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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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ASSISTANCE IN THE DESIGN OF A PROTOTYPE PALM OIL EXTRACTION PRESS FOR RURAL AREAS

GUINEA

Technical report: Survey on small scale palm oil extraction and assistance in the design of a prototype press*

Prepared for the Government of Guinea
by the United Nations Industrial Development Organization

Based on the work of W. Lentz
Exrert in Palm Oil Fxtraction

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ABSTRACT

Palm oil extraction in the Republic of Guinea is at present done according to traditional methods with wild dura palms as the only source of fruit. A survey of the present situation was carried out and on the basis of its observations proposals are put forward regarding the planting of improved varieties of oil palms and the introduction of hand operated oil presses resulting in improved small scale extraction. The various types of presses are compared to the traditional method as regards labour input, oil extraction efficiency and economic feasibility. Socio-economic aspects of the modernisation of palm oil production are analysed with special reference to women's role in this activity. The possibility of manufacturing oil presses and ancillary equipment locally is reviewed.

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INTRODUCTION

The consultant has had some 8 years experience with small holder oil palm projects including small scale and intermediate scale oil extraction as well as the organisation of cooperative societies in the Republic of Cameroon. The mission to the Republic of Guinea, originally planned for 1984, was postponed to 1985 to permit the timing to coincide with the main oil palm harvesting season. The consultant arrived at Conakry on the 29th May 1985 and left on the 26th June. During the course of the mission the consultant travelled through the main oil producing regions of Basse Guinée and Guinée Forestière and gained first hand experience of the situation of oil producers including methods of extraction, condition of the groves and marketing of palm oil. At Conakry the CENTRE PILOTE was visited and possiblities of manufacture of small scale extraction equipment discussed with the director and his chief technical advisor. Meetings with the competent government officials at national, provincial and district levels completed the fact finding of the mission and enabled the consulted to carry out the objectives:

Review of existing traditional operations and comparative evaluation with best of innovated techniques; assessment of new techniques from the wider perspective of socio-economic aspects; selection of small scale extraction equipment with regard to possible manufacture in the Republic of Guinée.

RECOMMENDATIONS

1.) It is recommended that UNIDO should arrange for and finance the production of a small series of curb presses adapted for palm oil extraction with one of the european firms still offering these presses for the wine growers.

2.) It is recommended that UNIDO set up a project for the introduction and demonstration of these curb presses in the major palm oil producing regions of Guinea and at the same time prepare for the production of these presses at Centre Pilot in Conakry (itself a UNIDO project). The price of these presses as manufactured in Conakry must be accurately known at the time of demonstrating them to the farming population.

3.) It is recommended that the Government of the Republic of Guinea approach FAO for an expert to assist in the exact definition of the specific tenera palm seed material most suitable for village type plantations in the two major oil producing regions.

4.) It is recommended that the Government of the Republic of Guinea approach the European Development Fund for the financing of an oil palm project consisting entirely of small holder tenera palm plantings with small scale extraction based on the COLIN or some other small continuous screw press offering the alternative possibilities of manual operation or engine drive.

I. TRADITIONAL PALM OIL EXTRACTION

There is a marked difference in the conditions of palm oil production beteen the coastal plains of Basse Guinée and the region called Guinée Forestière in the southeast of the country bordering on to Liberia and Ivory Coast.

A. Basse Guinée

Oil palm production is important in the coastal plains and on the islands in the north and off the capital of Conakry. The productive area is by and large covered by the administrative districts of Boké, Boffa, Forécariah and the zone around the capital Conakry. Tradtional processing of palm oil was observed on the island of Kassa in the village of Sorro near Conakry, in the village of Tiyé near Boffa and in the village of Kolabounyi in the district of Boké. In addition to the information obtained from the villagers performing palm oil extraction at the time when these places were visited information on traditional extraction was obtained from the director of agriculture for Boké province, the director of the iol palm project for Boké province and from leading officials of the womens organisations on the provincial level in Boké, at Boffa the director of agriculture was extremely helpful in providing information and so was the directrice of the womens organisation. Unfortunately it had not been possible due to lack of time and transport to visit Forécariah administrative district as well.

The most detailed account was obtained at Tiyé village and the impression was there was little difference in the method employed for the traditional extraction throughout Basse Guinée. Traditional extraction here is entirely a women's job. The men climb the trees and leave the harvested bunches below the palms. Women and children carry the bunches to the extraction site which is frequently but not necessarily in the village but always near a water point. Bunches are apparently ha vested in a very ripe condition as the stripping of fruit takes place immediately after harvesting. The stripped fruit is then kept for 2 or 3 days in a drum or heap exposed to the full heat of

the sun. Fruit is then boiled, preferably in a 2oo liter petrol drum or one half of such a drum. After boiling the fruit is carefully pounded in a wooden mortar and then immersed in a vessel (basin or half drum) with warm water using a small strainer woven like a basket to move the fibers and nuts to and fro in the water thus washing out the oil. During this washing process nuts are deftly picked out whenever these come to the surface. Frequently this washing out of the fibers is repeated once or twice using fresh, clean water every time to improve the yield of oil. The oil is of course skimmed off and boiled for clarification in the usual manner and finally heated to drive off residual water.

The general impression was that fruit was not plentyful in Basse Guinée and extraction was being carried out with considerable care and great skill so as to obtain the maximum yield. According to the information obtained all the available fruit is harvested and special precautions are taken to prevent premature harvesting. The main season is May and June. Fruit begins to ripen a couple of weeks after the first rains of the season and harvesting may only commence after a signal has been given by the village head. Oil for sale on the market is only being produced during these two months of the main harvest while small harvests are possible up to the end of the year to provide oil for domestic consumption. The normal yield was always given as 2o liters of oil perdrum of fruit by all those questioned on this point. The 2o liters might be exceeded if the fruit was exceptionally ripe. In the absence of exact determinations of the oil content of the fruit it will be reasonable to assume a content of 22% and with 153 kg of loose fruit to the drum this works out to 55% extraction with 2o liters of oil, an excellent rate which apparently is occasionally exceeded.

On summing up it can be stated that the supply of fruit is the limiting factor for oil production in Basse Guinée and that in view of the high demand for oil processing even in the traditional manner is carried out very carefully to obtain maximum yields.

