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Introduction

From 2001-2004, KARI (Kenya Agriculture Research Institute) carried

Manure Milk and Dairy products

out research on utilization of milk meat, hides and skins in Northern Kenya. The following environmentally friendly recipes are extracts from this research.

The most valuable remaining part of the animal after slaughtering is the hide. Traditionally, hides and skins in northern Kenya are dried and since a local market for raw hides and skins hardly exists in the area, only the best hides are traditionally used for simple tanning. The resulting leather is hard and not very durable. Out of hides, skins and leather the women usually make traditional containers, covers for beds or clothing. For the latter, goat and sheep skins are preferred over camel hides. In other pastoral Kenyan societies, notably the Maasai around Kajiado, rural tanning enterprises have created employment and a small, but successful handicraft business supplying mainly the tourist sector has evolved. Using the below recipes it is possible with some practice to produce very good attractive leather in a village or home situation.

Added value by tanning
The total annual trade in raw hides and skins from Marsabit district in 2003 was estimated at 23,000 hides and 76,000 skins with a total turnover of USD 97,000. The market price is determined by volume offered, quality and weight of the raw hide / skin. Below table gives

some estimates from 2004 of the possible value addition to hides and skins by tanning. The calculations were made in US Dollars (In January 2009: 1 US$= Ksh 77/-).

Table 1. Approximate prices and possible value addition of tanned hides and skins (2004).

	Fresh weight	USD/Kg	Sale price USD	Leather Sq ft	USD/Sq ft	Leather Sale USD	Possible value addition USD
Goat skin	3-5	-	0.30-0.90	3-6	0.60-1.20	1.80-6.00	1.50-5.00
Sheep skin	3-6		0.30-0.90	3-6	0.60-1.20	1.80-7.00	1.50-6.00
Cow hide	10-20	0.30-0.60	3-12	10-20	0.50-1	5-20	5.00-20.00
Camel hide	20-35	0.30-0.60	6-20	20-35	0.60-1.20	12-40	6.00-20.00

Table 1 shows that a dried unprocessed goat skin which could at the time sell for Ksh 50/- if the size and quality was good, could fetch from

Ksh 200/- 400/- when tanned depending on quality and size. Considering the amount of goat skins which are just discarded, tanning skins and hides could become a good income booster where there is plenty of hides and skins available.

Table 2. Production costs and sales of hides and skins in Ngurunit, Marsabit district, January 2003 to April 2004

Type of hide/skin	Tanning method	Hides/skins produced	Average production costs (USD) per hide/skin	Average sale price (USD) per hide/skin	Average profit (USD) per hide/skin
Goat / sheep	Alum	20	2.80	3.75	0.95
Camel hide	Alum	5	9.95	15.60	5.65
Camel hide	Vegetable	5	13.20	16.30	3.10
Goats	Vegetable (mimosa powder)	10	3.00	4.50	1.50

Goats	***Acacia nilotica* pods**	**12**	**2.25**	**4.50**	**2.25**

*** The weight of wet/soaked goat/sheepskin was taken to be 4.5 kg whereas that of half a camel hide was estimated at 15 kg in calculating the cost of processing leather.**
The table shows that the vegetable tanned hides and skins were more expensive to produce, but also fetched a higher market price due to their better quality and appearance of the finished product.

Animals in pastoral environments are kept in bomas, which are night enclosures built piling up branches from thorny trees and bushes (such as *acacia* spp.) in a circle. The thorns cause frequent skin injuries in the animals and therefore unwanted marks on the finished leather which lowers the quality and the market price. The best sales prices for leather are obtained from unmarked undamaged hides and skins.
However home tanning is hard work, and takes time. Equipment does not have to be very expensive for small operations, but a small investment is needed.

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Preparation of hides/skins for tanning

Water Quality

Leather tanning requires plenty clean water of fairly good quality. Water quality: a concentration of calcium carbonate above 400 mg/litre is generally considered too hard for tanning and KIRDI recommended to use soapless detergents or soften the water with commercially available chemicals such as DIASOAK (available at swimming pool supply shops in Nairobi) before using it for leather tanning.

The water from Ngurunit and Laisamis had calcium carbonate content of 585 mg/litre or more and pH of 7.7.

The KARI experience in Ngurunit and in Laisamis showed that the local water worked well without treatment, despite the fact that it was harder than recommended. It was therefore concluded that the guidelines provided in the literature do not necessarily apply under all conditions.

Equipment needed

An initial investment is needed for the necessary tanning and finishing equipment (starter kit). Equipment and material can be obtained

through KIRDI (Kenya Industrial Research and Development Institute - Nairobi, Kenya - Tel:+254-20-603842/609440 - email: dir@kirdi.go.ke / info@kirdi.go.ke)

- 2 x 100 l black containers for de-hairing
- 2 x 100 l white containers for tanning
- 2 x 50 l containers with lids
- 2 fleshing beams with stands
- 2 fleshing knives
- 2 slickers for sammying
- 2 sammying (removing excess water by stretching and scraping) tables
- 2 oiling tables
- 4 buckets
- 1 sharpening file
- 8 to 10 pairs of plastic gloves (depending on group size)
- 10 waterproof aprons (protective clothing)
- 3 to 4 pairs of gumboots (depending on group size)
- hydrated lime - 50 kg
- Sodium sulphide - 50kg
- Caustic soda - 50kg
- Mimosa powder - 50kg
- Ammonium sulphate - 50kg

- Sodium metasulphite ? 10 kg (may be left out if bleaching is not needed)
- Fat liquor oil (castor oil based) - 20 litres.

All tanning and oiling work needs to be carried out in shaded areas, as leather should not dry directly in the sun, otherwise the fibres contract too quickly and the resulting product is too hard. Any large enough roofed and preferably netted-in area can be used. Netting or walls are needed to protect from dogs and wildlife, but there should be ample light for working. Chemicals and equipment need a lockable store.

Preparation of hides/skins for tanning

Camel hides measure between 18 and 25 square feet and weigh up to 35 kg. They are usually too heavy to handle properly if in one piece, and the usual practice is to just divide the hide at butchering time. Also some cow hides are too big to handle in one piece, so they can also be divided for example down the middle. However if at all cow hides can be handled in one piece, they will fetch better prices. Goat and sheep skin are always prepared as one piece.

Tanning can be done on either dehaired or non dehaired hides and

skins. Some goats for example have very beautiful markings on their skins, which may be worthwhile preserving for special purposes, in which case dehairing is not carried out, and the skin goes straight to tanning with the coat of hair on. Camel hides however are usually not very attractively coloured, and camel leather being strong and quite in demand will need dehairing.

To produce leather, the first step in preparing hides/skins for tanning is de-hairing and de-fleshing. Dry hides/skins need to be soaked in clean water for two to three days before de-hairing, wet (fresh) hides/skins can be de-haired directly.

Step 1: De-hairing

The most successful method used was a 4% solution of hydrated lime dissolved in enough water to adequately cover the hide. (calculated on the basis of the hide / skin weight. This means if a hide weighs 20 kg, hydrated lime needed is 4% of 20 kg or 0.8 kg lime) Hydrated lime is easily obtainable in Nairobi and surroundings at a cost of KES 500 per 50 kg (2004 price) The thick parts of camel hides take longer than other parts to release their hair. A recommended addition of 1% Sodium Sulphide (again on the basis of the weight of hides / skins) to speed up the process is possible, but this highly corrosive chemical needs to be used very fast. As time is not usually of importance in many rural areas, its use cannot really be justified in the normal

operation of a small rural tannery. Also, this chemical is neither very environmentally friendly nor safe to use in most environments, and hydrated lime does the dehairing perfectly even without it.

30 litres of water with the 4% hydrated lime was enough for 1 camel hide (two halves) or 15 goat/sheep skins.). When the hair slips off by slight pulling, the skins / hides are ready for scraping with blunt utensils on the grain side to remove all remaining hair. De-hairing of a sheepskin took one day of soaking in the solution, cow hides about two days, and camel hides three days. Frequent stirring of at least four or more times a day (the more the better) was necessary to ensure equal exposure of hide or skins to the lime solution. The hides/skins swell with the lime solution being soaked into to pores, and become very thick. It is very important to ensure that all parts of hides/skins are submerged under water/lime solution, as exposure to air with lime coating can cause 'burns' or discoloured patches on the finished leather.

Step 2: De-fleshing
After de-hairing remaining parts of flesh that need to be removed stand out very clearly and have to be scraped off. A fleshing beam and fleshing knives were used for this purpose. Suitable beams can made out of old fallen tree trunks and logs. They should be

smoothened to form a good firm basis for the fleshing knives, which were manufactured in Nairobi at Ksh 1500 each or made by local artisans according to a drawing by the hides and skins specialist of the government extension service.

Step 3: De-liming

After all of the hair and remaining flesh is removed, the hides/skins which have swelled to double or triple thickness during dehairing process, must be de-limed by washing in plenty of clean water and submerged in a neutralising solution until it reduces thickness and pH again. In our experiments the best de-liming chemical was 2% ammonium sulphate (a commonly available fertilizer, at about 1300 Ksh per 50 kg bag, percentage again calculated on the basis of the original weight of the hide / skin . Our original 20 kg hide would need 2% of 20 kg or 400g of ammonium sulphate). However, where this chemical is not available, a solution of 1 litre of vinegar in 10 litres of water can be used, which also produced good results.

The skins/hides were submerged in the solution and stirred every couple of hours. Through frequent monitoring the point when the lime-induced swelling disappears completely needed to be established. With small skins, this process will take only a few hours, whereas heavy hides may need to be left in the solution over night. After removal from the de-liming solution the hides / skins need to be

washed well in clean water to be ready for the tanning solution.

Changing the very alkaline environment of de-hairing into a slightly acidic environment is important as the tanning works best in the latter. Large-scale tanneries work with highly corrosive chemicals such as sulphuric acid, but this is too risky and dangerous under home or village conditions. The vinegar solution worked very well in Ngurunit. An alternative which could be tested - if the above mentioned ingredients are all not available - is based on experiences with rural tanning in Zambia where fermented maize flour was used (Hoyle 1994). Maize flour can easily be found in most places in Africa and it will ferment on its own if put in water.

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Tanning

Step 4: Tanning

Tanning methods
The most commonly used tanning methods for leather in Kenya are chrome based tanning or vegetable tanning (with mimosa or other

plant derived extracts). The team also tested alum tanning, as alum is easily available and alum tanning recipes for home tanning are often found in literature. Alum tanning does not change the colouring of hairs, and so would be best suited for skins where it is decided to preserve the hair coat.

Hides or skins tanned in the same solution need to be soaked at the same time. When a second hide or skin was added to the tanning solution the following day, it seemed to actually be removing tanning chemicals from the first hide or skin, rendering the process less efficient and resulting in products of less good quality.

Alum tanning

Ali tanning was described by Hardwick (1996) and the US Department of Agriculture (1962). In this process, the collagen fibres in the skin / hide are coated with a layer of alum molecules. Alum tanning is commonly recommended in the literature for home tanning (Hoyle 1994, Hardwick 1996) as it is an easy, safe and environmentally friendly method of tanning. 250 g of rock aluminium are fully dissolved in 3 litres of hot fresh water. 200 g of table salt are separately dissolved in 4 litres of cold fresh water. The two liquids are slowly mixed while constantly stirring. If the liquids are mixed too quickly, the resulting solution becomes cloudy and is not very effective. The resulting 7 litres of solution are left to cool down to room temperature

and then up to 4 small skins are submerged. For one camel hide, the ingredients have to be quadrupled to produce enough liquid for tanning.

This method can be used for both non-de-haired hides / skins (for decorative purposes) and for de-haired hides/skins (to produce leather). With non-de-haired hides / skins only de-fleshing needs to precede the tanning. Alum tanning will produce pure white leather, or clean looking skins with the hairs left on.

Goat and sheepskins needed three to five days in the tanning solution with frequent stirring (at least four times a day). Large camel hides require up to seven days. To test for full penetration of the solution into the hide/skin, a small cut on the side will show whether the solution has saturated the hide/skin completely. Alternatively, a crease can be made on the edge of the hide/skin and if is does not disappear, tanning is complete. This was the case after two days for a sheepskin, while a camel hide took four days to reach the same stage.

After removal from the alum solution, the hides / skins were dried on a clothes line or wire in the shade. While drying, skins were regularly stretched and pulled by hand to remain smooth. A camel hide needed to be taken down intermittently and pulled with blunt metal scrapers

on the flesh side of the hide or a wooden scraper on the grain (hair) side. Be careful not to make knife marks on the grain side of the hide, as this lowers the value of the finished product. The pulling and stretching of camel and cow hides is best done on a flat clean surface (table or bench) to press out water and to stretch fibres. Alternatively, the hide/skin can be strung up on a wooden frame and worked over repeatedly with scrapers to prevent the fibres from contracting while drying and to break the hard fibres so that the leather becomes soft and pliable. Be prepared for quite a bit of work during this stage - the more stretching, the softer the leather and the better the final price.

The disadvantage of the alum method is that the resulting produce cannot be cleaned with water since the alum molecules remain water-soluble. Therefore, items must be dry cleaned, which is not convenient in most rural areas. No fixation process seems to be available, but treatment with castor oil solution or any of the fat liquor recipes listed below will help preserve the tanning and repel water.

Vegetable (mimosa) tanning
As an alternative method, vegetable tanning with commercially available wattle bark extract (mimosa powder) was tested on two camel hides and ten goat/sheepskins. This tanning extract is available in Kenya from East African Tanning, Thika. On the first day, 5% of the

mimosa powder (based on weight of hides / skins - our 20 kg hide would require 1 kg mimosa powder) was dissolved in enough water to completely cover the hides/skins. As described for alum tanning, frequent stirring, preferably hourly was necessary so that the tanning solution would completely penetrate the hides / skins. On the second and on the third day another 5% mimosa powder (same amount as on day one) was added to the solution and stirring continued on regular basis for the next 3-4 days. A small cut can be made in the thickest part (on the neck side) of the hide/skin to see if the tanning solution has penetrated. Mimosa tanning gives a reddish-brown tinge, and the distinction between tanned and un-tanned leather is quite clear. After removal from the tanning solution, the hides/skins were washed thoroughly in clean water, then pressed/scraped with blunt scrapers to remove as much water as possible.

Vegetable tanning (*Acacia nilotica* pods)
A brain and smoke tanning recipe used by native Americans described by Dinsmore and Dinsmore (1996) was also tested on a small goatskin. It is often said that each animal has enough brains available to tan its hide, but Dinsmore and Dinsmore (1996) mention that lighter solutions could work as well. However, when trying this method in Ngurunit, the small skin used, although very soft in the tanning solution, dried out much faster than could be comfortably handled, and so the final

product did not turn out well. If this method is preferred by pastoralists, more work is needed to adapt the recipe to the northern Kenyan hot and dry conditions. There was a considerable interest in the method, as some of the women mentioned they had seen their mothers or grandmothers use a similar method, but knowledge on details had now been lost.

Hoyle (1994) provides a list of tannin containing trees, of which *Acacia nilotica* is mentioned to contain 40 % tannin in its pods. As this tree grows in Northern Kenya, the pods were collected and some experiments on its suitability as a locally available tanning material were done. At first the crushed pods were simply soaked to see what sort of solution was produced. The water soaked up the tannin materials from the pods and became red in colour, very similar to the commercial wattle bark (mimosa) solution. Experiments were carried out on goatskins with very good results. Literature describing oak bark extraction for tanning purposes (US Department of Agriculture 1962) was used as a guide for developing a method of extracting the tanning material from the pods.

First, 5 kg of *Acacia nilotica* pods in a bag were crushed by hitting the bag with a mallet. The crushed pods were then mixed with 20 litres of fresh water and left to soak for six days with frequent stirring (four to

six times a day). In the meantime, a goatskin and a neckpiece of a camel hide were prepared for tanning by de-hairing, de-fleshing and de-liming as described above. When ready for tanning, half of the pod solution (ten litres) was strained into another bucket to remove the pod pieces and then the skin and hide piece were soaked in the extract. The bucket with the crushed pod solution was refilled to the top with water and regular stirring continued. After three days this solution was strained of the crushed pods and added gradually to the soaking skin and hide piece. At the same time, three additional kg of the Acacia nilotica pods were crushed and added to 10 litres of water in order to produce more extraction solution to substitute for the first batch when its efficiency was decreasing. This method continued for three weeks during which every four or five days the soaked pods were strained out. to get the water for adding to the soaking hide/skins and more pods (about 1 kg each time after the initial starting amounts) being crushed and put into clean water (about 5 litres). The skin/hide piece was left in the solution until the red colour had penetrated the skin as evidenced by cutting a small cross section on the thickest part of the skin.

Although the Acacia method is slow, the leather produced from this method had a very attractive tannish brown hue which seemed to be preferred by customers over the reddish brown mimosa tanned leather.

The experiments carried out using an extract of *Acacia nilotica* pods to tan goatskins and a neckpiece from a camel hide showed results of similar, and sometimes superior quality to the mimosa tanned skins/hides. There is great potential and advantage of using *Acacia nilotica* pods over mimosa for two reasons. One is that the pods are locally available, abundant and a renewable resource in the Northern Kenya area. Secondly, mimosa powder that was purchased in large quantities at the beginning of the project appeared to be loosing its tanning qualities, probably due to the heat. The result is that the mimosa tanned products later had a stronger and somewhat unpleasant smell than before and the mimosa solution did not appear to be effectively penetrating the hides/skins like it did when the powder was fresh.

The result of tanning with *Acacia nilotica* pods was a pliable, good coloured tanned skin and hide piece. The women therefore tanned a full batch of 10 skins after only one day of the pods soaking. However, this amount of skins seemed to slow down the process greatly and made the penetration of the brown tanning colour into the centre of the skins less effective. Presumably the short soaking period of the pods did not allow the tannins in the pods to be effectively released into the water. We concluded that for this tanning method it is

essential that the extraction solution of the pods is prepared at least four to six days before submerging the skins in it.

Step 5: Fixation of the tanning chemicals
Soda ash measuring an equal amount to 5% of the original weight of the untanned hides / skins was dissolved in a water bath and the damp hides / skins added. While frequently stirring over the next fifteen to twenty minutes the tanning chemical was thus fixated in the leather. After this they were again washed in clean water.

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Finishing process

Step 6: Bleaching and dying
When bleaching and dying was desired it is usually easiest to do it immediately after the fixation process. To bleach the leather 1% Sodium metabisulphite (in these recipes all % was on basis of original weight of hide/ skins) was dissolved in a warm water bath, the hides / skins submerged and stirred for at least thirty minutes. This gave a slightly lighter colour of the final leather, and a clearer colour of potentially desired dyes. Commonly used and available leather dyes

were dissolved in warm water and the hides / skins submerged for one to two hours according to instructions. A vinegar solution (1 L vinegar in 10 L water) was used for fixing the dyes. The women preferred natural colours, but one could equally dye this leather in any desired colour.

Step 7: Oiling for an appealing product
The tanned (bleached / dyed) hides / skins were subsequently dried on a clothes line or on a frame while regularly scraping with blunt tools (e.g. a slicker) to prevent fibres from contracting. When just damp, the hides / skins were laid on a flat surface and oiled on both sides with the following solution as recommended by Hoyle (1994):

1.5 l water
200 g soap (bar soap is fine)
300 ml vegetable oil.

To prepare this solution, the soap was shredded with a knife and all ingredients heated up in a pot to form a uniform emulsion. This emulsion was cooled down until lukewarm and spread onto the slightly damp hide / skin. Best results were achieved when this process was performed on a table covered with a plastic sheet. The grain side was covered first, then the hide/skin was turned over and the fibre (flesh)

side covered with generous amounts of the emulsion (until the hide / skin was fully covered in Vaseline-coloured smudge). This emulsion need to soak in over night with the fibre side facing up to maximise penetration. Covering with a second plastic sheet over night help improve absorption of the emulsion and prevent the hide / skin from getting dirty in dusty environments.

KIRDI (the Kenya Industrial Research and Development Institute) has developed a product from castor oil, which they recommend as superior to the above-described emulsion for oiling leather. However, this has yet to be tested properly under village conditions. But the castor plant grows wild in the environment, and could produce locally available oil, if tests are successful.

The following morning, excess emulsion is scraped off the hide/skin before a final drying process while scraping / stretching with a slicker as described before. When almost dry, the hides / skins are worked over a rounded metal (an old metal hoe was used, but more appropriate tools can be manufactured) to ensure a smooth, soft leather surface. It is very important to start working the hide / skin when it is still damp and continue doing so until it is completely dry. Otherwise, a tanned hide / skin can become hard and stiff if it is not worked enough at this stage of the process. If this happens, the skin /

hide can be re-dampened and worked again until dry and soft. This problem was encountered on one occasion when some oiled skins were left to dry too long before working, resulting a stiffer product than desired.

Step 8: Sanding and Polishing
To obtain an even smoother surface the dry leather can be sanded on the flesh side. Pumice stones are quite efficient for sanding. Additional polishing on the grain side with a clean smooth glass bottle or a hot iron will give the leather a shiny appearance.

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Local reference address for tanning equipment

- **KIRDI Kenya Industrial Research and Development Institute - P.O.BOX 30650 - NAIROBI,KENYA - TEL:+254-20-603842/609440 - FAX: +254-20-607023 - email: dir@kirdi.go.ke / info@kirdi.go.ke**

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Introduction - Market for Bee products

Honey

There is currently a very high demand for honey both in Kenya and overseas. Kenya is now licensed to export honey to the European Union. Market opportunity exists for beekeepers but lack of production is at present the main constraint in Kenyan beekeeping. Good quality honey can fetch a high price. Any farmer who has the good fortune and skill to obtain honey should have no trouble selling it. In general, if you present honey to the consumer in a clean, unspoiled condition, the price will be higher. Beekeepers should aim for the highest grade of honey to maximise returns from beekeeping. Honey in Kenya is sold in the following grades:

- Crude honey. This is a mixture of ripe and unripe honey. At harvesting time, the wax, honeycomb, and bee-and-brood comb are all mixed into one container. This container is often an old tin. Crude

honey is used mainly for brewing local beer because quality requirements are not very strict. The demand for this type of honey is high.

