Oils Extraction

=== Minor oilseeds (reference list) ===

A reference list of publications related to small-scale processing methods for minor oilseeds is given below.

**Argan**


**Avocado**


**Macadamia**


**Niger seed**


**Winged bean**


**References**


ATI (in press) State-of-the-art study of small-scale coconut processing.


--- Sunflower seed ---

Sunflower is an annual plant that thrives in the tropics at medium and high elevations and, under suitable conditions, in temperate climates. Smallholders harvest the crop by hand, pulling off the sunflower heads when dry and rubbing off the seeds. Large plantation stands are harvested using a combine harvester.

Varieties

There are numerous varieties of sunflower seed. Many hybrid varieties have a thin, soft shell and a high oil content. Most indigenous local varieties have thick, hard shells and relatively low oil contents. Smallholders in many countries prefer to grow local varieties of sunflower, as the plants, when harvested, can provide seed for growing the next season. The progeny from hybrid seeds cannot be used for this purpose; fresh seed stock has to be purchased every growing season. This incurs extra cost, time and effort for the smallholder. There is often no premium offered by merchants to farmers for high oil-content crops. A local variety of sunflower seed called 'Record', which has a thin shell and a high oil content, grows in Tanzania. Soft-shelled, high oil-content sunflower seed types such as 'Record' (another of this type is called 'Peredovik') are ideal for processing in the ram press.

Hot water flotation

In a method used in Tanzania, sunflower seed is roasted in a clay pot over a wood fire and then pounded manually to make a fine flour. The flour is boiled with water in an oil drum for up to 9 h. After boiling, cold water is added to bring the oil to the surface; it is then skimmed off and dried. Oil yield is 1.25 l from approximately 10 kg of undecorticated seed, which is equivalent to an extraction efficiency of 38% for a low oil-content seed (30% total oil) or 23% for a high oil-content seed (50% total oil).
Laboratory studies have shown that the yield of available oil can be increased to about 53% by using sunflower kernels, and that the hot water for one extraction can be recovered and used for further processing, thus saving on energy and water consumption.

Manually-operated presses

Bridge press using the KIT process (Wiemer and Altes, 1989)

KIT have developed a hand-operated system for sunflower in association with UNATA who can supply all the necessary equipment. The equipment is as follows:

* sunflower seed decorticator
* winnower
* roller mill
* 'cooking' furnace
* bridge press

A suggested layout for this equipment is shown in Figure 16. The throughput of the equipment is 150 kg of undecorticated seed/day. For seed with an oil content of 32-35%, oil production ranges from 31 to 34 l of oil/day. Details of the method, which was developed in association with TDAU (see Appendix 2) and several women's groups in Zambia, are given in a publication Simple Sunflower Production at the Village Level which is available from UNATA.

Scissor press

This system was developed by the Institute of Production Innovation (IPI) of the University of Dar es Salaam (Chungu et al., 1987). The equipment is available from Themé Farm Implements Co. Ltd of Arusha, Tanzania, and is basically the same as that used in the KIT process described above. The heart of the process is a scissor press which has a capacity of 21 kg decorticated seed/in. The daily throughput of the plant is 210 kg seed (140 kg decorticated seed), and oil production varies from 46 to 69 l, depending on the oil content of the seed. The effect of the various processing steps on oil yield is shown in Figure 17. An instruction booklet describing the process is available from the University of Dar es Salaam (Chungu, 1986).

Ram press operation, near Ilonga, Tanzania
Coconuts grow in the coastal areas of the tropics and subtropics, 20°N and 20°S of the equator. Major producing countries are: The Philippines, Indonesia, Malaysia, Sri Lanka, India, Côte d’Ivoire, Mozambique, Tanzania, and the Pacific Islands.

Harvesting of the nuts is carried out by allowing them to fall naturally, by climbing the trees and picking, or by cutting the nuts using a knife attached to a long pole. Immature nuts should not be harvested as they contain less oil than mature nuts.

Fresh nuts are de-husked by means of a wooden or metal spike fixed into the ground. The coconut is brought down forcibly on to the spike by the operator and twisted to remove portions of the husk. The process is repeated until all the husk is removed. Fresh coconut kernel contains 32-35% oil, corresponding to a moisture content of 54-49%.