B. Guinée Forestière

This region comprises the extreme east and south of the Republic of Guinea. Oil palm production from natural groves is not of the same importance throughout the region. However, in the administrative area of Macenta and in the region around Nzérékoré in the extreme south with the three administrative districts of Nzérékoré, Yomou and Lola palm oil is by far the most important cash crop. Traditional extraction was witnessed in the village of Irié some 50 kilometers to the south of Macenta on the main road to Nzérékoré and still within the country populated by the ethnic group of the Toma. It was also observed in the village of Komou some ten kilometers to the north of Nzérékoré. Additional information was obtained from the assistant director of agriculture at Macenta concerning Macenta administrative district and especially the methods followed by the Toma people and again from the officials responsible for agricultural production on the the provincial level at Nzérékoré, notably the officer charged with the development of nurseries for tenera palms.
The extraction methods followed by the Toma people inhabiting the area around Macenta is different from the coast and different from that employed around Nzérékoré. There is no boiling of fruit prior to oil extraction. Heat is only applied for the finishing of the oil. Instead of boiling the fruit prior to pounding it is submitted to a prolonged fermentation to soften the fruit. Harvesting and oil extraction during the main season here is a social event for the young people. Young men climb the trees, young men and young women take the fruit to the village. There the extraction is also a social affair. Men and women take part. The men do part or all of the pounding, which is here done in hollows in rocky places or in pits dug out in the ground. The women then take over for the washing out and finishing of the oil. This is done in conically shaped pits dug out in the ground the sides of which are covered by triangular shaped pieces of timber. The pits are 60 to 80 cm deep and the fruit is agitated by treading it with the feet while at the same time oil is being skimmed off the surface with a small vessel. A photo of such a washing pit is given in the annex.

After finishing the oil by boiling in usual fashion the women sell the oil on the market unless traders have already advanced money against the harvest and get off at a much lower overall price. The money obtained for the oil is controlled by the women. The oil obtained by this traditional procedure is on account of the fermentation high in acidity and apparently not as popular any more on the market as the oil produced by different methods in neighbouring areas. Therefore boiling of the fruit as the first step in oil extraction is gainig popularity also in the Toma country. The traditional extraction that was witnessed near Irié village already incorporated the boiling of the fruit in 2oo liter drums rather than fermentation. Around 15 liters of oil are obtained by this method from a drum of fruit giving extraction efficiencies of around 4o % or less. The advantage of the method is however the low demand placed on direct labour and firewood. The method is fast, several drums of fruit can be processed by two persons during the course of a day making it attractive where fruit is abundant and the labour demand the limiting factor in oil production. This certainly appears to pertain in Macenta administrative area, as we were assured that not nearly all the fruit growing on the wild palms is being harvested. This presumably is partly due to the fact that the main oil palm harvesting season coincides with the peak work load of preparing fields for rice planting (men's work), planting out (mens work) and weeding of the young rice (women's work).

Traditional oil extraction in the area centered on Nzérékoré is similiar to the one employed in Basse Guinée but the procedures are not being carried out nearly as carefully. Pounding for example is frequently done in holes dug out in the ground and lined with peaces of wood or metal sheeting rather than proper mortars. The same applies to the washing out of the oil which is done in larger vessels and apparently never repeated. Here also fruit appears to be abundant so that the available supply is not fully utilised. The social organisation of oil production: harvesting by men, transport to the village by women, pounding of fruit by men, finisning and marketing of the oil by women. The main harvesting season here is April, May, June

and there is a second season in October and November. In between these two seasons and after the small season there are still some small harvests for domestic consumption only. Villages in the area arouns Nzérékoré tend to be much larger than those in Basse Guinée and processing of palm fruit is not as frequently inside the village, but rather at numerous washing places near the respective palm groves and next to a water point.

II. TECHNICAL NOTE ON IMPROVED PALMS

The fruit of the oil palm grows in bunches weighing under west african conditions from 5 kg to 4o kg. The individual fruit may weigh from 3 g to 3o g. It consists of a kernel usually enclosed in a hard woody shell and an outer fibrous layer called mesocarp or pericarp containing some 5o % by weight of red palm oil. Oil palms are classified into 3 main forms on the basis of the internal characteristics of the individual fruit:
DURA, in which the fruits have a thick shell between the mesocarp and the kernel;
TENERA, in which the fruits have a thin shell (may be cut with a knife) and much thicker mesocarp layer; and
PISIFERA, with no shell and part of the fruit without kernel.
All three forms occur in palm groves but unless selection has taken place the DURA form dominates with well over 9o %.

Studies by BEINAERT and VANDERWEYEN published in 1941 showed that crossing of dura with pisifera form resulted in a tenera progeny, while self-pollination of tenera resulted in dura, tenera and pisifera progeny in the proportion 1:2:1 proving tenera a hybrid of dura with pisifera. These observations are the basis for breeding tenera varieties with a high proportion of mesocarp and a thin shell, which have made it possible to increase greatly the oil yield per tree and per hectar. By inter-origin crossbreeding palms can be "made to measure" for specific requirements of the various growers be they estates disposing of fertilizers and pesticides or small holders preferring a more robust type of palm attaining their lower yield potential without fertilizers; also palms may be selected which are adapted to specific climatic conditions etc.

If fruit is treated in factories the entire bunches are supplied and the weight is indicated as tons or kg ffb (fresh fruit bunch); for small scale extraction fruit is normally stripped from the bunches in the field or grove and is then termed just fruit or "loose fruit".
As a rule of thumb: 1ooo kg ffb = 65o kg loose fruit.

III. IMPROVED OIL PALMS AND TRADITIONAL AGRICULTURE

The palm groves supplying the fruit for traditional oil extraction, although never planted, do not exist independent of human activity. Their origin, development and eventual decline is closely interrelated with the type of agriculture adopted by the people of West Africa: Clearing and burning of forest land, cultivation for a limited period followed by a longer period of regeneration by bush fallow, renewed clearing and burning etc. Oil palms are not found in the dense forest. Conditions for palm seedlings to develop are best during the transition from cultivation to bush fallow. However, palms are scorched during burning and although quite resistant when adult seedlings will not develop sufficiently with a short rotation cycle to survive the first burning. When this condition arises regeneration of the groves is no longer assured. Since it takes more than 2o years for a grove to reach full development, the situation observed at any particular time is of course determined by the land use patterns of the last 2 decades.

The length of the cycle of cultivation and regeneration will of course depend on the pressure on available land suitable for farming. 12 - 2o years of bush fallow after 3 years of cropping appear to be necessary according to numerous observations to conserve soil fertility of average soils under rain forest climatic conditions, considerably less for fertile alluvial soils on low lying land. In the major oil producing areas of Guinée Forestière (Macenta, Nzérékoré, Yomou and Lola administrative districts) population increase since independence has to large extent been absorbed by clearing of additional forest land and palm groves still vigorous and abundant. According to agricultural extension services on the district level at Macenta remaing forest land in that district is being cleared rapidly and authorities are becoming uneasy on account of a marked change in climatic conditions and thinking about some reforestation.

The period of bush fallow there has been shortened to as little as 4 years in places, formerly 7 years after 1 year of cropping with rice. Bush fires, formerly unknown, are getting to be a problem. Apparently boundaries between climatic zones are shifting.
No such problems are apparent in the heart of Guinée Forestière to the south of Macenta in the region centered on Nzérékoré. There bush fallow is now 7 years after 1 year of cropping with rice, formerly 15 years of bush fallow were practised.
While natural palm groves are still vigorous and abundant in Guinée Forestière this is not the case in Basse Guinée where crop rotation cycles have become so short that not only deterioration of the groves is becoming obvious in most areas, but the proportion of forest land and land under longer term bush fallow has become so low that devastating bush fires are now the major problem facing traditional agriculture and agricultural extension officers there do not believe that there is much future any more in natural palm groves as a source of palm oil.

