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ENT-604 **Apiculture** **3(2-1)**

Syllabus For Final Term Examination

Chapter 3 Bee forage and floral calendars

Contents - Previous - Next

Honey and most other hive products do not originate directly with honeybees: they are natural products which the bees have collected and processed.

The bees visit flowering plants to obtain nectar, which is the source of honey, as well as pollen. As was seen in Chapter 2, many plant species possess, inside their flowers near the base of the petals, glands called nectaries, which secrete nectar. (Some plants have nectaries unconnected with their flowers, called extrafloral nectaries.) It should be recalled, however, that not all plant species have nectaries that secrete enough nectar to attract bees.

The concentration of sugar in nectar depends on several factors: the plant species and variety, the soil type, the time of day of collection, the temperature and relative humidity, etc. As a rule, plants with a higher sugar concentration in their nectar are more attractive to bees than those with weaker nectars, because in the process of making honey the bees are obliged to get rid of excess water in the nectar, so that in treating more highly concentrated nectars, they need to expend less time and energy.

When the excess water has been evaporated from the nectar and the enzymatic reactions in the conversion of nectar to honey have been completed, the honey is ready for storage, to serve as the bees' reserve of carbohydrates to cover the colony's energy requirements. In the broad sense, then, honey is the colony's energy reserve, all or part of which will be expended in the process of foraging.

From the standpoint of the beekeeper, a colony is "productive" when it stores a surplus of honey, i.e. when it can collect and convert into honey more nectar than it consumes. The beekeeper harvests all or most of this "surplus" honey. In some beekeeping systems, he may have to provide the bees with sugar syrup to replace the honey harvested, particularly at times when the colony requires additional food.

In both stationary and migratory beekeeping, the beekeeper seeks to place his colonies in or near areas where a sufficient quantity of honey plants - be they crop or pasture plants, weeds, shrubs, forest trees, roadside planting, etc. exists, in season or throughout the year, within the economical flight range of the foragers. Planting special crops for bees is not likely to yield a good economic return: arable land will provide better returns if it is used for other agricultural purposes. Beekeeping is thus one of the rare forms of agriculture in which the planting of crops is not specifically required.

A. Honey plants and pollen plants

In order to survive, prosper and be productive, honeybee colonies, as has already been observed, must have a supply of both nectar and pollen in adequate quantities. Not all plant species are equally good for beekeeping. Some supply both nectar and pollen abundantly when in bloom, and these are often called honey plants, because

they are best suited for honey production. Plants producing nectar but little or no pollen are also considered to be honey plants. Other plants, however, may yield pollen but little or no nectar. These pollen plants are also important in beekeeping, especially at the time of colony build-up, when the bees need large amounts of the protein contained in pollen for their brood-rearing.

Ideally, a good beekeeping area is one in which honey and pollen plants grow abundantly and with a relatively long blooming season. Such areas are however not always available or easy to find. The beekeeper therefore combines his skill in colony management with migratory practices in order to provide his bees with good, productive foraging environments. He must know the time and duration of the blossoming season of every major honey plant, including the environmental factors affecting them, and make a reasonable assessment of the supporting capacity of each area, i.e. the number of colonies that can be put to productive work there.

Since the practice of modern beekeeping is relatively new in Asia, the compilation of economic bee forages and the identification of areas suitable for beekeeping are still far from complete. Asian beekeepers may find useful information in many internationally-published books, pamphlets and technical articles which contain lists of honey and pollen plants, some of which may already be abundant in parts of Asia, waiting to be exploited by beekeepers. A list of some commonly-known honey plants recorded in some Asian countries appears in Table 2/1.

Table 2/1. Some Important Asian Bee Forage Plants

Species	**Family**	**Common Name**
Aesculus turbinata	Hippocastanaceae	Japanese horse-chestnut
Astracalus sinicus	Leguminosae	Chinese milk vetch
Bombax ceira	Bombaceae	silk-cotton tree
Brassica campestris	Cruciferae	rape
Brassica spp.	Cruciferae	mustard
Calliandra calothyrsus	Leguminosse	calliandra
Castanea pubinervis	Fagaceae	sweet chestnut
Ceiba pentandra	Bombaceae	kapok
Cirsium spp.	Compositae	thistle
Citrus spp.	Rutaceae	orange, pomelo
Clethra barbinervis	Clethraceae	
Cocos nucifera	Palmae	coconut
Croton spp.	Euphobiaceae	
Cucumis spp.	Cucurbitaceae	cucumber, melon
Cucurbita moschata	Cucurbitaceae	pumpkin
Diospyros kaki	Ebenaceae	persimmon
Eriobotrya japonica	Rosaceae	loquat
Eucalyptus spp.	Myrtaceae	eucalyptus
Eupatorium odoratum	Compositae	snakeroot

Euphoria longan	Sapindaceae	longan, lam yai
Fagopyrum esculentum	Polygonaceae	buckwheat
Gossypium spp.	Malvaceae	cotton
Helianthus annulus	Compositae	sunflower
Hevea brasiliensis	Euphobiaceae	rubber
Ilex pedunculosa	Aquifoliaceae	gallberry
Ilex rotunda	Aquifoliaceae	
Lespedeza spp.	Leguminosae	bush clover
Ligustrum japonicum	Oleaceae	privet
Litchi chinensis	Sapindaceae	litchi
Malus pumice	Rosaceae	apple
Medicago sativa	Leguminosae	lucerne, alfalfa
Melilotus alba	Leguminosae	sweet clover
Prosopis cineraria	Leguminosae	mesquite
Prunus spp.	Rosaceae	cherry, apricot, peach
Pyrus pyrifolia	Rosaceae	pear
Rhus spp.	Anacardiaceae	sumac
Robinia pseudoacacia	Leguminosae	black locust
Salix spp.	Salicaceae	willows
Sesamum indicum	Pedaliaceae	sesame
Styrax japonica	Styracaceae	snowball
Tilia japonica	Tiliaceae	linden, lime
Tilia maximowicziana	Tiliaceae	linden, lime
Tithonia tagetifolia	Compositae	Mexican sunflower
Trifolium pretense	Leguminosae	red clover
Trifolium repens	Leguminosae	white clover
Tridax procumbens	Compositae	
Ziryphus jujuba	Rhamnaceae	Chinese jujube

