

ABSTRACT

## A HEAT ASSISTED PALM OIL SCREW PRESS

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This article describes a palm oil screw press which has been developed for use by farmers in Sierra Leone.

Special features of the press are:

- (a) It can be easily dismantled into various components for easy transportation.
- (b) The incorporation of heat in the form of steam to facilitate the easier extraction of palm oil during pressing.
- (c) The time for the complete process of loading, pressing and unloading is significantly decreased due to design features of the press.

Also discussed are some preliminary results obtained with this machine, pointing out its advantages and areas for improvement.

In addition, several factors which should be considered during future tests to completely assess the performance of the press are elaborated.

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## INTRODUCTION

Palm oil is an important component of the diet of the majority of Sierra Leoneans. This oil which is obtained from the mesocarp of palm fruit is widely used throughout many countries in Africa.

The quantity of palm oil produced in Sierra Leone, using relatively large and sophisticated mills on an industrial scale is very small compared to the total quantity consumed. Thus most of the oil consumed is produced at the farm level using traditional methods, which produce about 35 to 50 percent of the oil available in the fruit.

Methods used for extracting palm oil at the village level are basically similar, the differences being in the methods used to soften the mesocarp and pressing of the oil out of them.

In one of the methods, the fruits are boiled to soften them and are then put in a pit which is lined with mud. The farmers separate the pulp from the kernel by stepping on the fruit. Water is then poured on the mashed fruit and the oil which floats at the top is scooped off. A variation of the process allows the fruit to soften by fermentation over a period of days before being threshed in the pit. In another method, the oil is squeezed out of the mashed fruit by hand; washing it in water and scooping up the oil.

Several disadvantages are associated with the traditional processes namely:

- (a) Only about 35 to 50 percent of the available oil is said to be extracted.
- (b) Due to the fermentation process used to soften the epicarp and the usual delay between harvest and processing, the oil produced is acidic, thus lowering its quality.
- (c) The process is unhygienic.
- (d) The process is time consuming.

In order to improve the processing of palm fruit, oil presses using screw shafts for the application of the pressure necessary to extract the oil have been designed in Sierra Leone. These presses typically have a screw attached to a piston which move vertically in a perforated drum. When the drum is loaded with palm fruit and the piston lowered, oil is extracted and passes through the perforations into a receptacle. To unload the drum after pressing, the screw is rewound, the drum is lifted out and emptied.

It is obvious that the process of loading and unloading is time consuming. Also, many of the existing palm oil presses are difficult to transport due to their bulk and weight. They are heavy since designers try to make them robust so as to withstand the high stresses involved during pressing. Another problem involved with these presses is that the oil flows slowly during extraction due to its viscosity which also increases processing time and decreases the quantity of oil extracted.

In order to alleviate the problems mentioned in the preceding paragraph, a palm oil screw press has been designed. This article describes the main features of the design and manufacture, and preliminary test results using the press under real life farm conditions over the past three years. Certain observations on the general procedure for assessing the performance of the press in future work are outlined.

### DESIGN FEATURES OF HEAT ASSISTED PRESS

The general view of the palm oil press is shown in figure 1. It consists of a piston which is attached to a threaded shaft and made to move vertically in a perforated drum by turning the handle shown in a horizontal plane. The screw press is mounted on a hollow tube stand 27 inch (68.6 cm) high. Steam is produced in the "boiler" and passed into the palm oil press through a heat resistant flexible rubber hose.

A close up view of the external features of the press is shown in figure 2 and design details are shown in figure 3.

The handles used for moving the screw thread are three 2 cm diameter mild steel rods 60 cm long attached to a circular mild steel piece with a square hole which fits loosely in the squared end of the screw shaft. One of the handles is welded to the centre piece while the two others are screwed in. This facilitates transportation by reducing the bulk of the disassembled handles.