Interest in improved tenera palms on behalf of the population varies accordingly in the different oil producing regions:
In Basse Guinée and there especially in Boffa administrative district village people are interested to the point that they will buy tenera seedlings and the supply of seeds is now the limiting factor. Most of the existing small tenera plantations, some of colonial origin and some created under FAO auspices in 1958-60 are also within Boffa administrative district and so people there are more familiar with this material. Agricultural extension services now charged with the administration of these small plantations (several hundred hectar in all in plots from 20 to 50 ha) are aware of the importance of selecting suitable land only to assure satisfactoy yields of around 5 tons ffb/ha under the prevailing climatic conditions, which are not ideal for high yielding palms.
In Macenta administrative district there is no interest in tenera palms and local authorities up to now have made no attempts to introduce them. This is a mountainous district with a great deal of infrastructure problems. There is one small privately

owned tenera plantation in existence but does not stir any interest.

In Nzérékoré at the level of the provincial administration the officers concerned from the Director of Production on down are quite conscious of the fact that Nzérékoré, Yomou and Lola adminstrative districts offer the most favourable climatic conditions of the entire Republic of Guinée for cultivation of improved tenera palms. It appears that only the lack of foreign exchange for the importation of quality seed from neighbouring Ivory Coast has so far kept the provincial authorities from implementing a comprehensive oil palm nursery program for the supply of seedlings to the population. Nzérékoré market can be trusted to absorb any amount of palm oil as trade goes out as far as Senegal and deep into Mali, not only the inland regions of Guinée. The good prices offered for the oil (150-200 syli/l in the main season, 250-300 syli/liter in Oct., Nov.) stimulate the interest as palm oil is the major cash crop of the region.

In summing up it must be clearly understood that any attempt to improve the productivity of traditional palm oil extraction should be aimed at improving not only the process of extraction but the fruit supply as well. Typical average oil content of loose fruit from natural grove palms is around 22%, fruit from improved tenera palms of the type recommended for village plantations contains around 34% oil. Therefore, quite apart from the additional advantage of harvesting from low palms grouped in small plantations rather than tall palms scattered widely over the farm land the same weight in a headload of fruit hauled to the village contains 50% more oil, the same labour input and the same consumption of firewood for the processing of a drum of fruit produces 50% more oil. Also, in most instances amortisation of the modern equipment, presses etc., for improved processing will not be possible without the higher yield obtained from the improved type of fruit.

IV. IMPROVED TRADITIONAL PALM OIL EXTRACTION

Improved traditional processing incorporates one or several pieces of equipment of a type unknown to traditional procedures. The organisation remains within the framework of the family and the informal neighbourhood cooperation. Capital investment is low and flexibility is high. Most of the early improvements were undertaken in Nigeria at the time when the country was a major exporter of palm oil from village production. Improvements aimed primarily at increases in yield from a given quantity of fruit but also at quality improvements made necessary by the prolonged handling and storage of the oil in connection with export. This is the origin of the insistence on bunch sterilisation, a procedure that cannot be termed an improvement from the point of view of a small producer selling on the domestic market.

A. Small screw press with depericarping

Introduced in West Africa in the 192o-ies it never became very popular and eventually was displaced from the market by the rising popularity of the curb press. The reason for giving a description at all is that, oddly enough, efforts have been made in recent years to re-introduce this procedure with minor modifications. The presses employed were of the "bridge" type featuring perforated steel cylinders into which a ram was screwed down from above. A typical size would have been suitable for a charge of about 15 kg of pericarp fibers without nuts. The nuts were picked out from the pounded pulp prior to pressing, a process also called depericarping. Mechanical depericarping was the method employed in the early palm oil factories but later completely abandoned in industrial processing in favour of digesting and pressing the entire fruit complete with nuts left in. Although giving slightly higher extraction rates than the curb press (6o%-7o% as compared to 55-65%) operation is slow and labourconsuming. Calculations show that the weight of a perforated steel cylinder suitable for a 15 kg charge and a working pressure of 4o to 5o bar (58o-72o p.s.i.) would be well in excess of 2o kg. During operation of the press the heavy cylinder

has to be inserted and withdrawn manually for each pressing cycle. Together with the tedious work of depericarping this would have resulted in a low overall throughput. These disadvantages were apparently not offset by the small edge in extraction efficiency which the system had over the curb press. Rapid cooling of the charge during pressing would be a problem as the steel cylinder offers no insulation against heat loss.

B. Screw press (curb press) without depericarping

Of the various types of presses offered for palm oil extraction in West Africa a modified winepress of a type still popular to this day in Italy and Austria with small wine growers finally became dominant and reportedly some ten thousand units were sold in Nigeria alone. It was in widespread use before 1939 and originally known after its inventor as the Duchscher press was later offered by many firms in various sizes and termed the curb press. A photo of such a press is given in the annex and the basic dimensions and design data are given on a separate page. Like all successful agricultural implements the press is of simple design. A threaded steel shaft anchored to a base constructed of steel members covered by a timber base plate with a tray and spout in between constitutes the basic structure. The cage consists of vertical wooden slats spaced about 3 millimeters apart and held together by two circular steel bands. The cage is constructed in two halves hinged on one side and splits open for the removal of the spent charge. Charging of the press is facilitated by the absence of any obstructing members of a press frame necessitated by a bridge type construction. The piston or ram is suspended from a cross head into which steel bars are inserted to give the required leverage for the operation of the press. Four persons are required in the final stage of pressing for about 1o to 15 minutes. From 35 to a maximum of 5o tons of pressing force are possible with 4 persons using extensions from 1,2o to 1,4o meters effective radius and working pressures of between 3o and 4o bar (43o to 58o p.s.i.)are possible depending also on the diameter of the cage.

According to information supplied by a press manufacturer curb presses had been successfully adapted for use as olive oil extractors at cake pressures of around 45 bar. That appears to be about the upper limit for the curb press.

A press cage of 45 cm inside diameter by 50 cm heigth will take a charge of about 75 kg pounded fruit or two pressings to a drum of fruit. A cage of 40 cm diameter will be more suitable for operation by women and will handle a drum of fruit in three pressings. The success of curb press operation depends to a large extent on the preparation of fruit prior to pressing and on getting the charge into the press as hot as possible, 70°C or above. Pounding in a mortar and reheating with the addition of some water are indispensable. To facilitate handling of the hot fruit between sterilisation and pounding and again between reheating and charging of the press NIFOR devised a special tipping frame for 200 liter drums that can be made up locally from angle iron and steel pipe.

