



SMALL SCALE OILSEED PROCESSING

Most countries in the world have large refineries producing oil from a variety of plants including sunflower, rapeseed, mustard seed, soya, maize, and palm. These large centralised enterprises have the advantage of high efficiency and reduced costs due to the economy of scale. Despite this, in many situations smaller scale decentralised oil extraction can prove to be economic and provide opportunities for income generation. Most commonly, opportunities exist where:

- Oil produced in the large refineries does not find its way out to more remote and distant rural areas.
- High transport costs are involved in wide distribution of cooking oil, thereby increasing the price of oil.
- Small farmers produce oilseeds such as sunflower for sale to the large refineries which they then buy back, at high cost, in the form of cooking oil but without the valuable high protein oil cake.
- The crude oil is used to produce added value products, most commonly soap.
- More unusual, high value oilseeds are available.

The main risks that need to be considered are:

The policy environment

In many countries the oil processing sector is highly politicised and regulations exist which make entering the market difficult and tend to support the monopoly of the large processors. Large refineries may, for example, insist that farmers sell all their seed under a contract. In other cases seed has to be sold to a central Government marketing board, the board also supplies seed for planting.



Figure 1: Sunflower.

Photo credit: Practical Action / Morris Keyonzo



Figure 2: Sunflowers grown in Kenya

Photo credit: Practical Action / Morris Keyonzo

To determine whether small scale processing is likely to be economic it is important to first investigate the local situation and regulations.

Raw material supply

Clearly there must be sufficient raw material available locally. One factor that will influence the viability of the enterprise will be the amount of credit needed to purchase a stock of seed. The enterprise should aim to keep the minimum stock of seed but always have enough to continue operating throughout the year. This requires considerable working capital.

Health and safety

As oil processing is classified as a food processing enterprise it will be subject to local legislation. Care should be taken that standards are understood and met. The particular problem of aflatoxins will require attention. Aflatoxins are natural poisons produced by certain moulds that grow on seeds and nuts. They are of considerable concern to oil seed processors. The growth of aflatoxin producing moulds can be prevented by correct drying and by preventing moisture pickup by seeds in storage. It is most important that those considering establishing an edible oil enterprise should be able to recognise aflatoxin producing moulds and understand how to correctly select and store raw materials. If aflatoxin is present very little passes to the extracted oil, the majority will be found in the cake remaining after extraction. Aflatoxin-contaminated cake presents a real danger if incorporated in livestock feeds. As aflatoxin is difficult to remove good practice is essential to prevent any mould growth and so prevent problems.

Not all oilseed crops are suitable for processing at a small scale, the most common types that are suitable include, sunflower, sesame, and mustard seed. Typical oil contents of seeds are shown in Table 1.

Common oilseeds	Oil content %	Use
Castor	35 - 55	Paints, lubricants. Non-edible as it contains ricin which is highly toxic.
Cotton	15 - 25	Soaps. Non edible as it contains gossypol which is a toxic. Sophisticated equipment can be used to remove gossypol.
Linseed/flaxseed	35 - 44	Paints, edible nutritional supplement.
Rape/canola/mustard	40 - 45	Cooking, biodiesel.
Sesame	35 - 50	Cooking.
Sunflower	25 - 40	Cooking, biodiesel.
Less common Oilseeds		
Neem	45 - 50	Soap, cosmetics, insecticides.
Karanja	27 - 39	Insecticides.
Pumpkin	34 - 54	Lighting, edible.
Avocado	3 - 30	Cooking, edible, cosmetics.
Niger	38 - 50	Cooking, medicinal, soap, paint.

Table 1 Oils and their uses

In many cases the crude extracted oil is not suitable for human consumption until it has been refined to remove undesirable free fatty acids that taste rancid, dark colours, waxes and toxic components. Refining involves considerable extra equipment costs. The most suitable oils for small and medium scale extraction are those that need little or no refining eg. mustard, sesame, and sunflower.