The screw shaft  $1\frac{1}{2}$  inch (3.8 cm) in diameter and  $12\frac{1}{2}$  inch (31.8 cm) long, has 8 square threads per inch. It is threaded through a block which is welded on to a  $9\frac{1}{2}$  inch (24.1 cm) diameter,  $\frac{1}{4}$  inch (0.64 cm) thick mild steel plate, reinforced by a triangular hollow square channel as shown in figure 3 and 4. At the apex of this triangular support are welded blocks with vertical holes and smaller radial holes (figures 3 and 4). The piston,  $8\frac{1}{2}$  inch (21.6 cm) in diameter, is attached to the bottom end of the screw shaft (figure 3) so that it is free to rotate with respect to the shaft during pressing. This arrangement minimizes the effort needed by the operator to overcome frictional forces during the oil extraction process.

As shown in figure 3, the assembly to which the screw thread is attached (and discussed in the preceding paragraph) is fitted to the outer perforated cylinder using three locking pins passing through the blocks shown in figure 4. The three vertical locking posts (figure 5) through which the blocks are fitted, ensure no relative motion between the outer perforated cylinder and the screw block assembly. The locking pins prevent any vertical motion of the screw block assembly.

The outer perforated cylinder is made from  $\frac{1}{4}$  inch (0.64 cm) thick mild steel plate and  $\frac{1}{4}$  inch (0.64 cm) diameter holes drilled around it. It has an external diameter of 10 inch (25.4 cm) and height of 12 inch (30.5 cm). Another perforated cylindrical container (made from  $\frac{1}{8}$  inch (0.32 cm) thick mild steel plate) also 12 inch (30.5 cm) high and having an internal diameter of  $8\frac{3}{4}$  inch (22.2 cm) has holes of  $\frac{1}{8}$  inch (0.32 cm) in diameter drilled around it as shown in figure 6. This inner cylinder fits inside the outer cylinder without rotating during pressing by means of the pins attached to the inner cylinder (figure 6) which fit in the two slots shown in figure 5.

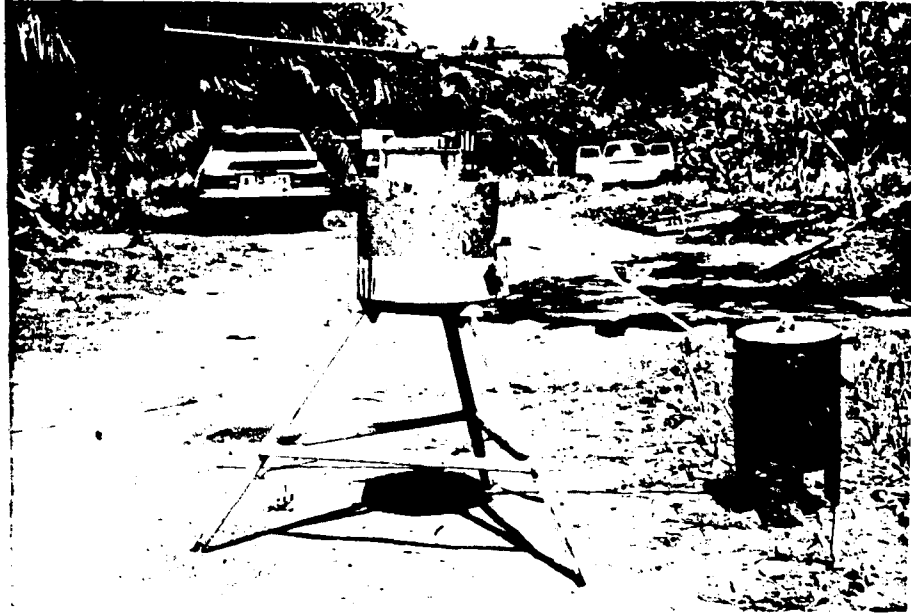


Fig. 1 Overall view of screw press  
connected to steam generator.



Fig. 2 General features of the  
assembled screw press.