B. Floral calendars

A floral calendar for beekeeping is a time-table that indicates to the beekeeper the approximate date and duration of the blossoming periods of the important honey and pollen plants in his area. The experienced beekeeper will have acquired much of this information over the years, but published charts are also available for many areas.

The floral calendar is one of the most useful tools of the apicultural extension worker. It enables him to inform

the beekeepers on what to expect in bee-forage availability, and when, so that they can manage their colonies in the most rational manner. Beekeeping in any specific area cannot develop without an understanding of the calendar, and for migratory beekeeping, special calendars for the different foraging zones along the migration route are required.

Assembling a floral calendar for any specific area is simple but time-consuming. It requires complete observation of the seasonal changes in the vegetation patterns and/or agroecosystems of the area, the foraging behaviour of the bees, and the manner in which the honeybee colonies interact with their floral environment. The accuracy of a floral calendar, and hence its practical value, depend solely on the careful recording of the beginning and end of the flowering season of the plants and how they affect the bees. The preparation of an accurate, detailed calendar will therefore often require several years of repeated recording and refinement of the information obtained.
The steps normally taken in building up a floral calendar are as follows:

1. The beekeeper makes a general survey of the area, drawing up a list of flowering plants found, special attention being paid to plants with a high floral population density per unit area or per tree.
2. He places several strong honeybee colonies in the area, inspecting the hives regularly and observing changes in the amount of food stored within the hive to determine whether it is depleted, stable or increasing. Any food gains or losses can be monitored accurately by weighing the hives.

Fig. 3/1. Floral calendar, in the form of a circular chart, indicating the periods of availability of major nectar and pollen sources in northern Thailand

3. At the same time that he monitors the hives' food stores he surveys areas in the vicinity of the apiary and within the flight range of the bees, to record the species of plants that the bees visit.
4. He determines whether the plants are visited for nectar or for pollen. Pollen-foragers will have pollen pellets attached to their hind legs. To determine whether the bees visit flowers for nectar the observer squeezes the abdomen of individual bees to obtain a drop of regurgitated nectar, tasting it for sweetness or measuring the nectar concentration with a hand refractometer.
5. He studies the frequency with which the bees visit each flower species, in relation to changes in the level of the colonies' food stores. If there is a continuous increase in food stores, in direct response to the availability of the plants visited, the plants are good forage sources. When the food stores remain stable, the plants can be depended upon to meet the colonies' daily food requirements, but they cannot be classified as major honey sources.
6. He carefully records all the changes in the blossoming of the plants visited. When the colonies begin to lose weight, the flowering season is finished for all practical purposes.

Once all the data on forage species have been assembled and repeatedly verified, they should be judged as they relate to the actual performance of the honeybee colonies. The calendar can then be drawn up in the form of circular or linear charts, showing the weekly or monthly availability of each plant and their flowering sequence.

C. Assessment of areas for beekeeping

Productive beekeeping depends on good colony management and good beekeeping areas, and in order to promote it as a profitable agricultural occupation, areas with a good potential for beekeeping must be located and evaluated. Asia is rich in places inhabited by feral swarms of native honeybees, and this fact often inspires premature judgements to the effect that beekeeping can be promoted almost anywhere in the continent where native bees are found. The truth, however, is that most feral colonies of Asian honeybees adopt a migratory strategy, moving with the seasons and the availability of forage. Thus, the temporary presence of a few feral swarms of honeybees here and there, for short periods, does not necessarily indicate that there is enough forage in the area to support year-round commercial beekeeping.

As in the assembling of floral calendars, weighing the hive is one of the most accurate ways of assessing the suitability and supporting capacity of an area. One major problem in this respect is how to select sites for assessment. The following guidelines for the exploration and evaluation of potential beekeeping areas may be found useful:

1. Referring to lists of known major honey plants in other countries or regions with similar vegetation patterns, agro-ecosystems, climate and edaphic conditions, determine whether similar plants are to be found in the area under study.

2. The seasonal occurrence, in unusally high numbers, of feral nests of native honeybees can often indicate that there is ample forage in the area, at least during the period in question.

3. The mere presence of flowering trees and shrubs in limited numbers, or of a few hectares of land covered with good honey plants preferred by bees, does not necessarily indicate that the area has potential for commercial beekeeping.

4. Practical, large-scale beekeeping operations call for large areas, usually hundreds or thousands of hectares of nearby land bearing good forage with high population densities. Good honey plants are characterized by relatively long blossoming periods, generally in terms of several weeks or months; high density of nectar-secreting flowers per plant or unit area; good nectar quality with high sugar concentrations; and good accessibility of the nectaries to the bees. The foraging land should be well proportioned, in terms of length and width, so as to promote foraging efficiency.