Methods of extraction

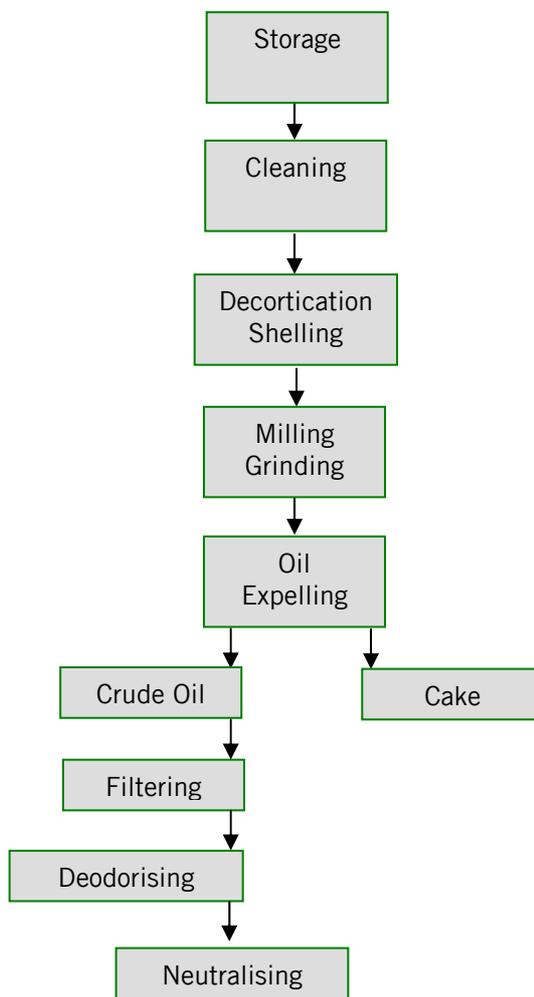
Five common methods are used to extract oil:

- Water assisted. Here the finely ground oilseed is either boiled in water and the oil that floats to the surface is skimmed off or ground kernels are mixed with water and squeezed and mixed by hand to release the oil.
- Ghani. A ghani consists of a large pestle and mortar rotated either by animal power or by a motor. Seed is fed slowly into the mortar and the pressure exerted by the pestle breaks the cells and releases the oil.
- Manual pressing. Here oilseeds, usually pre-ground, are pressed in manual presses. Some pre-heating and the addition of water can improve yields.
- Expelling. An expeller consists of a motor driven screw turning in a perforated cage. The screw pushes the material against a small outlet, the "choke". Great pressure is exerted on the oilseed fed through the machine to extract the oil. Expelling is a continuous method unlike the previous two batch systems.
- Solvent extraction. Oils from seeds or the cake remaining from expelling is extracted with solvents and the oil is recovered after distilling off the solvent under vacuum. This process is usually only carried out in large scale production plants and is not suitable for small scale production.

Most small enterprises will find that small expellers are the best technology choice. Methods such as water extraction and manual pressing only produce small amounts of oil; the extraction efficiencies (the percentage recovered from a possible maximum) are low and labour requirements high. Solvent extraction while highly efficient involves very substantial capital cost and is only economic on a large scale. There is also a health and safety risk from using inflammable solvents.

The basic steps involved in processing oilseeds by expeller are shown in the flow diagram below.

Flow diagram



technical brief

Equipment required

The equipment needed to set up a small or medium scale oil extraction enterprise falls into three main categories:

- pre-extraction equipment; dehullers or decorticators, seed/kernel crackers, roasters, grinding mills.
- extraction equipment; ghani, manual bridge press or ram press, expellers
- equipment for basic refining of the oil; filters, settling tanks for caustic soda to treat free fatty acids FFA (do not use aluminium tanks).
- packaging equipment

The specific equipment required will depend on the particular crop being processed, the final oil quality required and the scale of operation.

Shelling or dehulling

Most oil-bearing seeds need to be separated from their outer husk or shell. This is referred to as shelling, hulling or decorticating. Shelling increases the oil extraction efficiency and reduces wear in the expeller as the husks are abrasive. In general some 10% of husk is added back prior to expelling as the fibre allows the machine to grip or bite on the material.

A wide range of manual and mechanical decorticators are available.

After decortication the shell may have to be separated from the kernels by winnowing. At small scale this can be done by throwing the material into the air and allowing the air to blow away the husk. At larger scale mechanical winnowers and seed cleaners are available.

Milling is carried out to reduce the size of particles and improve the efficiencies of extracting oil.

Heating or conditioning

Pre-heating the seeds prior to expelling improves the release of the oil by breaking the cell walls and by thinning the oil. The most basic method of heating is spreading the seed on a black plastic sheet exposed to the heat of the sun for 15 minutes. Stoves can be used either with a pan for 5 minutes or with a double-boiler for 15 minutes. There is a likelihood that the seed will burn while using a pan which is not the case with a double-boiler. A double-boiler is an arrangement in which one pan is placed inside a larger pan without touching the bottom or sides. Water is placed at the bottom of the larger pan and is heated to produce steam that heats the seed in a more controlled manner preventing the seed from burning. Special kettles can be made, for example from an old oil drum, or a commercially available kettle that is specifically designed for this task can be purchased. Pre-heating is often done with the kettle mounted above the expeller.