Coconut oil may be obtained directly from the fresh kernel (wet processing) or, more commonly, from the dried kernel (cope).

Copra

Copra usually contains 69-70% oil on a moisture-free basis. To prepare copra, the coconuts are first split in half and dried either in the sun or in special driers. When the nuts are partially dried, the meat shrinks away from the shell allowing the kernel to be removed easily. The kernels are then further dried to a maximum moisture content of 9%, but ideally to a moisture content of 6%. Copra is normally sold to traders and then on to large processing mills where it is expelled for oil and cake. Oil from copra is generally refined and deodorized before being sold for edible purposes. However, in some countries, notably Sri Lanka and Indonesia, the natural coconut flavour is favoured and the oil is consumed without further processing.

If the copra is not prepared carefully and the product is underdried, it will go mouldy during storage, leading to a marked deterioration in oil quality. In addition, if the copra is attacked by the yellow-green mould, Aspergillus flavus, it is likely to be contaminated by a toxic chemical called aflatoxin. When such contaminated copra is processed, aflatoxin passes into both oil and copra cake. Fortunately, aflatoxin is removed from coconut oil during refining, but it is retained in the cake. The problem is such that the European Community has imposed stringent regulations on permitted levels of aflatoxin in imported copra cake and meal to be used in animal feeds.

Household wet processing of coconut
In many countries, for example Indonesia, Sri Lanka and Tanzania, fresh coconuts are used at household level for oil or milk extraction. The nuts are cracked in half and the meat scraped out using a rasp (see Plate VI). The grated coconut is collected and water is added. The mixture is kneaded by hand and then squeezed to produce a ‘milk’. This process is repeated several times and the liquid combined. The milk may then be boiled immediately to obtain the oil. This method also produces a crispy residue after boiling which is highly appreciated in The Philippines as a confectionery item known as latik. A more common procedure, carried out in Tanzania, is to allow the milk to stand overnight. The oily upper layer (cream) which separates is then boiled to obtain oil. Using this method oil extraction rates vary from about 12 to 23 l of oil/100 kg fresh coconut kernel. This represents a yield of between 22.6 and 43.4 l of oil/100 kg if calculated on a copra equivalent basis, which corresponds to an oil extraction efficiency range of 32-61%.

Wet processing of coconut on a village scale

There are many village-scale industries that use wet processing and most of these are, in effect, scaled-up versions of the domestic method. Such operations usually incorporate a powered grater and some form of manual press to extract the coconut milk.

Wet processing of coconuts has attracted much interest in recent years. This centres on the possibility of producing products, other than oil, that are suitable for human consumption. It would be expected that such processes would yield high quality oil and an edible protein concentrate as their major products. Several processes exist, but they have failed because of high capital costs and the difficulties involved in marketing new products.

Village-scale wet processing of coconut is the subject of a joint project being undertaken in The Philippines by The Philippine Coconut Authority (PCA), the Philippine-based Industrial Technology Development Institute (ITDI) Appropriate Technology International (ATI) and Koninklijk Instituut Voor de Tropen (KIT).

Coconut oil extraction using a low-pressure bridge press (NRI ‘water-assisted’ method)

Traditional methods of oilseed extraction usually incorporate the addition of a proportion of seed to the ground oilseed before extraction. The influence of moisture content on the extraction of oil from grated coconut has been examined at NRI in laboratory trials using a hand-operated bridge press (Hammonds et al., 1991, 1993). Experimental results showed that at an optimum moisture content of about 10-12%, about 70% of the oil could be extracted at a pressure of about 50 p.s.i. At 100 p.s.i., about 77% of the oil could be recovered. Extraction efficiency decreased with increasing particle size.
Preliminary field tests on this method have been undertaken in Tanzania using a 240 mm diameter cage. The main practical problem was how to prepare the dried grated kernel to within the optimum specific moisture range. It was established that the moisture content of grated coconut kernel was reduced to about 3% after 4 h of drying in the sun. Tests indicated that a mixture of wet and dry coconut gratings at a ratio of 19:100 gave a moisture content in the required range. The following method is based on this finding and is presently being evaluated by a village women’s group in Tanzania.