As the introduction of pressing into the traditional extraction process greatly reduces the amount of time required for the separation of oil from the fibers pounding of fruit becomes the bottleneck of the improved process taking up approximately 2/3 of the labour input for the extraction process. Comparative labour input is tabulated on page 36, annex.

The weight of a curb press will run around 200 to 250 kg but they can be constructed for easy dismantling so that no one part need exceed 50 kg. At any rate these are not mobile units as they need to be firmely anchored in the ground for operation and for that reason alone do not lend themselves to frequent transfer.

Price will be around 400 $ ex works if ordered in large numbers from european producers. Manufacture in Conakry would at least save the freight charge and possibly lower the price to somewhere around 300 $.

With 4 persons operating the press and doing the ancillary work a drum of sterilised fruit (153 kg) can be processed in less than two hours. Allowing five hours before the first drum is boiled ready for pressing and also allowing forslack in the organisation about 3 to 4 drums of fruit could be handled per

day - e.g. by several families taking turns at the press. Under conditions pertaining in Guinée Forestière an additional extraction of 6 to 7 liters of oil per drum of fruit could be expected over and above what can be obtained by traditional extraction. With oil at 0,5 $ per liter (producer price) and an investment of 450 $ for the press installed under a roof with ancillary equipment a throughput of 130 to 140 drums of fruit would be required to recover the investment. This works out to 45 drums per year for three years and with a 5-month season 9 drums per month would be the minimum to permit amortisation of the press in 3 years. In the mean time oil producers are already profiting from the reduced labour demand.
Conlusion: Provided oil producers are willing to organise themselves in such a way that presses are kept reasonably busy and excessive carrying distances for fruit are avoided curb press operation will be economically attractive under the conditions of Guninée Forestière. Basse Guinée is a different proposition. The high standard of traditional extraction leaves a margin of only 3 to 4 liters of oil per drum of fruit and with a season of only 2 to 3 months per year it is difficult to tell wether curb press operation could be attractive with wild dura fruit. The basic proposition being of course the same as above, namely that the extra oil produced over and above the yield with the purely traditional method would have to pay for the amortisation of the equipment in a three year period.

C. COLIN hand operated continuous screw press

This is the only really new and worthwhile thing in improved traditional processing since the introduction of the curb press. It became available in the decade before west african countries gained independence and apparently purchased mainly by europeans operating small tenera plantations with paid labour. The COLIN press gives good extraction from tenera fruit with much lower labour demand than any other hand operated system. It is not economical with wild dura fruit and for this reason disappeared at a period in african development when everybody related tenera palms with large industrial estates and these palms were

consicered unsuitable for the ordinary farmer except as an out-grower for the estate mills. Today there are good reasons to bring the COLIN press or some similiar construction back to the market. A fair number of the original COLIN press still remain in operation in the Makak area of the Republic of Cameroun along the Douala - Yaoundé railroad as witnessed by ref.(6) pp 11, 17, 18 and 45. In ref(3), p.37 capacity is given as o,25 tons FFB per hour corresponding to 1oo kg of fruit or little more than one drum (153 kg) per hour. Ref (6) also reports 1 drum per hour with three women operating the machine, one feeding the fruit and two cranking. The same source reports a motorized version doing somewhat better than 2 drums of fruit per hour. Ref (7), p.29 reports on the test of such a press at CENEEMA in Yaoundé. The report gives no figures only stating "good oil production" with tenera fruit processed without any pretreatment other than boiling. This is the way the press is being used by the villagers in the Makak area and the reason for its popularity: the tough and tedious work of pounding in a mortar is eliminated. Just feed in the hot, boiled fruit and turn the crank. as an agricultural officer at Nzérékoré in the Rep.of Guinea put it. This particular officer had been in charge of a small plantation near Guéckédou equipped with a COLIN press and kept it working for about ten years after independence without encountering any mechanical trouble whatsoever. With intermittent operation (2 labourers were harvesting as well as pressing) an average of 2oo liters of oil per week were produced throughout the season. Cranking of the press is hard work and requires several persons taking turns.

Technically the COLIN hand press is a scaled down version of the large industrial presses also developed by the firm of Pressoir Colin at Montreuil, Switzerland. The full range of COLIN presses was later on manufactured by SPEICHIM of Paris. Similiar large presses are currently being manufactured by all the producers of palm oil extraction machinery and have all but replaced the hydraulic press in palm oil factory design as the dura palm has virtually disappeared from industrial estates. All these presses employ the same principle: A screw shaped rotor revolves

slowly (around 1o RPM) in a close fitting perforated cage forcing the charge along towards a constricted discharge opening and in this way building up pressure that forces the liquid contained in the charge out through the small holes or slots in the cage. There are single screw and twin screw presses but the details are not important here. Industrial units always consist of a steam heated digester feeding directly into the continuous screw press. The smallest industrial unit currently offered has a capacity of 1 - 1,5 tons FFB/hr (6oo - 9oo kg fruit per hour) and uses motors of 5,5 KW on the digester and 3 KW on the press. Extraction efficiency of industrial units is above 9o% with high grade tenera fruit.

In the improved traditional process with hand operated COLIN press about 75% extraction efficiency is obtained without digestion when processing tenera fruit. This is about as good as any other kind of handpress will do with pounding and reheating of fruit and short of mechanical digestion. With dura fruit the COLIN press is little better than a careful traditional extraction.

In the absence of quotations, since the press is out of production, the price can only be estimated by comparison with other agricultural equipment of similiar complexity, precision and wear resistance. A price in the range of 3ooo $ fob for an order on the scale of 1oo to 2oo units appears to be a reasonable estimate. Feasibility calculations should be based on an installed cost of not less than 4ooo $ for a hand operated press and about 6ooo $ for the motorised version.

The following calculations are for the hand operated version processing tenera fruit of moderate yield (5 tons ffb per hectare and year for Basse Guinée and twice that figure for Guinée Forestière) and moderate oil content (23% on ffb, 34% on loose fruit). It is assumed that the peak harvest per month will be the same for both oil producing regions, namely 2ooo kg ffb per hectare. Assuming further a well organised use of the press by ten or more families, 2o days of pressing in the peak month and 7 drums of fruit pressed per day the press will handle

21.4oo kg of fruit or about 33 tons ffb in the peak month. Therefore, rounded down, 15 hectares of mature tenera plantation or about 21oo palms are served by one hand operated COLIN press. At 75% overall extraction the yearly production of palm oil per press works out at:

Basse Guinée: 1294o kg or about 14ooo liters at o,5 $/liter

Guinée For. : 2587o kg or about 28ooo liters at o,5 $/liter

Therefore, if amortisation of the investment is to be achieved over a 3 year period 2o% of the yearly proceeds will have to be set aside in Basse Guinée and 1o% in Guinée Forestière. Maintenance costs (rewelding of wearing parts) will have to be considered after the first one thousand hours of operation and from then on at regular intervalls. The total useful life of the press should not be assumed at much more than 3ooo hours, under the conditions cited above ten years in Basse Guinée and five years for Guinée Forestière.