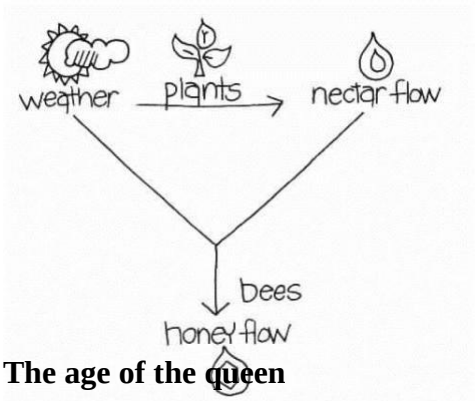
5. The supporting capacity of an area for honey production is best determined by monitoring weight changes in the bee colonies. Among other factors that affect the economic value of an area for beekeeping are average hive yields, prevailing honey prices in the area, as well as costs of colony-management inputs.

6. The fact that a flower is brightly coloured or that it has a strong scent does not always indicate that it is good for bees, unless the fact is confirmed by the criteria set out above.

7. The large-scale planting of honeybee forages has never been proved to be a profitable approach in terms of net economic return, except in integration with other agricultural activities, such as reafforestation, roadside plantings, animal pasture, etc.

Factors that affect honey flow

Honey flow is a term used by beekeepers indicating that one or more major nectar sources are in bloom and the weather is favourable for bees to fly and collect the nectar in abundance.



This has remained a question to many farmers as to why they harvest more honey in some seasons and less honey in other seasons. There are a lot of factors that can affect the size of your honey yield. Here are a few to concern yourself with;

The age of the queen

The queen is the mother of all the bees in the hive. When the queen becomes old she does not lay as many eggs and she becomes lazy. Field activities and nectar collection are strong with a good laying queen. If the queen fails to do this because of her age then the colony starts failing as the number of workers reduce. This means that there will be little nectar collected from the trees to make honey. **What to do:** Carry out re-queening by replacing the old aging queen with a young productive one. (See infosheet on re-queening.)

Nature of the environment where the apiary is located

A well selected apiary will enable bees to work and produce better honey yields.

A good location with ample nectar source is ideal. Good nectar source is a flowering plant that will bloom throughout the year like calliandra *(Calliandra Calonthursus)*, Acacia species or bottlebrush.

Hives that are well shaded also help a productive colony produce the expected honey quantities. When the apiary is too hot from direct sunlight it disorganises the activities of the bees or when the apiary is too cool or over shaded it is not the right temperature to ripen the nectar into honey and bees will spend a lot of time regulating internal temperatures thus limiting foraging activities.

What to do: Planting more flowering trees and plants around the apiary helps increase the nectar source readily available to the bees. Take care when siting your beehives and get advice from professionals or experienced beekeepers.

Time of harvesting

Honey should be harvested when it is mature and capped by the bees. If it is harvested too early the honey will be watery and not good quality. The best thing is to wait until the end of the blooming period when flowers are drying up. You may gauge when a hive is ready to harvest by getting a strong scent of honey from the hive. You can also lift it to feel the heavy weight from honey in the hive.

When you delay to harvest in time, bees eat the honey and you will find nothing when you harvest.

What to do: Always be aware what your bees are doing throughout the year and carry out colony inspection regularly.

Extended rainy and dry seasons

When the rains go for extended periods of time honey stores are filled with pollen and brood. The bees stop working on honey production and they focus on colony expansion. It can lead the queen to start laying in the honey combs also reducing the space for honey storage. While an extended dry spell take bees to shortage of forage and the only food for the bees is honey. They will eat the honey stores and at the time of harvesting there will be nothing left.

HONEY COLLECTION AND EXTRACTION

by D. Askquith-Ellis N.D.B.

If, when you visit the bees to collect the honey, some of the honey is uncapped test for 'ripeness' by shaking the comb. If honey shakes out it is not ready and the frame should be given back to the bees to ripen. If it is extracted with the rest of the honey it may cause fermentation and the loss of all your honey. When the supers are full of capped honey they are ready for extraction but before you can bring them home you must remove the bees from them.

Removing the Bees

This can be done in a number of ways

- Using a bee escape of some sort - Porter, Canadian etc.
- Using a 'fume' board' to drive the bees down into the brood nest
- Brushing the bees from each individual comb
- Using a mechanical blower to blow the bees out of the supers.

BEE ESCAPES

The principle of these is to allow the bees to exit the super but not allow them to return. The board containing the escape is placed below the super/s to be cleared (no more than 2 at a time) and the supers closely covered with a crown board (without holes) or a cloth. It is most important to make sure the supers and covering are bee tight. There is nothing the bees like better than to steal back the honey you think you are stealing from them!

Leave the hive for 24 hrs (12 in the case of a Canadian bee escape board) and when you return,there will (hopefully) only be a very few bees in the supers. In some instances the bees will not leave the super. This is usually caused by

a) the bee escape being blocked b) the bee escape allowing two way passage of the bees c) there being not enough room for the bees below the bee escape d) the queen having got into the supers and eggs and grubs are present. or e) the bees are getting access from the outside through a small gap!

Check all these and correct as necessary.

Remove the 'bee free' supers to your house or your car in the event of the bees being in an out- apiary, ensuring the doors and windows are all closed!

FUME BOARDS

Fume boards use a chemical which drives the bees away from the board and thus out of the super. Two chemicals are in common use, Benzaldehyde and Butric anhydride (BE-GO). Benzaldehyde is oil of bitter almonds and used carefully is quite safe but it may cause some irritation to the skin of some people. Butric anhydride is also safe but the smell is quite objectionable to some people.