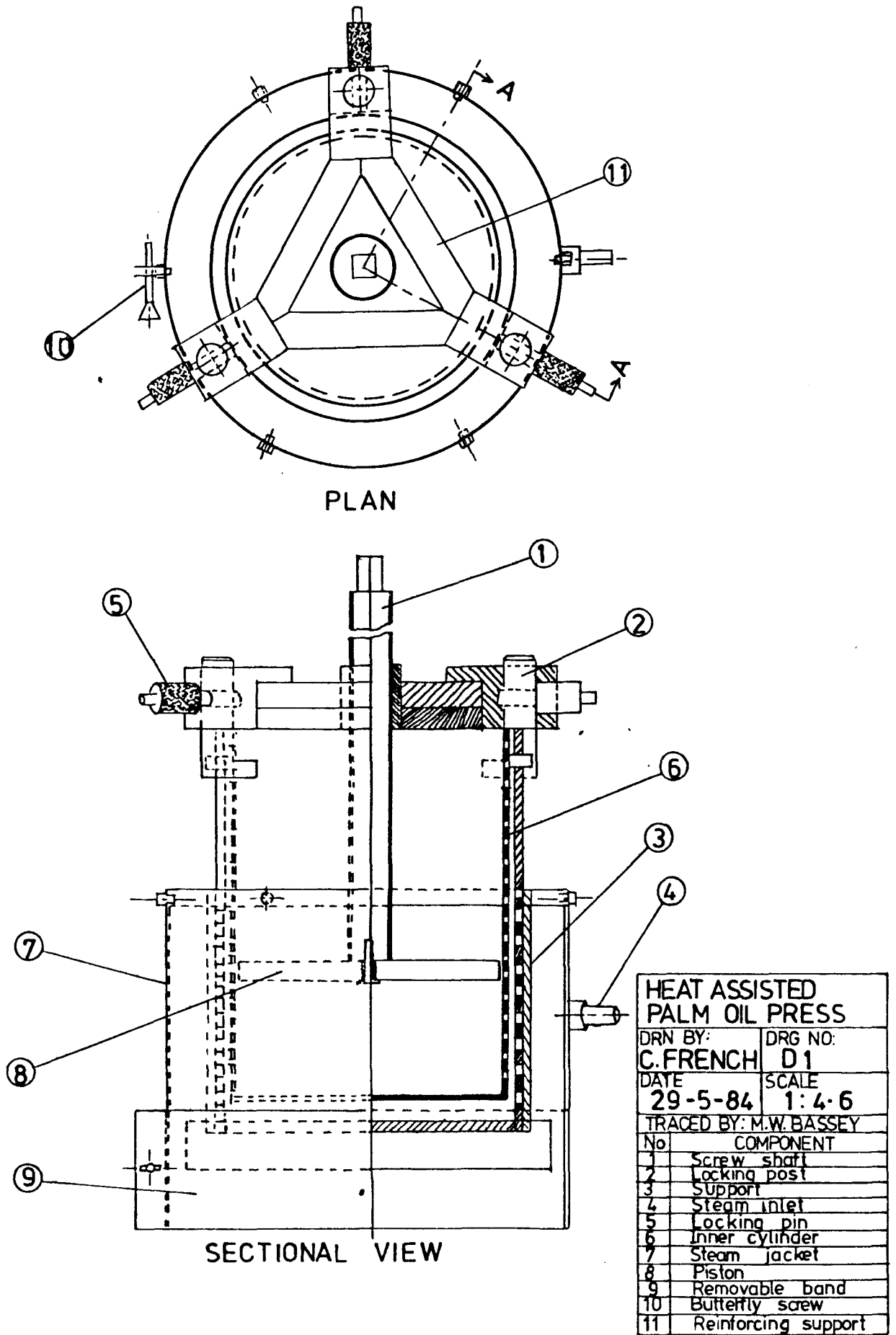


Fig. 3 Diagram showing design details of screw press.