D. Small screw press with heating device (Sierra L.)

The charge in the small bridge type screw presses will cool rapidly on account of the small volume and the high heat conduction of the small cylinder. Size of the cylinder on the other hand is limited by weight considerations. It has to be inserted and withdrawn manually together with the charge. The addition of a heating device (outer cylinder or mantle and steam generator) solved the particular problem but resulted in a slow and labour consuming overall process. This in turn led to rejection of the press by the prospective users. The mistake in this case was too narrow a scope in the design of the press resulting from a pre-occupation with pressing efficiency. The designer solved his technical problem but lost track of the needs of the user: a more efficient overall process both in terms of labour demand and of oil recovery as compared to the strictly traditional extraction. The curb press does a better overall job despite its lower pressing efficiency.

2. Improvised hydraulic hand presses

Various attempts have been made in recent years to replace the threaded steel shaft of the different types of discontinuous screw presses by hydraulic cylinders in order to facilitate operation and in order to reach the desired cake pressure irrespective of the bodily forces of the operator. Screw press design is limited by a constraint inherent in the mechanics of the system: The higher the transmission ratio (the slower the screw) the higher the friction losses will become, so that most srew presses operate around 15% mechanical efficiency. With a hydraulic system any desired transmission ratio is possible without much difference in mechanical efficiency by simply choosing the appropriate size of pumping cylinder relative to the size of the cylinder generating the pressing force. However, cylinders, pistons and valves are components that require precision manufacturing and are, especially in a tropical climate, subject to corrosion as moisture tends to accumulate by condensation in the hydraulic fluid.

One method of keeping the cost of improvised hydraulic equipment low is the use of mass produced components or entire selfcontained units such as the various types and sizes of hydraulic lifting devices sold e.g. as jacks for heavy motor vehicles and similiar applications. Ref (7) deals with the design and trials of a press similiar to the small screw presses with depericarping described earlier except that the pressing force is generated by a 8 ton hydraulic automobile jack. The press cage is quite small with a capacity of only 7 kg of pounded fruit per charge. The design is of a recent date (1984) and field experience with the press will show wether it comes up to original expectations in terms of throughput and efficiency. Throughput will depend on the extremely short pressing cycle of 8 - 10 minutes per charge claimed by thedesigner being maintained for several hours in field use. 3 - 4 hours is the time given by the designer for the processing of one drum of fruit. It appears unlikely that it can be maintained under normal operating conditions. The press is designed to operate at a cake pressure

of 40 bar and is supposed to give efficiencies of 70% - 80% oil extraction. Experience will show wether the advantages of hydraulic operation will overcome the reluctance prospective user have hitherto shown against this type of press and especially the recommended practice of picking out nuts prior to pressing in the case of dura fruit. Experience will also have to disperse reservations regarding useful service life of the hydraulic unit expressed by an important german supplier of such units when consulted on their use in connection with fruit presses. Ordinary low cost hydraulic units of the type incorporated into the press design described in ref (7) are entirely manufactured from ordinary carbon steel. Cylinders, pistons and the valve placed between pumping and working cylinder would all be subject to corrosion. Corrosion and/or gasket wear will eventually lead to leakages of hydraulic fluid and adequate precautions would have to be taken to prevent contamination of palm oil with the hydraulic fluid. It does not appear prudent therefore to propagate this press design widely until it has proven its worth in the country of origin, the Republic of Cameroun.

Curb presses are also being fitted with a hydraulically operated top head for wine pressing notably in Italy. A reproduction of a curb press featuring such a unit is given in the annex. Although BOSELLO of Padova, who used to supply such presses adapted as palm oil extractors, is no longer in business a number of smaller firms would readily supply this kind of press if an initial order of 50 to 100 units were placed at a price of around 600 $ - 700 $. The hydraulic units are being supplied by a large specialised firm to all the small italian press manufacturers. Cylinders are claimed to be chromium plated and valves fabricated from non rusting materials reducing corrosion to easily replaceable pistons. On account of the top mounted hydraulic system only an approved type of hydraulic fluid harmless in contact with foodstuffs may be used. This is not likely to be available in remote palm oil producing areas.

F. Sophisticated hydraulic press

At least two manufactureres - Stork of Amsterdam and De Wecker of Luxembourg - offer an exellent hydraulic palm oil press of small size and suitable for operation with a hand pump. These are being manufactured to a high technical standard and are really small scale industrial rather than agricultural equipment as indicated also by prices in the range of 8ooo $ to 1o.ooo $.

Although NIFOR develcped an entire range of improvised auxiliary equipment for use with the STORK press around 196o the result was an unbalanced process that did not measure up to the cost and the potential of the press. When combined with motor driven mechanical digestors these presses will handle 1/2 ton ffb or somewhat more than 2 drums of fruit per hour at about 85 % extraction efficiency when correctly operated with hot and well digested fruit. These presses permit cake pressures of up to 7o bar. The cost of 15.ooo $ to 2o.ooo $ for press, digester and motor is over and above the scale of informally organised improved traditional processing and so is the technical skill and organisational ability prerequisite for prolonged successfull operation. These presses are appropriate to the next higher class of improved processing termed in recent years the village mill.

V. INTERMEDIATE SCALE PROCESSING

In the decade 1965 - 1975 a considerable number of the large, modern type of palm oil factories or mills in the 2o/4o/6o tons ffb/hr range together with estates of several thousands of ha each were created in West Africa. A fully equipped modern industrial mill would appear to be economically feasible from a capacity of 6 tons ffb/hr upward but not really attractive below the range of 1o - 12 tons ffb/hr. Features would include full energy autonomy from a steam power plant fuelled with waste, processing steps and flow of materialsfully mechanised and automated to a large extent, highest extraction rates of oil and recovery rates of kernel to the highest quality standards, high capital investment and comparatively few but highly qualified employees. Logistics of fruit supply and demanding maintenance schedules would be among the difficulties encountered in mill operation. Difficulties in securing the large tracts of land as well as an adequate and stable labour force, also the ecological problems raised by thousands of hectares of monoculture are amongst the problems encountered at the estate end. Also, many of these mills originally created with loans repayable in foreign exchange ended up selling the greater part of their production on the domestic markets.

A. Mini-mills

For these and other reasons intermediate scale processing has received increased attention in recent years. It covers the range of 1 - 3 tons ffb/hr between improved traditional processing on the one side and full scale industrial on the other. Suppliers of oil mill equipment are endeavouring to meet this trend by offering mini-, compact- and junior mills that are still essentially fully mechanised but feature simplified technical solutions and replace the automatic control device by the human operator. Simple, manually fired low pressure steam boilers supply process heat only and diesel powered generating sets supply the energy for the electric motors. Quality standards are geared to the rapid turn-over on the domestic market and there is some compromise with extraction rates. A mill of this

type pre-assembled in containers with 1 - 1,5 tons ffb/hr capacity would be in the range of $ 400.000 fob european seaport, kernel recovery section not included. The extraction unit alone consisting of digester and press together with the supporting structure and drive would be in the range of $ 60.000 . All these intermediate scale mills are designed to take in fruit bunches and pre-suppose at least a nucleus estate and of course motor transport of fruit. There would not be much chance of amortisation below 3000 operating hours per year.