- **Semi-refined honey. Semi-refined honey is generally the liquid honey that remains when you skim wax off the top of crude honey. Honey sinks to the bottom as it is heavier. Semirefined honey still contains particles of wax and other debris such as bees? legs. It can be stored for the beekeeper?s own use or it can be refined further and packed for sale. It gains a higher price than crude honey.**
- **Refined honey. Refined honey is clean. You strain it to remove all particles of beeswax and other materials. Remember: refined honey is unchanged, it is only strained. Nothing else is added so it is still the pure honey that bees made in the hive.**
- **Chunk honey. Whole combs of capped honey can be harvested carefully from the beehive. You can cut up pieces of the comb and put them into jars of liquid honey. This gives the consumer a feeling that the honey is real and not adulterated with sugar. Chunk honey can fetch a higher price than refined honey.**
- **Comb honey. Honeycombs of capped honey that have a nice white capping can be cut up, placed on small trays, and covered with cling film. These are very marketable in Kenya and command a very high price in the market, particularly in affluent Nairobi suburbs and other towns. This product should be the ultimate aim of all beekeepers**

with access to these markets. This product is priced per gram.

Beeswax

Most people in Kenya throw away wax combs upon harvesting or after honey extraction. Beekeepers do not know its value. Local villages use beeswax in very limited ways, e.g., for shoe repairs by cobblers. Some companies such as Bata (shoe company) and Kiwi (shoe polish company) purchase beeswax, which they often obtain from miti ni dawa (honey beer) brewers. You leave the wax after brewing beer from crude honey, which contains honeycombs. Baraka Agricultural College buys clean beeswax cakes from other buyers.

Propolis

Export markets for propolis exist. People use it as medicine, selling it as capsule, ointment, or tincture (dissolved). You can chew propolis raw as medicine for the throat. It is on sale in this form in very limited quantities in Nairobi. When harvesting, simply scrape off propolis and store in an airtight container. You can also try making medicine from propolis, e.g., propolis ointment.

Source: This information is taken from the book "A Beginner's Guide to Beekeeping in Kenya" from Thomas Carroll (2006).

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Honey

Honey harvest

- Harvest honey during dry spells, i.e., January, February, March, July, August, September, November, and December.
- The harvest time in each area differs, so check the right time in your area. In areas where there are dominant bee plants like coffee, sunflower, etc., you should harvest after the flowers wither.
- Regular inspection of hives during nectar flow will ensure that the beekeeper harvests as soon as honey is ready.
- Do not harvest unripe honey.
- Ideal harvesting time of the day is from 5.30pm to 7.30pm.

How to harvest honey:

- Ensure you are sting-proof by putting on protective clothing.
- You will need a smoker in good working condition and a clean and dry plastic bucket with lid for storing honey.
- Smoke the entrance of the hive with about eight to 10 puffs and then gently lift the lid and smoke again. Leave hive for a minute or two before opening lid to allow smoke to affect bees. Smoke causes

bees to engorge themselves with honey making it difficult for them to bend and sting. (They become toofull!)

- **Very gently tap top bars with a hive tool. A hollow sound will indicate where there is no comb.**
- **Remove top bar from the hive that has no comb attached, so you can examine the rest of bars in the hive. Honeycombs are usually at the end of the hive opposite the entrance. Select combs that are ¾ or more sealed or capped full of honey. (These combs are said to be ripe or have a low moisture content, <19%, which ensures that honey will not ferment later when bottled. Leave combs with brood and pollen for future production of honey.)**

When harvesting a comb:

- **Brush bees gently from the comb using a bee brush. You can cut the harvested comb from the top bar to fall into the bucket.**
- **Replace lid of bucket to prevent bees from entering with the honey.**
- **Return top bar, minus comb, to the hive.**
- **As an alternative, place the whole comb and top bar (after brushing bees off) in another empty hive or catcher box where you can take it away later for comb honey. Fix spare top bar in place of the one removed.**

Gentle smoking is a continuous process during harvest time to

control bees. It is important to avoid smoking the honey directly or excessively because it can damage honey flavour. After harvesting, replace the first bar and cover hive with the lid. Make a final smoke before you leave to keep bees away from the harvester and to prevent them from following him/her all the way home. Remember to move through a bushy area first to get rid of bees.

Honey Processing

Honey processing is the action of preparing honey to improve its shelf life and meet the customer's and consumer's preferences. The main methods of honey processing are: Honey straining:
This is done soon after harvesting before honey granulates because granulation makes straining difficult. Staining must be carried out in a room free from robber bees. On large or small scale honey production honey straining can be done using (1) a honey press, (2) a filter tank, (3) a bamboo honey strainer, (4) a perforated plastic basin.

How to do (using a honey press):

- **Put the straining bag into the honey press**
- **Break combs of honey into small pieces and put them into the straining bag**

- **Close the honey press and press combs with the use of either the screw- type honey press or jack-type honey press**
- **Collect the strained honey in a plastic container that is placed under honey press opening**
- **Leave the strained honey in the container to settle and allow beewax particles to float on top**
- **Skim out floating beeswax particles in order to obtain clean honey to be packed for marketing or home consumption.**

N.B. Two people are better than one when harvesting or carrying out any bee operations. Two smokers in operation are also better than one to ensure a continuous supply of smoke for subduing bees. Sufficient smoke is very important when working aggressive bees.

How to refine honey

Step 1.
Remove wax capping from combs using a knife to cut off the capping.

Step 2.
Break combs into smaller particles and sieve them through a net or nylon fabric into a plastic container (See Photo 36.) The sieving process can take a few days. Cover sieved honey with a lid and keep

in a dry room away from bees.

Step 3.
You can place the bucket in sunshine for two or three hours to heat honey gently so it flows freely.

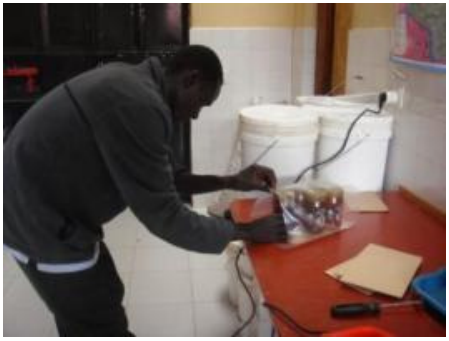
Warning: NEVER boil honey as this destroys its flavour and medicinal characteristics!

Once honey has drained through the cloth and settled at the bottom of the bucket (usually after 2 days or so), use a jug to pour it into honey jars for sale. For wax remaining behind on the straining cloth, squeeze out any remaining honey and process leftover wax.

Packaging and Marketing

Package honey in either plastic or glass jars, which should be clean and dry. 454g jars are available in Kenya from Nairobi suppliers as are plastic trays for selling comb honey. Labelling of honey must include:

- **net weight of honey**
- **name and address of producer**
- **country of origin (Kenya)**
- **description of contents, e.g., ?pure honey?**



Packaging honey jars

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Initially you can make a simple label by hand or on a computer, which you can then photocopy. You can have a more attractive label printed later, but this is costly and requires many jars to spread the cost. Some people use Kasuku/Kimbo plastic containers or tree top bottles (700ml) to sell honey. Metal paint tins (mikebe ya rangi) are not good. Honey is acidic and can eat the metal and spoil the honey.

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Where to sell honey

You can sell your bottled and labelled honey directly to shops. Build up a name for supplying the right quality, in the right quantity, at the right price, on time. Many beekeepers develop a reputation for beekeeping and people flock to their homes to buy honey directly. If you are enterprising, you can even set up a shop of your own selling bee products. You could also buy and sell honey from other beekeepers.

A shop or kiosk located in the right place such as the market or along a busy route can attract many customers.
You can also consider the option of forming a beekeeping association to market products of farmers in your area. Examples are the Kakamega Forest Beekeepers Association and the Transmara Association of Beekeepers.
You can also consider the option of starting a cooperative. An example of a successful beekeeping cooperative is Ruai Beekeeping Cooperative Society in Naru Moru, which markets eight tonnes of honey per annum collectively.
The advantage of farmers marketing together is fixed costs, e.g., transport, can be spread over a larger quantity of honey reducing cost. Collective selling gives farmers access to higher priced markets such as Nairobi.

Whatever type of honey you produce, you can easily find a market for it in Kenya and the price you receive will compare favourably with that available elsewhere in the world.

Source: This information is taken from the book "A Beginner's Guide to Beekeeping in Kenya" from Thomas Carroll (2006).

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Beeswax

Beeswax is a product of the beehive. For every 100kgs of honeycomb, you can get about eight to 10kgs of beeswax.
Honeybees secrete beeswax in the form of thin scales. 12- to 17-day-old worker bees produce them through glands on their ventral (stomach) surface. Honeybees use beeswax to build honeycomb cells in which they raise their young and store honey and pollen.

To produce wax, bees must consume about eight times as much honey by mass. Estimates are that bees fly 150,000 miles to yield one

pound of beeswax or 530,000 km/kg.

Beeswax is extracted from combs of bees. It is used to make candles, shoe polish and water proofing materials. In a newly installed KTBH (Kenya Top Bar Hive), the wax is applied on top-bars to attract bees to the hive and also acts as comb foundation. Beeswax is also used to encase human drugs to prevent degradation by stomach enzymes. It is also used in the cosmetic industry.

How to extract wax from combs

Step 1. Mix combs and water in a sufuria (aluminium pot) and heat. Wax melts at about 62 to 64° Celsius, so there is no need to boil. Boiling damages the wax and can be dangerous. Overheated wax can burst into flames. Do not use iron, brass, zinc, or copper containers for heating wax as it can discolour the finished product.

Step 2. Pour melted combs and water into an extraction bag. You can use cotton for sieving. (You can also use the small bags maize seeds come in after you clean thoroughly.)

Step 3.Smear sides of a second sufuria with soapy water to prevent wax from sticking to its sides.

Step 4. Filter wax into the second sufuria. Use two sticks (such as two

top bars) to squeeze the bag containing melted combs to extract wax. The yellow wax will come out along with water; waste will remain in the filter bag. If the combs contained bee brood, you can feed these to poultry as they would be cooked by then.

Step 5. After filtering, wax separates from water and floats to the top.

Step 6. Remove wax after leaving it to cool in the sufuria, with lid on to keep away dust, for 12 hours.

Step 7. Scrape dirt from the bottom of wax cake when cooled.

Step 8. Store wax blocks in a cool dry place. Never store near pesticides/chemicals as it may absorb them.

Your wax block is now ready for sale or for further use. Wax currently sells in Kenya at a price of about KSH100 to 150 per kilogramme or more depending on the demand.

Recipes

How to make beeswax candles:

The basic elements of a candle are the solid wax as fuel for the flame

and a wick, which serves to bring the molten wax to the flame. Oil lamps work on the same principle, but they need a container to hold the liquid fuel.

The best material for the wick is a fibre which burns with very little ash at low temperatures. Pure cotton thread is the best. Several thin cotton threads should be braided or plaited together until the desired thickness is reached. Twisting of the threads is not recommended, since they might unwind during burning and then create an irregular flame consuming much more fuel. Commercially produced candle wick can often be purchased in speciality shops.

The wick needs to be in the centre of the candle for even burning. The diameter of the wick in proportion to candle diameter is important to maximize the light obtained from the quantity of wax and to prevent wax dripping down the side of the candle. Thicker candles need thicker wicks, but thick candles with a relatively thin wick burn longer and give less light, since the flame is shaded by the remaining edges of the candle. The precise ratio depends on the purpose of the candle and should be determined by experiment.

There are various pigments available from specialty suppliers for colouring wax and some natural dyes will also work. Regular paint pigments are often insoluble in fat or burn incompletely and so should not be used. Normal food colouring does not work very well as it will

leave residues, might clog the wick or produce stains. If only applied as a thin outer layer it may be acceptable but special fat soluble pigments give much better results.

Melting wax

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Melted wax in moulds
© S. Fontana, BioVision

How to make beeswax furniture/ shoe polish:

Ingredients:

- **200g Beeswax**
- **100g Turpentine**
- **50g Baby oil**

1) Grate beeswax into flakes.
2) Gradually add turpentine to soften wax.
3) Add oil and mix.
4) Store in a tin with a tight-fitting top or in a jar.

Tipp: To soften the thread for easier sewing of shoes, leather and other thick materials, pull thread through small block of beeswax. The wax stiffens and smoothes the thread.

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Propolis

Propolis is a sticky substance collected by bees from buds or bark of trees.

Records show that propolis contain:

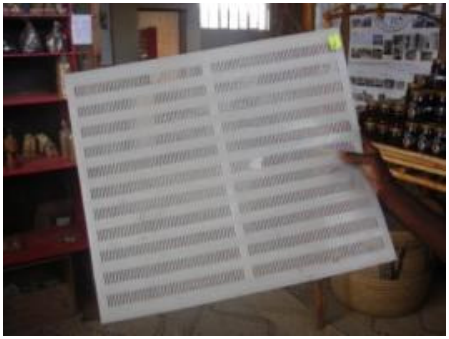
- **>55% resins and balsams**
- **>25% waxes**
- **10% essential oils**
- **>5% pollen**
- **>5% other materials**

Bees use the material for reducing the size of the hive entrance, filling cracks, polishing the interior of the hive, strengthening comb attachment, killing intruders by covering them and as barriers against ants (nest defense). Stingless honey bees store lumps of propolis on hive corners inside the hive for emergency use.

Propolis has also been used in human medicine and for veterinary purposes. It has antibiotic properties thereby inhibiting the growth of microorganisms. It is used for making adhesives e.g. glue, wood

pastes for sealing leaking roofs and cracks on wooden furniture. When chewed it heals backaches. Propolis plays an essential role in the antimicrobial defense of some trees, as they control many pathogenic microorganisms such as fungi, bacteria and viruses.

Note: Propolis gathering and storing by honeybees can be artificially influenced by slightly enlarging spaces in the hive parts like entrance, between the top bars/frames and top cover, and between the floor board and the hive body only during honey flow period.



When harvesting propolis, the beekeeper should:

- **Use a hive tool to scrap-off propolis smears and lumps from hives parts, without including hive paints and without damaging the hive boards.**
- **Be careful not to drop it because soil and other debris will stick to it**
- **Keep the collected propolis in an air tight and non corrosive container to retain its quality.**

Special plastic sheet for propolis production (same bis as beehive)

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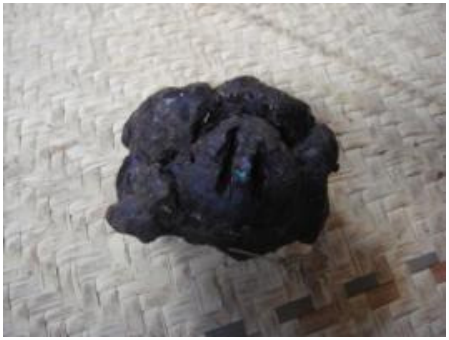

A piece of raw propolis

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Raw propolis

Propolis is ready for sale after harvesting without further processing. Unprocessed propolis can be used in chunks, or it may be frozen and broken or ground to fine powder. Large pieces of pure propolis can be chewed, but it should only be consumed in small quantities, since it may cause stomach upsets. Smaller pieces and powders can be taken in capsules or mixed with food or drinks.

How to make propolis extract

Ingredients:
Propolis
96% Ethanol
A dark flask or bottle (the dark colour protects the content from light/sunlight)

1) Fill half of the bottle with alcohol (90%-alcohol)
2) Cut propolis into small pieces and fill the rest of the bottle with them
3) Shake the bottle everyday for about 3 weeks
4) Sieve it.

Closing the bottle with a cloth for a while allows evaporation, so that the propolis extract will be get more concentrated.
(Rezept: R. Gloor, Cabesi Project, West Pokot)

How to make propolis cream

Ingredients:
120g wax
480g olive or peanut oil
30 g propolis
Small tins

1) Melt the wax and oil together on a double pan
2) Add propolis and stir it throughly until it cools
3) Pour the mixture on small tins

(Recipes: R. Gloor, Cabesi Project, West Pokot)

How to make propolis ointments

1) Simple Vaseline-based ointment

Ingredients (in parts by weight):
1 Propolis extract
9 Vaseline or other petrolatum

- **Prepare a propolis extract in 96% ethanol to a concentration of 10% propolis then reduce the solvent to obtain 30% propolis content by weight.**
- **Mix the extract with a small quantity of the Vaseline.**
- **Once the mix is homogeneous or well emulsified the rest of the Vaseline can be added slowly. If not mixed well the propolis extract will separate and leave dirty looking droplets in the cream.**
- **Warming in a water bath will improve mixing. Using an emulsifier or electric mixer makes mixing easier.**

The propolis extract may make up to 10% (by weight) of the final ointment. 10% of lanoline can also be melted with the Vaseline (using a water bath) following the same procedures as for the propolis.

2) Simple ointment based on vaseline or animal fat

This ointment can be used for application on cuts, abscesses and festering wounds in animals and external ulcers and burns in humans

(see also cabesi recipe of propolis cream above).

Ingredients (in parts by weight):
10 Vaseline or animal fat
1 Propolis

- **Bring the vaseline or fat to boiling point, then cool to 50-60 °C**
- **Add propolis, heat to 70-80°C, stir for 10 minutes and cover for 10 minutes.**
- **Filter through one layer of thin cloth into clean container and seal.**

It is ready as soon as it has cooled, but will not store for very long, particularly if animal fats are used.

3) Simple oil-based ointment

Ingredients (in parts by weight):
2 Propolis ethanol extract, 20% (s. method above)
1 Beeswax
7 Lanolin
10 Butter of palm, cacao, keraté or similar

- **Melt the beeswax in a water bath, slowly stir in the melted lanolin and mix well.**
- **While the mixture is cooling mix in the butter.**

- **The propolis extract is best mixed with a small amount of butter and added to the rest of the mixture once the latter has cooled to less than 40°C.**

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Royal jelly

Royal jelly, also known as bee milk, is secreted by 5-15 days old worker honey-bees. It is produced by the hypopharyngeal gland (sometimes called the brood food gland) of young worker (nurse) bees, to feed young larvae and the adult queen bee.

Royal jelly is always fed directly to the queen or the larvae as it is secreted; it is not stored. This is why it has not been a traditional beekeeping product. The only situation in which harvesting becomes feasible is during queen rearing, when the larvae destined to become queen bees are supplied with an over-abundance of royal jelly. The queen larvae cannot consume the food as fast as it is provided and royal jelly accumulates in the queen cells. The exact definition of commercially available royal jelly is therefore related to the method of

production: it is the food intended for 4-5 days old queen bee larvae.

Naturally produced royal jelly is too little for commercial purposes. However, royal jelly production can be done using artificial queen rearing with either plastic or beeswax queen cups in stinging-bees using movable-comb hives (frame or top bar hives). This is done during honey flow period when bees are are actively collecting nectar (honey) and pollen.

How to produce royal jelly successfully (the "Doolittle" method)

Step 1: Pick two frames/bars with pollen and honey from storng colonies and put them in the nuclei box, one on each side, followed by a sealed worker brood comb on either side, and a comb with eggs and very young larvae in the middle.

Step 2. Shake young nurse bees in the nuclei box hive and deprive them of the queen for 24 hours.

Step 3. Open the queen-less nuclei box having the frame/ bar already mounted with the queen cups. Then remove the middle frame/ bar with eggs and young larvae. Return them to the strong colonies and replace the space in the nuclei box with a frame/ bar mounted with queen cups.

Step 4.Check the frame /bar with queen cups in the centre of the nuclei box after 24 hours, to see if the queen cups have signs of being accepted by the workers (e.g. moulding and trimming of the cups).

Step 5. Open the queen rearing nuclei hive and remove the frame/ top bar with the accepted queen cups and also pick a comb with 8-24 hours old larvae from the strong colonies to a warm house free from wind.

Step 6.Using the grafting pin, prime the queen cups with a drop of royal jelly scooped from very young worker larval cells, then graft the queen cups with 8-24 hous old worker larvae before the frame/ top bar is returned to the nuclei hive of the original position. Next give the nuclei hive more young nurse bees and wait for another 24 hours.

Step 7. Inspect the queen rearing nuclei box hive to see if the grafts are being attended by nurse bees and have been accepted. If not, regraft and wait for 24 hours (remove the former graft before putting a new one in).

After 3 days, the accepted queen cells are filled with royal jelly (about 148-280 mg per cell or 450g per 1000 queen cells).

- **Cut the queen cells with a sharp thin bladed knife to the level of**

the royal jelly, on the fourth day of the graft.

- **Remove the queen brood with forceps and suck off the royal jelly with a syringe.**

How to strain and store royal jelly

- **Store the harvested royal jelly in dark coloured bottles with wide opening and cover them with air tight lids. Note: Sunlight destroys some nutritive elements and vitamins in royal jelly.**
- **Strain the collected royal jelly through a 40-mesh per cm strainer to remove any unwanted materials such as pollen particles, wax or larval moults.**
- **Put the strained royal jelly in hte dark bottles with wide opening and store it in a refrigerator at 1.7°C for immediate consumption or sale, and in a deep freezer for a longer storage period.**
- **The process is repeated using the same queen cups.**

Source: Kihwele et al. (2001)

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Pollen

Botanically, pollen is a higher plant's male reproductive element, produced in the anthers. It is transferred by either gravity, wind, animals, birds or insects to the plant's female reproductive organs stigma, to fertilize ovules (seed-embryo) to develop into viable seed in the fruit.
Pollen in honey is used to identify species of bee fodder plants. In beekeeping, pollen is an essential part of bee's diet as it contains protein, fat, minerals, vitamins and enzymes. It is collected from the flowers by worker bees and brought to the hive in form of pellets, where it is mixed with honey (bee bread) ready for consumption or storage.

Bee bread is consumed by humans by chewing the pollen comb. Pollen in the form of pellets is collected by the beekeeper with an aid of a pollen trap. Pollen traps are of various types . Pollen should be collected from the pollen trap every after 2-3 days to prevent fermentation or infestation by pests. After collection, it is dried, winnowed and packed into clean air tight containers for consumption or sale to food processors.