Recommended method for village use

1. Select 45 coconuts of the same size.
2. Set aside five coconuts from this batch.
3. Grate the remaining 40 coconuts and dry them in the sun for 4 h on a suitable surface. Coconut mats, galvanized roofing sheets or plastic sheet would be satisfactory. The area selected for this should be free from dust and interference by animals and children. Cassava or rice drying areas would be suitable.
4. After 4 h of drying, gather the dried coconut and divide it equally among five bowls of the same size so that the same level of dried coconut is in each of the bowls.
5. Now grate the five coconuts that were set aside and, without delay, add one grated coconut to each of the five bowls. Mix the wet and dry coconut together well.
6. Divide the contents of each bowl equally between two bags and load them into the press.
7. Press the oil out from the coconut in the bags by applying pressure for about 30 min. This pressure should be applied slowly and should only build up to a maximum towards the end of the 30 min.
8. The oil obtained should be filtered through a cotton bag to remove any fragments of coconut gratings which may be present.

The entire oil extraction process should be completed in one day. If this is not possible, the process can be halted after the grated coconut has been dried in the sun for 4 h and before the five coconuts have been grated. The dried, grated coconut must be carefully stored under cover overnight, preferably in sealed plastic bags. The process should be continued the following day by grating the five remaining coconuts, adding the freshly grated coconut to the dried grated coconut, and then completing the oil extraction process as normal.

Initial results indicate that the oil extraction efficiency is about 64%, which is a little lower than that achieved in the laboratory trials. The coconut flavour of the oil from this process is not as strong as that of oil from the traditional domestic
process. However, a consumer survey has shown the oil to be generally acceptable for the preparation of food. The new process requires neither firewood nor water and avoids the laborious extraction of ‘cream’ from the grated coconut flesh.

Coconut oil extraction using a low-pressure bridge press (the KIT method)
Source: UNATA-PRESS No. 21986

The fresh kernel from 40-45 grated nuts is dried either in the sun, or in an artificial drier, to yield approximately 8 kg of dried material with a moisture content of about 4%. Water (8% by weight) is added and the mixture heated for 20 min. at 75°C with stirring. The conditioned coconut is then transferred to the 171 cage of the UNATA 4201 press in five equal portions, separating each portion with a metal plate. Pressure is applied slowly to reach a maximum in about 15 min. Three pressings an hour give 13.5 l of oil, which corresponds to an extraction efficiency of 72%. The press-cake can be ground in a hammer mill, rolled, moisturized and pressed to give additional oil. The combined yield from the two processes represents an extraction efficiency of 90%.

Note In the KIT process, the addition of 8% water to the dried coconut gratings raises the moisture content to 11%, which is the same as that used in the NRI method. Pre-heating the mixed dried and wet gratings prior to pressing in the NRI method would probably bring the oil recovery up to that achieved in the KIT process.

Coconut oil extraction from coconut gratings using the ram press

Sun-dried coconut gratings containing approximately 3% moisture can be processed in a ram press. The throughput in a CAMARTEC BP-30 press, of gratings heated to 60°C, is 3.9 kg/in, yielding 2.46 l of high quality oil. This is equivalent to an extraction efficiency of 85%, which is comparable to that achieved by a small-scale expeller. This process shows considerable promise, but has yet to be widely adopted.

Use of the ghani to process copra

Copa is easily processed in a ghani but must first be disintegrated in a hammer mill. Water added during this process is normally in the range of 2-5%. The average amount of oil extracted is about the same as that obtained by a single pass on a small-scale expeller, i.e. 60 l of oil/100 kg of copra.