B. Village mills

The village mill approach to intermediate scale processing does not aim at a fully mechanised mill. It is an attempt to create a well balanced process making optimum use of a few essential pieces of high quality imported equipment to secure high oil extraction and eliminate bottle necks of excessive labour- and fuel demand, such as pounding of fruit in mortars, maintaining numerous individual fires, hand cracking of nuts and hauling of water. As proposed and executed by G. Blaak and reported in ref (2) it is a logical extension of earlier efforts by NIFOR to build an improved traditional process around a STORK hydraulic hand press. Some self imposed constraints of the NIFOR concept have been dropped by replacing bunch sterilisation by sterilisation of loose fruit and by introducing engine drive and a steam boiler. Electric power transmission is avoided by using 2 small diesel engines: one for the digester and hydraulic pump of the presses (hand operated in the original design), the second directly coupled to the water pump and nut cracker. The digester is a special type designed by Blaak for this mill and termed the rapid horizontal digester. By employing a comparatively powerful engine (5,5 KW) for the size of the digester and compromising on the extraction rate digesting time is shortened to 3 - 4 minutes thus eliminating the need for steam heating as long as the fruit is introduced very hot. A horizontal type of digester allows a simple and economic design of the bearing supported shaft and power transmission eliminating the need for costly bevel gears and the like.

A very important aspect of all improved methods of palm oil processing is the fuel economy. Good fuel economy can only be gained by including a steam boiler suitable for firing of the waste matter originating in the process itself: pericarp fibers and the shells of cracked nuts. The boiler will replace the numerous inefficient fires required otherwise. Steam is piped to the points where heat is needed. The mill incorporates 2 STORK hydraulic presses (any equivalent press could be substituted). Throughput is limited by the capacity of the digester: 4oo kg/hr of loose fruit (o,65 tons ffb/hr), a little better than 2 and 1/2 drums of fruit per hour. Extraction efficiency will be around 85 % giving 48 liters of oil per drum of tenera fruit.

The first mill of this type was erected in 1976 in the Republic of Cameroon at Mbonge village near Kumba. By the time the report of ref.(2) was published, the mill had been in operation for 3 successive years without major breakdowns. The mill can serve up to 15o ha of village plantations under favourable circumstances. Tractor and trailer transportation of fruit will be indispensable to keep the mill fully supplied with fruit. The term village mill must be seen as contrasting the estate mill. It does not necessarily imply that a single village will normally keep the mill fully supplied with fruit.

Cost of the imported equipment is given as ₰ 36 ' ›o in ref.(2). It would have to be adjusted to at least ₰ 45.o ›b european seaport. This includes 2 hydraulic presses, 1 ce.rifugal water pump, 1 nut cracker, 1 digester, 2 diesel engines of 5,5 kw, 1 water tank of 7 m^3, 1 steam boiler of 12o kg/hr capacity. Cost of the locally constructed ancillary equipment, building etc. will differ as conditions change according to time and place.

Twelve persons are required to operate the basic process of oil production. Auxiliary personnel will be required for hand separation of fibers and nuts from the press cake and for separation of kernel and shell after nut cracking. Sorting tables are provided for this purpose.

VI. SOCIO-ECONOMIC ASPECTS OF NEW TECHNIQUES

If a new technique is not attractive to prospective users it will be rejected forthwith, if it is not appropriate the technical skills (operation, maintenance) and organisational capability of the recipients it will fail in the long term after outside assistance has been withdrawn. These prerequisites of the successfull communication of innovative techniques will in the following paragraphs be applied ti improved methods of palm oil extraction suitable for conditions now existing in the Republic of Guinea.

A. Attractiveness

If it offers an obvious advantage corresponding to a real, conscious need a proposed innovation will be attractive to prospective users. Thus, if fruit is abundant and palm oil commands a good price on the market but women just can not cope with the work of processing all the fruit an innovation reducing the amount of work involved in treating a drum of fruit will be attractive, provided it does not impose a dispropportionate financial burden. An abstract technical improvement of one step only in the processing line, such as higher pressing efficiency will not. The following 2 points appear to be essential for a successful introduction:

1.) A decrease in the total work load. This is not always easy to evaluate as subjective elements are also involved: Which aspect of traditional processing is the most tedious or tiring ?

2.) An increase in oil production of sufficient importance to pay for the equipment over a reasonable period of time, say three years.

If fruit is plentiful as in Guinée Forestière and parts of Sierra Leone the amount of oil produced for a given effort or amount of time spent will decide the issue. In countries where these were available the curb press has stood this test and the CCLIN expeller was received with enthousiasm even for dura fruit on

account of its high productivity although the amount od oil obtained from dura is scarcely better than with traditional extraction. The Sierra Leone small screw press with heating device and other small and slow presses before it were rejected. The gain in extraction was apparently not worth the time lost in tedious depericarping and other aspects of the generally slow process. There is not much difference in the time required per pressing cycle wether the press be large or small. Apparently a process that is slower than the traditional extraction is never accepted, even if it yields more oil.

B. Appropriate technology

It is the test of time that will decide wether a technology that was attractive at the moment of introduction is appropriate under the conditions prevailing on the spot. To avoid failures the attempt must be made to check a proposed innovation out against the general technological level attained in the region concerned. Thus, before recommendeing the use of diesel or petrol engines in connection with agricultural equipment it would be important to know wether there is already some familiarity with this technology through the use of motor cycles, outboard engines and the like, where competent repairmen and basic supplies of fuel, lubricants and spares are available, in general wether conditions are such that the normal, technically possible service life may be expected. The answers to these questions will be different at the present time for Basse Guinée as compared to Guinée Forestière. In Guinée Forestière only equipment of a tried and proven design and known to function reliably without any need for spare parts during the normal service life can be recommended. A curb press of good quality will give ten years of service. The COLIN expeller also has proved its worth under comparable circumstances.
To take another example: The type of village mill successfully introduced at Mbonge village in the Republic of Cameroon was appropriate technically there, because numerous inhabitants of the very village had been trained in the various operational

and maintenance skills required during employment in a nearby estate mill. It would not necessarily be appropriate technology in other regions of Cameroon or other west african countries.