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Information Source Links

- **Carroll, Thomas (2006). A Beginner's Guide to Beekeeping in Kenya. Legacy Books, Nairobi, Kenya. ISBN: 9966-7078-6-7**
- **Kihwele, D.V.N., Massawe, A.J., Lwoga, P.D. and Burton, S. (2001). Beekeeping in Tanzania. Ministry of Natural Resources and Tourism, Dar-es-salaam, Tanzania.**
- **Krell, R. (1996). Value-added products from beekeeping. FAO Agricultural Services Bulletin No.124. ISBN: 92-5-103819-8**

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Contacts in Kenya

- **African Beekeepers Limited**

Industrial Area - P.O. Box 3752-00506 - Nairobi Mobile: (254) (0)722 700226
Remarks: It manufactures equipment and markets honey.

- **African Union**

Maendeleo Ya Wanawake House - Nairobi
Remarks: It has an interesting collection of beekeeping books in its library.

- **Apiculture Division - Ministry of Livestock and Fisheries Development, Hill Plaza Building**

P.O. Box 34188?00100 - Nairobi
Telephone: (254) (0)20 2722601/2722637 / Fax: (254) (0)20 2728609
Remarks: Contact for information and advice or get in touch with your local District Beekeeping Officer. There's one in every district.

- **Baraka Agricultural College - P.O. Box 52 - Molo**

Telephone: (254) (0)51 721091/ Email: baraka@sustainableag.org
Website:www.sustainableag.org
Remarks: Contact for bee equipment, advice, training courses, honey, and beeswax marketing

- **General Plastics Limited**

P.O. Box 10032 - Nairobi
Enterprise Road off Mombasa Road - Industrial Area near Hillock Inn
Telephone: (254) (0)20 530032/3/4/5
Remarks: It supplies plastic jars and lids for packing honey.

- **Honey Care Africa Limited**

Muringa Avenue, Jamhuri Park - Nairobi
Telephone: (254) (0)20 574448
Remarks: It promotes Langstroth hives. It also buys and markets honey.

- **ICIPE (International Centre for Insect Physiology and Ecology)**

P.O. Box 30772-00100 - Nairobi

Telephone: (254) (0)20 8632000 / Fax: (254) (0)20 8632001/8632002
Remarks: It has a commercial insect section dealing with beekeeping
E-mail: dg@icipe.org

- **Kerio Valley Development Authority**

KVDA Plaza - P.O. Box 2660 - Eldoret
Telephone: (254) (0)53 2063361/ Email: kvda@kenyaweb.com

- **National Beekeeping Station - Apiculture and Emerging Livestock Division**

Ministry of Livestock and Fisheries Development Lenana
P.O. Box 34188-00100 - Nairobi
Telephone: (254) (0)20 564302
Remarks: Check out for its library, bee equipment, and advice.

- **Ruai Beekeeping Cooperative Society**

P.O. Box 8 - Naru Moru
Remarks: This is a great example of collective marketing of bee products in Kenya. It markets up to 8 tonnes of honey per year.

- **Self-Help Development International Kenya**

2nd Floor, Catholic Diocese of Nakuru Building
Stadium Road off Kenyatta Avenue
Telephone: (254) (0)51 2212291
Email: kenya@shdi.org
Remarks: The agency currently promotes beekeeping in the Gilgil area.

- **Strengthening Informal Sector Training and Enterprise (SITE)**

Jabavu Road, Nairobi
Telephone: (254) (0)20 2718155
Remarks: It deals in training and support to beekeeping and bee equipment.

- **The Kenya Beekeepers Association**

c/o The National Beekeeping Station
P.O. Box 34188-00100 - Nairobi

- **The Kenya Honey Council - P.O. Box 271-00606 - Sarit Centre, Nairobi**

Telephone: (254) (0)20 4183120
Email: info@kenyahoneycouncil.org
Website: www.kenyahoneycouncil.org
Remarks: An umbrella body representing different stakeholders in the Kenya beekeeping sector.

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Milk and Dairy products

Clean milk production

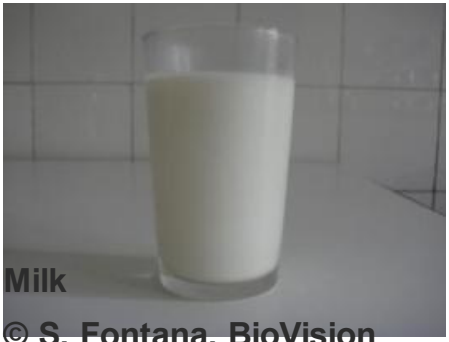
Milk value addition: butter, cheese, yoghurt

Marketing of milk

Information Source Links

Clean milk production

Milk is highly perishable, it easily contract diseases. It has a high protein content making it a suitable medium for bacteria growth. For these reasons clean milk production practices are inevitable. It is advisable that farmers observe the following areas in order to produce clean



Milk

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and quality milk for human consumption.

1. The Cow

Milk for human consumption should be from

- **Cows in good health. That is the cow should be free from zoonotic diseases e.g. Brucellosis and Tuberculosis. Cows should be free from Mastitis**
- **Cows free from drugs. The farmer should always ensure the drug administered to the animal is out of it's system as per the manufacturer's instructions**
- **Feed the cow should be clean free from disease causing organisms. Cows should not be fed on feeds, pastures or weeds that may cause milk tainting (poor smell in milk) this may include feeds with Mexican Marigold, high levels of fish mills or poultry droppings**
- **Restrain to tie the animal, if necessary. Troublesome animals**

should have their tails tied.

2. Milk parlour

- **The milk parlour (dairy) should be kept clean. If possible it should have a cement floor for easy cleaning. For large herds it is necessary to have a movable parlour to avoid bacterial and micro-organisms build up on the parlour location**
- **It should be cleaned after every milking**
- **Should be free from bad smell (odour)**
- **Provides clean water ad-lib for animals to drink**
- **If feeds are to be given during milking provide a feed trough**

3. Milking Utensils

- **Use aluminium or stainless steel utensils**
- **When washing, rinse the excess milk with cold water, then wash hot water plus detergents (soap). Scrub with a good washing material or brush. Rinse with cold water and place them on rack to dry. (The rack should be in on open place where direct sunlight can reach)**
- **Utensils store should be clean and well ventilated**

Using right utensils for hygienic milk handling

4. The Milker

- **The milker should be healthy and clean. He/she should maintain short nails and hair (for ladies with long hair let them cover it when milking)**
- **Ensure the milker washers his hands with soap (detergents) and warm clean water before milking.**
- **Never smoke during milking time**

- **Milk quickly and completely without interruptions**

5. Milking

- **Clean the udder and wipe with a clean cloth before milking (advisable to have a cloth for each animal if not many).**
- **Check for mastitis with a strip cap.**
- **Milking should be done quickly and efficiently without interruptions in either the cow or milker. Strip all the milk from the udder of the animal to avoid mastitis.**
- **Do not pull the teats but squeeze them. After milking do not forget to apply milking jelly and dip the teats in iodine solution before releasing the animal**
- **Always milk the healthy animals first while those with mastitis and other disease later. (Do not mix clean milk with contaminated milk).**

6. Milk handling

- **Immediately after milking filter the milk through a clean muslin cloth and sieve. The two should be washed thoroughly and dried after every milking period. Move milk into a clean cold room for storage if not sold or transported immediately.**
- **Transport milk in the morning for household consumption should be boiled immediately and returned to the cold storage.**

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Milk value addition: butter, cheese, yoghurt

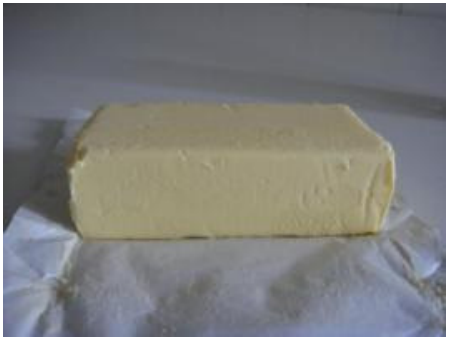
BUTTER

Butter is obtained by separation of the milk and subsequent churning of the cream. It contains a minimum of 80% butterfat. Butter can be made from fresh or sour cream. One litre of cream makes 300 to 400 g butter.

How to make butter

If the cream is fresh:

- **Heat the milk/cream to 80 o to 90°C**
- **Cool it quickly, such as in running water, to 18°C**
- **Ripen by adding 50ml (3 tablespoons) of sour butter milk or starter culture. Stir this into the milk or cream. Cover container and leave for 24 hours at 18? C**



Butter

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If you use milk or cream which is sour naturally, you do not require the ripening process.

Churning:

- **Half fill a churn with sour milk or cream**
- **Churn with regular movement until the pieces of butter are as big**

as peas and the buttermilk looks watery. Do not let the pieces of butter become one large lump

- **If there are no pieces of butter after 30 minutes, change the temperature by adding cold or warm water then churn again**
- **For cream do not add more than 25% water**
- **Churning may take 15 to 60 minutes - the time depends on the weather conditions, type of churn, fullness of the churn and fat content of the milk**
- **Carefully remove the pieces of butter from the lid and side with clean cold water. The water with butter will float on top of the butter milk**
- **Pour off the butter milk through a coarse sieve.**

Washing:

- **Wash the butter to remove butter milk. The more butter milk you remove the better the butter**
- **Half fill the churn with clean cold water. Churn for at least 10 minutes**
- **Use a skimmer to remove the pieces of butter floating on the water or wash the butter in a sieve**
- **Sieve the butter and butter milk, put the butter milk on one side, turn the butter over while washing with clean cold water. Do not let the butter become one large lump.**

If you wash your butter carefully, you lower the water content and it gives it a longer shelf life. Do not over wash: your butter will have less solids-not-fat and a poor smell.

Salting:

- **Salt according to taste - 10g per kg of butter. Leave it overnight.**

Kneading:

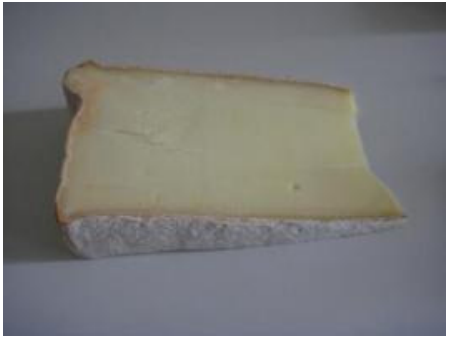
- **Work (knead) the following day to improve the structure and quality**
- **Wash the work table with clean water**
- **Work the butter with a dump wooden spoon or a dump roller until it has a smooth surface and you can see no more drops of water. As you work, remove any water.**

Storage:

- **Store butter in a cool place, in a pot or wrapped in a greaseproof paper or aluminium foil**
- **Sprinkle a little salt on the surface of butter in a pot; this prevents fungus. You can freeze butter but it becomes rancid quickly after defrosting**

- **Divide the butter into many small parts and defrost only what you need**
- **Do not freeze salted butter; it easily becomes fatty or oily and smells fishy**
- **If you keep butter for too long it tastes rancid and develops fungus.**

CHEESE



Cheese

Cheese is the solid part of milk, also known as curd, obtained by separating it from the liquid part (known as whey) by a chemical reaction. Curds are separated from the whey by adding an acid, bacteria culture and/or starter (rennet). Cheese can be described according to its texture as hard, semi-hard or soft or it can be described according to extent of maturing as fresh or ripened.

How to make cheese

There are several recipes to making cheese. Here one of them.

To make cheese you need:

- **Good quality milk:**
  - **with a low bacteria content**
  - **from healthy cows: do not use milk from cows with mastitis or other diseases**
  - **milk which does not contain antibiotics**
  - **do not use colostrum**
- **Clean equipment:**
  - **make sure you clean and sterilize your milking utensils**
  - **rinse you utensils thoroughly in clean water.**

To make cheese follow these steps:

1. Use fresh whole milk. Reduce the fat content by allowing the milk to stand for about one hour, and then skim off the top layer.

2. Heat the milk to about 85°C to destroy most of the bacteria present and also to increase yield through the precipitation of the whey protein.

3. Dilute lemon juice with an equal quantity of clean water so that the lemon can be distributed uniformly. Add about 30 ml (about 3 tablespoons) of lemon juice per litre of milk. Stir the milk while

carefully adding the lemon juice. The curd precipitates almost immediately.

4. Continue stirring for about three minutes after adding the lemon juice.

5. Allow the curd to settle for 15 minutes. Separate the curds from the whey by draining through a sieve or a cloth (use a cotton cloth folded twice).

6. While draining the whey, stir the curd to prevent excess matting (coagulation).

7. Add salt to the curd at the rate of about 4 g (about a level tea spoon) per 100ml of curd and mix thoroughly. The amount of salt may be varied to cater for different consumer tastes and preferences.

8. Transfer the curd to a mould lined with cheese cloth. The mould may be cylindrical or square shaped and may be made from metal, plastic or wood.

9. Cover the curd by folding over the cheese cloth. Fit a clean wooden board, cut to neatly inside the mould, to enable the curd to be pressed.

10. Press the curd overnight using metal weights placed on top of the wooden shape. Press with twice the weight of the cheese (so, for every 1 kg cheese use 2 kg press). Press for 1 to 2 hours then take

the cheese out of the mould.

11. Store the cheese as it is or cut it into suitably sized pieces for sale.

12. Coat the cheese with a thin film of butter to enhance the appearance.

13. Ripen the cheese on clean wooden shelves for at least 4 weeks at a temperature of 12 to 16°C. During the ripening take the cheese off the shelves every three days, put vinegar on a cloth and wipe the cheese. This prevents fungi. The longer you ripen the cheese the stronger the flavour.

FERMENTED CHEESE (MALA)

This is milk that has undergone the fermentation process due to introduction of a specific bacterium either from a commercial culture or from by adding a small amount from a previous batch of fermented milk. The process described below is based on a traditional process.

How to make mala

1. Use good quality milk, i.e. free from antibiotics and preservatives,

not adulterated.

2. If making sweetened cultured milk, add sugar at the rate of 20 to 25 kg per 500 litres (40 to 50 g per 1 litre).

3. Heat the milk to 92 to 95°C for 3 to 5 minutes or 85°C for 30 minutes or just bring to the boil.

4. Cool to 22 to 25°C (warm room temperature).

5. Inoculate with a commercial fermented milk culture or mix with a small amount of fermented milk.

6. Incubate at 22 - 25°C (warm room temperate) for 16 to 18 hours.

7. Cool to 20°C (just cool to the touch) in 30 minutes.

8. In case of flavoured cultured milk, add flavour and colour.

9. Stir until smooth.

10. Pack at 20°C.

11. Refrigerate for 10 to 12 hours to help recover thickness lost during stirring.

12. Distribute for consumption and/or sale.

YOGHURT

Yoghurt is a form of fermented milk whereby fermentation is achieved through the introduction of specific "friendly" bacteria into milk under very carefully controlled temperature and environmental conditions. The source of bacteria can be a small amount of plain live yoghurt bought from the shop or one may obtain a commercial starter culture.

How to make plain yoghurt

1. Use about 5 litres of good quality milk, i.e. free from antibiotics and preservatives, not adulterated.

2. Bring the milk to 85°C over a stove and keep it there for two minutes (or just boil for two minutes) to kill any undesirable micro organisms.

3. Pour the milk into a tall, sterile (rinsed with boiling water) container and allow to cool to 43°C (just warm to touch with the back of the hand).

4. Take about half a cup of plain yoghurt (bought from the shop) and warm it slightly, i.e. to the same temperature as the milk.

5. Mix the warmed yoghurt with the milk and cover tightly.

6. Put the mixture in a constantly warm place (e.g. food basket) at

43°C (just warm to the touch) and leave it for six hours.

7. Remove and leave it for about 30 minutes to cool to room temperature.

8. Add flavour and colour if required while stirring gently.

9. Pack into sterile containers.

10. Store in the fridge for 10 to 12 hours.

11. Distribute for consumption and/or sale.

Fruit can be added to plain yoghurt to make a tasty, refreshing and healthy snack.

How to prepare the yogurt culture

- **Boil 50 ml of milk and allow it to cool to room temperature**
- **Take one ampoule of commercial yogurt culture and add to the milk**
- **Keep the milk at a hot room temperature (37°C) for 12 to 16 hours**

To make fruit yogurt (10 x 100ml):

-
- **Take 1 litre of milk and heat a little but do not boil**

- **Add the milk powder and sugar**
- **Stir the above mixture in a food mixer**
- **When dissolved, heat the milk to 85°C (keep milk just below boiling point)**
- **Then allow the milk to cool to room temperature**
- **Add 10 ml of prepared yoghurt culture (see above) and mix gently**
- **Take 100 ml size paper cups and add 25 gm of chopped fruit**
- **Fill cups with milk solution**
- **Keep the cups in an incubator at 42°C for six hours**
- **After 6 hours transfer the cups to the refrigerator and chill for 6 to 8 hours**
- **The fruit yogurt is now ready for sale or consumption**
- **Store at 5°C.**

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Marketing of milk

The dairy industry is based mostly on smallholder milk production and informal traders. Generally informal milk outlets absorb most of the milk from smallholder farmers accounting for over 86% of the total milk sold, while formal market handle 14% of all the total milk

produced. Brokers, traders/hawkers, transporters, co-operatives and farmer groups are the most important participants at the rural markets. Cooperatives remain the main channel for collecting milk destined to the formal market. Kenya is among the few countries in the region that have recognized the critical role played by the informal players made significant efforts to main streaming them into the national economy. A draft policy, the new Dairy Development Policy is awaiting parliament approval. This policy openly acknowledges the role of informal milk markets in the development of the sector and will help to legitimize small-scale milk traders, subject to them being trained and certified in milk hygiene. Currently there are over 1,500 licensed informal milk traders in the country.

The Kenyan milk market is liberalized and competition in milk processing and marketing has increased significantly in the industry. Over 40 private and dairy co-operative processors have been licensed to process and market milk and milk products. The industry has a processing capacity of 2.5 million litres per day. The Kenya Cooperative Creameries (KCC) is estimated to have a processing capacity of 1.2 million litres of milk per day and the other processors combined have a processing capacity of about 1.3 million litres of milk per day. Production of high value milk products such as milk powder, fermented milk and butter for export is encouraged.

Dairy cooperatives have played an important role in the development of the Kenyan dairy sector as markets have become competitive and farmers have to be efficient in order to access markets for their dairy products. The power of group marketing is seen in the way organized groups can enforce market contracts and measure and monitor quantities and quality of goods and services. The Kenyan dairy cooperatives are a success story and have helped achieve stability in smallholder dairy milk marketing. Cooperatives enable farmers to access subsidized inputs and credit, provide a safety milk outlet during peak production provision of technical support and other services required for milk production. For isolated areas, cooperatives serve the crucial function of bulking and marketing. Due to the alternative market outlets offered by farmer co-operatives, market prices tend to stabilize, production per cow improves and jobs are created.

Export market for dairy products

Kenya has potential to export dairy products, having the largest and well-developed dairy herd in Sub-Saharan Africa. Indeed, Kenya and Sudan are the largest Sub-Saharan Africa dairy producers accounting for 47% of the total cow milk produced, with Kenya having a market share of 24% (CBS 2003). Kenyan exports of milk products have been

on the increase from KShs 117.5 million to KShs 140.6 million in 1998 to 2002 respectively, while total value of import has declined from KShs 353 million to KShs 135 million in 1998 to 2002 respectively. Kenyan dairy products are currently being exported to Zambia, Tanzania, Uganda, Democratic Republic of Congo, Rwanda, Burundi and Saudi Arabia among other countries, while the imports are mainly from the European Union and East African Region.

Exports from Kenya enjoy preferential access to world markets under a number of special access and duty reduction programmes. These include regional markets (EAC, COMESA), EU-African-Caribbean-Pacific/Lome Convention and the African Growth & Opportunity Act (AGOA). Kenya is a member of most major international and regional intellectual property conventions ? the World Intellectual Property Organization (WIPO), the African Regional Industrial Property Organization, the Paris Convention on the Protection of Industrial Property, and the Berne Convention on the Protection of Literary and Artistic Works. His creates an enabling environment for growth of dairy sector.

Legal and regulatory framework

The dairy industry in Kenya is supported by an elaborate legal and

regulatory framework. The main regulatory body in the dairy industry is the Kenya Dairy Board (KDB) and has the responsibility of developing, promoting and regulating the dairy industry. The Kenya Bureau of Standards is the statutory body charged with enforcement of standards and certification of quality standards of all products and services in the country.

Supporting structures

The dairy industry in Kenya is supported by a well-established dairy cattle breeding programme for the major dairy cattle breeds (Friesian, Ayrshire, Guernsey and Jersey). The breeding programme is underpinned by centralized performance recording spearheaded by the Kenya Stud Book and Dairy Recording Services of K, which operate under the KLBO, which is a farmer organization. Artificial Insemination (AI) plays an important role in development of the dairy sub-sector. The AI services have largely been privatized to provide an opportunity for investment by the private sector. The Central Artificial Insemination (CAIS) is a government corporation that is mandated to process, storage and distribution of semen and plays a crucial role in the progeny testing of dairy bulls in the country.

The Kenyan government has continued to create and provide an enabling environment for investors in the country. There exists a

number of guaranteed investor friendly arrangements such as the Export Processing Zones (EPZ) program which offers attractive incentives to export-oriented investors and EPZ Authority to provide one stop-shop service for facilitation and aftercare. The Investment Promotion Centre (IPC) promotes all other investment in Kenya including in Manufacturing under Bond (MUB) program while the Tax Remission for Export Office (TREO) is a program for intermittent imports for export production. There exists generous investment and capital allowances, bilateral investment and trade agreements.

The Constitution of Kenya provides guarantees against expropriation of private property. In addition, capital repatriation, remittance of dividends and interest are guaranteed to foreign investors under the Foreign Investment Protection Act (FIPA). Kenya as a member of MIGA (Multilateral Investment Guarantee Agency) provides investors with an opportunity to insure their investment in Kenya against a wide range of non-commercial risks. Kenya is also a member of the African Trade Insurance Agency (ATI), a multilateral export credit and political risk agency for COMESA member states as well as the International Council for Settlement of investment Disputes (ICSID).