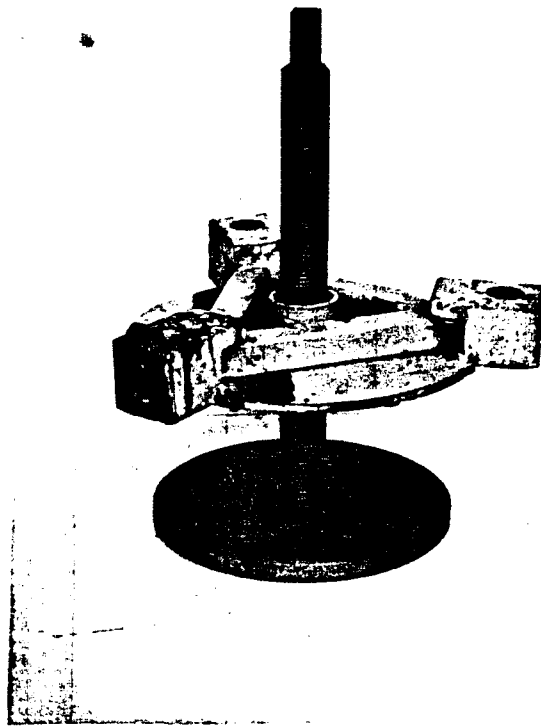


Fig. 4      Photograph showing details  
             of the screw shaft assembly.

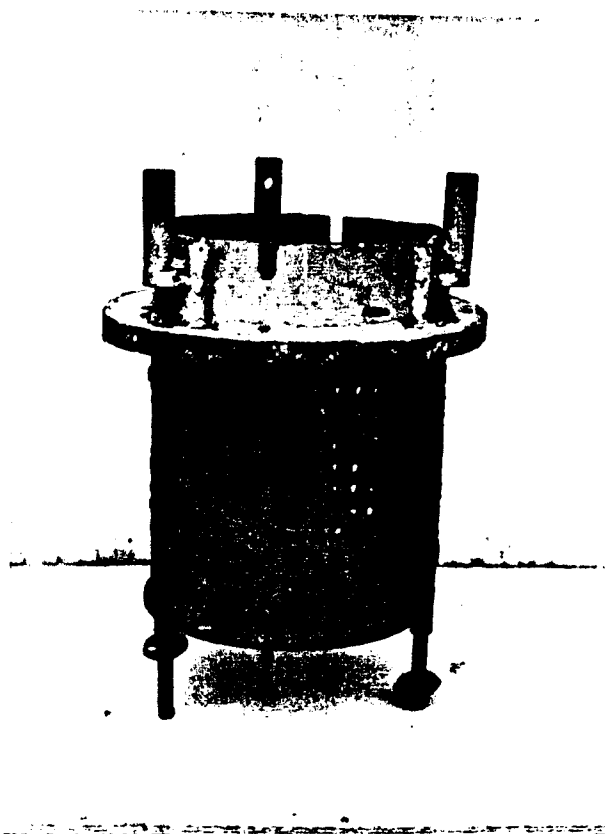


Fig. 5      The perforated outer cylinder with the vertical locking posts to accomodate screw shaft assembly.

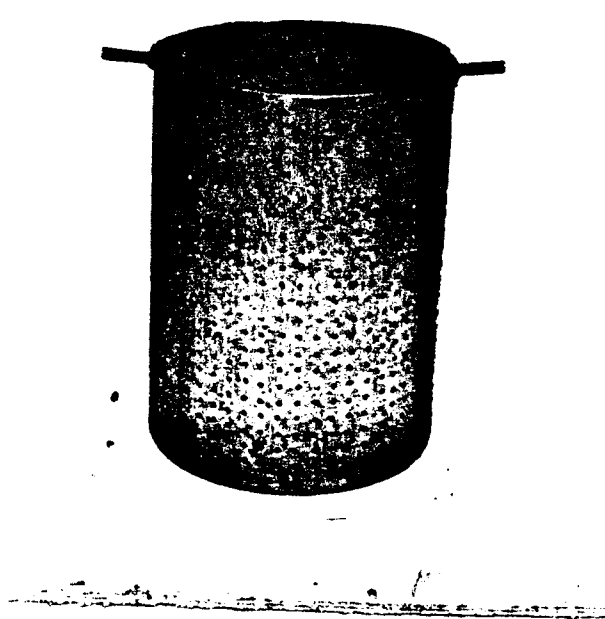


Fig. 6      Photograph showing the inner perforated cylinder in which palm fruits are pressed.