C. Appropriate organisation

The proposed innovative technology must be realised within an appropriate organisational frame work. If a cooperative society rather than informal cooperation is required e.g. to obtain a loan for the purchase of equipment and to regulate its use the structure and bye-laws of this cooperative society should follow the line of traditional associations such as women's societies. The aim must be a self supporting process of development. Appropriate forms of organisation may well be the most important aspect of such a process and may provide the first experience in the use of the written word as an instrument of self-organisation. If successful these forms of organisation will then find application in other sectors as well. The danger lies in the co-operative society becoming dependent upon the extension officer or other technical advisor, professional secretary etc.. This is bound to happen if the organisation becomes too large (exceeding 2o - 3o members) or is led into complex activities beyond the comprehension of the members. Under the conditions prevailing at present in most west african countries a cooperative society of village people will be overtaxed if called upon to controla village mill of the type proposed by G. Blaak and described in the chapter on intermediate scale processing. The technology employed may be appropriate to the skills of the Mbonge village people. The scale and organisational complexity of the operation is not.

In the early stages of development village level cooperative societies will do fine organising a nursery for the supply of improved palms and later on the purchase of a curb press, COLIN press or other improved implement and regulating the use by members including contributions for repayment of a loan. Mill type processing may become viable in a later stage of

development once infrastructure has been improved and surplus fruit is offered for sale. The mills would then have to compete with improved small scale processing for the fruit the latter remaining indispensable as an alternative to assure a faire price to the producers for their fruit.

D. Safeguarding women's role

The only way to avoid upsetting traditional patterns of the distribution of work and income between men and women is gradual, well prepared and voluntary introduction of change. Obviously, traditional patterns can not be conserved alltogether if one wishes to introduce technological change. It has frequently been observed that the introduction of mechanical implements or any kind of modern tools has made a certain function acceptable and attractive to men that was formerly entirely a women's domain. The introduction of the new method or tool appears to lift or neutralise the traditional barrier between what is considered men's work and women's work. In palm oil extraction there is frequently a second element involved where men have taken up palm oil extraction and that is the planting of improved palms by the men.

To safeguard womens's role in the extraction and marketing of palm oil it will therefore be necessary to insure that:

1.) the equipment to be introduced is suitable for operation by women;

2.) women are trained and prepared for the new technology;

3.) women participate in the work of raising seedlings and planting of improved varieties of palms to ensure future access to the fruit supply.

VII. MANUFACTURING CAPACITY FOR OIL PRESSES IN CONAKRY

Already operational in the capital Conakry is a UNIDO project called "Centre Pilot" focused on the training of repair and maintenance personnel for existing industries. As a second function the C.P. also carries out repair and overhauling of all kinds of mobile industrial equipment including vehicles.
The centre is well equipped with machine tools including wood working machines and employs a permanent staff of skilled operators.
As a step towards financial self sufficiency the C.P. has recently begun production of a simple press for making of concrete building blocks and those responsible welcome the idea of producing curb presses for palm oil extraction. This production does not pose any technical problems for the C.P. but it is quite clear that in view of the extremely difficult conditions prevailing at the present time in Guinea they are in no position whatsoever to carry out experiments, improvements of design etc.
Farmers in the bush, on the other hand, need equipment giving trouble free service for many years. Repair facilities are, as a rule, not available to them. Therefore, to avoid teething troubles that could ruin the entire oil press project from the onset (The Sierra Leone failure is a warning) it is proposed that UNIDO arrange for the production of a small series of curb presses with one of the european firms still supplying curb presses to the small wine growers and which firms can easily turn them out adapted for palm oil extraction. It is the functionality of the smallest details that decides the usefullness of an implement to the farmer. This can best be insured by exactly copying a tried and proven model. There are no legal problems involved. It is just a question of who can produce these simple implements at the most economical price including cost of transport to the final market.

CONCLUSIONS

1.) Throughout the Republic of Guinea modernisation of palm oil production is only just beginning. Apart from a few small experimental tenera plantations in Boffa and Boké administrative districts and a pilot extraction unit near the boundary between these only dura fruit from groves is available and extraction is strictly traditional. The situation regarding road transport, postal services, foreign exchange etc. is still so difficult that only equipment of a tried and proven design that does not require spare parts, special hydraulic fluid etc. during normal service life will be suitable.

2.) In Guinée Forestière circumstances are favourable for the improvement of oil production from the wild dura fruit of the natural groves. Introduction of pressing with curb presses into the traditional extraction process will increase oil production by 30% - 60% and reduce labour input for the extraction process only by some 60 %. Given a reasonably efficient organisation of press utilisation the cost of the press will be recovered in less than 3 years. Service life of a curb press: 10 years or more. Wild groves are incompletely harvested at present. It is expected that introduction of the curb press will lead to a fuller utilisation of this potential.

3.) In Basse Guinée scarcity of wild fruit and the short duration of the harvesting season do not permit amortisation of pressing equipment in the absence of a regular supply of fruit from improved palms with the possible exception of some coastal groves and the islands in the north.

4.) Under the favourable climatic conditions of Guinée Forestière improved tenera palms will do well on average soils. The region centered on Nzérékoré has a vast potential for this development. In Basse Guinée where climatic conditions are marginale for oil palms tenera palms will require carefully selected soils to do reasonably well and palms will have to compete with other crops for the more fertile land.

5.) Unless women take an active part in the planting program for improved palms they may later on find themselves restricted to the processing of wild fruit only. Training in the new techniques will also be important if women are to conserve their their position in oil extraction and marketing.

6.) The COLIN continuous screw press is particularly well suited for small scale extraction of tenera fruit under the conditions prevailing in Guinea. Early introduction of this press will be a strong incentive towards the success of a planting program, but a curb press will be more economical until the palms come into full bearing when about 15 hectar of palms can be served by one COLIN hand operated press and there will be no problems with the amortisation of the press, provided a co-operative or other suitable organisation will permit the utilisation of one press by about 1o families. It is a reasonable assumption that the high productivity of the COLIN press will prove instrumental in the realisation of the full potential of Guinée Forestiere as an oil producing region. It is not expected that it will ever completely replace the much cheaper curb press more easily afforded by an individual owner.

7.) Manufacture of the curb press is possible in Conakry e.g. with the workshop equipment and skilled personnel available at Centre Pilot. For the COLIN press at least the reworking of worn parts can be done locally. Manufacture of auxiliary equipment for both presses can also be done locally. If improved traditional extraction and planting of tenera palms is developed into a major nationalprogram the demand for curb presses and COLIN type presses will be many hundred of each type.