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Animal husbandry and beekeeping

Manure

Status: under construction

Animal diseases
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Introduction

Manure is a valuable resource on an organic farm. Livestock are not efficient in taking nutrients from feed and forage. Normally, 75-90% of major nutrients that are fed to livestock pass directly to the animal into the manure. How good these nutrients can be returned to the soil, depends on the way the manure is stored and handled.

Raw manure is to be treated with caution as it includes threats to both human health and to the environment (e.g. pollution of the water ways). To reduce the risks, organic farmers usually compost manure

before applying it.

If using raw manure, note:

- **if it is to be applied to crops for human consumption, there must be at least four months between application of the raw manure and harvest**
- **if you grow crops that accumulate nitrates, e.g. brassicas, the raw manure must be applied at least four months before these crops are planted.**
- **apply raw manure in moderate amounts**
- **the soil must be warm**
- **the soil must be moist**

The advantages of composting manure are following:

- **More humus. Fully composted manure adds in the long term more humus to the soil than raw or partially composted manure. Humus increases soil fertility and improves soil structure.**
- **Less work. During the composting process, the volume of the fully composted pile is only half the size of the initial pile. This means half as many trips spreading half of the amount of manure, compared to spreading raw manure.**

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The role of manure

Biomass turnover is a major factor in crop-livestock systems, because crops and crop residues are meant to feed animals and the manures are used to maintain soil fertility. Although manure can supply other nutrients, it is commonly known that nitrogen (N) is the most important. The efficiency of N utilization and system productivity are influenced by the ratios of availability and losses occurring in the N transformation pathway.

Compost manure, just before application

Interest and efforts towards utilization of manures from livestock to improve soil fertility and crop production have continued since Biblical time. Jesus gave parable whereby a fig tree which failed to produce fruits after applying dung (fertilizer in the new versions) was to be cut down. Ammonium (NH_4^+) is the most important soil fertility nutrient arising from manure. It is a

© TP Lanyasunya, Kenya product of microbial protein degradation in the ruminant gastrointestinal track. The microbes multiply into large numbers using ammonia (NH3) in reconstituting their own proteins, with excreted NH4+ being surplus to microbial requirements or spilled from imbalanced anabolic processes. From the animal production point of view, production of NH3 and NH4+ is nutritionally wasteful since they represent waste of dietary protein. Consequently, a livestock farmer utilizing manure will not count manure rich in NH4+ but rather a valuable resource for nitrogen recycling and cost reduction.

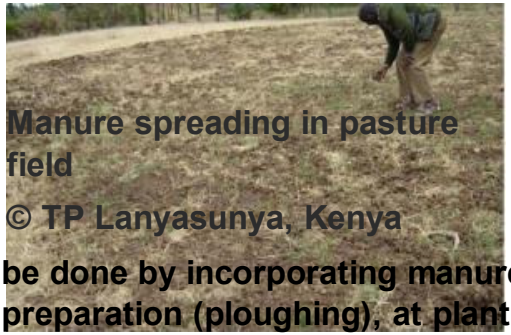
Manure: Heaping before spreading

© TP Lanyasunya, Kenya

Supply of nutrients by manure

There can be huge loss (24 - 83 %) of NH4+ as a result of drying manure. This is as a result of NH3 volatilisation. Such losses can be reduced substantially (e.g. to 5%) by ploughing fresh manure into soil whereby NH4+ can be used directly by plants or converted to nitrate (NO3-), which is another available form. The fact that highest NH4+ is in the fresh manure indicate that fresh faeces are of great potential as source of N. Therefore to maintain high quality in manure, drying and exposure to air should be avoided. In the contrary, it is ironically believed by many farmers, e.g. among communities in Eastern and Southern Africa, that fresh faeces (manure) is harmful to crops by causing 'burning'. As a result, there is low use of fresh faeces on the farms. Such beliefs may relate to the high NH4+ concentration in fresh faeces as evident in the present study. The burning may result from localised high concentrations caused by poor distribution. A great value is liable to be lost if fresh manure is not appropriately conserved and applied.

Continuous direct application of freshly produced manure (faeces) may only be of practical value to perennial crops. In the case of seasonal crops, it would be recommendable to bulk the manures



Manure spreading in pasture field

© TP Lanyasunya, Kenya

in heaps to minimise ammonia volatilization, while at the same time allowing decomposition to continue. The manure can then later be collected from the heaps and strategically applied. Application can be done by incorporating manure into the soil during seed bed preparation (ploughing), at planting or during weeding.

In manure use, precaution need to be undertaken to avoid burning of crops due to high concentration of ammonium. Uniformity of spreading and correct rate of nutrients supply to the crops are crucial considerations in order to prevent the burning. For these reasons, it is recommendable that in routine applications, the manure being used should be analysed for nutrient content, particularly total nitrogen (N), ammonium-N, phosphate (P2O5) and potash (K2O).

The crops requirements should be matched with the nutrient supply from the manures and soil. Availability of affordable analytical services is therefore necessary to support correct use of manures. Proper sampling is crucial for accurate analysis, and this will require that several sub-samples are collected and mixed to make up the samples submitted for analyses. The samples for analysis should be kept

carefully to avoid biased results i.e. if losses occur in the process.

An example of a management system where fresh manure is efficiently utilized is in Sahel regions of West Africa. In this system, manure is directly deposited onto the land intended for cropping by grazing animals. This done through arrangements, which can be contractual in nature (Powell et al., 2003). Besides maximising nitrogen supply, this management system also has the advantages of storage and labour savings. Powell et al. (2003) suggested that another strategy to minimise nitrogen losses is to maintain a vigorous biological community (e.g., beetles, earthworms, chickens, turkeys) that can chop, bury, and decompose the manure so that it is quickly fixed into forms that are not easily leached or volatilized. Another important factor to consider when planning direct manure deposit is irregular distribution. Inevitably, more manure is deposited near watering, feeding, and bedding areas.

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Pig manure

Pig urine and dung are good fertilisers for the land, so it is wise to

make good use of them. After sweeping and cleaning the pens, the solid manure can be spread on the land directly. The wet, run-off manure and urine can be led through furrows (channels) into a collecting pond. With time the water will seep into the ground and the solid manure will build up. As the pond fills up with solid manure, you can remove the manure and put it on land. Before using the dung, it is best to let it decompose. Do so by putting it in a heap (pile) and under a shade. Keep the pile moist and turn it occasionally for it to increase compost quality.

Compost can be made by adding soil, grass cuttings, leaves, etc which can be used as fertiliser on cultivated lands or can be sold for an extra income.

The manure plays an important role in increasing soil fertility especially in improving the organic content in the soil. Only about 1/3 of the nitrogen in dung will be available to the plant. Pig dung has about 23% DM and 16% organic matter.

Production of pig dung

Fatteners (20 -100kgs) can produce 2- 4kg; breeding pigs can produce 5-8 kg of mixed manure (dung and liquid) per day. On a 20-sow pig farm up to 300 tons of composted manure can be produced every year. The amount produced will however depend on type of feed,

amount of drinking water, wastewater, beddings (litter) provided. Application: 20-40 tons/ha/year for crop land and 10-20 tons /ha/year for grazing land. Usually just before the rains or during the rainy season.

Combined with on-farm fish culture

Pig keeping can be combined with on-farm fish culture. Pig manure can be used to fertilise the fishpond. The manure, or some (not too much) of the rich run-off from the pens, will stimulate the growth of any natural fish food and water plants. The plant *Ipomoea reptans* growing on the surface of the water grows for instance more rapidly and provide excellent green fodder for pigs. Pig manure in the pond increases the food available for the fish that in turn grow faster.

Pig house with fish pond

For more information on fish farming click here

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Goat manure

Manure

Goat manure is a useful product with commercial value and is used in many parts of East Africa. The manure has a higher content of nitrogen and phosphoric acid than that of cows. The urine is rich in nitrogen and potassium. The manure is an excellent fertilizer and has the potential to increase crop yields.

Compost

A very efficient method of making compost is to stack the manure in a neat square pile (manure from other livestock can be added to make an even more valuable by product, i.e., cow, sheep, donkey, chicken and camel dung). Where possible the pile should be kept moist by watering. After two weeks the whole pile should be turned over and left to mature. Whilst this pile is maturing a second pile can be started. In this way the farmer has a continuous supply of compost for his farm or for sale.

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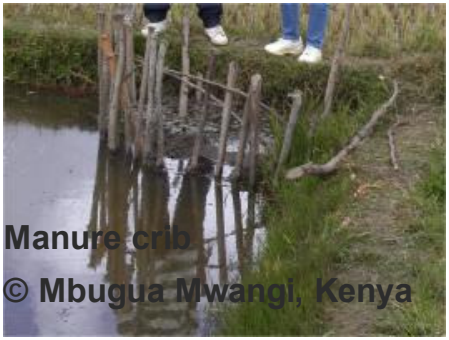
Manure and fish production

Animal manure is widely used in Kenya in fish production in earthen ponds in. The quality of manure as a fertilizer varies depending on the source animal and the quality of feed fed to the animal. Pig, chicken and duck manures increase fish production more than cow and sheep manure. Animals fed high quality feeds (grains) produce manure that is better as a fertilizer than those fed diets high in crude fibre. Fine manures provide more surface area for the growth of microorganisms and produce better results than large clumps of manure.
Manure should be distributed evenly over the pond surface area. Accumulations of manure on the pond bottom produce low oxygen conditions (during decomposition) in the sediment resulting to reduced microbial activity and sometimes result in the sudden release of toxic chemicals into the water.

Methods of applying Manure

- **Crib method: A compost crib constructed using wooden sticks at one**



Manure crib
© Mbugua Mwangi, Kenya

or more sides of the pond. It helps fertilize the water gradually. The manure in the crib requires frequent turning to facilitate the release of nutrients.

- **Bag method: A bag is filled with manure and tied to the corner of the pond. The bag is shaken weekly or daily to release nutrients.**

Manure application rates for ponds

Manure application rates depend on the size of the pond, which is expressed as surface area of the water in the pond. The

recommended rate is 50g of dry matter per m2 per week i.e. 5Kg/100m2/week.

The maximum rate depends on the quality of the manure, the oxygen supply in the pond and water temperature. If early morning dissolved oxygen (DO) is less than 2 ppm, manuring should be reduced or stopped until DO increases. When water temperatures are less than 18° C, manure application should be discontinued. At low temperatures the rate of decomposition decreases and manure may accumulate on the pond bottom. A subsequent increase in temperature could then result in oxygen depletion.

Agricultural Lime

- **Used to improve soil quality, which helps the organic and chemical fertilizers to work better. It also helps to clear up muddy water.**
- **In red soils; about 20kg per 100m2 can be applied. Black cotton soils may require a little more.**

Some characteristics of farm manure:

- **Contains trace minerals and vitamins.**
- **Uses oxygen to decompose.**
- **Is highly variable in composition depending on feeds given to the**

animals and bedding used

- **Can help reduce turbidity due to clay silt in the ponds**
- **Can help reduce seepage in ponds**
- **Some of the ingredients can be consumed directly by the fish**

Integrated systems

Manure application can be made easy by placing animal production units adjacent to or over the fish ponds so that fresh manure can easily be delivered to the pond on a continuous basis. This also allows the feed wasted by the animals to fall into the fish pond and utelised by the fish. Effective and safe manure loading rates are maintained by having the correct number of animals per pond surface area.

Chicken/fish farming Maximum tilapia yields are obtained from the manure output of 5,000 to 5,500 chickens/ha, which deliver 100 to 113 Kg (dry weight) of manure/ ha/day. Several crops of chickens can be produced in one fish production cycle.

Duck/fish farming

Ducks are grown on ponds at a density of 750 to 1500/ha. The ducks are raised in confinement, fed intensively, and allowed a small portion of the pond where they forage for natural foods and deposit their manure. Ducks reach marketable size in 10 to 11 weeks and therefore

staggering production cycles is needed to stabilize manure output.

Pig house with fish pond

© Stephen Gikonyo, Kenya

Pig/fish farming

Approximately 60 to 70 pigs/ha are required to produce a suitable quantity of manure (90 to 100 pounds of dry matter/acre/day) for tilapia production. The pigs are usually grown from 44 to 220 pounds over a 6-month period. In certain cultures and religion, where pigs are considered unclean, used of pig manure might reduce the marketability of the fish.

Harvesting

Fish produced for consumption should be harvested when they reach market size. In Kenya, tilapia are ready for harvesting within six to nine months depending on the size at stocking, target harvest size,

water temperature and level of management employed. The time of harvesting is determined through regular sampling which should be done monthly. A day or two before harvesting, feeding and fertilizer application should be stopped. During harvesting:

- **Fish should be checked for off flavors**
- **Fish should be harvested during cool weather**
- **Harvesting and transportation equipment should be set up well in advance to ensure reduced stress and minimal fish mortality.**

Tilapias are best harvested by seining for partial harvesting and complete drainage for complete harvesting. Once harvested, fish should be handled with care and transported to the market while still fresh.

Growth and yields

Under proper management and optimal conditions, 1-gram fish are cultured in nursery ponds to 20 to 40 grams in 5 to 8 weeks and then stocked into grow-out ponds. In mono-sex, males can reach 200+ grams in 4 to 5 months, 400 + grams in 5 to 6 months, and 500+ grams in 8 to 9 months.

Dress-out percentage on tilapia is low compared to species such as trout and catfish. Tilapias have a dress-out of 51 to 53 percent of live weight for whole-dressed fish (head-off) and 32 to 35 percent for

fillets.

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Chicken manure

Poultry manure

© Ann Wachira, KARI, Kenya

Litter in the poultry house should be kept dry and removed regularly to reduce the load of parasite. Chicken manure contains the highest amount of Nitrogen of any livestock manure. It is therefore very valuable as fertilizer, but if applied fresh to crops can also burn these crops. The best way of utilizing chicken manure is to compost it along with any plant material found around the farm.

Uses of litter

- **As fertilizer for crop production**
- **Compost improvement**
- **Feed in fish ponds**

- **Biogas production**

Average composition of Chicken manure

	Fresh Manure	Litter manure
Dry matter %	20-22	50
Nitrogen	1-1.5	1-2
Phosphorus	1-2	2
Potassium	0.7	1
Calcium	2.2	3

Quantify manure yield

Chicken manure can be used in fish ponds. The manure is partly eaten by the fish while the rest is used by plants to grow and then eaten by fish.
Dried poultry manure maybe used to feed ruminants (cattle and goats) in combination with grains and molasses.
A biogas digester can be used to make gas from the manure.
The slurry left over may also be used as fertilizer for use in crops or fish ponds.

- **100 layers will produce about 3 tons of manure during a 448 day**

period (from chicks to end of first laying period

- **1000 broilers will produce about 1.1 tons of manure in 42 days**

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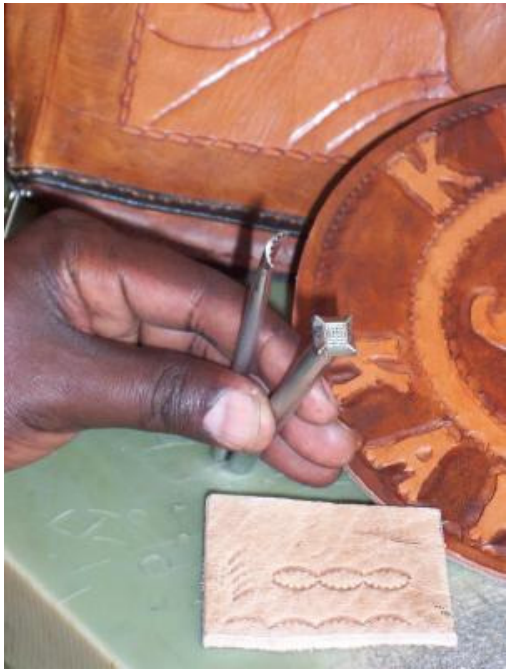
Leather production 5. Course for women learning about leather preparation at KIRDI, Nairobi.

Dairy products



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Skin preparation, defleshing

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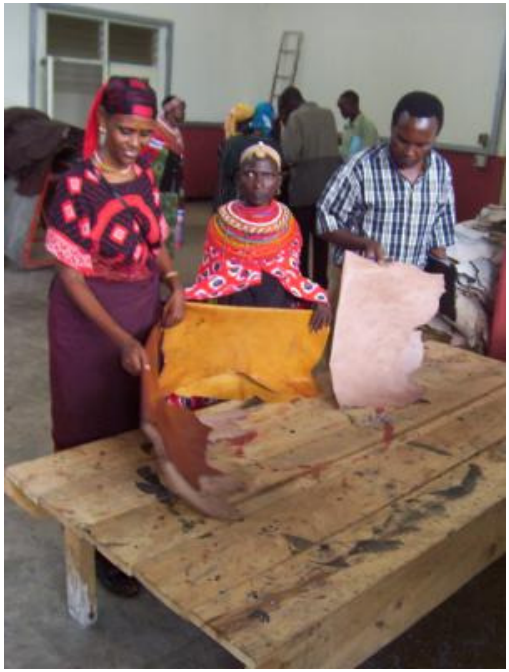

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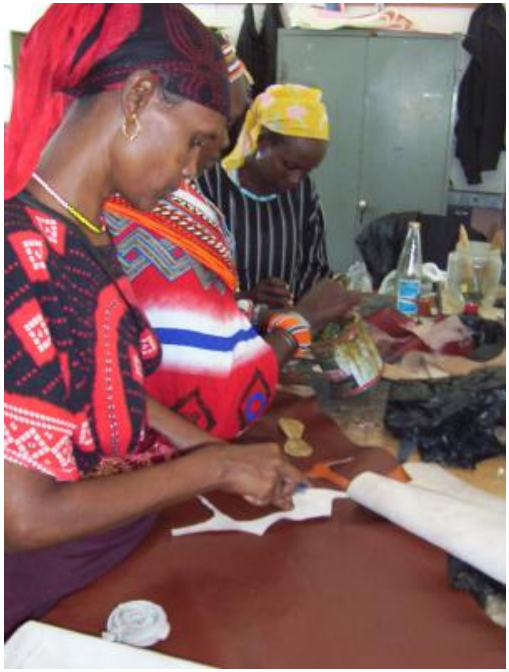

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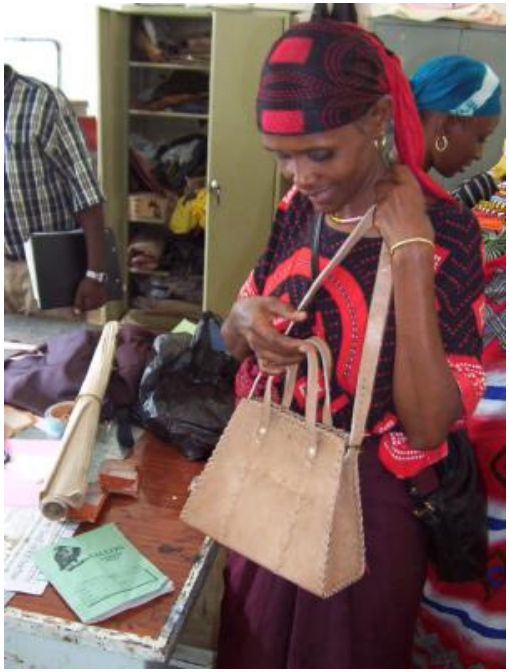

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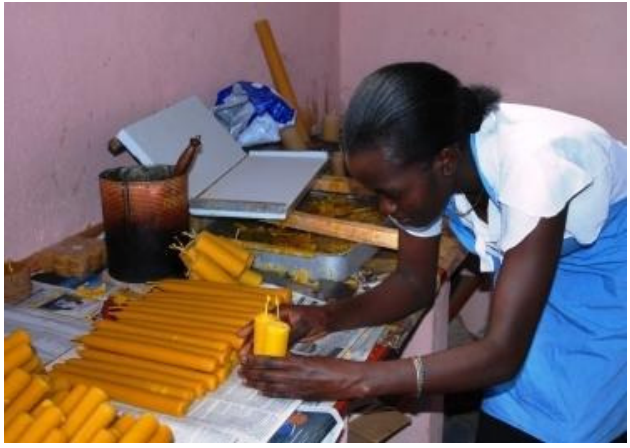

Cabesi Market Place, Makutano

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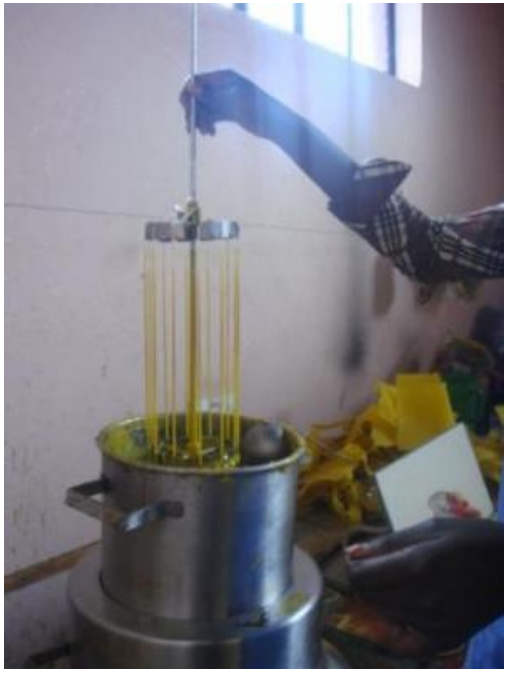
Tool to make multiple hand-pulled candles

Making hand-pulled candles



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Making candles

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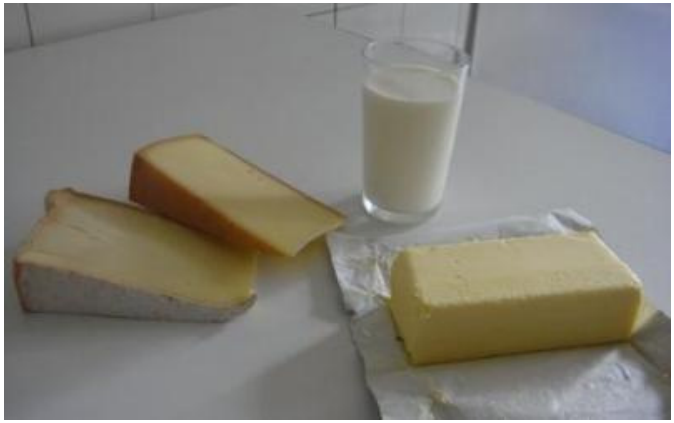

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tion

Leather production

From 2001-2004, KARI (Kenya Agriculture Research Institute) carried out research on utilization of milk meat, hides and skins in Northern Kenya. The following environmentally friendly recipes are extracts from this research.