A fume board is made to the dimensions of the hive top with 4" deep sides, a piece of absorbent cloth (or sacking) is pinned to the underside. This cloth is lightly doused with the chosen chemical. the crown board is removed from the hive, the bees are smoked moderately and the fume board is placed on top. The smoke makes the bees start to retreat from the supers and the fumes finish the process. It is very quick and effective and requires only one visit to an out apiary.

BRUSHING THE BEES ***(editor: not a first choice… harms the bees, makes them mad, etc.)***

Take to the apiary an empty super, a crown board to keep it off the ground, and a cloth to cover it. Place the crown board on the ground beside the hive, the empty super on it and cover with the cloth. Remove the roof and crown board from the hive and smoke the bees. Remove one frame at a time from the supers, brush the bees from it onto the ground in front of the entrance, place the bee free frame into the waiting super and cover. Repeat until you have cleared all the frames, using the newly emptied super for the next box of cleared frames.

MECHANICAL BLOWER

This machine blows the bees out of the super. The supers to be cleared are first removed from the hive and the roof replaced. The supers are placed one at a time on the roof with the top bars facing the back of the hive. The blower is directed from behind the hive blowing a stiff blast through the frames. The bees will be blown to the ground in front of the hive.

Extracting The Honey

There are two main types of extractors - the tangential and the radial. Each holds a varying number of frames and extracts by centrifugal force. The difference lies in the way the frames are held within the unit.

In the radial extractor the frames are held like the spokes of a wheel on the radii of the rotor. The top bar of the frame is furthest away from the centre to take advantage of the slope of the honey cells. Honey flows from both sides of the comb at the same time.

The tangential extractor holds the frames at right angles to the radii and the honey is extracted from only one side at a time. Some of these extractors have a

double sided cage and this swings through 90 degrees if the direction of the motor is reversed. Others (more commonly) are non-reversing and the frames have to be turned by hand. Extract half the honey from the first side, turn and extract all the honey from the second side, turn again and fully extract the first side. This is to prevent the combs disintegrating under the pressure of centrifugal force.

Always load extractors evenly and remember that pollen and set honey do not come out and may cause the extractor to swing about over the floor.

If you are going to sell even a small amount of your honey you must use a stainless steel or food grade polythene extractor. There are many old tin extractors on the market but my personal view is to leave them well alone. Hire the association extractor until you can afford to buy a 'proper' one! This will also give you the experience of at least one sort of extractor which will enable you to make a more knowledgeable choice when you do buy.

and try their extractor; for a very small amount of honey (editor: Better yet: find a mentor and ask to extract your honey when the mentor is doing their extracting – remember, cleanup is a chore!)

The Extracting Room

Honey is incredibly sticky and gets into the most inaccessible place -when choosing a room in which to extract remember this!! For newcomers, the kitchen is the most popular place to extract honey, it has a sink and water supply and hopefully a washable floor (if not put polythene over it). Put a layer of newspaper over the floor and keep plenty handy to cover the spills as they occur.

You will need a knife or special de-capping fork to de-cap the honey and a container m which to catch the cappings and drippings of honey.The knife can be a serrated kitchen knife or a heated knife especially for de-capping. The container should be big enough to catch the cappings without them dropping on the floor and ideally a strainer is in place within it to allow some of the honey to drain from the cappings. A bridge, into the centre of which a nail is driven, is placed over the container and the frame is balanced on the nail whilst de-capping. This allows the frame to be turned easily. -

Cut the cappings from the honey as close to the surface as possible leaning the comb to one side to allow the cappings to fall away from the frame. Place the de-capped frame- into the extractor and continue until it is full. Extract slowly at first and build up speed as the frames empty of honey. Continue in this way until the job is finished.

After extracting the spring flow replace the supers on the hives for the bees to clean and refill. Having extracted the summer flow the supers must be stored for next year. There are two things you can do with these 'wet' supers - that is the supers containing the newly extracted comb. Either replace them on the hives for

the bees to clean up then store in a shed, outside, or on the hives over the crown board ensuring mice cannot get access to them, or store them 'wet' in a bee and mouse proof place. It is said that putting wet supers on the hives in spring encourages the bees to enter them, the down side is that the honey left in them may ferment and smell nasty.

The Honey

Honey should if possible be strained directly from the extractor but if it has started to granulate in the comb it will not go through a fine strainer. In this situation it may be either warmed immediately, strained and stored in buckets or it may be run straight into buckets. In this case, before it is bottled it must be warmed until it becomes liquid, and strained. Of course for your own use you do not have to strain it at all.

Honey that is bottled immediately it has been extracted may set very hard in the jar and be difficult to remove. To avoid this first store it in honey buckets and when it is required warm it gently until it is runny enough to bottle.

It is easy to build a warming box for your honey and it may be warmed by two 40 watt platform to place the honey buckets, under which can be set the light bulbs.

To warm crystallized honey to the point of being able to bottle it, place the buckets in the warming cabinet at a temperature of 90-105 °F for 2 to 4 days. When stirred this will be at a good consistency for bottling and not set hard again (probably). To reduce honey to a clear liquid increase the temperature to no more than 120 °F for 2 days. This will take some experimenting with since larger containers take longer than smaller ones. Do be careful not to over heat honey or it tastes like toffee!

To bottle honey you do need a HONEY GATE set into the side of a bucket at its lower edge. It is no fun to try pouring honey into jars or ladling it with a soup ladle!!

Crystallization of Honey

Khalil Hamdan
Apeldoorn, the Netherlands

Honey crystallization or granulation is a natural phenomenon by which honey turns from liquid (runny) state to a semi-solid state. Beekeepers refer to this as set honey.