Coconut oil extraction from copra using a small-scale oil expeller

Using the De Smet Rosedown Mini 40 expeller

The small-scale processing of copra was demonstrated to be technically feasible and potentially profitable in the Cook Islands (Barrett et al., 1987). The equipment comprised a copra chopper, a De Smet Rosedown Mini 40 screw press and a filter press. At copra throughputs of approaching 65 kg/in, yields of clarified oil and copra cake were approximately 55% and 40%, respectively, on a
weight basis. The oil yield was equivalent to about 60 l of oil/100 kg of copra, containing 5.3% moisture. This corresponded to an oil extraction efficiency of close to 84%. When copra containing 9.2% moisture was processed, the crude oil extraction rate fell from 58% to 37%. Over-dried copra with a moisture content of 2% proved to be difficult to process with the Mini 40. It was judged that well-dried copra, with a moisture range of 4.5% to 7%, could be processed without pre-heating.

A consumer survey indicated that coconut oil could be marketed as a cooking oil to substitute for imported vegetable oils; its potential use in soap manufacture was also recognized, while copra cake was readily marketed for animal feed.

Using the CeCoCo Hander H52 expeller

A copra processing plant on the Caribbean island of Nevis using CeCoCo equipment, which included the H52 expeller, was tested by NRI staff in 1985. The press functioned well on warm disintegrated copra (60-70°C) conditioned to a moisture content of about 3%. Copra throughput was a little over 50 kg/in and the yield of clarified oil, expeller cake and filter press-cake was 56.8%, 35% and 6%, respectively, from copra containing 4.4% moisture. This represents an oil extraction efficiency of 86%.

The fry-dry process

The fry-dry process is used in Indonesia and by-passes the cope-making step. Ground, fresh, coconut kernel is dried by immersion in hot coconut oil. The final product has a cooked flavour which is very popular in Indonesia.

In one process (Boutin, 1990), fresh kernel is ground to pass a 6 mm screen and heated in coconut oil for about 30 min. at a temperature not exceeding 120°C. The ratio of oil to coconut is about 2:1 by weight and the dried coconut is removed when the foaming diminishes. The dried coconut is then processed in a small-scale expeller.

Uses of coconut oil

Coconut oil is used as a cooking oil and in the preparation of oil and fat blends for the food industry. It has important industrial uses, particularly as an ingredient in soap-making.
The groundnut is an annual plant. Varieties are grown as two types, either as a bushy bunch or as a runner. Hybrids of the two, ‘semi-upright’, are grown commercially. Groundnuts grow in tropical and subtropical regions, and in warm parts of temperate regions. They are cultivated as a rainfed crop, or under irrigation in the dry season.

When mature, plants are dug or pulled up and the pods removed by picking or flailing. Bunch-type groundnuts have small- to medium-sized pods containing one or two round kernels in a thin shell. Runner types have one to three oval kernels in medium-sized, thicker-shelled pods. The kernel consists of about 60-75% of the whole nut. Oil content of groundnut kernels is 45-55%, depending on variety.

Under-dried groundnuts, like copra, are very susceptible to attack by the mould Aspergillus flavus, and hence contamination by aflatoxin (see Chapter 4, Coconuts, and Shantha, 1984). The safe moisture level for groundnuts is below 10%. Oil produced from mouldy groundnuts should not be used for edible purposes.

Village traditional manual processing of groundnuts, Ghana

Groundnuts are shelled by hand. The kernels are roasted over a fire on a metal sheet. The kernels are lightly rolled between flat stones, then winnowed to remove the testa (skins). This step is important because the testa is bitter and will affect the flavour of the fried by-product (see below). The roasted kernels are either ground in a local maize mill or crushed between two stones to form a paste. The former process is preferred since it is quicker and reduces labour requirement. Water is added to the paste in a large bowl and the mixture is stirred and kneaded by hand. The amount of water added is not measured, but gauged using experience. After about 15 min., the mixture darkens and forms a more resilient paste which is difficult to knead. At this time, oil separates from the mixture. The mixture is continuously kneaded for about 5 more min. The groundnut paste (which, at this stage, can be formed into a cohesive ball) is then removed. The oil is poured into a separate container and needs no further treatment before consumption. The remaining groundnut paste is rolled into thin strips, then into rings, and fried in groundnut oil to produce a popular, tasty snack (called cull cull in Ghana).

Throughput: 2 kg batch size using a mechanical grinding mill yielded 0.5 l of oil in a little over 2 h.