Expelling

A wide range of makes and sizes of expellers are available. A ghani is a pestle and mortar that is traditionally animal powered. Its capacity is approximately 40 kg a day although this will vary depending on the size, strength and number of animals used. Animals need to be replaced after 3 or 4 hours work as they tire.



Figure 3 : Decortication (removal/winnowing of husks) machine for sunflower seeds. The decortication machine is used in conjunction with Tinytech oil mills. Photo credit: Kieth Machell / Practical Action

Motor driven ghanis are now common in South Asia where they are used for mustard and rape seed oil extraction. Their capacity is approximately 12 to 15 kg per charge. Each charge takes around 75 minutes to process, so several charges can be processed in a day.

The equipment can be made locally and the running costs can be low. The oil yield is relatively high at around 60% although production is slow.

Small-scale manual presses have been promoted by a number of organisations. As these machines do not require any power source their running costs are minimal.

Types of manual press include:

- Spindle press
- Bridge press, also known as a screw press
- Ram press
- Hydraulic press

Manually powered spindle presses are usually small table mounted devices with a capacity of around 2 to 5 kg per hour.

The bridge press comprises of a cylinder that contains the seed which is compressed by rotating a screw down onto the seed. The screw is held in place by a frame that bridges over the seed container. As the seed is compressed the oil drains through holes in the cylinder onto a collection tray. The process is relatively slow as the cylinder needs to be filled, compressed and then the remaining cake needs to be removed.

Ram presses use a lever mechanism to produce high pressures on a piston that forces the oil out of the seed. Manual ram presses can be tend to be hard work.

Hydraulic presses use a hydraulic pump to exert a high pressure on the seed. Hydraulic jacks from cars and trucks can be used. The process is similar to a screw press, in that the seed has to be loaded into a cylinder and then pressed to extract the oil, which runs onto a collection tray. Once the seed has been pressed the remaining cake needs to be removed. Capacities are from around 1 kg per press.

In India in particular a number of efficient small or "baby" motorised expellers are available with a capacity of up to 100 kg/hr. A typical machine has a central cylinder or cage fitted with eight separate sections or "worms". This flexible system allows single or double-reverse use and spreads wear more evenly along the screw. When the screw becomes worn only individual sections require repair, thus reducing maintenance costs. As the seed passes through the expeller the oil is squeezed out, exits through the perforated cage and is collected in a trough under the machine. The solid residue, oil cake, exits from the end of the expeller shaft where it is bagged.



Figure 4: A manual screw press
Photo credit Practical Action / Paul Harris



Figure 5: Tinytech oil expeller in operation in Zimbabwe.
Photo credit: Practical Action / Keith Machell

Filtration

The crude expelled oil contains solid particles. These can be removed by allowing the oil to stand and then filtering the clear oil by gravity through fine cloth. A better but more expensive method is pumping the crude oil through a filter press.

Clarification

Filtering will remove insoluble contaminants such as fibre but fresh extracted oil will also contain moisture, resins and colorants from the seed. Clarification is a relatively simple method of removing these unwanted elements and can be done by letting the oil stand undisturbed for a few days and then separating the upper layer, or by using a clarifier in which the oil is held in a tank with a heat source. This can be an old oil drum above a fire or commercially available equipment. The oil is boiled to drive off water and to destroy naturally occurring enzymes and contaminating bacteria. After heating the oil is allowed to stand and the contaminants separate out. The oil is filtered through a cloth and is reheated to ensure that all the moisture has been removed.

The typical system described above consists of the following equipment.

- Decorticator with blower to remove shell, 150 kg/hr
- Boiler, 50 kg steam/hr
- Cooker
- Expeller (motorised) 75 -100 kg/hr
- Filter pump and press
- Clarifier

Refining

In many local markets further refining is not required as the complex flavours of unrefined oils are preferred. International markets tend to prefer lighter less intense oils for cooking which means further processing of the oil.

There is a series of refining processes that can be carried out after the oil has been filtered.

De-odorising

Volatile compounds that produce bad odours can be eliminated through the process of sparging, i.e. bubbling steam through the oil, under a vacuum.

Wintering

Allowing the oil to stand for a time at low temperatures so that glycerides, which naturally occur in the oil, with higher melting points solidify and can then be removed from the oil by filtering. Over time glycerides can degrade releasing fatty acids into the oil increasing the acidity levels and reducing the quality.

