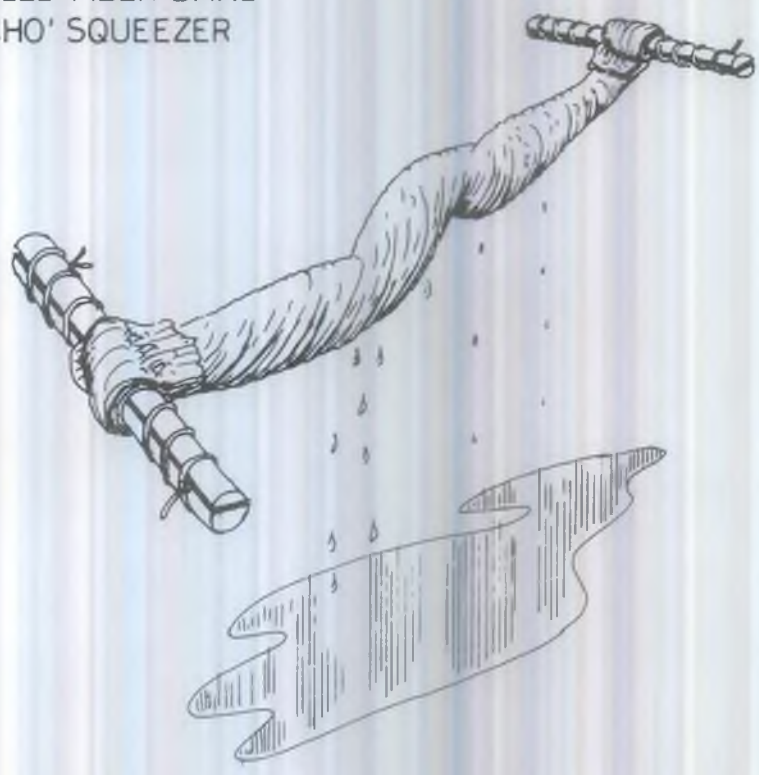

AWASSA COLLEGE OF AGRICULTURE
DEPARTMENT OF AGRICULTURAL ENGINEERING & MECHANIZATION

NORAGRIC PROJECT ON "ENSET" PROCESSING EQUIPMENTS

CLAMP (4) & STONE BASE (5)

| DESIGNED: M.T. | DATE: 31ST AUG., 1994 | SCALE: 1:5 |
|---|---|---|

HANDLED FIBER BAND
'KOTCHO' SQUEEZER



SERRATED HORN PULVERIZER

AWASSA COLLEGE OF AGRICULTURE
DEPARTMENT OF AGRICULTURAL ENGINEERING & MECHANIZATION

NORAGRIC PROJECT ON "ENSET" PROCESSING EQUIPMENTS

HANDLED FIBER BAND "KOTCHO" SQUEEZER AND SERRATED HORN PULVERIZER

| DESIGNED: M.T. | DATE: AUG., 1994 | SCALE: |
|---|---|---|