The most valuable remaining part of the animal after slaughtering is the hide. Traditionally, hides and skins in northern Kenya are dried and since a local market for raw hides and skins hardly exists in the area, only the best hides are traditionally used for simple tanning. The resulting leather is hard and not very durable. Out of hides, skins and leather the women usually make traditional containers, covers for beds or clothing. For the latter, goat and sheep skins are preferred over camel hides. In other pastoral Kenyan societies, notably the Maasai around Kajiado, rural tanning enterprises have created employment and a small, but successful handicraft business supplying mainly the tourist sector has evolved. Using the below recipes it is possible with some practice to produce very good attractive leather in a village or home situation.

Added value by tanning
The total annual trade in raw hides and skins from Marsabit district in 2003 was estimated at 23,000 hides and 76,000 skins with a total turnover of USD 97,000. The market price is determined by volume offered, quality and weight of the raw hide / skin. Below table gives some estimates from 2004 of the possible value addition to hides and skins by tanning. The calculations were made in US Dollars (In January

2009: 1 US$= Ksh 77/-).

Table 1. Approximate prices and possible value addition of tanned hides and skins (2004).

	Fresh weight	USD/Kg	Sale price USD	Leather Sq ft	USD/Sq ft	Leather Sale USD	Possible value addition USD
Goat skin	3-5	-	0.30-0.90	3-6	0.60-1.20	1.80-6.00	1.50-5.00
Sheep skin	3-6		0.30-0.90	3-6	0.60-1.20	1.80-7.00	1.50-6.00
Cow hide	10-20	0.30-0.60	3-12	10-20	0.50-1	5-20	5.00-20.00
Camel hide	20-35	0.30-0.60	6-20	20-35	0.60-1.20	12-40	6.00-20.00

Table 1 shows that a dried unprocessed goat skin which could at the time sell for Ksh 50/- if the size and quality was good, could fetch from Ksh 200/- 400/- when tanned depending on quality and size. Considering the amount of goat skins which are just discarded, tanning skins and hides could become a good income booster where there is plenty of hides and skins available.

Table 2. Production costs and sales of hides and skins in Ngurunit, Marsabit district, January 2003 to April 2004

Type of hide/skin	Tanning method	Hides/skins produced	Average production costs (USD) per hide/skin	Average sale price (USD) per hide/skin	Average profit (USD) per hide/skin
Goat / sheep	Alum	20	2.80	3.75	0.95
Camel hide	Alum	5	9.95	15.60	5.65
Camel hide	Vegetable	5	13.20	16.30	3.10
Goats	Vegetable (mimosa powder)	10	3.00	4.50	1.50
Goats	*Acacia nilotica* pods	12	2.25	4.50	2.25

*** The weight of wet/soaked goat/sheepskin was taken to be 4.5 kg whereas that of half a camel hide was estimated at 15 kg in calculating the cost of processing leather. The table shows that the vegetable tanned hides and skins were more expensive to produce, but also fetched a higher market price due to their better quality and appearance of the finished product.**

Animals in pastoral environments are kept in bomas, which are night enclosures built piling up branches from thorny trees and bushes (such as *acacia* spp.) in a circle. The thorns cause frequent skin injuries in the animals and therefore unwanted marks on the finished leather which lowers the quality and the market price. The best sales prices for leather are obtained from unmarked undamaged hides and skins.
However home tanning is hard work, and takes time. Equipment does not have to be very expensive for small operations, but a small investment is needed.

Preparation of hides/skins for tanning

Water Quality

Leather tanning requires plenty clean water of fairly good quality.
Water quality: a concentration of calcium carbonate above 400 mg/litre is generally considered too hard for tanning and KIRDI recommended to use soapless detergents or soften the water with commercially available chemicals such as DIASOAK (available

at swimming pool supply shops in Nairobi) before using it for leather tanning.
The water from Ngurunit and Laisamis had calcium carbonate content of 585 mg/litre or more and pH of 7.7.
The KARI experience in Ngurunit and in Laisamis showed that the local water worked well without treatment, despite the fact that it was harder than recommended. It was therefore concluded that the guidelines provided in the literature do not necessarily apply under all conditions.

Equipment needed
An initial investment is needed for the necessary tanning and finishing equipment (starter kit). Equipment and material can be obtained through KIRDI (Kenya Industrial Research and Development Institute - Nairobi, Kenya - Tel:+254-20-603842/609440 - email: dir@kirdi.go.ke / info@kirdi.go.ke)

- 2 x 100 l black containers for de-hairing
- 2 x 100 l white containers for tanning
- 2 x 50 l containers with lids
- 2 fleshing beams with stands
- 2 fleshing knives
- 2 slickers for sammying
- 2 sammying (removing excess water by stretching and scraping) tables
- 2 oiling tables
- 4 buckets

- 1 sharpening file
- 8 to 10 pairs of plastic gloves (depending on group size)
- 10 waterproof aprons (protective clothing)
- 3 to 4 pairs of gumboots (depending on group size)
- hydrated lime - 50 kg
- Sodium sulphide - 50kg
- Caustic soda - 50kg
- Mimosa powder - 50kg
- Ammonium sulphate - 50kg
- Sodium metasulphite ? 10 kg (may be left out if bleaching is not needed)
- Fat liquor oil (castor oil based) - 20 litres.

All tanning and oiling work needs to be carried out in shaded areas, as leather should not dry directly in the sun, otherwise the fibres contract too quickly and the resulting product is too hard. Any large enough roofed and preferably netted-in area can be used. Netting or walls are needed to protect from dogs and wildlife, but there should be ample light for working. Chemicals and equipment need a lockable store.

Preparation of hides/skins for tanning

Camel hides measure between 18 and 25 square feet and weigh up to 35 kg. They are usually too heavy to handle properly if in one piece, and the usual practice is to just divide the hide at butchering time. Also some cow hides are too big to handle in one

piece, so they can also be divided for example down the middle. However if at all cow hides can be handled in one piece, they will fetch better prices.
Goat and sheep skin are always prepared as one piece.

Tanning can be done on either dehaired or non dehaired hides and skins. Some goats for example have very beautiful markings on their skins, which may be worthwhile preserving for special purposes, in which case dehairing is not carried out, and the skin goes straight to tanning with the coat of hair on. Camel hides however are usually not very attractively coloured, and camel leather being strong and quite in demand will need dehairing.
To produce leather, the first step in preparing hides/skins for tanning is de-hairing and de-fleshing. Dry hides/skins need to be soaked in clean water for two to three days before de-hairing, wet (fresh) hides/skins can be de-haired directly.

Step 1: De-hairing
The most successful method used was a 4% solution of hydrated lime dissolved in enough water to adequately cover the hide. (calculated on the basis of the hide / skin weight. This means if a hide weighs 20 kg, hydrated lime needed is 4% of 20 kg or 0.8 kg lime) Hydrated lime is easily obtainable in Nairobi and surroundings at a cost of KES 500 per 50 kg (2004 price) The thick parts of camel hides take longer than other parts to release their hair. A recommended addition of 1% Sodium Sulphide (again on the basis of the weight of hides / skins) to speed up the process is possible, but this highly corrosive chemical needs to be used very fast. As time is not usually of

importance in many rural areas, its use cannot really be justified in the normal operation of a small rural tannery. Also, this chemical is neither very environmentally friendly nor safe to use in most environments, and hydrated lime does the dehairing perfectly even without it.

30 litres of water with the 4% hydrated lime was enough for 1 camel hide (two halves) or 15 goat/sheep skins.). When the hair slips off by slight pulling, the skins / hides are ready for scraping with blunt utensils on the grain side to remove all remaining hair. De-hairing of a sheepskin took one day of soaking in the solution, cow hides about two days, and camel hides three days. Frequent stirring of at least four or more times a day (the more the better) was necessary to ensure equal exposure of hide or skins to the lime solution. The hides/skins swell with the lime solution being soaked into to pores, and become very thick. It is very important to ensure that all parts of hides/skins are submerged under water/lime solution, as exposure to air with lime coating can cause 'burns' or discoloured patches on the finished leather.

Step 2: De-fleshing
After de-hairing remaining parts of flesh that need to be removed stand out very clearly and have to be scraped off. A fleshing beam and fleshing knives were used for this purpose. Suitable beams can made out of old fallen tree trunks and logs. They should be smoothened to form a good firm basis for the fleshing knives, which were manufactured in Nairobi at Ksh 1500 each or made by local artisans according to a drawing by the hides and skins specialist of the government extension service.

Step 3: De-liming

After all of the hair and remaining flesh is removed, the hides/skins which have swelled to double or triple thickness during dehairing process, must be de-limed by washing in plenty of clean water and submerged in a neutralising solution until it reduces thickness and pH again. In our experiments the best de-liming chemical was 2% ammonium sulphate (a commonly available fertilizer, at about 1300 Ksh per 50 kg bag, percentage again calculated on the basis of the original weight of the hide / skin . Our original 20 kg hide would need 2% of 20 kg or 400g of ammonium sulphate). However, where this chemical is not available, a solution of 1 litre of vinegar in 10 litres of water can be used, which also produced good results.

The skins/hides were submerged in the solution and stirred every couple of hours. Through frequent monitoring the point when the lime-induced swelling disappears completely needed to be established. With small skins, this process will take only a few hours, whereas heavy hides may need to be left in the solution over night. After removal from the de-liming solution the hides / skins need to be washed well in clean water to be ready for the tanning solution.

Changing the very alkaline environment of de-hairing into a slightly acidic environment is important as the tanning works best in the latter. Large-scale tanneries work with highly corrosive chemicals such as sulphuric acid, but this is too risky and dangerous under home or village conditions. The vinegar solution worked very well in Ngurunit. An alternative which could be tested - if the above mentioned

ingredients are all not available - is based on experiences with rural tanning in Zambia where fermented maize flour was used (Hoyle 1994). Maize flour can easily be found in most places in Africa and it will ferment on its own if put in water.

Tanning

Step 4: Tanning

Tanning methods

The most commonly used tanning methods for leather in Kenya are chrome based tanning or vegetable tanning (with mimosa or other plant derived extracts). The team also tested alum tanning, as alum is easily available and alum tanning recipes for home tanning are often found in literature. Alum tanning does not change the colouring of hairs, and so would be best suited for skins where it is decided to preserve the hair coat.

Hides or skins tanned in the same solution need to be soaked at the same time. When a second hide or skin was added to the tanning solution the following day, it seemed to actually be removing tanning chemicals from the first hide or skin, rendering the process less efficient and resulting in products of less good quality.

Alum tanning

Ali tanning was described by Hardwick (1996) and the US Department of Agriculture (1962). In this process, the collagen fibres in the skin / hide are coated with a layer of alum molecules. Alum tanning is commonly recommended in the literature for home tanning (Hoyle 1994, Hardwick 1996) as it is an easy, safe and environmentally friendly method of tanning. 250 g of rock aluminium are fully dissolved in 3 litres of hot fresh water. 200 g of table salt are separately dissolved in 4 litres of cold fresh water. The two liquids are slowly mixed while constantly stirring. If the liquids are mixed too quickly, the resulting solution becomes cloudy and is not very effective. The resulting 7 litres of solution are left to cool down to room temperature and then up to 4 small skins are submerged. For one camel hide, the ingredients have to be quadrupled to produce enough liquid for tanning.

This method can be used for both non-de-haired hides / skins (for decorative purposes) and for de-haired hides/skins (to produce leather). With non-de-haired hides / skins only de-fleshing needs to precede the tanning. Alum tanning will produce pure white leather, or clean looking skins with the hairs left on.

Goat and sheepskins needed three to five days in the tanning solution with frequent stirring (at least four times a day). Large camel hides require up to seven days. To test for full penetration of the solution into the hide/skin, a small cut on the side will show whether the solution has saturated the hide/skin completely. Alternatively, a crease can be made on the edge of the hide/skin and if is does not disappear, tanning is complete. This was the case after two days for a sheepskin, while a camel hide

took four days to reach the same stage.

After removal from the alum solution, the hides / skins were dried on a clothes line or wire in the shade. While drying, skins were regularly stretched and pulled by hand to remain smooth. A camel hide needed to be taken down intermittently and pulled with blunt metal scrapers on the flesh side of the hide or a wooden scraper on the grain (hair) side. Be careful not to make knife marks on the grain side of the hide, as this lowers the value of the finished product. The pulling and stretching of camel and cow hides is best done on a flat clean surface (table or bench) to press out water and to stretch fibres. Alternatively, the hide/skin can be strung up on a wooden frame and worked over repeatedly with scrapers to prevent the fibres from contracting while drying and to break the hard fibres so that the leather becomes soft and pliable. Be prepared for quite a bit of work during this stage - the more stretching, the softer the leather and the better the final price.

The disadvantage of the alum method is that the resulting produce cannot be cleaned with water since the alum molecules remain water-soluble. Therefore, items must be dry cleaned, which is not convenient in most rural areas. No fixation process seems to be available, but treatment with castor oil solution or any of the fat liquor recipes listed below will help preserve the tanning and repel water.

Vegetable (mimosa) tanning
As an alternative method, vegetable tanning with commercially available wattle bark

extract (mimosa powder) was tested on two camel hides and ten goat/sheepskins. This tanning extract is available in Kenya from East African Tanning, Thika. On the first day, 5% of the mimosa powder (based on weight of hides / skins - our 20 kg hide would require 1 kg mimosa powder) was dissolved in enough water to completely cover the hides/skins. As described for alum tanning, frequent stirring, preferably hourly was necessary so that the tanning solution would completely penetrate the hides / skins. On the second and on the third day another 5% mimosa powder (same amount as on day one) was added to the solution and stirring continued on regular basis for the next 3-4 days. A small cut can be made in the thickest part (on the neck side) of the hide/skin to see if the tanning solution has penetrated. Mimosa tanning gives a reddish-brown tinge, and the distinction between tanned and un-tanned leather is quite clear. After removal from the tanning solution, the hides/skins were washed thoroughly in clean water, then pressed/scraped with blunt scrapers to remove as much water as possible.

Vegetable tanning (*Acacia nilotica* pods)

A brain and smoke tanning recipe used by native Americans described by Dinsmore and Dinsmore (1996) was also tested on a small goatskin. It is often said that each animal has enough brains available to tan its hide, but Dinsmore and Dinsmore (1996) mention that lighter solutions could work as well. However, when trying this method in Ngurunit, the small skin used, although very soft in the tanning solution, dried out much faster than could be comfortably handled, and so the final product did not turn out well. If this method is preferred by pastoralists, more work is needed to adapt the

recipe to the northern Kenyan hot and dry conditions. There was a considerable interest in the method, as some of the women mentioned they had seen their mothers or grandmothers use a similar method, but knowledge on details had now been lost.

Hoyle (1994) provides a list of tannin containing trees, of which *Acacia nilotica* is mentioned to contain 40 % tannin in its pods. As this tree grows in Northern Kenya, the pods were collected and some experiments on its suitability as a locally available tanning material were done. At first the crushed pods were simply soaked to see what sort of solution was produced. The water soaked up the tannin materials from the pods and became red in colour, very similar to the commercial wattle bark (mimosa) solution. Experiments were carried out on goatskins with very good results. Literature describing oak bark extraction for tanning purposes (US Department of Agriculture 1962) was used as a guide for developing a method of extracting the tanning material from the pods.

First, 5 kg of *Acacia nilotica* pods in a bag were crushed by hitting the bag with a mallet. The crushed pods were then mixed with 20 litres of fresh water and left to soak for six days with frequent stirring (four to six times a day). In the meantime, a goatskin and a neckpiece of a camel hide were prepared for tanning by de-hairing, de-fleshing and de-liming as described above. When ready for tanning, half of the pod solution (ten litres) was strained into another bucket to remove the pod pieces and then the skin and hide piece were soaked in the extract. The bucket with the crushed pod solution was refilled to the top with water and regular stirring continued. After

three days this solution was strained of the crushed pods and added gradually to the soaking skin and hide piece. At the same time, three additional kg of the Acacia nilotica pods were crushed and added to 10 litres of water in order to produce more extraction solution to substitute for the first batch when its efficiency was decreasing. This method continued for three weeks during which every four or five days the soaked pods were strained out. to get the water for adding to the soaking hide/skins and more pods (about 1 kg each time after the initial starting amounts) being crushed and put into clean water (about 5 litres). The skin/hide piece was left in the solution until the red colour had penetrated the skin as evidenced by cutting a small cross section on the thickest part of the skin.
Although the Acacia method is slow, the leather produced from this method had a very attractive tannish brown hue which seemed to be preferred by customers over the reddish brown mimosa tanned leather.

The experiments carried out using an extract of *Acacia nilotica* pods to tan goatskins and a neckpiece from a camel hide showed results of similar, and sometimes superior quality to the mimosa tanned skins/hides. There is great potential and advantage of using *Acacia nilotica* pods over mimosa for two reasons. One is that the pods are locally available, abundant and a renewable resource in the Northern Kenya area. Secondly, mimosa powder that was purchased in large quantities at the beginning of the project appeared to be loosing its tanning qualities, probably due to the heat. The result is that the mimosa tanned products later had a stronger and somewhat unpleasant smell than before and the mimosa solution did not appear to be effectively

penetrating the hides/skins like it did when the powder was fresh.

The result of tanning with *Acacia nilotica* pods was a pliable, good coloured tanned skin and hide piece. The women therefore tanned a full batch of 10 skins after only one day of the pods soaking. However, this amount of skins seemed to slow down the process greatly and made the penetration of the brown tanning colour into the centre of the skins less effective. Presumably the short soaking period of the pods did not allow the tannins in the pods to be effectively released into the water. We concluded that for this tanning method it is essential that the extraction solution of the pods is prepared at least four to six days before submerging the skins in it.

Step 5: Fixation of the tanning chemicals
Soda ash measuring an equal amount to 5% of the original weight of the untanned hides / skins was dissolved in a water bath and the damp hides / skins added. While frequently stirring over the next fifteen to twenty minutes the tanning chemical was thus fixated in the leather. After this they were again washed in clean water.

Finishing process

Step 6: Bleaching and dying
When bleaching and dying was desired it is usually easiest to do it immediately after

the fixation process. To bleach the leather 1% Sodium metabisulphite (in these recipes all % was on basis of original weight of hide/ skins) was dissolved in a warm water bath, the hides / skins submerged and stirred for at least thirty minutes. This gave a slightly lighter colour of the final leather, and a clearer colour of potentially desired dyes. Commonly used and available leather dyes were dissolved in warm water and the hides / skins submerged for one to two hours according to instructions. A vinegar solution (1 L vinegar in 10 L water) was used for fixing the dyes. The women preferred natural colours, but one could equally dye this leather in any desired colour.

Step 7: Oiling for an appealing product
The tanned (bleached / dyed) hides / skins were subsequently dried on a clothes line or on a frame while regularly scraping with blunt tools (e.g. a slicker) to prevent fibres from contracting. When just damp, the hides / skins were laid on a flat surface and oiled on both sides with the following solution as recommended by Hoyle (1994):

1.5 l water
200 g soap (bar soap is fine)
300 ml vegetable oil.

To prepare this solution, the soap was shredded with a knife and all ingredients heated up in a pot to form a uniform emulsion. This emulsion was cooled down until lukewarm and spread onto the slightly damp hide / skin. Best results were achieved

when this process was performed on a table covered with a plastic sheet. The grain side was covered first, then the hide/skin was turned over and the fibre (flesh) side covered with generous amounts of the emulsion (until the hide / skin was fully covered in Vaseline-coloured smudge). This emulsion need to soak in over night with the fibre side facing up to maximise penetration. Covering with a second plastic sheet over night help improve absorption of the emulsion and prevent the hide / skin from getting dirty in dusty environments.

KIRDI (the Kenya Industrial Research and Development Institute) has developed a product from castor oil, which they recommend as superior to the above-described emulsion for oiling leather. However, this has yet to be tested properly under village conditions. But the castor plant grows wild in the environment, and could produce locally available oil, if tests are successful.

The following morning, excess emulsion is scraped off the hide/skin before a final drying process while scraping / stretching with a slicker as described before. When almost dry, the hides / skins are worked over a rounded metal (an old metal hoe was used, but more appropriate tools can be manufactured) to ensure a smooth, soft leather surface. It is very important to start working the hide / skin when it is still damp and continue doing so until it is completely dry. Otherwise, a tanned hide / skin can become hard and stiff if it is not worked enough at this stage of the process. If this happens, the skin / hide can be re-dampened and worked again until dry and soft. This problem was encountered on one occasion when some oiled skins were left to

dry too long before working, resulting a stiffer product than desired.

Step 8: Sanding and Polishing

To obtain an even smoother surface the dry leather can be sanded on the flesh side. Pumice stones are quite efficient for sanding. Additional polishing on the grain side with a clean smooth glass bottle or a hot iron will give the leather a shiny appearance.