Naturally Crystallized honey
Photo source: Draperbee.com

Crystallization of honey is little understood by the consuming public. Many assume that honey appears crystallized to be an adulterated or unnatural product. That is not so. Actually, crystallization process is natural and spontaneous. Most pure raw or unheated honey has a natural tendency to crystallize over time. Crystallization does not affect the honey except for colour and texture. Crystallized honey is not spoiled and preserves the flavour and quality characteristics of the liquid honey. Some honey users like it in this state since it is easy to spread on bread or toast without dripping off and the taste is richer.

Bear in mind that crystallization of honey has no bearing on its quality, but it is an attribute of pure and natural honey.

Why honey crystallizes?

Honey is a highly concentrated sugar solution. It contains more than 70% sugars and less than 20% water. There is much sugar in honey relative to the water content. This means that the water in honey contains an extra amount of sugar than it could naturally hold. The overabundance of sugar makes honey unstable.

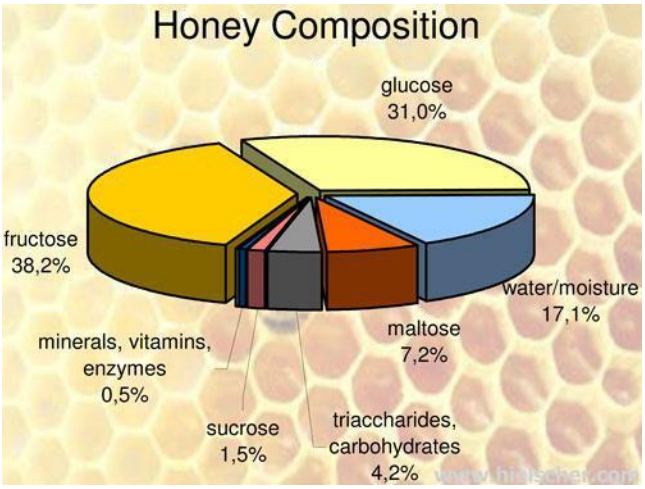
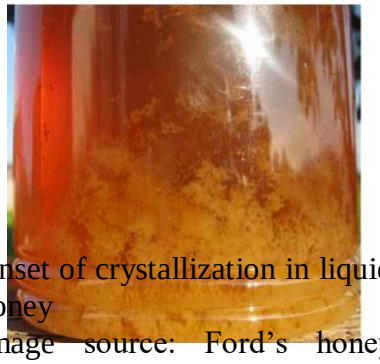
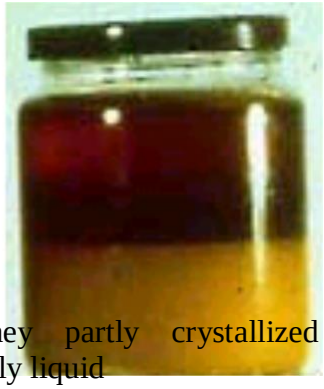


Image source: hielschr.com

It is natural for honey to crystallize since it is an over-saturated sugar solution. The two principal sugars in honey are fructose (fruit sugar) and glucose (grape sugar). The content of fructose and glucose in honey varies from one type of honey to the other. Generally, the fructose ranges from 30- 44 % and glucose from 25- 40 %. The balance of these two major sugars is the main reason that leads to crystallization of honey, and the relative percentage of each determines whether it crystallizes rapidly or slowly. What crystallizes is the glucose, due to its lower solubility. Fructose is more soluble in water than glucose and will remain fluid. When glucose crystallizes, it separates from water and takes the form of tiny crystals. As the crystallization progresses and more glucose crystallizes, those crystals spread throughout the honey. The solution changes to a stable saturated form, and ultimately the honey becomes thick or crystallized.

Some honeys crystallize uniformly; some will be partially crystallized and form two layers, with the crystallized layer on the bottom of the jar and a liquid on top. Honeys also vary in the size of the crystals formed. Some form fine crystals and others large, gritty ones. The more rapid honey crystallizes, the finer the texture will be. Crystallized honey tends to set a lighter/paler colour than when liquid. This is due to the fact that glucose sugar tends to separate out in dehydrating crystals form, and that glucose crystals are naturally pure white. Darker honeys retain a brownish appearance.


Onset of crystallization in liquid honey
Image source: Ford's honey farm


Honey partly crystallized and partly liquid

How fast will honey crystallize?

Different types of honey will crystallize at different rates. Some honey crystallizes within a few weeks after extraction from the combs, whereas others remain liquid for months or years. The following factors influence the speed of crystallization:

- the nectar source collected by bees (the sugar composition of honey),
- the methods in which honey is handled (processed) and
- the temperature in preservation.

The time it will take the honey to crystallize depends mostly on the ratio of fructose to glucose, the glucose to water ratio. Honey high in glucose sugar, with a low fructose to glucose ratio will crystallize more rapidly, such as alfalfa, cotton, dandelion, mesquite, mustard and rape (brassica napus). Honey with a higher fructose to glucose ratio (containing less than 30% glucose) crystallizes quite slowly and can stay liquid for several years without special treatment, for example, robinia (black locust), sage, longan, tupelo and jujube/sidr (ziziphus spina-christi).
The higher the glucose and the lower the water content of honey, the faster the crystallization. Oppositely, honey with less glucose relative to water is a less saturated glucose solution and is slow to crystallize. Honey with heightened water content often crystallizes unevenly (not as a homogeneous mass) and separates into crystallized and liquid parts.