Bridge press, Malawi

The nuts are shelled by hand and the kernels crushed in a roller mill. Water is added (15% by weight) and the mixture is covered and left to stand for 1 h. The
mixture is then heated with stirring for 15 min. prior to pressing in a bridge press. Oil is sold locally.

Throughput: Batch size 10 kg, 8 charges/day.

Yield: 35 l oil/10 kg batch, 28 l oil/day.

Oil clarification procedure: Oil is boiled with water for 2 h, after which the sediment is allowed to settle.

The residue (groundnut cake) is produced in the form of slabs. Sometimes these are incorporated into family meals, but more often they are sold as animal feed. The cost of equipment for this type of operation, if purchased from Europe, is around £ 1800 ax-factory.

Bridge press, The Gambia

Nuts are shelled by hand and the kernels pounded using a pestle and mortar. Care must be taken not to pound the nuts to a sticky paste. After a few minutes of pounding, the partially-ground material is sieved (using mosquito screen of approximately 1 mm mesh) and collected. The unsieved material (the larger groundnut particles) is returned to the mortar for further pounding. This process is repeated until all the pounded material passes through the sieve. The pounded groundnut flour is placed in a colander over a metal cooking vessel containing boiling water fuelled by a wood fire. The material is steamed for about 20 min. This work is normally carried out by women. The steamed material is wrapped in a piece of sack and placed in the cage of the bridge press. The press plate is screwed down manually on the seed. Oil flows out through a hole in the bottom of the press (via holes in the cage) on the application of pressure. The press requires two operators.

After extraction the cake is removed from the press, repounded, steamed, and pressed again. The oil extraction efficiency of the process is about 66%. This is equivalent to an oil yield of about 3.9 l/10 kg groundnut kernels. The oil does not require clarification. The residue is fed to animals.

Use of the ghani to process groundnuts

Groundnuts are commonly processed in ghans in India. Water added during the process is normally in the range of 5-10%. Extraction efficiency ranges from 60% to 65%.

Groundnut processing in a small-scale expeller

Groundnuts can be processed successfully in small-scale expellers provided the seed is properly prepared. Seed preparation usually involves the addition of water and the process benefits from pre-heating.

Using a diesel-powered CeCoCo H54 expeller (The Gambia)
Groundnuts are shelled by hand and the kernels placed on a tarpaulin on the ground. About 160 kg of peanuts in shells are required to produce 100 kg of kernels. Approximately 2 l of water are mixed into every 100 kg of kernels. The moistened seed is passed through the expeller three times to yield 47 kg of crude oil and 50 kg of press-cake. The overall throughput of kernels is about 50 kg/in. The crude oil is left to stand for three days and the clarified supernatant oil (35.8 kg) is poured off leaving 11.2 kg of sediment (‘foots’). The foots are processed by heating with water (see Chapter 2) to yield an additional 13.2 kg of clarified oil. Thus, the overall recovery of clarified oil is 42.4 kg (46 b/100 kg. Cake is sold to local farmers/householders for animal feed.
The oil palm requires a rainy tropical climate. Natural distribution in West Africa lies between 13°N and 12°S. It grows in the transition zone between the rainforest and savannah, in moister locations of the grasslands, and in forest areas. Wild oil palms begin to fruit after 10 years and do not give a full crop for about 20 years. Cultivated palms come into bearing at about the fourth year, reach their peak after 12-15 years, and continue bearing fruit for 40 to 50 years.

The fruit is an oval-shaped drupe 2.5-5 cm in length and 2.5 cm in diameter. It consists of a thin, pliable exocarp, an orange/red pulpy mesocarp and a hard nut containing a single kernel. Fruits are borne tightly clustered in large bunches which may weigh from 5 kg in young poor palms, to as much as 40 kg in 15-year-old palms in good condition. Three types of fruit can be recognized according to the thickness of the shell:

(i) ‘aura’ with a shell thickness of 2-8 mm; (ii) ‘tenera’ with a shell thickness of 0.5-3 mm; and (iii) ‘pisifera’ without any shell.

Wild and semi-wild groves in West Africa consist mainly of palms of the aura type. High-yielding varieties are a cross between aura and pisifera and produce fruits of the tenera type. The fruit-pulp contains between 40% and 62% oil (on average, 56%) while the ratio of pulp to nuts depends on the climate and the variety.