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- **SID (Society for International Development). 2004. Pulling apart - facts and figures on inequality in Kenya. Society for International Development, Eastern Africa Regional Office, Nairobi, Kenya, www.sidint.org**
- **US Department of Agriculture. 1962. Farmer's Bulletin No. 1334. Home Tanning of Leather and Small Fur Skins. Extension Services. Box 1109, Juneau, Alaska.**

Local reference address for tanning equipment

- **KIRDI Kenya Industrial Research and Development Institute - P.O.BOX 30650 - NAIROBI,KENYA - TEL:+254-20-603842/609440 - FAX: +254-20-607023 - email: dir@kirdi.go.ke / info@kirdi.go.ke**

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Bee products

Bee products

Introduction - Market for Bee products

Honey

There is currently a very high demand for honey both in Kenya and overseas. Kenya is now licensed to export honey to the European Union. Market opportunity exists for beekeepers but lack of production is at present the main constraint in Kenyan beekeeping. Good quality honey can fetch a high price. Any farmer who has the good fortune and skill to obtain honey should have no trouble selling it. In general, if you present honey to the consumer in a clean, unspoiled condition, the price will be higher. Beekeepers should aim for the highest grade of honey to maximise returns from beekeeping. Honey in Kenya is sold in the following grades:

- **Crude honey. This is a mixture of ripe and unripe honey. At harvesting time, the wax, honeycomb, and bee-and-brood comb are all mixed into one container. This container is often an old tin. Crude honey is used mainly for brewing local beer because quality requirements are not very strict. The demand for this type of honey is high.**
- **Semi-refined honey. Semi-refined honey is generally the liquid honey that remains when you skim wax off the top of crude honey. Honey sinks to the bottom as it is heavier. Semirefined honey still contains particles of wax and other debris such as bees? legs. It can be stored for the beekeeper?s own use or it can be refined further and packed for sale. It gains a higher price than crude honey.**

- **Refined honey. Refined honey is clean. You strain it to remove all particles of beeswax and other materials. Remember: refined honey is unchanged, it is only strained. Nothing else is added so it is still the pure honey that bees made in the hive.**
- **Chunk honey. Whole combs of capped honey can be harvested carefully from the beehive. You can cut up pieces of the comb and put them into jars of liquid honey. This gives the consumer a feeling that the honey is real and not adulterated with sugar. Chunk honey can fetch a higher price than refined honey.**
- **Comb honey. Honeycombs of capped honey that have a nice white capping can be cut up, placed on small trays, and covered with cling film. These are very marketable in Kenya and command a very high price in the market, particularly in affluent Nairobi suburbs and other towns. This product should be the ultimate aim of all beekeepers with access to these markets. This product is priced per gram.**

Beeswax

Most people in Kenya throw away wax combs upon harvesting or after honey extraction. Beekeepers do not know its value. Local villages use beeswax in very limited ways, e.g., for shoe repairs by cobblers. Some companies such as Bata (shoe company) and Kiwi (shoe polish company) purchase beeswax, which they often obtain from miti ni dawa (honey beer) brewers. You leave the wax after brewing beer from crude honey, which contains honeycombs. Baraka Agricultural College buys clean beeswax cakes from other buyers.

Propolis

Export markets for propolis exist. People use it as medicine, selling it as capsule, ointment, or tincture (dissolved). You can chew propolis raw as medicine for the throat. It is on sale in this form in very limited quantities in Nairobi. When harvesting, simply scrape off propolis and store in an airtight container. You can also try making medicine from propolis, e.g., propolis ointment.

Source: This information is taken from the book "A Beginner's Guide to Beekeeping in Kenya" from Thomas Carroll (2006).

Honey

Honey harvest

- **Harvest honey during dry spells, i.e., January, February, March, July, August, September, November, and December.**
- **The harvest time in each area differs, so check the right time in your area. In areas where there are dominant bee plants like coffee, sunflower, etc., you should harvest after the flowers wither.**
- **Regular inspection of hives during nectar flow will ensure that the beekeeper harvests as soon as honey is ready.**
- **Do not harvest unripe honey.**
- **Ideal harvesting time of the day is from 5.30pm to 7.30pm.**

How to harvest honey:

- **Ensure you are sting-proof by putting on protective clothing.**
- **You will need a smoker in good working condition and a clean and dry plastic bucket with lid for storing honey.**
- **Smoke the entrance of the hive with about eight to 10 puffs and then gently lift the lid and smoke again. Leave hive for a minute or two before opening lid to allow smoke to affect bees. Smoke causes bees to engorge themselves with honey making it difficult for them to bend and sting. (They become toofull!)**
- **Very gently tap top bars with a hive tool. A hollow sound will indicate where there is no comb.**
- **Remove top bar from the hive that has no comb attached, so you can examine the rest of bars in the hive. Honeycombs are usually at the end of the hive opposite the entrance. Select combs that are ¾ or more sealed or capped full of honey. (These combs are said to be ripe or have a low moisture content, <19%, which ensures that honey will not ferment later when bottled. Leave combs with brood and pollen for future production of honey.)**

When harvesting a comb:

- **Brush bees gently from the comb using a bee brush. You can cut the harvested comb from the top bar to fall into the bucket.**
- **Replace lid of bucket to prevent bees from entering with the honey.**
- **Return top bar, minus comb, to the hive.**

- **As an alternative, place the whole comb and top bar (after brushing bees off) in another empty hive or catcher box where you can take it away later for comb honey. Fix spare top bar in place of the one removed.**

Gentle smoking is a continuous process during harvest time to control bees. It is important to avoid smoking the honey directly or excessively because it can damage honey flavour. After harvesting, replace the first bar and cover hive with the lid. Make a final smoke before you leave to keep bees away from the harvester and to prevent them from following him/her all the way home. Remember to move through a bushy area first to get rid of bees.

Honey Processing

Honey processing is the action of preparing honey to improve its shelf life and meet the customer's and consumer's preferences. The main methods of honey processing are: Honey straining:
This is done soon after harvesting before honey granulates because granulation makes straining difficult. Staining must be carried out in a room free from robber bees. On large or small scale honey production honey straining can be done using (1) a honey press, (2) a filter tank, (3) a bamboo honey strainer, (4) a perforated plastic basin.

How to do (using a honey press):

- **Put the straining bag into the honey press**
- **Break combs of honey into small pieces and put them into the straining bag**
- **Close the honey press and press combs with the use of either the screw- type honey press or jack-type honey press**
- **Collect the strained honey in a plastic container that is placed under honey press opening**
- **Leave the strained honey in the container to settle and allow beewax particles to float on top**
- **Skim out floating beeswax particles in order to obtain clean honey to be packed for marketing or home consumption.**

N.B. Two people are better than one when harvesting or carrying out any bee operations. Two smokers in operation are also better than one to ensure a continuous supply of smoke for subduing bees. Sufficient smoke is very important when working aggressive bees.

How to refine honey

Step 1.
Remove wax capping from combs using a knife to cut off the capping.

Step 2.

Break combs into smaller particles and sieve them through a net or nylon fabric into a plastic container (See Photo 36.) The sieving process can take a few days. Cover sieved honey with a lid and keep in a dry room away from bees.

Step 3.
You can place the bucket in sunshine for two or three hours to heat honey gently so it flows freely.

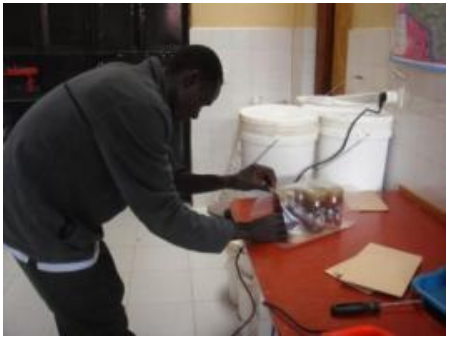
Warning: NEVER boil honey as this destroys its flavour and medicinal characteristics!

Once honey has drained through the cloth and settled at the bottom of the bucket (usually after 2 days or so), use a jug to pour it into honey jars for sale. For wax remaining behind on the straining cloth, squeeze out any remaining honey and process leftover wax.

Packaging and Marketing

Package honey in either plastic or glass jars, which should be clean and dry. 454g jars are available in Kenya from Nairobi suppliers as are plastic trays for selling comb honey. Labelling of honey must include:

- **net weight of honey**
- **name and address of producer**
- **country of origin (Kenya)**
- **description of contents, e.g., ?pure honey?**



Initially you can make a simple label by hand or on a computer, which you can then photocopy. You can have a more attractive label printed later, but this is costly and requires many jars to spread the cost. Some people use Kasuku/Kimbo plastic containers or tree top bottles (700ml) to sell honey. Metal paint tins (mikebe ya rangi) are not good. Honey is acidic and can eat the metal and spoil the honey.

Packaging honey jars

© S. Fontana, BioVision

Where to sell honey

You can sell your bottled and labelled honey directly to shops. Build up a name for supplying the right quality, in the right quantity, at the right price, on time. Many beekeepers develop a reputation for beekeeping and people flock to their homes to buy honey directly. If you are enterprising, you can even set up a shop of your own selling bee products. You could also buy and sell honey from other beekeepers.

A shop or kiosk located in the right place such as the market or along a busy route can attract many customers.
You can also consider the option of forming a beekeeping association to market products of farmers in your area. Examples are the Kakamega Forest Beekeepers Association and the Transmara Association of Beekeepers.
You can also consider the option of starting a cooperative. An example of a successful beekeeping cooperative is Ruai Beekeeping Cooperative Society in Naru Moru, which markets eight tonnes of honey per annum collectively.
The advantage of farmers marketing together is fixed costs, e.g., transport, can be spread over a larger quantity of honey reducing cost. Collective selling gives farmers access to higher priced markets such as Nairobi.

Whatever type of honey you produce, you can easily find a market for it in Kenya and

the price you receive will compare favourably with that available elsewhere in the world.

Source: This information is taken from the book "A Beginner's Guide to Beekeeping in Kenya" from Thomas Carroll (2006).

Beeswax

Beeswax is a product of the beehive. For every 100kgs of honeycomb, you can get about eight to 10kgs of beeswax.
Honeybees secrete beeswax in the form of thin scales. 12- to 17-day-old worker bees produce them through glands on their ventral (stomach) surface. Honeybees use beeswax to build honeycomb cells in which they raise their young and store honey and pollen.

To produce wax, bees must consume about eight times as much honey by mass. Estimates are that bees fly 150,000 miles to yield one pound of beeswax or 530,000 km/kg.

Beeswax is extracted from combs of bees. It is used to make candles, shoe polish

and water proofing materials. In a newly installed KTBH (Kenya Top Bar Hive), the wax is applied on top-bars to attract bees to the hive and also acts as comb foundation. Beeswax is also used to encase human drugs to prevent degradation by stomach enzymes. It is also used in the cosmetic industry.

How to extract wax from combs

Step 1. Mix combs and water in a sufuria (aluminium pot) and heat. Wax melts at about 62 to 64° Celsius, so there is no need to boil. Boiling damages the wax and can be dangerous. Overheated wax can burst into flames. Do not use iron, brass, zinc, or copper containers for heating wax as it can discolour the finished product.

Step 2. Pour melted combs and water into an extraction bag. You can use cotton for sieving. (You can also use the small bags maize seeds come in after you clean thoroughly.)

Step 3.Smear sides of a second sufuria with soapy water to prevent wax from sticking to its sides.

Step 4. Filter wax into the second sufuria. Use two sticks (such as two top bars) to squeeze the bag containing melted combs to extract wax. The yellow wax will come out along with water; waste will remain in the filter bag. If the combs contained bee brood, you can feed these to poultry as they would be cooked by then.

Step 5. After filtering, wax separates from water and floats to the top.

Step 6. Remove wax after leaving it to cool in the sufuria, with lid on to keep away

dust, for 12 hours.

Step 7. Scrape dirt from the bottom of wax cake when cooled.

Step 8. Store wax blocks in a cool dry place. Never store near pesticides/chemicals as it may absorb them.

Your wax block is now ready for sale or for further use. Wax currently sells in Kenya at a price of about KSH100 to 150 per kilogramme or more depending on the demand.

Recipes

How to make beeswax candles:

The basic elements of a candle are the solid wax as fuel for the flame and a wick, which serves to bring the molten wax to the flame. Oil lamps work on the same principle, but they need a container to hold the liquid fuel.

The best material for the wick is a fibre which burns with very little ash at low temperatures. Pure cotton thread is the best. Several thin cotton threads should be braided or plaited together until the desired thickness is reached. Twisting of the threads is not recommended, since they might unwind during burning and then create an irregular flame consuming much more fuel. Commercially produced candle wick can often be purchased in speciality shops.

The wick needs to be in the centre of the candle for even burning. The diameter of the wick in proportion to candle diameter is important to maximize the light obtained from the quantity of wax and to prevent wax dripping down the side of the candle. Thicker candles need thicker wicks, but thick candles with a relatively thin wick burn longer and give less light, since the flame is shaded by the remaining edges of the candle. The precise ratio depends on the purpose of the candle and should be determined by experiment.

There are various pigments available from specialty suppliers for colouring wax and some natural dyes will also work. Regular paint pigments are often insoluble in fat or burn incompletely and so should not be used. Normal food colouring does not work very well as it will leave residues, might clog the wick or produce stains. If only applied as a thin outer layer it may be acceptable but special fat soluble pigments give much better results.

Melting wax

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Melted wax in moulds

How to make beeswax furniture/ shoe polish:

Ingredients:

- **200g Beeswax**
- **100g Turpentine**
- **50g Baby oil**

1) Grate beeswax into flakes.
2) Gradually add turpentine to soften wax.
3) Add oil and mix.
4) Store in a tin with a tight-fitting top or in a jar.

Tipp: To soften the thread for easier sewing of shoes, leather and other thick materials, pull thread through small block of beeswax. The wax stiffens and smoothes the thread.

Propolis

Propolis is a sticky substance collected by bees from buds or bark of trees.

Records show that propolis contain:

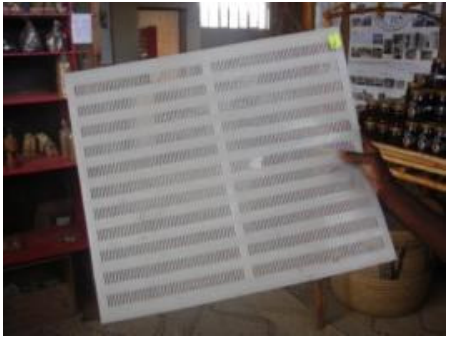
- **>55% resins and balsams**
- **>25% waxes**
- **10% essential oils**
- **>5% pollen**
- **>5% other materials**

Bees use the material for reducing the size of the hive entrance, filling cracks, polishing the interior of the hive, strengthening comb attachment, killing intruders by covering them and as barriers against ants (nest defense). Stingless honey bees store lumps of propolis on hive corners inside the hive for emergency use.

Propolis has also been used in human medicine and for veterinary purposes. It has antibiotic properties thereby inhibiting the growth of microorganisms. It is used for making adhesives e.g. glue, wood pastes for sealing leaking roofs and cracks on wooden furniture. When chewed it heals backaches. Propolis plays an essential role in the antimicrobial defense of some trees, as they control many pathogenic

microorganisms such as fungi, bacteria and viruses.

Note: Propolis gathering and storing by honeybees can be artificially influenced by slightly enlarging spaces in the hive parts like entrance, between the top bars/frames and top cover, and between the floor board and the hive body only during honey flow period.

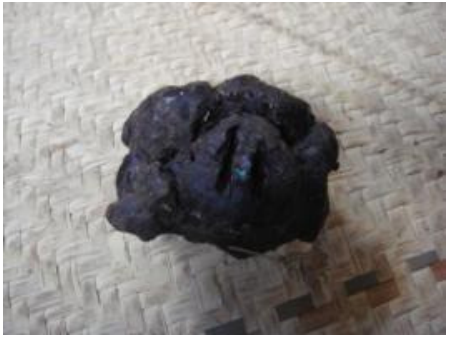


When harvesting propolis, the beekeeper should:

- **Use a hive tool to scrap-off propolis smears and lumps from hives parts, without including hive paints and without damaging the hive boards.**
- **Be careful not to drop it because soil and other debris will stick to it**
- **Keep the collected propolis in an air tight and non corrosive container to retain its quality.**

Special plastic sheet for propolis production (same

bis as beehive)
© S. Fontana, BioVision



A piece of raw propolis

© S. Fontana, BioVision

Raw propolis

Propolis is ready for sale after harvesting without further processing. Unprocessed propolis can be used in chunks, or it may be frozen and broken or ground to fine powder. Large pieces of pure propolis can be chewed, but it should only be consumed in small quantities, since it may cause stomach upsets. Smaller pieces and

powders can be taken in capsules or mixed with food or drinks.

How to make propolis extract

Ingredients:
Propolis
96% Ethanol
A dark flask or bottle (the dark colour protects the content from light/sunlight)

1) Fill half of the bottle with alcohol (90%-alcohol)
2) Cut propolis into small pieces and fill the rest of the bottle with them
3) Shake the bottle everyday for about 3 weeks
4) Sieve it.

Closing the bottle with a cloth for a while allows evaporation, so that the propolis extract will be get more concentrated.
(Rezept: R. Gloor, Cabesi Project, West Pokot)

How to make propolis cream

Ingredients:
120g wax
480g olive or peanut oil
30 g propolis
Small tins

1) Melt the wax and oil together on a double pan
2) Add propolis and stir it throughly until it cools
3) Pour the mixture on small tins

(Recipes: R. Gloor, Cabesi Project, West Pokot)

How to make propolis ointments

1) Simple Vaseline-based ointment

Ingredients (in parts by weight):
1 Propolis extract
9 Vaseline or other petrolatum

- **Prepare a propolis extract in 96% ethanol to a concentration of 10% propolis then**

reduce the solvent to obtain 30% propolis content by weight.

- **Mix the extract with a small quantity of the Vaseline.**
- **Once the mix is homogeneous or well emulsified the rest of the Vaseline can be added slowly. If not mixed well the propolis extract will separate and leave dirty looking droplets in the cream.**
- **Warming in a water bath will improve mixing. Using an emulsifier or electric mixer makes mixing easier.**

The propolis extract may make up to 10% (by weight) of the final ointment. 10% of lanoline can also be melted with the Vaseline (using a water bath) following the same procedures as for the propolis.

2) Simple ointment based on vaseline or animal fat

This ointment can be used for application on cuts, abscesses and festering wounds in animals and external ulcers and burns in humans (see also cabesi recipe of propolis cream above).

Ingredients (in parts by weight):
10 Vaseline or animal fat
1 Propolis

- **Bring the vaseline or fat to boiling point, then cool to 50-60 °C**
- **Add propolis, heat to 70-80°C, stir for 10 minutes and cover for 10 minutes.**
- **Filter through one layer of thin cloth into clean container and seal.**

It is ready as soon as it has cooled, but will not store for very long, particularly if animal fats are used.

3) Simple oil-based ointment

Ingredients (in parts by weight):
2 Propolis ethanol extract, 20% (s. method above)
1 Beeswax
7 Lanolin
10 Butter of palm, cacao, keraté or similar

- **Melt the beeswax in a water bath, slowly stir in the melted lanolin and mix well.**
- **While the mixture is cooling mix in the butter.**
- **The propolis extract is best mixed with a small amount of butter and added to the rest of the mixture once the latter has cooled to less than 40°C.**

Royal jelly

Royal jelly, also known as bee milk, is secreted by 5-15 days old worker honey-bees. It is produced by the hypopharyngeal gland (sometimes called the brood food gland)

of young worker (nurse) bees, to feed young larvae and the adult queen bee.

Royal jelly is always fed directly to the queen or the larvae as it is secreted; it is not stored. This is why it has not been a traditional beekeeping product. The only situation in which harvesting becomes feasible is during queen rearing, when the larvae destined to become queen bees are supplied with an over-abundance of royal jelly. The queen larvae cannot consume the food as fast as it is provided and royal jelly accumulates in the queen cells. The exact definition of commercially available royal jelly is therefore related to the method of production: it is the food intended for 4-5 days old queen bee larvae.

Naturally produced royal jelly is too little for commercial purposes. However, royal jelly production can be done using artificial queen rearing with either plastic or beeswax queen cups in stinging-bees using movable-comb hives (frame or top bar hives). This is done during honey flow period when bees are are actively collecting nectar (honey) and pollen.

How to produce royal jelly successfully (the "Doolittle" method)

Step 1: Pick two frames/bars with pollen and honey from storng colonies and put them in the nuclei box, one on each side, followed by a sealed worker brood comb on either side, and a comb with eggs and very young larvae in the middle.

Step 2. Shake young nurse bees in the nuclei box hive and deprive them of the queen

for 24 hours.

Step 3. Open the queen-less nuclei box having the frame/ bar already mounted with the queen cups. Then remove the middle frame/ bar with eggs and young larvae. Return them to the strong colonies and replace the space in the nuclei box with a frame/ bar mounted with queen cups.

Step 4.Check the frame /bar with queen cups in the centre of the nuclei box after 24 hours, to see if the queen cups have signs of being accepted by the workers (e.g. moulding and trimming of the cups).

Step 5. Open the queen rearing nuclei hive and remove the frame/ top bar with the accepted queen cups and also pick a comb with 8-24 hours old larvae from the strong colonies to a warm house free from wind.

Step 6.Using the grafting pin, prime the queen cups with a drop of royal jelly scooped from very young worker larval cells, then graft the queen cups with 8-24 hous old worker larvae before the frame/ top bar is returned to the nuclei hive of the original position. Next give the nuclei hive more young nurse bees and wait for another 24 hours.

Step 7. Inspect the queen rearing nuclei box hive to see if the grafts are being attended by nurse bees and have been accepted. If not, regraft and wait for 24 hours (remove the former graft before putting a new one in).

After 3 days, the accepted queen cells are filled with royal jelly (about 148-280 mg per

cell or 450g per 1000 queen cells).

- **Cut the queen cells with a sharp thin bladed knife to the level of the royal jelly, on the fourth day of the graft.**
- **Remove the queen brood with forceps and suck off the royal jelly with a syringe.**

How to strain and store royal jelly

- **Store the harvested royal jelly in dark coloured bottles with wide opening and cover them with air tight lids. Note: Sunlight destroys some nutritive elements and vitamins in royal jelly.**
- **Strain the collected royal jelly through a 40-mesh per cm strainer to remove any unwanted materials such as pollen particles, wax or larval moults.**
- **Put the strained royal jelly in hte dark bottles with wide opening and store it in a refrigerator at 1.7°C for immediate consumption or sale, and in a deep freezer for a longer storage period.**
- **The process is repeated using the same queen cups.**

Source: Kihwele et al. (2001)

Pollen

Botanically, pollen is a higher plant's male reproductive element, produced in the anthers. It is transferred by either gravity, wind, animals, birds or insects to the plant's female reproductive organs stigma, to fertilize ovules (seed-embryo) to develop into viable seed in the fruit.
Pollen in honey is used to identify species of bee fodder plants. In beekeeping, pollen is an essential part of bee's diet as it contains protein, fat, minerals, vitamins and enzymes. It is collected from the flowers by worker bees and brought to the hive in form of pellets, where it is mixed with honey (bee bread) ready for consumption or storage.