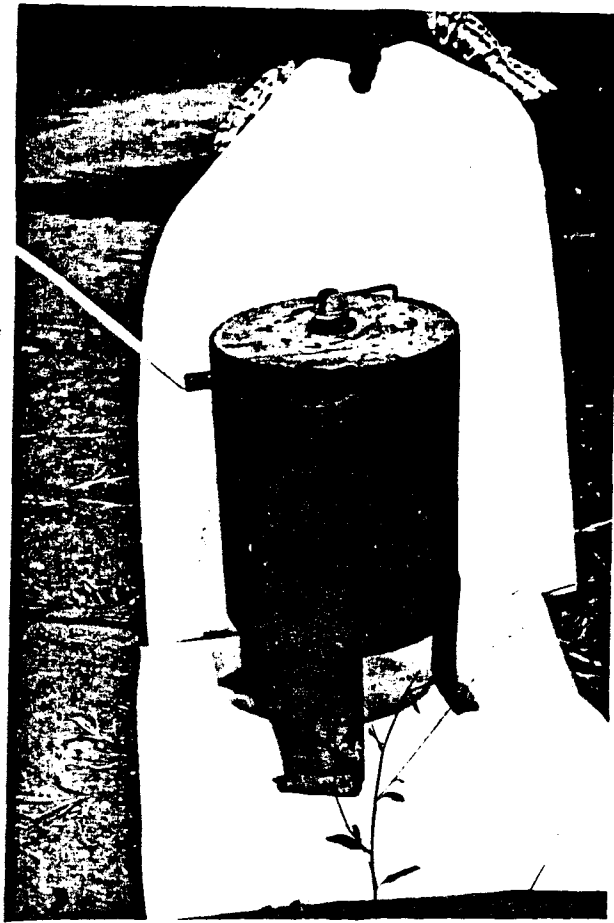


Fig. 7      The steam generator



A cover, the steam packet, made from 1/6 inch (0.16 cm) galvanized sheet is used to cover the external cylinder (see figures 2 and 3). A nipple is attached to this cover, half way along its height and used for connecting the press to the hose as shown in figure 1. The lower section of the steam jacket consists of a removable circular band, held in place by the butterfly screw (figure 3), and can be removed as desired for easy cleaning of the press.

The steam generator (shown in figure 7) is fabricated from 1/8 inch (0.32 cm) thick galvanized iron sheet. It is 12 inch (30.5 cm) high, 9 inch (22.9 cm) in diameter and rests on legs 6 inch (15.2 cm) above the ground. Water is added through a hole at the top which is closed by a threaded cover during operation. Heat is produced by a fire underneath the steam generator. Since the rate of steam generated is slow and the pressure in the oil press is effectively atmospheric, pressures in the steam generator are only slightly greater than atmospheric.

### OPERATION AND PERFORMANCE

In operation, the palm fruits to be processed are separated from the bunch by prying them loose or by hand threshing. It is advisable to process the palm fruits soon after harvest so as to minimize the formation of free fatty acids.

After separation of the palm fruit from the bunches, they are washed, then boiled for about two hours to soften the fruit. Some of the fruit are then drained and pounded for about 5 minutes to separate the fruit from the kernel and the fibre/kernel mash are then loaded into one of the inner perforated cylinders shown in figure 6. This is then inserted inside the outer perforated cylinder and the screw thread assembly located in place by the lock pins.

The steam generator which was earlier partly filled with water and heated with the residue from the harvested palm fruit bunches is connected to the press by using the flexible hose. Steam produced is fed directly into the palm fruit mash in the inner removable cylinder. The level of the water in the steam generator is easily verified by inserting a piece of stick through the top hole.

Pressure is then applied to the contents of the press by lowering the screw shaft slowly and the oil flowing out is collected by a container placed directly underneath the machine. This oil contains a small amount of water from the boiled fruit as well as steam condensed from the steam generator. It is however removed by heating the oil produced.