Two types of oil are produced from the oil palm, red palm oil from the fruit, and white oil from the kernel. The oil content of the fruit is about 55% and that of the kernel is about 47%. The fatty acid composition of palm oil is very different from that of palm kernel oil (see Table 2). Typically, for tenera fruit, 100 t of fresh fruit bunches will yield 21 t of red palm oil and 6 t of decorticated palm kernels. Thus, palm kernel oil represents about 12% of total oil production. Both types of oil are processed at industrial level, especially in Malaysia and Indonesia. The industrially-produced oils are refined and deodorized to yield colourless, taste-free, odourless products.

Traditional small-scale processing methods are divided into two types: ‘the soft oil’ process and ‘the hard oil’ process.

‘Soft oil’ process

In the soft oil process the separated fruits are softened by boiling in water and then pounding to disintegrate the pulp. The mass is then treated with a large volume of water, the pulp squeezed, and the oily layer skimmed off and heated to remove water. Only small amounts of free fatty acids are produced by this method and the product is mainly liquid.

‘Hard oil’ process
In the hard oil process, the pulp of the palm fruits is softened by fermentation in wooden troughs. Fermentation takes place in successive stages, alternating with moistening and pounding for several days. Oil mixed with water and vegetable tissue drains out and is collected, boiled with water, and the oil skimmed off. Considerable amounts of free fatty acids are produced, giving the oil a special flavour and leading to a 'hard' palm oil.

General small-scale technique using machinery

The general technique for small-scale oil palm processing methods using machinery is as follows. The whole fruit bunches are sterilized by steaming or boiling in water. This operation destroys enzymes responsible for the formation of free fatty acids. The fruits are then separated from the bunch, either mechanically or by hand, and digested by stirring at a high temperature. Digestion renders the mass homogenous, detaches the pulp from the nuts and makes kernel removal easier. A mixture of oil and water is extracted from the mass using a curb press, a hydraulic press, or continuous low-pressure screw expellers. The mixture is allowed to stand and the oil separated from the water by decantation. The palm nuts are separated from the residue by hand.

Readers are referred to Weimer and Altes (1989) for detailed descriptions of palm oil processing using small machines.

Palm oil processing operation: Christian village, near Accra, Ghana

Process type: village traditional manual processing of palm fruit.

Treatment: All operations are carried out by women. Palm fruits are purchased from the local market. The fruits are boiled in water for about 2 h and then transferred to a large pit dug in the ground containing water. The pit is about 2 ft deep and 5 ft in diameter. A woman enters the pit and treads on the fruits, liberating palm oil which floats to the surface of the water. Handfuls of fruit are then collected from the bottom of the pit and wrung out by hand on to the surface of the water. When all the fruits have been collected from the pit and wrung out, the oil is scooped off the top and collected. The oil is boiled to remove water traces and is then ready for use. The woman stays in the pit to receive the next batch of palm fruits to be processed. The palm nuts are separated from the palm fibre by hand and are sold in the local market. The fibre is dried and used as fuel. About 240 l of clarified oil can be produced in two days. The oil is either used by operators or sold locally.

The women operators state that oil processed in this way tastes better and sells more easily than that produced by mechanized processes. Two people are employed full time for two days on this process.
Decortication

Refer to Appendix 2 for sources of equipment for decorticating palm kernels.

Hot water flotation

In one traditional method (Wiemer and Altes, 1989) separated palm kernels are roasted and crushed by pounding. The pounded mass is then mixed into excess water and boiled for hours, during which the oil is skimmed off. Finally, the oil is dried by heating. About 18 kg palm kernels can be processed in 12 h to yield 4.3 l of oil, which is equivalent to an extraction efficiency of about 40%. The oil tends to be dark in colour because of over-heating during the roasting step.

Another method used in the eastern part of Nigeria is to steep the whole kernels in water for 1-3 days and then to roast gently in an iron pot until the oil exudes (Cornelius, 1977).