The speed of honey to crystallize depends not only on its composition, but also on the presence of catalysts, like seed crystals, pollen grains and pieces of beeswax in the honey. These minute particles serve as nuclei for crystallization. Raw honey (unheated and unfiltered) contains bits of wax, pollen and propolis, and crystallizes faster. Honey that has been processed (e.g. heated and filtered) will remain in its liquid form longer than raw honey due to the elimination of nuclei, which encourage the growth of glucose crystals. Honey prepared for commercial market is usually heated and filtered. Heating and filtration of the honey dissolve any sugar crystals and remove foreign particles that might be present in it. Therefore, the crystallization is hindered.

The storage temperature has a big effect. Honey crystallization is most rapid around 10-15 ºC (50- 59 ºF). At temperature below 10 ºC (52 ºF) the crystallization is slowed down. Low temperature increases the viscosity of honey (honey is thicker when cool), and this retards the formation and diffusion of crystals. Honey resists crystallization best at higher temperatures more than 25 ºC (77 ºF). When the temperature is 40 ºC (104 ºF) the crystals dissolve. Temperature above 40 ºC (104 ºF) will damage the properties of honey.

The table below shows the relative speed of crystallization in descending order of various honeys.

Relative Crystallization Speed of Various Honeys

Honey Type	Crystallization
African acacia	Very slow
Black locust (*Robinia pseudoacacia*)	Very slow
Cranberry	Very slow
Litchi	Very slow
Longan	Very slow
Milk vetch (*Astragalus*)	Very slow
Milkweed (*Ascelpia syriaca*)	Very slow
Sage (*Salvia officinalis*)	Very slow
Sidr/jujube	Very slow
Tulip poplar	Very slow
Tupelo	Very slow
Bell heather (*Calluna cinerea*)	Slow
Blackberry	Slow
Borage (*Borago officinails*)	Slow
Buckwheat	Slow
Chestnut (*Castania sativa*)	Slow
Citrus (Orange blossom honey)	Slow
Eucalyptus	Slow
Fireweed (*Epilobium angustifolium*)	Slow
Linden/lime/basswood (*Tilia*)	Slow
Maple (*Acre spp.)*	Slow
Hawthorn (*Crataegus spp.)*	Slow
Nodding thistle (*Carduus nutans*)	Slow
Rosemary	Slow
Sourwood (*Oxydendrum arboreum*)	Slow
Spanish Lavender (*Lavendua Stoechas*)	Slow
Thyme (*Thymus vulgaris*)	Slow
Alfalfa	Rapid
Apple, pear, plum and cherry	Rapid
Clover (*Trifolium*)	Rapid
Cotton	Rapid
Dandelion	Rapid
Lavender (Common lavender) *	Rapid
Phacelia (lacy or tansy phacelia)	Rapid
Field bean (*Vicia faba*)	Rapid
Goldenrod (*Solidago*)	Rapid
Holly (*Ilex aquifolium*)	Rapid
Ivy (*Hedera Helix*)	Rapid
Mesquite (*Prosopis spp.)*	Rapid
Mustard	Rapid
Oilseed rape	Rapid
Raspberry	Rapid
Star thistle (*Centaurea solstitialis*)	Rapid

Sunflower	Rapid
Wild thyme (*Thymus serpyllum*)	Rapid

b) It is temperature dependent. It tends to crystallize quickly when stored below 21-23º C (70-75º F). If it is stored at higher temperatures like 23-32ºC (75-90º F) it usually does not crystallize very quickly.

Liquefying crystallized honey

Crystallized honey can be brought back to liquid consistency by gently heating it in a hot water bath (Bain Marie) or warming cabinet (box) until the honey re-liquefies. Heating should be applied indirectly, not by direct flame to a container.

The temperature in the beehive is about 35 ºC (95 ºF) and can rise to 40ºC (104 ºF) during summer periods when bees are ripening honey. In order to liquefy honey, it is best to heat it at 35-40 ºC (95-104 ºF). The temperature should not go beyond 40 ºC (104 ºF) to avoid overheating. Overheating honey for any period of time will reduce its quality by destroying its enzymes, loss the delicate flavour, aroma and darkening the honey colour. Heating must be done with care if the nutritional value of the honey is not to be spoiled. It is possible to re-liquefy crystallized honey without damaging its quality by the methods described below.

Hot water bath – heat a saucepan filled with enough water to reach the level of honey in the jar to 35 - 40ºC (95-104 ºF), then remove it from the heat or turn off the heat. Take the lid off of the honey jar and immerse the jar in the water. Let it stand for about 20-30 minutes. The heat will slowly dissolve the glucose crystals and become liquid again. Stir occasionally to even the heat throughout the honey, as crystallized honey is a poor conductor of heat. Replace the hot water if needed. Remove the jar of honey from the water bath when honey becomes liquid again.

This works well with honey in glass jars, but not so well with plastic containers. They can warp or melt. If honey is packaged in a plastic container set in warm water, not hot water.

Honey in a plastic bucket can be re-liquefied by transferring or scooping it into glass jars, and the process above is used.

