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17418

Distr.
LIMITED

ID/WG.480/13(SPEC.)
6 April 1989

United Nations Industrial Development Organization

ORIGINAL: ENGLISH

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

Lusaka, Zambia, 9-13 January 1989

THE NEED FOR INDIGENOUS, SIMPLE FOOD PROCESSING
AND PRESERVING EQUIPMENT**

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

** The views expressed in this paper are those of the author and do not necessarily reflect the views of the Secretariat of UNIDO. Mention of firm names and commercial products does not imply the endorsement of the United Nations Industrial Development (UNIDO). This document has not been edited.

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1. The need for food processing and storage facilities in Zambia

The processing and preserving of food products are essential in the agricultural system of any country. The significance of these activities differ among countries, depending on the relative spread of production and consumption centres, the climate and the prevailing levels of agricultural production. In Zambia, the need for food processing and preservation facilities are accentuated by the following factors:

- a. The seasonal nature of food production. In Zambia, most food crops are rainfed. Hence, they are grown from November to May. However, since consumption takes place throughout the year, the food must be processed and stored--first to increase storage life and also to prepare for consumption.
- b. A food surplus/deficit situation between the producer and the consumer areas. Over 60 per cent of the food crop is produced in the sparsely-populated rural areas, while the main consumption areas are the towns situated along the line of the rail. Processing facilities are, therefore, required before and after hauling the produce to the consumption areas to increase food value so it can sell higher to the consumer and save on hauling costs.

Lately, two additional factors have intensified the need for food processing and preservation facilities in Zambia. These are:

- a. The shift from mining to agriculture as the mainstay of the economy. With the expected exhaustion of the copper reserves with the next 15-20 years, the agricultural sector is now receiving greater attention from the government and the private sector. As a result, agricultural production has risen steadily; so has the number of processing and preservation facilities.
- b. The need to expand the export trade to earn foreign exchange. The critical shortage of foreign exchange in the country has caused a greater interest in the export trade among food producers in the country. To command better prices on export markets, the food must be exported in a processed form. This calls for more and better food processing and preservation facilities.

2. The current state of the food processing and preservation industry in Zambia

Until recently, food processing and preservation activities in Zambia were found at two levels only:

- a. The family level, where food is processed and preserved for consumption by the producing family. A variety of traditional methods of processing are used and mostly done by women.
- b. The industrial level, where raw food purchased from small- and large-scale producers is processed and preserved by private and parastatal companies for sale to the general public. The methods used are generally large scale and capital intensive. The equipment used is invariably imported.

The recently increased support by the government for small-scale entrepreneurship has led to an introduction of "intermediate" food processing and preservation methods. These methods are generally applicable at the family and/or semi-industrial levels. Most of the equipment required can be designed and manufactured locally. This paper discussed the design, development and manufacture of such "simple" equipment in Zambia.

3. The need for the development of simple food processing and preserving equipment-----

The increase of small-scale food producers in the country requires that much more attention be paid to the development of food processing and preservation equipment suitable for individual farmers and/or groups of farmers, such as small co-operatives. The availability of such simple equipment on the local market at affordable costs would benefit the users and the whole country in the following ways:

- a. It would enable the small producer himself to process and preserve his produce so that it is more suitable for transportation to the consumption areas and for export. This would generally cut down the amount of total produce material requiring hauling to the consumption centres.
- b. It would enable the producer to process and preserve part of his produce for consumption in his own household or community. Presently, it is not uncommon to find, for example, sunflower growers queuing up at a local retail shop for cooking oil, which is produced by large-scale processing companies such as Refined Oil Products. In many cases, this makes the oil more expensive for the producer and negatively affects the nutritional status of the household and the local community. The situation is sometimes further complicated by government subsidies on processed food, which can make it cheaper for the producer to buy finished food products than to process those of his own.
- c. It would become possible for the producer to add value to his produce and, therefore, sell it at a higher price. A case in point in Zambia is the high demand for simple groundnut shelling units, which seems to have been generated by the large differential between the producer price of unshelled and shelled groundnuts recently offered by the government.
- d. It would enhance or even stimulate the local consumption of produce. This can only increase the nutritional well being of even the remotest communities to the benefit of the entire country.
- e. Local processing and preservation of food and other produce would create more jobs in the producer community. This is, indeed, a very important issue in Zambia and in many other developing countries where job opportunities are concentrated in the relatively few industrial and commercial centres in the country, thereby resulting in the so-called "urban drift".