In an experimental procedure (Lukey, personal communication), palm kernels were ground in a plate mill and boiled with water for 1 h. The oil yield from 1 kg of kernels was 0.37 l which is equivalent to an extraction efficiency of about 60%. The residue from this extraction was passed through a 1 mm sieve. Particles retained on the sieve contained about 41% residual oil, while the fine particles had an oil content of 34%. These analyses emphasize the need for fine grinding in this type of extraction procedure.

Bridge press

Preliminary laboratory trials (Donkor, unpublished work) have shown that oil can be extracted from palm kernels in a bridge press. An oil extraction efficiency of 55% was achieved with roasted kernels ground to a fine paste, a paste moisture content of 20%, and a seed temperature of 60°C.

Small-scale expeller

Palm kernels are easily processed in a small-scale expeller and for some machines it is not necessary to grind the nuts. However, if the nuts are ground, then it is important to avoid the formation of fines (Head, et al., 1989). Processing whole, coarse- and finely-ground kernels in the De Smet Rose down Mini 40 expeller resulted in choke temperatures of approximately 100, 120 and 140°C, respectively, the latter causing the cake to char.
Rape and mustard are similar species and for the purposes of this manual can be treated as one oilseed. Rape is one of the most widely cultivated oilseed crops. Basically a temperate crop, it prefers temperatures below 25°C during growth. The traditional rapeseed crops of the Indian subcontinent are characterized by the presence of high amounts of erucic acid and a group of anti-nutritional, sulphur-containing compounds called glucosinolates. The expansion of the cultivation of oilseed rape in recent years in both western Europe and Canada is the result of plant breeding, which has culminated in the production of 'double zero' seed varieties in which erucic acid and glucosinolates are virtually eliminated. However, high-erucic rapeseed oil is still in demand for industrial purposes.

Traditional rapeseed processing

The traditional method for processing rapeseed on the Indian subcontinent is the ghani. The animal-powered ghani can process about 10 kg of seed in 2 h while the throughput of a power ghani can be as high as 14 kg/in. As is usual in ghani operations, water is added in stages during processing (10-12% of the seed weight for rapeseed). The added water not only allows oil release, but also favours enzymatic breakdown or glucosinolate into volatile compounds that add pungency to the oil. The flavour of oil from the animal-powered ghani is said to be better than that from the power ghani due to the slower processing rate which allows more time for the flavour to develop.

The presence of glucosinolates in rapeseed limits the use of the oilseed for ruminant feed or as a fertilizer. The destruction of glucosinolates means that rapeseed cake from a ghani has greater application as an animal feed.

Processing rapeseed in an expeller

The ghani process is rapidly being replaced by small-scale expellers which have an improved oil recovery and higher seed throughput. Sometimes, high oil recoveries are only achieved by repeatedly recycling the expeller cake (Dietz, 1992). The breakdown of glucosinolates during small-scale expelling is aided by processing at relatively high moisture contents (8-10%) (Dietz et al., 1989). These conditions are incorporated into the following method which is used at NRI.

Processing rapeseed in the Hander Type 52 expeller

1. The seed is heated to about 70°C to give a feed moisture content of 6%.

2. First press: the conditioned feed is processed with the choke set to give a cake 1 mm thick. The processing rate should be more than 60 kg/in and the seed should be self-feeding. Power drawn is 4 4.5 A and production of coarse ‘fools’ should be negligible.
3. The moisture content of the cake is adjusted to 9%. This will normally require the addition of about 3% water. The cake is then heated for about 30 min. in a system which limits moisture loss (i.e. the 'cement mixer' conditioner with a loose-fitting lid over the feed opening). The final temperature should be 100°C, and the moisture content about 7%.

4. Second press: this is carried out with the choke set to give a cake just under 1 mm thick. Processing rate is 50-60 kg/in and the feed (which breaks up during the conditioning) should be self-feeding. Power drawn is 4.5-5 A and again, production of coarse 'fools' is negligible.