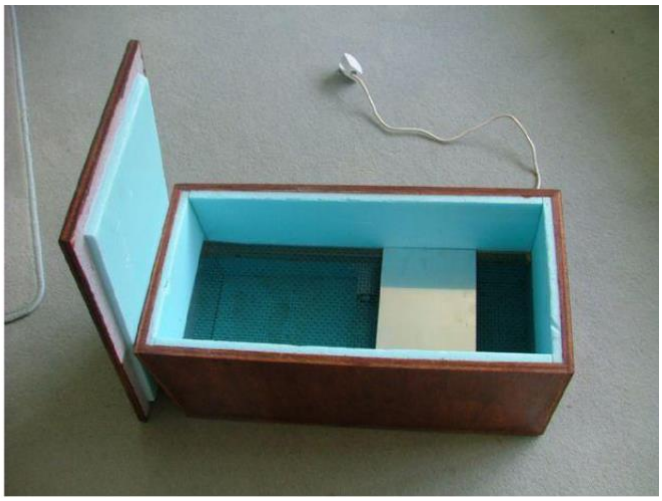
A hot water bath
Image source: 3 bees honey.com

Honey warming cabinet – another method to re-liquefy honey on a small scale is to heat it in a warming box with a 40 watt light bulb until it is liquid. This is a slow process and may take 12- 48 hours. The ideal box temperature is between 35-40 ºC, although some beekeepers use higher

temperature to speed up liquefaction of the honey. A lower temperature at longer time is better for the honey. When the honey to be re-liquefied is in buckets, stir the bucket from time to time to speed up the process.

A warming cabinet can be an insulated wooden box or a modified old refrigerator fitted with an electric light bulb at the base as the heat source and a thermostat to monitor the temperature. It is suitable for decrystallizing a stack of honey jars, or one or two buckets of 30 Ib.

Building a warming box for your honey is easy. Basically, the process of construction is to heat the space with a light bulb. A light bulb provides a constant, steady heat. For information regarding making a honey heater, see the links below.



Left: A well insulated buckets and jars warming cabinet. Courtesy of Windmill Hill Farm
Right: A warming box insulated with polystrene. It holds 12 jars and runs on electric - 40watt bulb.

Avoiding crystallization

- Store honey at room temperature in tightly closed containers. The optimum temperature for storing honey is 21 to 27 ºC (70-80 ºF). Avoid storing honey in cold temperature of 11 to 18 ºC (52- 64ºF), which is ideal for crystal formation. Don't store in the refrigerator.

Refrigerator temperatures accelerate the process of crystallization.

- Filter honey through 80 micro filter, or pass it through one or more sheets of fine nylon cloth supported with a wire sieve to remove any small particles such as pollen grains, flecks of wax, crystals and air bubbles that could initiate crystallization.

- Heat honey in a double boiler or in a hot air to 40ºC or 104 ºF to melt any sugar crystals may be present and delay crystallization. Check the honey temperature with a candy thermometer to avoid the risk of overheating.

Honey packers of supermarket honey in the US heat liquid honey to 63

ºC (145 ºF) for thirty minutes, or 71 ºC (160 ºF) for one minute or so (flash heat) and then quickly cooled at 49- 52 ºC(120-125 ºF) for minimization of heat damage. This high temperature kills the yeast cells that cause fermentation and keeps honey from crystallizing on the market self for a long period of time. The resulting honey contains very little of the nutritional value of minimally processed or raw honey including amino acids, minerals, vitamins, live enzymes, and antioxidants that are considered essential for good health.

3. When storing supers of empty combs for winter it is important to get your supers throroughly cleaned after the extraction of the honey. Place them back on the hive for the bees to clean the residual honey from the cells and store it in the brood chamber. Extracted combs stored with traces of wet honey can form micro-crystals causing next year's honey to crystallizes prematurely.
   Note: Using an inner hive cover with an open feeder hole between the wet supers and the brood chamber makes the bees more likely to move the honey below it.

Related Books

Eva Crane, Honey: *A Comprehensive Survey* (Heinemann, London, 1979).

Robin Chapman, *How to Make a Warming Cabinet (box) for two Honey Buckets* (A BeeCraft Publication).
This is a booklet on manufacturing your own Warming Cabinet in order that honey stored in 30lb buckets may be easily poured out into jars after warming.

Links

Building A Honey Heater *"In the Beekeeper's Work Shop"*
Homemade Honey Warmer *Honey Run Apiaries | Beekeeping |* Honey Warmer A Honey Heater for the Hobbyist Beekeeper Honey *Heater Guide2*

How to maximize honey production

By Khalil Hamdan, Apeldoorn, The Netherlands

One of the main reasons for keeping bees is to harvest the honey that bees store in their hives. Honey yield fluctuates from one year to another and varies between colonies. Some colonies of bees will be active during the season foraging and store more honey, some will be less active and produce little honey.

The amount of honey produced per colony depends on a number of factors.
The most important factors that affect honey production are:

- Availability of bee pasture
- The queen's condition
- Hive population
- Nutrition
- Swarming
- Space in the hive for expansion of the brood nest and storage of honey
- The colony's freedom from disease
- The beekeeper's experience
- The weather

Adequate nectar producing plants and trees, colonies with vigorous queens and large number of foraging bees, proper hive management techniques and favourable weather conditions will ensure greater honey crop.

Ways to help achieve high honey yields

c) Choose a good location with good nectar producing plants and trees for the bees to forage. The most important honey-producing plants and trees are citrus, apple, apricot, plum, peach, cherry, pomegranate, guava, prickly pear, banana, loquat, carob, chestnut, jujube (zizyphus spp), broad bean, peas, bean (phaseolus vulgaris), eggplant, cucumber, melon, strawberry, sunflower, cotton, sesame, anise, fenugreek, chick pea, lentil, mustard, lucerne, borage, flax, eucalyptus, robinia, acacia, willow, thyme, rosemary, lavender and thistles.

d) Locate hives near nectar sources within a mile radius. This is the economical distance for honey gathering. Bees fly two miles to find food, but honey production increases if nectar is nearby.