Neutralisation

Fatty acids can be neutralised by adding a sodium hydroxide solution, also known as caustic soda, or by stripping, which is a similar process to de-odorising.

Bleaching

Some oils have a very dark colour to them that is unpopular with consumers. The appearance of the oil can be lightened by bleaching

De-gumming

Degumming is a way of treating seed that have a high phosphatide content. The phosphatide, which makes a gummy residue, is removed by mixing the oil with 2 or 3 % water. This hydrated phosphatide can then be removed by settling, filtering or centrifuged.



Figure 6: The final product in Zimbabwe
Photo credit: Practical Action / Mike Battcock

Packaging

The packaging should be stored in airtight and moisture-proof containers in a cool, dark location to ensure a long shelf-life.

In general, more profit can be made if the cooking oil is packed in retail-size bottles. In many countries glass or plastic bottles are difficult to obtain and need to be purchased in large quantities, which ties up capital. The possibility of using second-hand bottles should be examined. A survey needs to be carried out to make sure that the packaging used meets the demands of customers (eg size of pack, type of container). A simple manual piston filler can be used to fill retail packs.

Marketing

The viability of any oil extraction enterprise depends to a considerable extent on the sale of the oil cake for use in animal feeds and other sub-products. Markets for oil cake must be investigated and demand established before starting the enterprise.

Further reading

- *Essential Oils* Practical Action Technical Brief
- *Oil Extraction* Practical Action Technical Brief
- *Coconut Processing* Practical Action Technical Brief
- *The Manual Screw Press: For small-scale oil extraction* by Kathryn H. Potts and Keith Machell, ITDG Publications, ISBN 1 85339 198 0
- *Minor Oil Crops: FAO Agricultural Services Bulletin 94* by B. L. Axtell, FAO, ISBN 92 5 103128 2
<http://www.fao.org/docrep/X5043E/x5043E0e.htm>
- *Small Scale Vegetable Oil Extraction* by S.W. Head et al, NRI, ISBN 085954 387 0

Equipment suppliers

Note: This is a selective list of suppliers and does not imply endorsement by Practical Action.

Agro Industrial Agency
Near Malaviya Vadi
Gondal Road
Rajkot - 360 002
India
Tel: +91 (0)281 461134, 462079, 451214
Fax: +91 (0)281 461770
Email: jagdishindia@hotmail.com

- "Jagdish" Tiny oil press
Used for the extraction of vegetable oil from oilseeds. The reverse worm system in the pressing chamber results in the highest recovery of oil.
Capacity: 50 kg/hour Power: Diesel/Electric

TinyTech
Tagore Road
Rajkot - 360 002
India
Tel: +91 (0)281 2480166, 2468485, 2431086
Fax: +91 (0)281 2467552
Email: tinytech@tinytechindia.com
Website: <http://www.tinytechindia.com/>

- Oil expellers
Capacity: 125 kg/hour. Power: Electric
- Filter Press
This is suitable for the filtration of oil. It gives transparent, very clean oil without any solid particles.
Capacity: 100-200 litres/hour

Rajan Universal Exports
 "Raj Buildings"
 Post Bag No 250
 162, Linghi Chetty Street
 Chennai-600 001
 India
 Tel: +91 (0)44 5341711, 5340731, 5340751
 Fax: +91 (0)44 5342323
 E-Mail: rajeximp@vsnl.com
 Website: <http://www.rajeximp.com/>

- ☐ "RAJA" Brand oil expellers are suitable for extracting oil from palm kernel, sunflower, Sesame, Copra, Groundnut, Cotton, Soya, Mustard etc.

Alvan Blanch
 Chelworth
 Malmesbury
 Wiltshire
 SN16 9SG
 United Kingdom
 Tel: +44 (0) 666 577333
 Fax: +44 (0) 666 577339
 E-Mail: info@alvanblanch.co.uk
 Website: <http://www.alvanblanch.co.uk>

- Expellers / Oil screw press - model mini 50
 Barrel constructed from separate cast rings spaced apart by shims. The barrels are 60mm diameter by 155mm drainage length with a single piece worm shaft driven from the discharge end through a totally enclosed intermediate chain. The unit is complete with feed hopper, manual feed chute, oil discharge spout and base plate. A versatile, low cost machine, designed to suit village communities or small industries. Suitable for oil and cattle cake. Capacity: 50 kg/hour input. Power: Diesel/Electric.