Overall processing rate is about 35 kg seed/in and the residual oil content of the cake is 12-14% (MFB). Oil extraction efficiency is 72-77%, equivalent to 32-35 l of clarified oil/100 kg of seed.
Sesame is an annual crop grown in tropical, subtropical and warm temperate regions. It thrives in temperate regions during the summer and in tropical lowlands under semi-arid conditions. Varieties may be classified either as shattering or non-shattering, according to whether the seed capsules open on drying. Under optimal conditions, some varieties take only 3-4 months to reach maturity; in less favourable conditions, some slower types may take 8 months. When harvesting by hand, the crop is cut close to the ground with a sickle, tied in bundles, and stacked to dry. The crop is cut when the lowest capsules on the stem begin to open. The oil content of sesame seed and the fatty acid composition of the oil are given in Table 2. Natural sesame oil derived from good quality seed has a very pleasant flavour and can be consumed without further purification. The natural oil has excellent stability due to the presence of high levels of natural antioxidants (Lyon, 1972).

Hot water flotation

Hot water flotation is a traditional method in Uganda and Sudan for the extraction of sesame oil. The following is a description of a laboratory method, as details of the traditional method have not been located.

Sesame seed is ground to a paste and heated to 80-90°C for 15 min. Enough boiling water is then added to suspend the ground seed on stirring. The mixture is boiled with stirring for 15 min. After cooling the upper oil layer is separated off and dried by heating. The oil recovery from 0.5 kg seed is 108 ml, equivalent to an oil extraction efficiency of 41%.

Bridge press

Laboratory trials at NRI have demonstrated that sesame seed is suitable for processing in a bridge press. However, no results of its application in the field are available. In the laboratory trials, sesame seeds were ground to a paste using a powered mincer incorporating a plate with 2 mm holes. It is important to grind the seeds as finely as possible. Oil extraction was improved by the addition of water, and optimum oil recovery was achieved at a moisture content range of 11-13%. Yields of over 70% were recorded with sesame paste containing 12.7% moisture pre-heated to 50°C before pressing (see Figure 15).

Ram press

Work in Tanzania has indicated that sesame is suited to processing in the ram press. Pre-grinding is not required but pre-heating the seed by warming in the sun, preferably on metal roofing sheets, is strongly recommended. Use of the CAPU press at 4 strokes/mint gave an oil extraction efficiency of 57.5% in terms of clarified oil. The oil production rate was a little over 2.2 l/in. The oil extraction efficiency of the smaller CAMARTEC press under similar operating conditions was 62%, and the oil production rate was 1.5 l/in.
The ghani process (Sudan)

The following traditional method was described by Kamel-Eldin et al. (1992). The addition of oil to aid the extraction process is of particular interest.

Sesame seeds (12 kg, oil content 53.1% MFB) were ground in a camel-powered ghani with 0.5 l of water. Oil release was observed after 30 min. when the temperature of the mass was 41°C. After 40 min., 2 l of oil previously extracted (temperature 46°C) were added to assist extraction. Extraction was complete in 55-60 min., giving approximately 5 l of oil (temperature 50°C).

Small-scale expeller

The following operation was monitored at Illiassa in The Gambia (see Plate 7).
The soyabean, or soybean, is an annual, and with the selection of the appropriate variety, can be grown in a wide range of conditions. The plant is essentially subtropical, but cultivation extends to tropical regions and temperate regions up to latitude 52°N. The seeds are contained in a short hairy pod that is harvested when fully mature. The traditional method of harvesting soyabeans in Asia and many tropical countries has always been by hand, but the crop is easily harvested by machine.

Soyabeans are widely used as a food crop. They are unusual oilseeds in that the products derived from their processing, soya oil and soya meal, are of almost equal value. The oil content of soyabeans (approximately 20%) is relatively low but the composition of the meal is ideal for the manufacture of animal feeds. Soyabean meal is also the raw material in the manufacture of 'textured vegetable protein' used for human consumption. Commercial processing of soyabeans is nearly always carried out in large-capacity solvent extraction plants. The final stage of this process involves 'toasting' the meal which ensures the removal of an anti-nutritional factor present in the bean. The flavour and instability of crude soya oil, together with the low oil content of the seed, mean that soyabeans are not ideally suited to small-scale processing.

Processing soya beans in a Reinartz APV11 expeller

(International Institute for Tropical Agriculture, Ibadan, see Plate IX)