4. Main considerations in the design, development and manufacture of equipment

To realize the potential benefits outlined above, it is imperative that any such available food processing and preservation equipment is suited to the conditions--financial and otherwise--of the small food producer in Zambia. Specifically, the following issues need to be addressed during the design, development and manufacture of such equipment:

- a. Mode of operation. In Zambia, it is still true that most small-scale producers do not have access to electricity or even to a reliable source of liquid fuels even if they were affordable. The utilization of renewable energy resources, such as windpower or minihydros, is still in its infancy. It, therefore, seems that a majority of the required food processing and preservation equipment needs to be manually driven.
- b. Use of locally available resources. The relatively short, useful life associated with equipment imported into developing countries such as Zambia can be attributed to the lack of local input during their design, development and manufacture. The resources referred to are, namely:
 - (1) Materials. Most engineering products require regular maintenance and replacement of worn parts. For imported equipment, the materials used to manufacture the spares need to be imported as well. Usually, the local small producer (or even the local dealer for the produce) generally does not have ready access to the necessary foreign exchange. Therefore, the use of locally available materials in the design of the equipment is essential.
 - (2) Manufacturing facilities. Imported designs are often not matched to the manufacturing facilities that are readily available. For example, casting facilities are not generally available and, yet, a lot of the imported equipment contains cast components. Basically, this means that spares cannot be easily manufactured locally. The design and development of equipment should, therefore, include an appraisal of the manufacturing facilities available within the country.
3. Manpower. The absence of local manpower in the design, development of imported equipment generally leads to the manufacture of products that are unsuitable to the needs and capabilities of the intended users. This is particularly true of many products (and technologies) generated in the developed countries specifically for developing countries as these are most always based on incomplete or distorted information about the social-economic and technological status of the end users. A sound knowledge of the end user's needs and capabilities is a prerequisite for the design and development of successful products: local manpower must, therefore, be involved in the design and development of equipment.
- c. Ease of use and maintenance. The majority of the expected users of the simple equipment under discussion cannot be expected to have opportunities for formal training in the proper operation and maintenance of equipment. Therefore, easy-to-operate and easy-to-maintain equipment is usually required.

Now a word of caution is necessary. In discussions on the design and development of simple equipment, the requirement for e.g., use of local materials, ease of maintenance, are frequently confused with the ease with which such products can be designed or even manufactured. There is no direct relationship; the design of these "simple" products needs to be approached in a similar way to that for the more "sophisticated" ones and should not preclude the use of the latest design and development tools, such as computer technology.

5. Current efforts in Zambia

A number of public and private institutions have realized the need for food processing and preservation equipment at the village or semi-industrial levels. Therefore, they are engaged in designing and/or manufacturing of such equipment. In most cases, the efforts are being made towards promoting the manufacture of equipment using modifications of designs previously developed within and outside the country.

Brief descriptions of the activities of the principal organizations involved in the development and manufacture of simple food processing and preservation equipment in Zambia are given below. Background information about each of the organizations is provided in Appendix I. Most of these organizations are also represented at this meeting.

a. National Council for Scientific Research (NCSR)

The following equipment has been developed in The Food Technology Research Unit of the NCSR:

- (1) A drum roaster for groundnuts and soyabean. This equipment was extensively used during the development of the infant foods "NUTRIFEX" and "FORMULA A", which are expected to be introduced soon on the market.
- (2) An indirect solar drier. The design of the equipment was aimed at improving the quality of dried vegetables in comparison to that obtained from traditional drying methods. The equipment is currently being used by many organizations for the drying of vegetables as well as fruits.
- (3) A hydraulic fruit juice press. Most of the components in this press are made from wood. Presently, the equipment is being used in the extraction of juice from pineapple for concentration purposes. It is able to produce 250-300 litres of juice daily.

b. Technology Development and Advisory Unit (TDAU), University of Zambia

Since its inception in 1975, TDAU has undertaken a lot of design and development work on food processing and preserving equipment as indicated below:

- (1) Hand-operated maize sheller. This small unit was developed some years ago. A batch was produced in TDAU and sold to small-scale farmers. Although there has always been an annual demand for these

units, their commercial production has not escalated due to a general lack of casting facilities in many small industry. A production of another batch for sale is planned before the next harvest season.