Bee bread is consumed by humans by chewing the pollen comb. Pollen in the form of pellets is collected by the beekeeper with an aid of a pollen trap. Pollen traps are of various types . Pollen should be collected from the pollen trap every after 2-3 days to prevent fermentation or infestation by pests. After collection, it is dried, winnowed and packed into clean air tight containers for consumption or sale to food processors.

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- **Krell, R. (1996). Value-added products from beekeeping. FAO Agricultural Services Bulletin No.124. ISBN: 92-5-103819-8**

Contacts in Kenya

- **African Beekeepers Limited**

Industrial Area - P.O. Box 3752-00506 - Nairobi Mobile: (254) (0)722 700226
Remarks: It manufactures equipment and markets honey.

- **African Union**

Maendeleo Ya Wanawake House - Nairobi
Remarks: It has an interesting collection of beekeeping books in its library.

- **Apiculture Division - Ministry of Livestock and Fisheries Development, Hill Plaza Building**

P.O. Box 34188?00100 - Nairobi
Telephone: (254) (0)20 2722601/2722637 / Fax: (254) (0)20 2728609
Remarks: Contact for information and advice or get in touch with your local District Beekeeping Officer. There's one in every district.

- **Baraka Agricultural College - P.O. Box 52 - Molo**

Telephone: (254) (0)51 721091/ Email: baraka@sustainableag.org
Website:www.sustainableag.org

Remarks: Contact for bee equipment, advice, training courses, honey, and beeswax marketing

- **General Plastics Limited**

P.O. Box 10032 - Nairobi
Enterprise Road off Mombasa Road - Industrial Area near Hillock Inn
Telephone: (254) (0)20 530032/3/4/5
Remarks: It supplies plastic jars and lids for packing honey.

- **Honey Care Africa Limited**

Muringa Avenue, Jamhuri Park - Nairobi
Telephone: (254) (0)20 574448
Remarks: It promotes Langstroth hives. It also buys and markets honey.

- **ICIPE (International Centre for Insect Physiology and Ecology)**

P.O. Box 30772-00100 - Nairobi
Telephone: (254) (0)20 8632000 / Fax: (254) (0)20 8632001/8632002
Remarks: It has a commercial insect section dealing with beekeeping E-mail: dg@icipe.org

- **Kerio Valley Development Authority**

KVDA Plaza - P.O. Box 2660 - Eldoret
Telephone: (254) (0)53 2063361/ Email: kvda@kenyaweb.com

- **National Beekeeping Station - Apiculture and Emerging Livestock Division**

Ministry of Livestock and Fisheries Development Lenana
P.O. Box 34188-00100 - Nairobi
Telephone: (254) (0)20 564302

Remarks: Check out for its library, bee equipment, and advice.

- **Ruai Beekeeping Cooperative Society**

P.O. Box 8 - Naru Moru
Remarks: This is a great example of collective marketing of bee products in Kenya. It markets up to 8 tonnes of honey per year.

- **Self-Help Development International Kenya**

2nd Floor, Catholic Diocese of Nakuru Building
Stadium Road off Kenyatta Avenue
Telephone: (254) (0)51 2212291
Email: kenya@shdi.org
Remarks: The agency currently promotes beekeeping in the Gilgil area.

- **Strengthening Informal Sector Training and Enterprise (SITE)**

Jabavu Road, Nairobi
Telephone: (254) (0)20 2718155
Remarks: It deals in training and support to beekeeping and bee equipment.

- **The Kenya Beekeepers Association**

c/o The National Beekeeping Station
P.O. Box 34188-00100 - Nairobi

- **The Kenya Honey Council - P.O. Box 271-00606 - Sarit Centre, Nairobi**

Telephone: (254) (0)20 4183120
Email: info@kenyahoneycouncil.org
Website: www.kenyahoneycouncil.org
Remarks: An umbrella body representing different stakeholders in the Kenya

beekeeping sector.

Information of www.infonet-biovision.org

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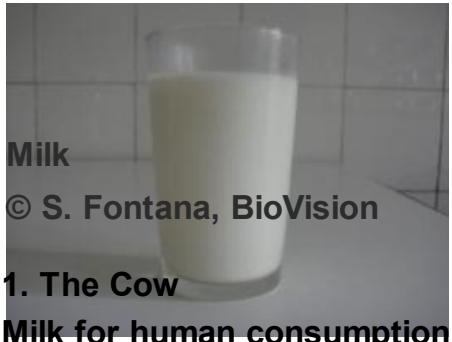
Milk and Dairy products

Milk and Dairy products

Clean milk production

Milk is highly perishable, it easily contract diseases. It has a high protein content making it a suitable medium for bacteria growth. For these reasons clean milk production practices are inevitable. It is advisable that farmers observe the following areas in order to produce



Milk

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clean and quality milk for human consumption.

1. The Cow

Milk for human consumption should be from

- **Cows in good health. That is the cow should be free from zoonotic diseases e.g. Brucellosis and Tuberculosis. Cows should be free from Mastitis**
- **Cows free from drugs. The farmer should always ensure the drug administered to the animal is out of it's system as per the manufacturer's instructions**
- **Feed the cow should be clean free from disease causing organisms. Cows should not be fed on feeds, pastures or weeds that may cause milk tainting (poor smell in milk) this may include feeds with Mexican Marigold, high levels of fish mills or poultry droppings**
- **Restrain to tie the animal, if necessary. Troublesome animals should have their tails tied.**

2. Milk parlour

- **The milk parlour (dairy) should be kept clean. If possible it should have a cement floor for easy cleaning. For large herds it is necessary to have a movable parlour to**

avoid bacterial and micro-organisms build up on the parlour location

- **It should be cleaned after every milking**
- **Should be free from bad smell (odour)**
- **Provides clean water ad-lib for animals to drink**
- **If feeds are to be given during milking provide a feed trough**

3. Milking Utensils

- **Use aluminium or stainless steel utensils**
- **When washing, rinse the excess milk with cold water, then wash hot water plus detergents (soap). Scrub with a good washing material or brush. Rinse with cold water and place them on rack to dry. (The rack should be in on open place where direct sunlight can reach)**
- **Utensils store should be clean and well ventilated**

Using right utensils for

hygienic milk handling

4. The Milker

- **The milker should be healthy and clean. He/she should maintain short nails and hair (for ladies with long hair let them cover it when milking)**
- **Ensure the milker washers his hands with soap (detergents) and warm clean water before milking.**
- **Never smoke during milking time**
- **Milk quickly and completely without interruptions**

5. Milking

- **Clean the udder and wipe with a clean cloth before milking (advisable to have a cloth for each animal if not many).**
- **Check for mastitis with a strip cap.**
- **Milking should be done quickly and efficiently without interruptions in either the cow or milker. Strip all the milk from the udder of the animal to avoid mastitis.**
- **Do not pull the teats but squeeze them. After milking do not forget to apply milking jelly and dip the teats in iodine solution before releasing the animal**
- **Always milk the healthy animals first while those with mastitis and other disease later. (Do not mix clean milk with contaminated milk).**

6. Milk handling

- **Immediately after milking filter the milk through a clean muslin cloth and sieve. The two should be washed thoroughly and dried after every milking period. Move milk into a clean cold room for storage if not sold or transported immediately.**
- **Transport milk in the morning for household consumption should be boiled immediately and returned to the cold storage.**

Milk value addition: butter, cheese, yoghurt

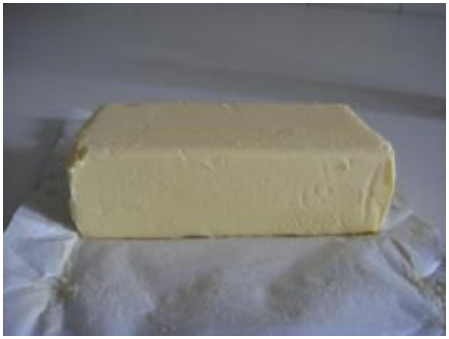
BUTTER

Butter is obtained by separation of the milk and subsequent churning of the cream. It contains a minimum of 80% butterfat. Butter can be made from fresh or sour cream. One litre of cream makes 300 to 400 g butter.

How to make butter

If the cream is fresh:

- **Heat the milk/cream to 80 o to 90°C**
- **Cool it quickly, such as in running water, to 18°C**
- **Ripen by adding 50ml (3 tablespoons) of sour butter milk or starter culture. Stir this into the milk or cream. Cover container and leave for 24 hours at 18? C**



Butter

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If you use milk or cream which is sour naturally, you do not require the ripening process.

Churning:

- **Half fill a churn with sour milk or cream**
- **Churn with regular movement until the pieces of butter are as big as peas and the buttermilk looks watery. Do not let the pieces of butter become one large lump**
- **If there are no pieces of butter after 30 minutes, change the temperature by adding cold or warm water then churn again**
- **For cream do not add more than 25% water**
- **Churning may take 15 to 60 minutes - the time depends on the weather conditions, type of churn, fullness of the churn and fat content of the milk**
- **Carefully remove the pieces of butter from the lid and side with clean cold water. The water with butter will float on top of the butter milk**
- **Pour off the butter milk through a coarse sieve.**

Washing:

- **Wash the butter to remove butter milk. The more butter milk you remove the better the butter**
- **Half fill the churn with clean cold water. Churn for at least 10 minutes**
- **Use a skimmer to remove the pieces of butter floating on the water or wash the butter in a sieve**
- **Sieve the butter and butter milk, put the butter milk on one side, turn the butter over while washing with clean cold water. Do not let the butter become one large lump.**

If you wash your butter carefully, you lower the water content and it gives it a longer

shelf life. Do not over wash: your butter will have less solids-not-fat and a poor smell.

Salting:

- **Salt according to taste - 10g per kg of butter. Leave it overnight.**

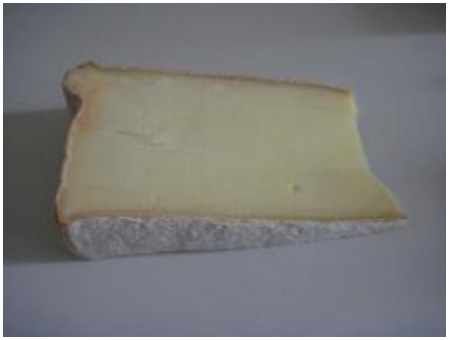
Kneading:

- **Work (knead) the following day to improve the structure and quality**
- **Wash the work table with clean water**
- **Work the butter with a dump wooden spoon or a dump roller until it has a smooth surface and you can see no more drops of water. As you work, remove any water.**

Storage:

- **Store butter in a cool place, in a pot or wrapped in a greaseproof paper or aluminium foil**
- **Sprinkle a little salt on the surface of butter in a pot; this prevents fungus. You can freeze butter but it becomes rancid quickly after defrosting**
- **Divide the butter into many small parts and defrost only what you need**
- **Do not freeze salted butter; it easily becomes fatty or oily and smells fishy**
- **If you keep butter for too long it tastes rancid and develops fungus.**

CHEESE



Cheese is the solid part of milk, also known as curd, obtained by separating it from the liquid part (known as whey) by a chemical reaction. Curds are separated from the whey by adding an acid, bacteria culture and/or starter (rennet). Cheese can be described according to its texture as hard, semi-hard or soft or it can be described according to extent of maturing as fresh or ripened.

Cheese

How to make cheese

There are several recipes to making cheese. Here one of them.

To make cheese you need:

- **Good quality milk:**
  - **with a low bacteria content**
  - **from healthy cows: do not use milk from cows with mastitis or other diseases**
  - **milk which does not contain antibiotics**
  - **do not use colostrum**
- **Clean equipment:**

- **make sure you clean and sterilize your milking utensils**
- **rinse you utensils thoroughly in clean water.**

To make cheese follow these steps:

1. Use fresh whole milk. Reduce the fat content by allowing the milk to stand for about one hour, and then skim off the top layer.

2. Heat the milk to about 85°C to destroy most of the bacteria present and also to increase yield through the precipitation of the whey protein.

3. Dilute lemon juice with an equal quantity of clean water so that the lemon can be distributed uniformly. Add about 30 ml (about 3 tablespoons) of lemon juice per litre of milk. Stir the milk while carefully adding the lemon juice. The curd precipitates almost immediately.

4. Continue stirring for about three minutes after adding the lemon juice.

5. Allow the curd to settle for 15 minutes. Separate the curds from the whey by draining through a sieve or a cloth (use a cotton cloth folded twice).

6. While draining the whey, stir the curd to prevent excess matting (coagulation).

7. Add salt to the curd at the rate of about 4 g (about a level tea spoon) per 100ml of curd and mix thoroughly. The amount of salt may be varied to cater for different consumer tastes and preferences.

8. Transfer the curd to a mould lined with cheese cloth. The mould may be cylindrical

or square shaped and may be made from metal, plastic or wood.

9. Cover the curd by folding over the cheese cloth. Fit a clean wooden board, cut to neatly inside the mould, to enable the curd to be pressed.

10. Press the curd overnight using metal weights placed on top of the wooden shape. Press with twice the weight of the cheese (so, for every 1 kg cheese use 2 kg press). Press for 1 to 2 hours then take the cheese out of the mould.

11. Store the cheese as it is or cut it into suitably sized pieces for sale.

12. Coat the cheese with a thin film of butter to enhance the appearance.

13. Ripen the cheese on clean wooden shelves for at least 4 weeks at a temperature of 12 to 16°C. During the ripening take the cheese off the shelves every three days, put vinegar on a cloth and wipe the cheese. This prevents fungi. The longer you ripen the cheese the stronger the flavour.

FERMENTED CHEESE (MALA)

This is milk that has undergone the fermentation process due to introduction of a specific bacterium either from a commercial culture or from by adding a small amount from a previous batch of fermented milk. The process described below is based on a traditional process.

How to make mala

1. Use good quality milk, i.e. free from antibiotics and preservatives, not adulterated.

2. If making sweetened cultured milk, add sugar at the rate of 20 to 25 kg per 500 litres (40 to 50 g per 1 litre).

3. Heat the milk to 92 to 95°C for 3 to 5 minutes or 85°C for 30 minutes or just bring to the boil.

4. Cool to 22 to 25°C (warm room temperature).

5. Inoculate with a commercial fermented milk culture or mix with a small amount of fermented milk.

6. Incubate at 22 - 25°C (warm room temperate) for 16 to 18 hours.

7. Cool to 20°C (just cool to the touch) in 30 minutes.

8. In case of flavoured cultured milk, add flavour and colour.

9. Stir until smooth.

10. Pack at 20°C.

11. Refrigerate for 10 to 12 hours to help recover thickness lost during stirring.

12. Distribute for consumption and/or sale.

YOGHURT

Yoghurt is a form of fermented milk whereby fermentation is achieved through the introduction of specific "friendly" bacteria into milk under very carefully controlled temperature and environmental conditions. The source of bacteria can be a small amount of plain live yoghurt bought from the shop or one may obtain a commercial starter culture.

How to make plain yoghurt

1. Use about 5 litres of good quality milk, i.e. free from antibiotics and preservatives, not adulterated.

2. Bring the milk to 85°C over a stove and keep it there for two minutes (or just boil for two minutes) to kill any undesirable micro organisms.

3. Pour the milk into a tall, sterile (rinsed with boiling water) container and allow to cool to 43°C (just warm to touch with the back of the hand).

4. Take about half a cup of plain yoghurt (bought from the shop) and warm it slightly, i.e. to the same temperature as the milk.

5. Mix the warmed yoghurt with the milk and cover tightly.

6. Put the mixture in a constantly warm place (e.g. food basket) at 43°C (just warm to the touch) and leave it for six hours.

7. Remove and leave it for about 30 minutes to cool to room temperature.

8. Add flavour and colour if required while stirring gently.

9. Pack into sterile containers.

10. Store in the fridge for 10 to 12 hours.

11. Distribute for consumption and/or sale.

Fruit can be added to plain yoghurt to make a tasty, refreshing and healthy snack.

How to prepare the yogurt culture

- **Boil 50 ml of milk and allow it to cool to room temperature**
- **Take one ampoule of commercial yogurt culture and add to the milk**
- **Keep the milk at a hot room temperature (37°C) for 12 to 16 hours**

To make fruit yogurt (10 x 100ml):

-
- **Take 1 litre of milk and heat a little but do not boil**
- **Add the milk powder and sugar**
- **Stir the above mixture in a food mixer**
- **When dissolved, heat the milk to 85°C (keep milk just below boiling point)**
- **Then allow the milk to cool to room temperature**
- **Add 10 ml of prepared yoghurt culture (see above) and mix gently**
- **Take 100 ml size paper cups and add 25 gm of chopped fruit**

- **Fill cups with milk solution**
- **Keep the cups in an incubator at 42°C for six hours**
- **After 6 hours transfer the cups to the refrigerator and chill for 6 to 8 hours**
- **The fruit yogurt is now ready for sale or consumption**
- **Store at 5°C.**

Marketing of milk

The dairy industry is based mostly on smallholder milk production and informal traders. Generally informal milk outlets absorb most of the milk from smallholder farmers accounting for over 86% of the total milk sold, while formal market handle 14% of all the total milk produced. Brokers, traders/hawkers, transporters, co-operatives and farmer groups are the most important participants at the rural markets. Cooperatives remain the main channel for collecting milk destined to the formal market. Kenya is among the few countries in the region that have recognized the critical role played by the informal players made significant efforts to main streaming them into the national economy. A draft policy, the new Dairy Development Policy is awaiting parliament approval. This policy openly acknowledges the role of informal milk markets in the development of the sector and will help to legitimize small-scale milk traders, subject to them being trained and certified in milk hygiene. Currently there are over 1,500 licensed informal milk traders in the country.

The Kenyan milk market is liberalized and competition in milk processing and marketing has increased significantly in the industry. Over 40 private and dairy co-operative processors have been licensed to process and market milk and milk products. The industry has a processing capacity of 2.5 million litres per day. The Kenya Cooperative Creameries (KCC) is estimated to have a processing capacity of 1.2 million litres of milk per day and the other processors combined have a processing capacity of about 1.3 million litres of milk per day. Production of high value milk products such as milk powder, fermented milk and butter for export is encouraged.

Dairy cooperatives have played an important role in the development of the Kenyan dairy sector as markets have become competitive and farmers have to be efficient in order to access markets for their dairy products. The power of group marketing is seen in the way organized groups can enforce market contracts and measure and monitor quantities and quality of goods and services. The Kenyan dairy cooperatives are a success story and have helped achieve stability in smallholder dairy milk marketing. Cooperatives enable farmers to access subsidized inputs and credit, provide a safety milk outlet during peak production provision of technical support and other services required for milk production. For isolated areas, cooperatives serve the crucial function of bulking and marketing. Due to the alternative market outlets offered by farmer co-operatives, market prices tend to stabilize, production per cow improves and jobs are created.

Export market for dairy products

Kenya has potential to export dairy products, having the largest and well-developed dairy herd in Sub-Saharan Africa. Indeed, Kenya and Sudan are the largest Sub-Saharan Africa dairy producers accounting for 47% of the total cow milk produced, with Kenya having a market share of 24% (CBS 2003). Kenyan exports of milk products have been on the increase from KShs 117.5 million to KShs 140.6 million in 1998 to 2002 respectively, while total value of import has declined from KShs 353 million to KShs 135 million in 1998 to 2002 respectively. Kenyan dairy products are currently being exported to Zambia, Tanzania, Uganda, Democratic Republic of Congo, Rwanda, Burundi and Saudi Arabia among other countries, while the imports are mainly from the European Union and East African Region.

Exports from Kenya enjoy preferential access to world markets under a number of special access and duty reduction programmes. These include regional markets (EAC, COMESA), EU-African-Caribbean-Pacific/Lome Convention and the African Growth & Opportunity Act (AGOA). Kenya is a member of most major international and regional intellectual property conventions ? the World Intellectual Property Organization (WIPO), the African Regional Industrial Property Organization, the Paris Convention on the Protection of Industrial Property, and the Berne Convention on the Protection of Literary and Artistic Works. His creates an enabling environment for growth of dairy sector.

Legal and regulatory framework

The dairy industry in Kenya is supported by an elaborate legal and regulatory framework. The main regulatory body in the dairy industry is the Kenya Dairy Board (KDB) and has the responsibility of developing, promoting and regulating the dairy industry. The Kenya Bureau of Standards is the statutory body charged with enforcement of standards and certification of quality standards of all products and services in the country.

Supporting structures

The dairy industry in Kenya is supported by a well-established dairy cattle breeding programme for the major dairy cattle breeds (Friesian, Ayrshire, Guernsey and Jersey). The breeding programme is underpinned by centralized performance recording spearheaded by the Kenya Stud Book and Dairy Recording Services of K, which operate under the KLBO, which is a farmer organization. Artificial Insemination (AI) plays an important role in development of the dairy sub-sector. The AI services have largely been privatized to provide an opportunity for investment by the private sector. The Central Artificial Insemination (CAIS) is a government corporation that is mandated to process, storage and distribution of semen and plays a crucial role in the progeny testing of dairy bulls in the country.

The Kenyan government has continued to create and provide an enabling environment for investors in the country. There exists a number of guaranteed investor friendly arrangements such as the Export Processing Zones (EPZ) program

which offers attractive incentives to export-oriented investors and EPZ Authority to provide one stop-shop service for facilitation and aftercare. The Investment Promotion Centre (IPC) promotes all other investment in Kenya including in Manufacturing under Bond (MUB) program while the Tax Remission for Export Office (TREO) is a program for intermittent imports for export production. There exists generous investment and capital allowances, bilateral investment and trade agreements.