After pressing, the screw thread is unwound slightly to release the pressure on the three lock pins and the screw thread assembly is lifted. The inner cylinder is lifted out and another already loaded is inserted for pressing. This use of several inner cylinders substantially reduces the processing time of a given harvest.

A prototype of the machine has been in operation under farm conditions for the past three years. It has proved to be robust in use and transportation as no breakdowns have been reported.

Although detailed performance tests have not been carried out due to lack of mainly financial resources, preliminary results on the performance of the heat assisted press indicate its commercial potential. At least 6000 kg of cleaned palm fruit have been processed in the machine and oil has been extracted at the rate of about 0.25 kg per kilo of fruit (including the kernel weight). Using two perforated cylinders, the time taken to load, press and recharge, range between 4 to 10 minutes, depending on the operators. In general only two people are required to operate the press. Depending on the operators, experience has shown that a minimum of 200 kg of fruit can be processed in an 8 hour day, i.e. boiling, pounding and pressing.

The effect of operator performance on the efficiency of the machine is an important aspect of the implementation of this technology in rural areas. An indication of this is shown in table 1.

**Table 1. Effect of operator on yield of palm oil press compared to traditional method.**

TEST	MASS OF CRUSHED FRUIT AND NUTS (kg)	MASS OF OIL PRODUCED (kg)	PERCENT OIL YIELD
1	200	29	15
2	198	54	27
3	141	29	21
TRADITIONAL METHOD	108	12	11

It is noted that using the same species of fruit, the traditional method produces oil equivalent to 11 percent of the total mass of fruit and nuts. Although the quantities of oil produced using the press are higher there is a substantial difference in the values. This observation on one hand shows the higher efficiency of the palm oil press compared to the traditional but indicates that its application can be impeded due to improper use. Tests carried out with this press on the single farm has indicated that some training is needed by operators to maximize its potential.

#### FUTURE ACTIVITIES

Experience with this press so far shows that it is more efficient and saves time compared to the traditional method. However, one aspect of paramount importance is the cost of the palm oil press. Its cost was 250 Leones in 1979 but would now, due to the unstable financial situation be at least 1500 Leones. Attempts therefore have to be made at lowering the cost as much as possible by changing certain aspects of the press' design.

In order to change any part of the press or modify the operation, it will be necessary to thoroughly test the machine to determine its performance under various operating conditions. Firstly, the traditional method must be thoroughly documented to assess the following:

- (a) the yield of palm oil per kg of fruit processed;
- (b) the effect of various varieties on the yield of oil per kg of fruit;
- (c) the quality of the oil obtained.

These results will give a better basis for comparison of the traditional method with the performance of the heat assisted palm oil press.

Tests on the press should consider:

- (a) amount of oil produced per kg of palm fruit;
- (b) oil quality;
- (c) percentage impurities and water in oil;
- (d) effects of using heat on palm oil yield;
- (e) optimum number of operators per press;
- (f) quantity of palm fruit processed in a working day;
- (g) effect of fruit variety on quantity of oil obtained;
- (h) economic assessment of the overall performance of palm oil press.

Activities to obtain the above mentioned information have been initiated at the University of Sierra Leone in collaboration with the International Development Research Centre (IDRC). The study generally consists of; obtaining detailed information on the traditional method, testing the heat assisted press and comparing its performance to another palm oil screw press currently in use in Sierra Leone, improvement on existing designs, limited field testing of appropriate presses in the rural environment, and assessment of the results for further implementation.

### CONCLUSION

The above presentation has described a palm oil screw press which incorporates heating during its operation to improve efficiency.

It is noted that the press as designed can withstand continuous operation under typical farm conditions with hardly any maintenance. Due to its design features it can be easily dismantled and transported by only two people.

The palm oil press is capable of doubling the quantity of oil produced compared to the traditional method.

Further testing are necessary to fully assess the technological and socio-economic impact of this palm oil press.

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