- (2) Hand-operated groundnut sheller. This is a low-cost sheller of wooden construction. Now, there is a renewed interest in the product by small-scale farmers due to a price incentive offered by the government for shelled groundnuts. The original design has recently been modified to accommodate many sizes of unshelled nuts.
- (3) Oil expressing unit. TDAU is currently involved in the testing and development work on three types of sunflower oil expressing units in collaboration with interested aid agencies. TDAU is also providing technical support to a local company (Lutanda Industries), which is commercially producing oil expressing equipment.
- (4) Sorghum dehuller. TDAU is collaborating with The Small-Scale Industry Development Organization (SIDO) in the promotion of the local production of a sorghum dehulling unit, which was originally designed in Botswana.

c. Village Industry Service (VIS).

With UNIDO assistance VIS has executed studies on the potential for food processing projects based on simple equipment. It has identified project opportunities in grain processing, production of jams and juices and in oil extraction. The organization has so far promoted projects involving the use of small maize mills and edible, oil-extraction equipment.

d. Small Industries Development Organization (SIDO)

In line with their mandate to foster and encourage the development of small-scale industries, SIDO is involved in a number of projects related to food processing and preservation. One such project is the localization of the manufacture of a sorghum dehulling unit to a design originally developed in Botswana. The University of Zambia (TDAU and Rural Studies Bureau) is collaborating with this work.

e. Industrial Development Corporation Limited (INDECO)

INDECO Ltd. is a state-owned corporation which, among other activities, is heavily involved in the processing of food products. Its food processing activities include milling, manufacture of meat products, processing of crop products like sugar, coffee and fruits, baking and production of edible fats and cooking oil. Although these are all large-scale operations and the equipment used is invariably imported, there is an innate potential for the corporation to play a very significant role in the design, development and manufacture of simple food processing equipment.

f. Kasisi Agricultural Training Centre

The Centre has an Appropriate Technology Workshop to make simple equipment for food processing and storage. A groundnut lifter has been developed here. The Centre is also used as a station for the field testing of

intermediate technology equipment designed and developed by other organizations. For example, TDAU is currently fieldtesting two types of sunflower oil expressing equipment at the Centre.

The other institutions involved in the development of simple food processing and storage equipment include (see Appendix I for addresses):

- g. Agricultural Engineering Section, Ministry of Agriculture and Cooperatives
- h. Zambia Cooperatives Federation
- i. Lutanda Industries (oil expression equipment)
- j. Livingstone Hardware Stores Limited
- k. Turning and Metals Limited
- l. Northland Engineering Limited

6. Main problems hindering progress

The technology of the design of small-scale food processing equipment is neither new nor exotic. Application of conventional technology to local situations is being undertaken in different countries concurrently and at a great cost. Success rates vary among places. Often development activities in one country are undertaken in isolation from similar work in another country, resulting in a situation where each country has to go through the re-invention of the wheel. No formal information exchange exists among the countries that are involved in the small-scale food processing equipment design and development. Technically, it is to the advantage of these countries to use or adapt slightly modified designs already developed elsewhere. Economically, it is cheaper to adapt a design than to develop an idea.

In most organizations working on design and development, there is no adequate technical design expertise available. Within the country, organizations supported for foreign-donor agencies usually engage international development workers who are not necessarily well-versed in engineering design. Among government-supported organizations, funds are often too low even for the minimum development work to start. Engineers of adequate caliber will usually not stay long at poorly-funded institutions. Obviously this deprives these centres of the desired capabilities for developing indigenous technology.

In cases where some development and/or adaptation has taken place, there have not been sufficient funds to mount adequate extension or promotion of the technology among the intended users of that technology. Basic adaptation requires that research is conducted to determine what design modifications are required to fit into a particular cultural, economic and environmental situation. In Zambia, this work is still in its infancy.