C S Bell Co
 170 West Davis Street
 PO Box 291
 Tiffin
 Ohio
 USA
 Tel: +1 419 448 0791
 Fax: +1 419 448 1203

- No.60 Power Grist Mill
 This mill is suitable for use on large and small farms. Adjustable for grinding texture. Includes hopper, feed regulator slide, coarse and fine grinding burrs and 12 inch diameter pulley. Capacity: 150 kg/hour. Power: Electric/Manual.

Forsberg Agritech India PVT Ltd
 123, GIDC Estate
 Makarpura
 Baroda - 390 010
 India
 Tel: +91 (0) 265 645752
 Fax: +91 (0) 265 641683
 Email: Forsagri@ad1.vsnl.net.in

- Pneumatic Aspirator / Winnower
 This machine is used for "air washing" of the material to remove all dust, lights and impurities which are lighter than the seed. Winnowing of harvested and threshed seeds.

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Ashoka Industries Kirama
Walgammulla
Sri Lanka

Tel: +94 71 764725

- Oil Expeller
Capacity: 5 litres/hour. Power: Electric.

Goldin India Equipment PVT Limited
F-29, B.I.D.C. Industrial
Estate
Gorwa
Vadodara - 390 016
Gujarat
India

Tel: +91 (0) 265 3801 168/380 461

Fax: +91 (0) 265 3801 168/380 461

Email: goldin@EQUIP.XEEBDQ.xeemail.com

- Screen Air Separator / Grain Cleaners
Most suited as pre-cleaner before storage of seeds. Variable speed drive ensures accurate quality separations at high capacity. Totally enclosed aspiration system with cyclone provides dust-free working in the plant.
Capacity: 100 - 2000 kg/hour. Power: Battery/Electric.

Flower Food Company
91/38 Ram Indra Road,
Soi 10, Km 4
Bangkok
Thailand

Tel: +66 2 5212203, 5523420

- Seed Decorticator Machine
Capacity: 500 kg/hour. Power: Electric.

Nigerian Oil Mills Ltd
P.O.Box 264
Atta
Owerri
Imo-State
Nigeria

- Milling Machine / Mills and Grinders
This machine is used for crushing palm kernels, groundnut seeds and moringa seeds to extract oil. Power: Electric/Manual.
- Oil Expeller
This machine is used for crushing palm kernels, groundnuts and moringa seeds to extract oil. Power: Electric/Manual.

Hander Oil Machinery Corporation
(Handa Yuki K.K.)
C.P.O. Box 293
Osaka 530-8692
Japan

Tel: +81 6 6328 4693

Fax: +81 6 6326 9620

Email: hander-taka@occn.zaq.ne.jp

Website: <http://www.occn.zaq.ne.jp/hander>

- Oil expellers
- Filter press
- Seed scorcher
- Patented fresh coconut oil extraction plants

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Organisations

NRI

Central Avenue
Chatham Maritime
Kent ME4 4TB
United Kingdom
Tel: +44 (0)1634 880088
Fax: +44(0)1634 880066/77
E-mail: postmaster@nri.org
Website: <http://www.nri.org/>

NRI was known as Natural Resource Institute is now part of the University of Greenwich. Formerly called The Tropical Development and Research Institute -TDRI- which was formed from the amalgamation of the Tropical Products Institute and the Centre for Overseas Pest Research (CORP).

Enterprise Works Worldwide
1828 L Street, NW, Suite 1000
Washington DC 20036
USA

Tel: +1 202 293 4600
Fax: +1 202 293 4598
Email: espositor@enterpriseworks.org
Web: <http://www.enterpriseworks.org>

Promote Caltech expellers, manual and motorised ram presses.

Enterprise Works Worldwide (EWW). EWW was formally Appropriate Technology International ATI and were started as part of the US Government's response to Schumacher. They are an NGO that has recently made a strategic shift towards business development services as the leading edge of their work. Now combined with VITA – Volunteers in Technical Assistance.

Practical Action
The Schumacher Centre for Technology and Development
Bourton-on-Dunsmore
Rugby, Warwickshire, CV23 9QZ
United Kingdom
Tel: +44 (0)1926 634400
Fax: +44 (0)1926 634401
E-mail: inforserv@practicalaction.org.uk
Website: <http://practicalaction.org/practicalanswers/>

Practical Action is a development charity with a difference. We know the simplest ideas can have the most profound, life-changing effect on poor people across the world. For over 40 years, we have been working closely with some of the world's poorest people - using simple technology to fight poverty and transform their lives for the better. We currently work in 15 countries in Africa, South Asia and Latin America.

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