The Constitution of Kenya provides guarantees against expropriation of private property. In addition, capital repatriation, remittance of dividends and interest are guaranteed to foreign investors under the Foreign Investment Protection Act (FIPA). Kenya as a member of MIGA (Multilateral Investment Guarantee Agency) provides investors with an opportunity to insure their investment in Kenya against a wide range of non-commercial risks. Kenya is also a member of the African Trade Insurance Agency (ATI), a multilateral export credit and political risk agency for COMESA member states as well as the International Council for Settlement of investment Disputes (ICSID).

Information Source Links

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Manure

Manure
Status: under construction

Introduction

Manure is a valuable resource on an organic farm. Livestock are not efficient in

taking nutrients from feed and forage. Normally, 75-90% of major nutrients that are fed to livestock pass directly to the animal into the manure. How good these nutrients can be returned to the soil, depends on the way the manure is stored and handled.

Raw manure is to be treated with caution as it includes threats to both human health and to the environment (e.g. pollution of the water ways). To reduce the risks, organic farmers usually compost manure before applying it.
If using raw manure, note:

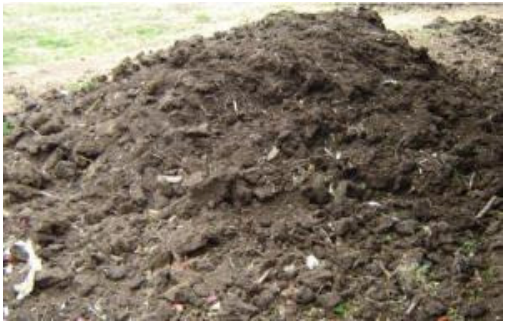
- **if it is to be applied to crops for human consumption, there must be at least four months between application of the raw manure and harvest**
- **if you grow crops that accumulate nitrates, e.g. brassicas, the raw manure must be applied at least four months before these crops are planted.**
- **apply raw manure in moderate amounts**
- **the soil must be warm**
- **the soil must be moist**

The advantages of composting manure are following:

- **More humus. Fully composted manure adds in the long term more humus to the soil than raw or partially composted manure. Humus increases soil fertility and improves soil structure.**
- **Less work. During the composting process, the volume of the fully composted pile is only half the size of the initial pile. This means half as many trips spreading half of the amount of manure, compared to spreading raw manure.**

The role of manure

Biomass turnover is a major factor in crop-livestock systems, because crops and crop residues are meant to feed animals and the manures are used to maintain soil fertility. Although manure can supply other nutrients, it is commonly known that nitrogen (N) is the most important. The efficiency of N utilization and system productivity are influenced by the ratios of availability and losses occurring in the N transformation pathway.



Compost manure, just before application

Interest and efforts towards utilization of manures from livestock to improve soil fertility and crop production have continued since Biblical time. Jesus gave parable whereby a fig tree which failed to produce fruits after applying dung (fertilizer in the new versions) was to be cut down. Ammonium (NH4+) is the most important soil fertility nutrient arising from manure. It is a product of microbial protein degradation in the ruminant gastrointestinal track. The microbes multiply into large numbers

© TP Lanyasunya, Kenya

using ammonia (NH3) in reconstituting their own proteins, with excreted NH4+ being surplus to microbial requirements or spilled from imbalanced anabolic processes. From the animal production point of view, production of NH3 and NH4+ is nutritionally wasteful since they represent waste of dietary protein. Consequently, a livestock farmer utilizing manure will not count manure rich in NH4+ but rather a valuable resource for nitrogen recycling and cost reduction.

Manure: Heaping before spreading

© TP Lanyasunya, Kenya

Supply of nutrients by manure

There can be huge loss (24 - 83 %) of NH4+ as a result of drying manure. This is as a result of NH3 volatilisation. Such losses can be reduced substantially (e.g. to 5%) by

ploughing fresh manure into soil whereby NH4+ can be used directly by plants or converted to nitrate (NO3-), which is another available form. The fact that highest NH4+ is in the fresh manure indicate that fresh faeces are of great potential as source of N. Therefore to maintain high quality in manure, drying and exposure to air should be avoided. In the contrary, it is ironically believed by many farmers, e.g. among communities in Eastern and Southern Africa, that fresh faeces (manure) is harmful to crops by causing 'burning'. As a result, there is low use of fresh faeces on the farms. Such beliefs may relate to the high NH4+ concentration in fresh faeces as evident in the present study. The burning may result from localised high concentrations caused by poor distribution. A great value is liable to be lost if fresh manure is not appropriately conserved and applied.

Manure spreading in pasture field

Continuous direct application of freshly produced manure (faeces) may only be of practical value to perennial crops. In the case of seasonal crops, it would be recommendable to bulk the manures in heaps to minimise ammonia volatilization, while at the same time allowing decomposition to continue. The manure can then later be collected from the heaps and strategically applied. Application can be done by incorporating manure into the soil during seed bed preparation (ploughing), at planting or during weeding.

 In manure use, precaution need to be undertaken to avoid burning of crops due to high concentration of ammonium. Uniformity of spreading and correct rate of nutrients supply to the crops are crucial considerations in order to prevent the burning. For these reasons, it is recommendable that in routine applications, the manure being used should be analysed for nutrient content, particularly total nitrogen (N), ammonium-N, phosphate (P_2O_5) and potash (K_2O).

The crops requirements should be matched with the nutrient supply from the manures and soil. Availability of affordable analytical services is therefore necessary to support correct use of manures. Proper sampling is crucial for accurate analysis, and this will require that several sub-samples are collected and mixed to make up the samples submitted for analyses. The samples for analysis should be kept carefully to avoid biased results i.e. if losses occur in the process.

An example of a management system where fresh manure is efficiently utilized is in Sahel regions of West Africa. In this system, manure is directly deposited onto the land intended for cropping by grazing animals. This done through arrangements, which can be contractual in nature (Powell et al., 2003). Besides maximising nitrogen supply, this management system also has the advantages of storage and labour savings. Powell et al. (2003) suggested that another strategy to minimise nitrogen losses is to maintain a vigorous biological community (e.g., beetles, earthworms, chickens, turkeys) that can chop, bury, and decompose the manure so that it is quickly fixed into forms that are not easily leached or volatilized. Another important

factor to consider when planning direct manure deposit is irregular distribution. Inevitably, more manure is deposited near watering, feeding, and bedding areas.

Pig manure

Pig urine and dung are good fertilisers for the land, so it is wise to make good use of them. After sweeping and cleaning the pens, the solid manure can be spread on the land directly. The wet, run-off manure and urine can be led through furrows (channels) into a collecting pond. With time the water will seep into the ground and the solid manure will build up. As the pond fills up with solid manure, you can remove the manure and put it on land. Before using the dung, it is best to let it decompose. Do so by putting it in a heap (pile) and under a shade. Keep the pile moist and turn it occasionally for it to increase compost quality.
Compost can be made by adding soil, grass cuttings, leaves, etc which can be used as fertiliser on cultivated lands or can be sold for an extra income.
The manure plays an important role in increasing soil fertility especially in improving the organic content in the soil. Only about 1/3 of the nitrogen in dung will be available to the plant. Pig dung has about 23% DM and 16% organic matter.

Production of pig dung

Fatteners (20 -100kgs) can produce 2- 4kg; breeding pigs can produce 5-8 kg of

mixed manure (dung and liquid) per day. On a 20-sow pig farm up to 300 tons of composted manure can be produced every year. The amount produced will however depend on type of feed, amount of drinking water, wastewater, beddings (litter) provided.
Application: 20-40 tons/ha/year for crop land and 10-20 tons /ha/year for grazing land. Usually just before the rains or during the rainy season.

Combined with on-farm fish culture

Pig keeping can be combined with on-farm fish culture. Pig manure can be used to fertilise the fishpond. The manure, or some (not too much) of the rich run-off from the pens, will stimulate the growth of any natural fish food and water plants. The plant *Ipomoea reptans* growing on the surface of the water grows for instance more rapidly and provide excellent green fodder for pigs. Pig manure in the pond increases the food available for the fish that in turn grow faster.

For more information on fish farming click here

Pig house with fish

pond
© Stephen Gikonyo, Kenya

Goat manure

Manure

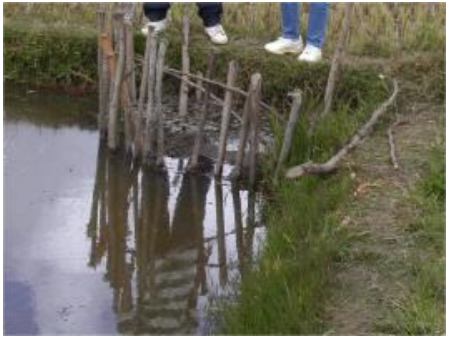
Goat manure is a useful product with commercial value and is used in many parts of East Africa. The manure has a higher content of nitrogen and phosphoric acid than that of cows. The urine is rich in nitrogen and potassium. The manure is an excellent fertilizer and has the potential to increase crop yields.

Compost

A very efficient method of making compost is to stack the manure in a neat square pile (manure from other livestock can be added to make an even more valuable by product, i.e., cow, sheep, donkey, chicken and camel dung). Where possible the pile should be kept moist by watering. After two weeks the whole pile should be turned over and left to mature. Whilst this pile is maturing a second pile can be started. In this way the farmer has a continuous supply of compost for his farm or for sale.

Manure and fish production

Animal manure is widely used in Kenya in fish production in earthen ponds in. The quality of manure as a fertilizer varies depending on the source animal and the quality of feed fed to the animal. Pig, chicken and duck manures increase fish production more than cow and sheep manure. Animals fed high quality feeds (grains) produce manure that is better as a fertilizer than those fed diets high in crude fibre. Fine manures provide more surface area for the growth of microorganisms and produce better results than large clumps of manure.
Manure should be distributed evenly over the pond surface area. Accumulations of manure on the pond bottom produce low oxygen conditions (during decomposition) in the sediment resulting to reduced microbial activity and sometimes result in the sudden release of toxic chemicals into the water.



Manure crib

Methods of applying Manure

- **Crib method: A compost crib constructed using wooden sticks at one or more sides of the pond. It helps fertilize the water gradually. The manure in the crib requires frequent turning to facilitate the release of nutrients.**
- **Bag method: A bag is filled with manure and tied to the corner of the pond. The bag is shaken weekly or daily to release nutrients.**

Manure application rates for ponds
Manure application rates depend on the size of the pond, which is expressed as surface area of the water in the pond. The recommended rate is 50g of dry matter per m2 per week i.e. 5Kg/100m2/week.

The maximum rate depends on the quality of the manure, the oxygen supply in the pond and water temperature. If early morning dissolved oxygen (DO) is less than 2 ppm, manuring should be reduced or stopped until DO increases. When water temperatures are less than 18° C, manure application should be discontinued. At low temperatures the rate of decomposition decreases and manure may accumulate on the pond bottom. A subsequent increase in temperature could then result in oxygen depletion.

Agricultural Lime

- **Used to improve soil quality, which helps the organic and chemical fertilizers to work better. It also helps to clear up muddy water.**
- **In red soils; about 20kg per 100m2 can be applied. Black cotton soils may require a little more.**

Some characteristics of farm manure:

- **Contains trace minerals and vitamins.**
- **Uses oxygen to decompose.**
- **Is highly variable in composition depending on feeds given to the animals and bedding used**
- **Can help reduce turbidity due to clay silt in the ponds**
- **Can help reduce seepage in ponds**
- **Some of the ingredients can be consumed directly by the fish**

Integrated systems

Manure application can be made easy by placing animal production units adjacent to or over the fish ponds so that fresh manure can easily be delivered to the pond on a continuous basis. This also allows the feed wasted by the animals to fall into the fish pond and utelised by the fish. Effective and safe manure loading rates are maintained

by having the correct number of animals per pond surface area.

Chicken/fish farming Maximum tilapia yields are obtained from the manure output of 5,000 to 5,500 chickens/ha, which deliver 100 to 113 Kg (dry weight) of manure/ ha/day. Several crops of chickens can be produced in one fish production cycle.

Duck/fish farming
Ducks are grown on ponds at a density of 750 to 1500/ha. The ducks are raised in confinement, fed intensively, and allowed a small portion of the pond where they forage for natural foods and deposit their manure. Ducks reach marketable size in 10 to 11 weeks and therefore staggering production cycles is needed to stabilize manure output.

Pig house with fish pond

© Stephen Gikonyo, Kenya

Pig/fish farming
Approximately 60 to 70 pigs/ha are required to produce a suitable quantity of manure (90 to 100 pounds of dry matter/acre/day) for tilapia production. The pigs are usually grown from 44 to 220 pounds over a 6-month period. In certain cultures and religion, where pigs are considered unclean, used of pig manure might reduce the marketability of the fish.

Harvesting

Fish produced for consumption should be harvested when they reach market size. In Kenya, tilapia are ready for harvesting within six to nine months depending on the size at stocking, target harvest size, water temperature and level of management employed. The time of harvesting is determined through regular sampling which should be done monthly. A day or two before harvesting, feeding and fertilizer application should be stopped. During harvesting:

- **Fish should be checked for off flavors**
- **Fish should be harvested during cool weather**
- **Harvesting and transportation equipment should be set up well in advance to ensure reduced stress and minimal fish mortality.**

Tilapias are best harvested by seining for partial harvesting and complete drainage for complete harvesting. Once harvested, fish should be handled with care and transported to the market while still fresh.

Growth and yields

Under proper management and optimal conditions, 1-gram fish are cultured in nursery ponds to 20 to 40 grams in 5 to 8 weeks and then stocked into grow-out

ponds. In mono-sex, males can reach 200+ grams in 4 to 5 months, 400 + grams in 5 to 6 months, and 500+ grams in 8 to 9 months.
Dress-out percentage on tilapia is low compared to species such as trout and catfish. Tilapias have a dress-out of 51 to 53 percent of live weight for whole-dressed fish (head-off) and 32 to 35 percent for fillets.

Chicken manure

Litter in the poultry house should be kept dry and removed regularly to reduce the load of parasite. Chicken manure contains the highest amount of Nitrogen of any livestock manure. It is therefore very valuable as fertilizer, but if applied fresh to crops can also burn these crops. The best way of utilizing chicken manure is to compost it along with any plant material found around the farm.

Poultry manure

© Ann Wachira, KARI, Kenya

Uses of litter

- **As fertilizer for crop production**

- **Compost improvement**
- **Feed in fish ponds**
- **Biogas production**

Average composition of Chicken manure

	Fresh Manure	Litter manure
Dry matter %	20-22	50
Nitrogen	1-1.5	1-2
Phosphorus	1-2	2
Potassium	0.7	1
Calcium	2.2	3

Quantify manure yield

Chicken manure can be used in fish ponds. The manure is partly eaten by the fish while the rest is used by plants to grow and then eaten by fish.
Dried poultry manure maybe used to feed ruminants (cattle and goats) in combination with grains and molasses.
A biogas digester can be used to make gas from the manure.
The slurry left over may also be used as fertilizer for use in crops or fish ponds.

- **100 layers will produce about 3 tons of manure during a 448 day period (from**

chicks to end of first laying period

- **1000 broilers will produce about 1.1 tons of manure in 42 days**

Information Source Links

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- **Wallace, J. (Ed)(2001). Organic Field Crop Handbook. Canadian Organic Growers Inc. ISBN 0-9695851-3-6.**

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Leather production

Images

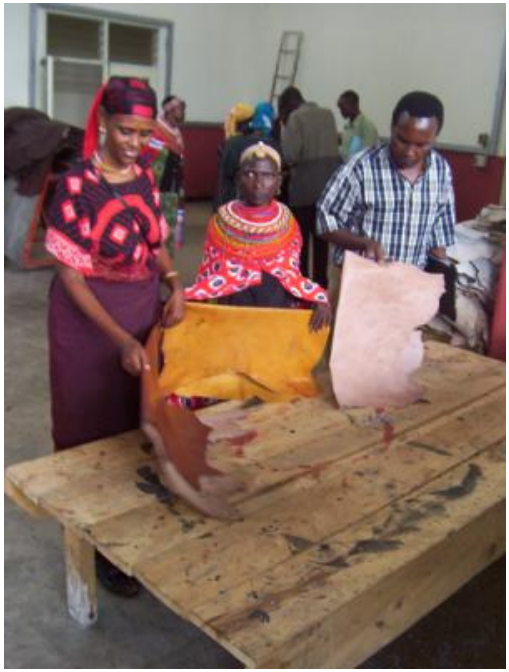
Leather production 5. Course for women learning about leather preparation at KIRDI, Nairobi.

Anne Bruntse

Skin preparation, defleshing

Anne Bruntse

Leather production 1. Course for women learning about leather preparation at KIRDI, Nairobi.



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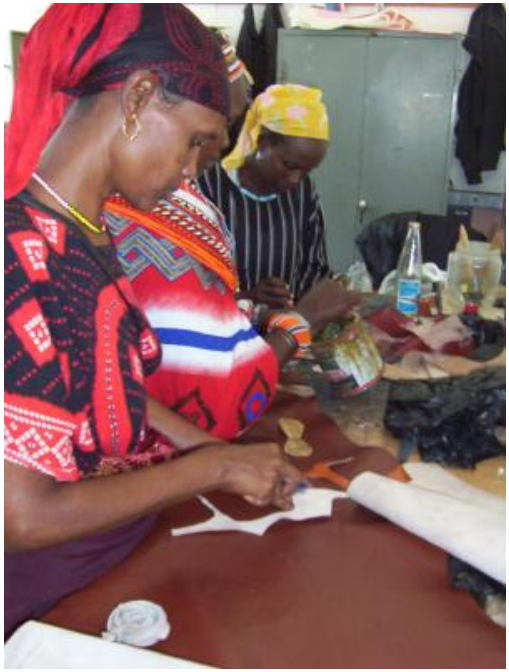

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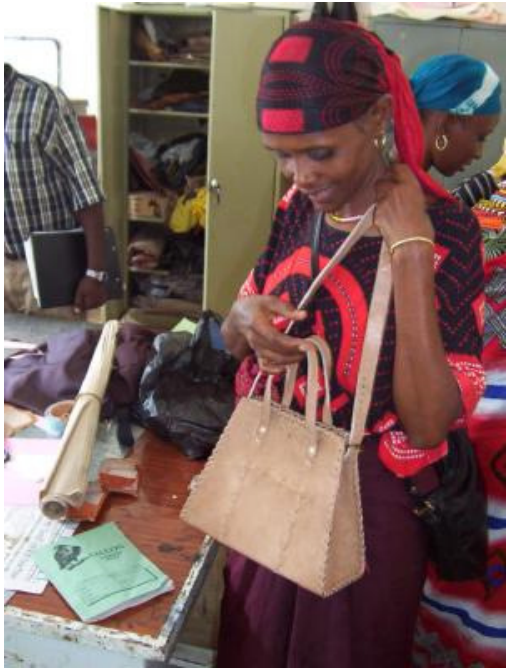

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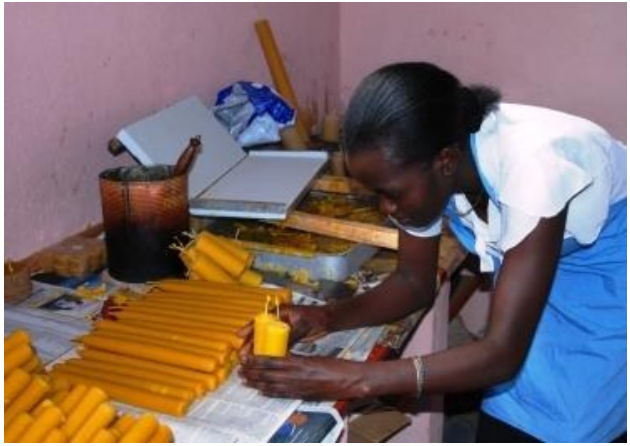
Bee products

Images



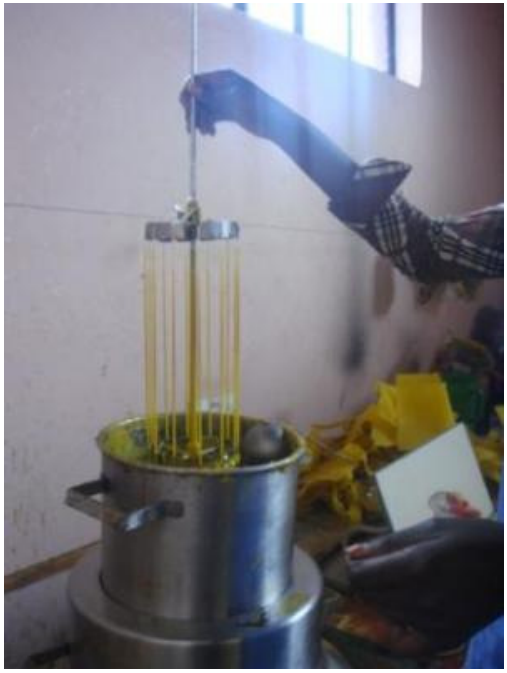
Cabesi Market Place, Makutano

V. Albertin, BioVision

Tool to make multiple hand-pulled candles

S. Fontana, BioVision

Making hand-pulled candles



S. Fontana, BioVision

Making candles

S. Fontana, Biovision

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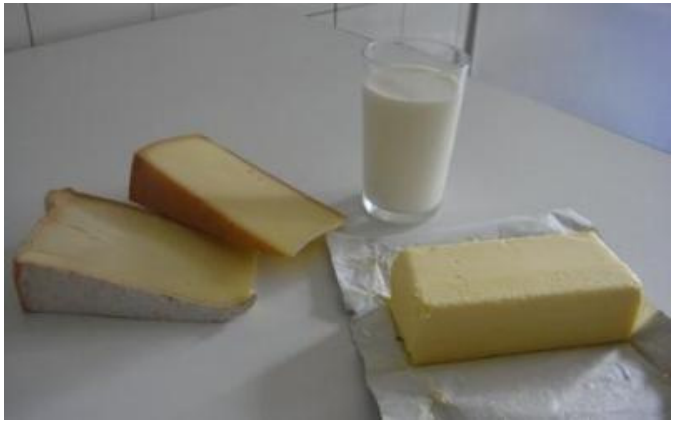
Milk and Dairy products

Images

Dairy products



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Manure

Images

Poultry manure

Ann Wachira, KARI, Kenya

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Products




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