Another important factor in the development of the food processing equipment industry is the scarcity of materials for equipment production. Often this means special quality steels are costly as they are invariably imported into the country. When and if these steels have been imported, the cost of the landed stocks makes the prices of the manufactured prototypes too high for the intended users of the equipment. It is usual to find completely imported versions of the same equipment selling for less than that being manufactured locally. Two main negative factors account for this: small-scale technology (third-world technology) receives subsidies on the export/manufacture from the home governments of the exporting organizations resulting in an unfair price advantage against local manufacturers. Steel imported for the manufacture of agricultural and food processing equipment is subjected to the same tax and customs levies as ordinary industrial steels. Because of the larger profit margins on the industrial products, manufacturers prefer to substitute this steel to manufacture industrial products for food processing equipment. It is also often said that price controls in the sectors where production is to be encouraged have negative effects. Deliberate targeting of incentives into these critical areas will accentuate development in the sectors.

Perhaps a major reason for the apparent lack of development in this area is the absence of co-ordination among the institutions working in food processing and preservation. If a co-ordinating body existed, information flow within the country could be assured and the means to address the constraints faced in the development of this industry could be found.

7. The future

The future for the small-scale food processing industry in Zambia looks good. This is not so for food preservation. Recent developments indicate that official emphasis in the national development is definitely shifting towards a distributed (decentralized) processing of food. Institutions have been created by the government to specifically address the establishment of small-scale industries (food processing is one of them) with the individual farmer or co-operative societies as the beneficiaries of the programmes. The deliberate encouragement of the processing activities by the government will result in the sharing of the large burden of production of processed foods that currently lies squarely on the large parastatals with the small-scale producers scattered around the country.

Recently the government, through the Ministry of Agriculture and Co-operatives, has encouraged development work at research institutions in Zambia with increased financial commitments in food processing. This is an encouraging trend. It can be expected that small-scale manufacturers of food products (both public and private) will be encouraged to use locally-produced equipment as direct importation is likely to become more difficult due to the shortage of foreign exchange.

The future of the small-scale food processing industry is predicted to improve if and when foreign-aid participation is directed at assisting the removal of engineering constraints of material supplies, especially those of steel. Such efforts will assist in establishing a sustainable, small-scale food processing and preservation industry in Zambia.

APPENDIX I

Organizations involved in the design, development and/or manufacture
of simple food processing and preserving equipment in Zambia

- A. National Council for Scientific Research (NCSR)
(Food Technology Research Unit, P.O. Box CH 158, Lusaka)

The National Council for Scientific Research is an organization created by the government to promote and co-ordinate scientific research and activities within Zambia. One of its specific functions is to encourage branches of science and technology, which have unique Zambian conditions as their field of study. The Council has, among other units, the Food Technology Research Unit which, through its Engineering Section, is involved in the design and the fabrication of low-cost food processing equipment.

- B. Technology Development and Advisory Unit (TDAU)
(University of Zambia, P.O. Box 32379, Lusaka)

TDAU is a Unit in the School of Engineering of The University of Zambia. Its objectives are: (a) to help and advise on the design and production of agricultural and household equipment locally; (b) to serve as a development center for new equipment and processes aimed at replacing imported models; (c) to act as a clearing house for designs and prototype development for other organizations; (d) to stimulate grassroot development of rural areas towards self-sufficiency; and (e) to serve as a center to pool advice from the University to various local industries. Since its inception, the Unit has been heavily involved in the design and development of food processing equipment.

- C. Village Industry Service (VIS)
(P.O. Box 35500, Lusaka)

VIS is one of many organizations created to promote grassroot development through providing various types of assistance and support services to small entrepreneurs. The organization is registered as a society and operates on the lines of a nongovernmental organization.

VIS is mainly concerned with rural development to promote intensive labor, agro-based cottage and village industries whether individual or co-operatives, which encourage income creation, utilize local resources and are based on simple equipment and machinery. Over the years it has identified potential for cottage industries in food processing, metal fabrication and blacksmithing, woodwork, chemical processing, textiles, woodcraft and leather goods.