Oil extraction rates

method		type of fruit: wild	DURA	TENERA
primitive traditional boiling or fermenting and cold pit washing			40% or less	
normal traditional boiling, pounding and warm washing			about 50%	
careful traditional the warm washing repeated once or twice			55%, max.60%	
curb press intensity of pounding and reheating as well as cake pressure influence the result			up to 70%	
COLIN hand press well boiled fruit, no pounding			55%	75%
village mill engine driven digester and sophisticated hydraulic press: intensity of digestion and temperature of fruit entering press influence the result	typical		80%	85%
	maximum		85%	90%

Oil recovered per drum of fruit

Basis of calculation: A 2oo l drum holds 153 kg of loose fruit.
One liter of palm oil weighs o,92 kg at tropical ambient temperature.
Wild dura fruit with 22% oil content;
tenera fruit (village type) with 34% oil.

method	type of fruit	
	wild **DURA**	TENERA
primitive traditional	15 l	
normal traditional	18 l	28 l
careful traditional	2o l	31 l
curb press	23-25 l	37-4o l
COLIN hand press	2o l	42 l
village mill	29 l	48 l

Labour input

for extraction of palm oil from 1 drum of fruit (153 kg fruit)

traditional method

Figures are based on time and motion studies carried out at Buea and Otélé in the Republic of Cameroun: ref (6), pp 5,6,17,18.

harvesting bunches
stripping and carrying of loose fruit } 18 hours (men)

extraction proper
- transfer of hot fruit
- pounding
- hauling of water
- washing out and skimming of oil

} 19 hours (women) = 4 women during 4 3/4 hrs

preparatory and finishing work
- boiling of fruit
- frying of oil

} 7 hours (women)

marketing 8 hours (women)

improved traditional method - curb press

harvesting etc 18 hours

extraction proper
- transfer of hot fruit
- pounding
- reheating
- pressing

} 7 hours = 4 persons during 1 3/4 hrs

preparatory and finishing work 7 hours

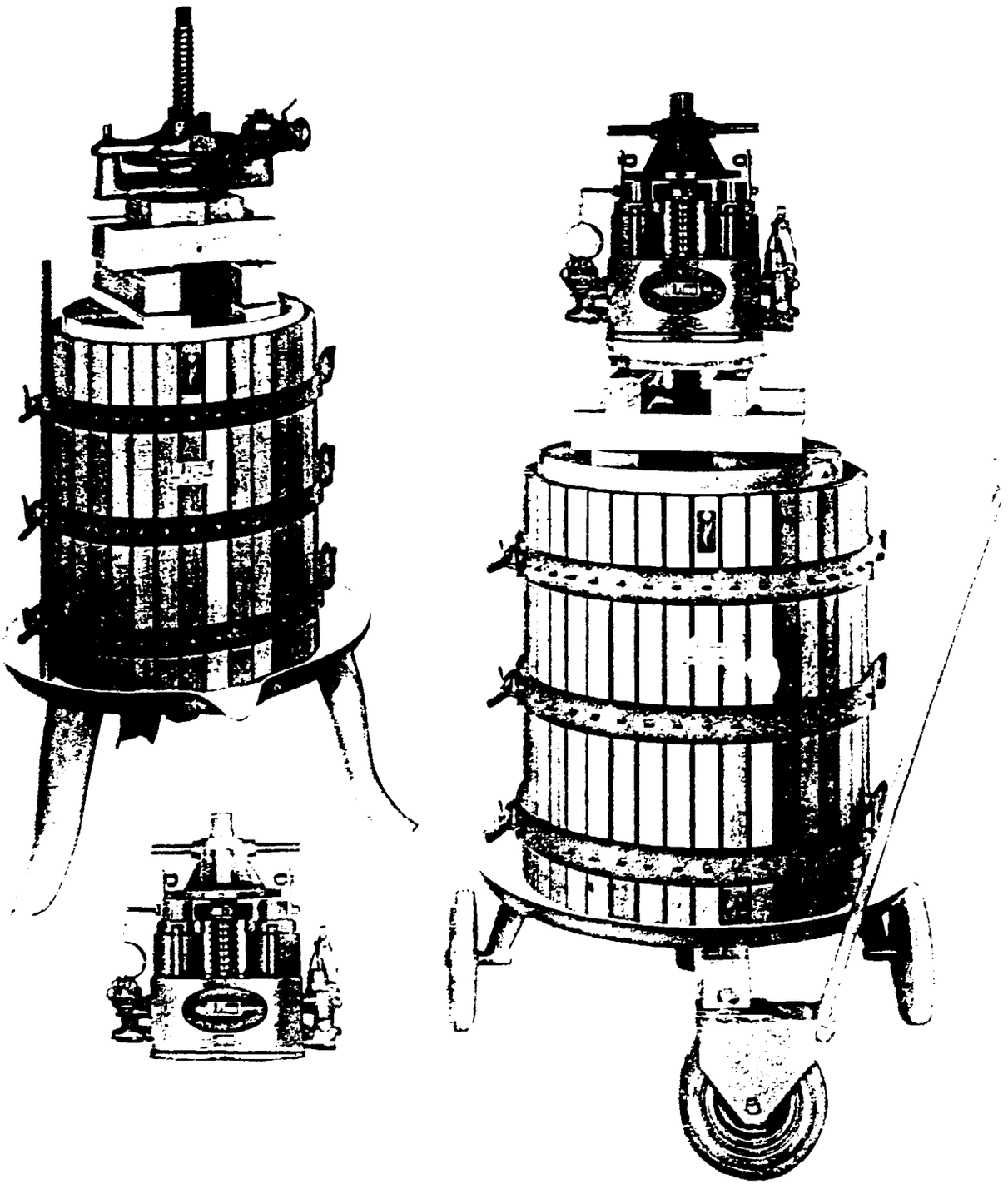
improved traditional method - COLIN hand press

harvesting etc. 18 hours
extraction proper 3 women during 1 hr = 3 hours
preparatory and finishing work 7 hours

Traditional palm oil extraction in Guinée Forestière, [illegible] village

de Wecker NG1 curb press for palm oil extraction

installed at Nchang village plantation
Southwest Province
Republic of Cameroon



curb press (wine press) with hydraulic top unit as offered by several small manufacturers in northern Italy

Curb press design data

cage dimensions: inside diameter 4oo mm, heigth 5oo mm;

screw shaft: of a good quality steel suitable for easy machining, nominal diameter (diameter of blank) 8o mm, metric ISO trapezoidal thread or square thread with a lead of 8 mm per turn; a travel of the ram of 32o mm from the first contact with the fruit to the fully compressed position must be provided and an additional 3oo mm for easy access when filling the cage;

cross head: threaded sleeve of bronze or brass, minimum length of sleeve 16o mm;

extension arms: 1,5o m long measured from the center of the screw shaft.

A press of these dimensions will have a capacity of 6o liters of pulp per charge. A 2oo liter drum of fruit will yield 17o liter of pulp after pounding with all the nuts in which can be dealt with in 3 pressings. One press cycle will take from 3o to 45 minutes. The press should be installed as low as possible above ground and the extension arms a maximum of 1,2o m above ground level with the ram halfway down in the position where pressure is beginning to build up. If the press is set up to high operation will be hampered.

A pressing force of 35 - 4o tons can be expected with 4 women operating the press provided the threads are in good condition and well lubricated with palm oil. 4o tons pressing force will give 33 bar (47o psi) cake pressure.

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