- D. Small Industries Development Organization (SIDO)
(SIDO House, P.O. Box 35373, Lusaka)

SIDO was created by a Zambian Act of Parliament in 1981 with the mandate to foster and encourage the development of small industries in Zambia. Its operational areas are project appraisal (project development and research,

project preparation), project supervision and technical resource/support. One of its specific functions is to provide assistance in procuring, obtaining or providing supplies, equipment or raw materials for small industries.

In this respect SIDO is involved in the promotion of the design, development and manufacture of simple food processing equipment.

E. Industrial Development Corporation Limited (INDECO)
(INDECO House, P.O. Box 31935, Lusaka)

INDECO Ltd. is a state-owned corporation and is a subsidiary of ZIMCO Ltd., which is the government arm responsible for state participation in Zambian industry. INDECO has 43 subsidiary companies and also has interests in a number of privately-owned enterprises. Many of the subsidiaries are involved in the large-scale processing of food.

F. Kasisi Agricultural Training Centre
(P.O. Box ..., Lusaka)

This is a small, church-run training centre intended to help nearby families to improve agricultural methods. During their two-year stay at the centre, the trainees are required to invest the proceeds from the sale of their production in the acquisition of oxen and implements to take back to their villages.

Attached to the Center is an appropriate technology workshop to make ox-drawn equipment such as carts, harnesses, ripper/planters, etc. The centre also has a small unit, which makes fibre-cement tiles and expressing oil from sunflowers.

G. Agricultural Engineering Section, Ministry of Agriculture and Co-operatives (P.O. Box 34890, Lusaka)

H. Zambia Co-operatives Federation
(P.O. Box 33579, Lusaka)

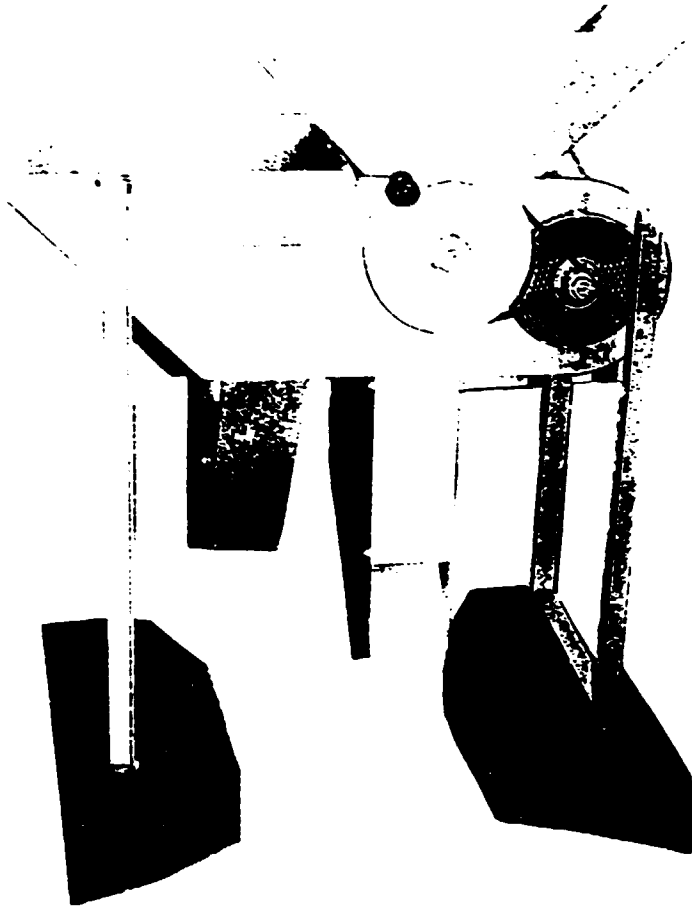
I. Lutanda Industries
(P.O. Box 33139, Lusaka)

J. Livingstone Hardware Stores Limited
(P.O. Box 60288, Livingstone)

K. Turning and Metals Limited
(P.O. Box 31608, Lusaka)

L. Northland Engineering Limited
(P.O. Box 71640, Ndola)

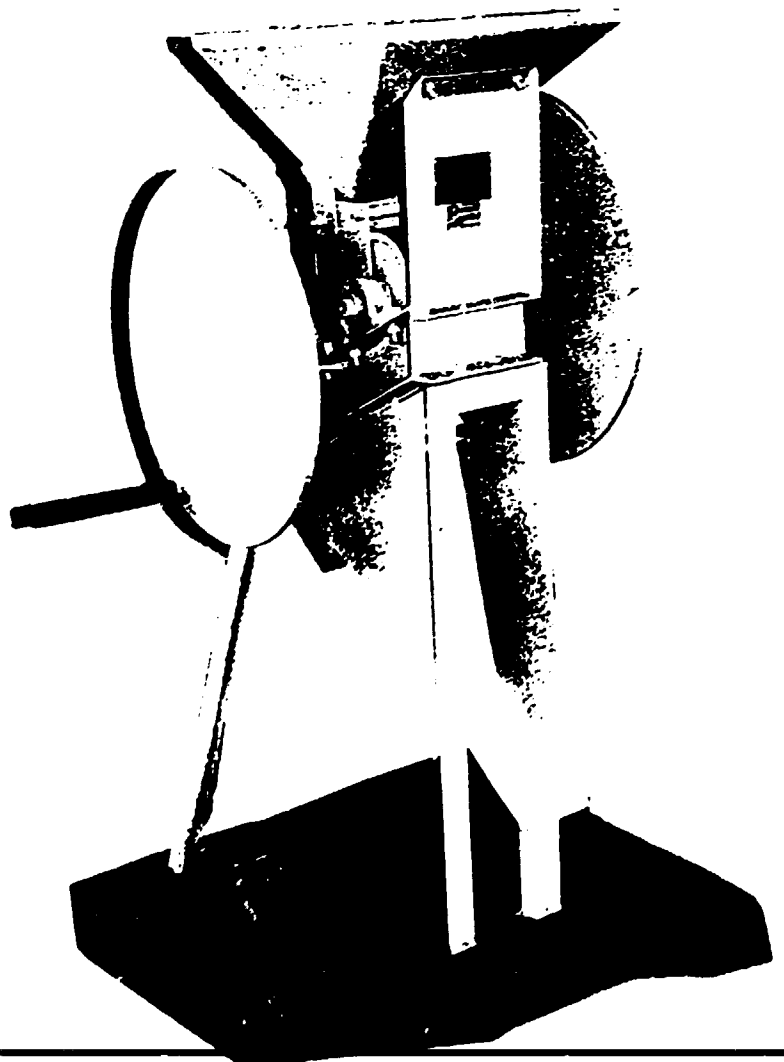
INDIGENOUS OIL EXPRESSING EQUIPMENT
MANUFACTURED IN ZAMBIA BY LUTANDA LTD.



STAGE 2 Winnowing

The Winnower separates the hulls from the kernels and any unbroken seeds. This separation need not be perfect, as the presence of some hulls assists the flow of oil within the press. Speed of operation should be fast enough to remove most of the hulls, but not so fast as to blow out broken kernels through the hull discharge chute. The hulls should be inspected to see if there are any bits of kernels blown out among them. These can then be separated by shaking in the traditional way.

Equipment Winnower



STAGE 3 Milling

Milling flattens the kernels and increases their surface area to help absorb moisture and heat. Crushing the kernels also helps break the oil-bearing cells and lets the oil leak out more easily.

Equipment Mill

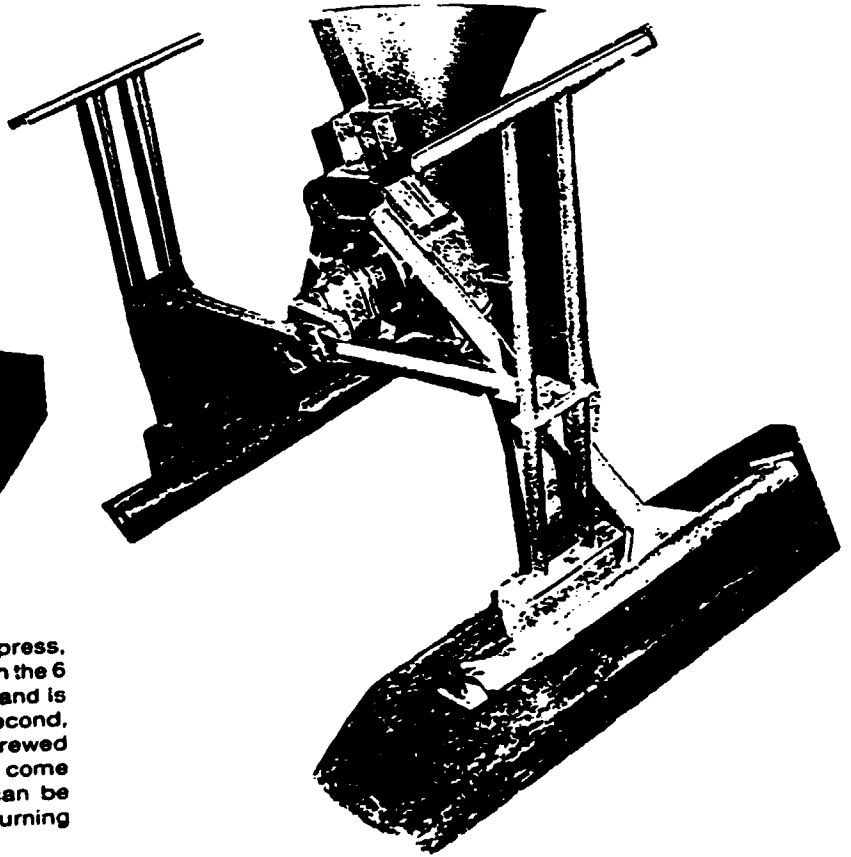
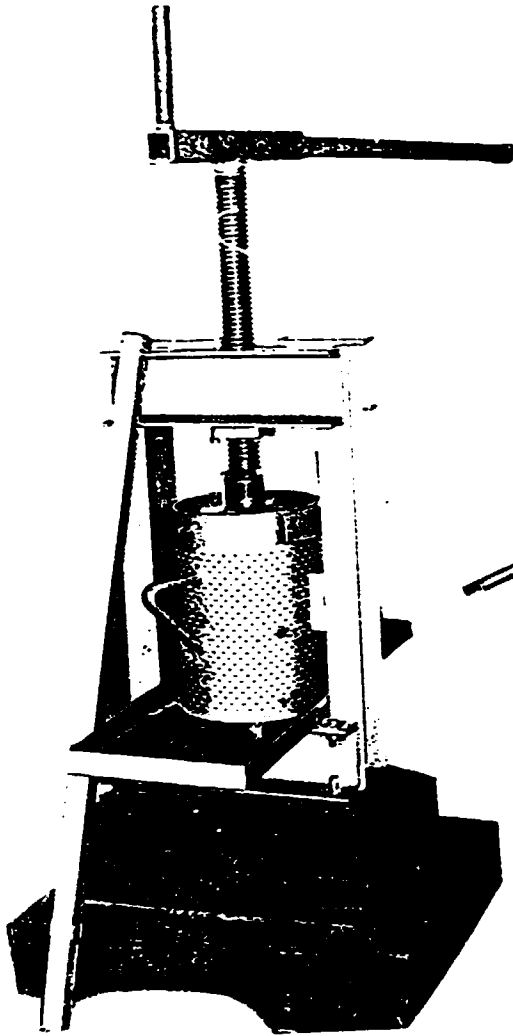
STAGE 4 Dehulling

Dehulling or decorticating breaks up the seed so as to release the inner part, called the kernel, which contains the oil. This is done with the Decorticator or Cracker.

The seeds enter at the centre of a rotating disc, which throws them against a plate surrounding it, and the impact breaks the hulls from the kernels.

The disc is rotated at about 3000 revolutions per minute by means of a gearbox turned by crank levers which are hand operated by two persons at about 1 pull per second. It should not be operated too fast because the kernels will then be broken up or chipped, which will result in parts of the kernels being blown out with the hulls during winnowing.

Equipment Decorticator



STAGE 5 Pressing

The material is now passed through the press, having first been loaded in layers between the 6 steel plates. The oil drips into a bucket, and is then passed through a sieve into a second, clean, bucket. The press should not be screwed too fast especially when the oil begins to come out. Let the oil flow freely; pressure can be increased when the flow slows by more turning of the spindle.

Suggested Layout