Beehives set in a cherry orchard. Hives located near the nectar source; combs will soon fill with honey

(Image credit: vanceman.com)

- Locate hives about 3 -5 km away from other big apiaries in the area to secure the maximum output of honey, and 1 -2 km between small apiaries (small number of hives) in rich nectar fields. Putting bee yards closer is not good management. Do not overstock at one spot. Overstocking will lead the hives to compete for the forage and as a result produce low honey harvests. As a rule of thumb, put 1-2 hives per acre (4000 sq metres) of blooming trees or crops for maximum production. This depends on the attractiveness of crops and the strength of colonies.

- Colonies should be headed with good queens. A queen bee lives about five years or longer, but egg-laying decreases significantly after her third year, which weakens the colony and reduces the honey production, and for this reason most beekeepers replace queens at the end of their second year in honey production colonies. Check now and then to see if the queen is laying eggs. If she is not, she is too old and needs to be replaced with a new one. A young queen in full lay in early season will assist the colony in building up strong populations capable of collecting a large honey crop. Some colonies may continue to have high production in their 3rd year and are still going strong into their 3rd years, but then you expect them to swarm or supersede. Bees replace a failing or an old queen with a more efficient queen by building a few supersedure cells near the centre of the comb. If only a few queen cells are found on the face of the comb during hive inspection, do not destroy them; these are supersedure cells and indicate a failing or an old queen. Allow them to develop. It is better to allow the bees to replace the queen than to purchase a new queen.

4. Strong colonies produce more honey: Prepare colonies to build up to full strength in time for the start of the bloom of major nectar-producing plants by feeding colonies sugar syrup 1 part sugar, 1 part water six weeks before the nectar flow begins to incite bees to brood activity. Use top feeders (slow feeding) with small holes punched in the lid of a can, plastic pail or glass jar. Invert the feeder on the bar tops of the brood nest in the hive. The bees suck the syrup from the feeder via the small perforations. It takes about 42 days for an egg to develop into a forager bee. Colonies that build up their peak populations during or after the main nectar flow will usually produce small honey crop. This is due to the small foraging force and the fact that they spend most of their time gathering food for feeding the brood. A strong healthy colony will have 40,000 - 60,000 bees or more in spring. In mild warm regions, February is the time when beekeepers should prepare their colonies for the major nectar flow in spring.

   Provide colonies with combs when brood extends over 4 or 5 frames. This gives space for the queen to lay eggs and the brood nest to expand and to avoid over crowding. Overcrowding can result from too many young bees, combs filled with pollen and honey, and lack of supers. Check beehives every 7 – 10 days to see how they are developing. If a colony is getting crowded and has 7 or more frames covered with bees, a second brood box should be added over the bottom box.

Managing bee colonies for population build-up before nectar flow starts is a priority. More bees=more honey.

(Photo source: NY honeybee.com)

A strong bee colony. A strong bee colony makes a big crop of honey

(Photo credit: USA ARS Honey Bee Breeding, Genetics & Physiology Research Lab. Baton Rouge, Louisiana)

7. Bees must have access to water close to the hives. They need water to dilute honey and cool the hive during hot weather. If water is nearby, they can spend more time gathering nectar and less time collecting water.

8. Add supers with drawn combs when the nectar flow starts in the area. When the first super is two thirds full, add an empty super between the brood box and the two-thirds full super. Add enough supers to accommodate incoming nectar and the large bee populations, this stimulates foraging and limits early swarming. Do not add too many supers at one time. It is important to know the time of a honey flow in the area so that you can add extra combs to allow enough space in time for the storage and ripening of nectar into honey be bees.

Supers are stacked above the brood chamber for honey storage
Photo credit: Bee yard of Honey Gardens Apiaries. St. Lawrence River valley, Upstate New York State,
www.honeygardens.com

8. Remove full supers and extract as soon as they are ready and return to the hives.

9. Dispense with queen excluders: They hinder the work speed of bees and slow the process of honey storing in supers.

10. Control swarming: Swarming reduces honey production due to the loss of bees, as the old queen leaves, taking more than 30-60 percent of the bees of the parent colony. The most important factors that cause swarming are the presence of a queen more than a year old and congestion in the hive (populous colony). The signs of swarming are large numbers of queen cells being constructed, large numbers of drones being raised and hive congestion. The more common ways of preventing and controlling swarming are:

Requeening: Use young queens. A colony with a new young queen is less likely to swarm. A colony with an older queen has about a 30% tendency to swarm. Changing the old queen in autumn or early in the year with a young one is an ideal way to suppress swarming.

Removal of queen cells: Inspect the brood nest during the swarming season regularly every 7-10 days to make sure that queen cells have not been built. Once queen cells are found, all queen cells are destroyed before they hatch.

Providing sufficient space to: Bees need space (extra combs and boxes) to rear brood and store honey and pollen during the active season. When a colony grows too big and becomes crowded and has shortage of space it is likely to swarm. Congestion is may be relieved by taking a few brood combs into a weaker hive that you wish to strengthen or by making a nucleus. The nucleus can be added back to the parent colony later in the season, when the risk of swarming is over. You can reduce the likelihood of swarming by adding supers to the hive.

Demaree method: It is an effective method to stop the bees from getting to the point of swarming. The method involves the separation of the queen from the brood. Remove the hive from its stand and place over the bottom board a new box. Transfer one open brood comb with larvae and eggs with the queen on it and a couple of combs of honey and pollen to the new box. Place the open brood comb with the queen on it in the centre; the combs of honey and pollen at the edge, then fill the empty space with frames of drawn combs or foundation. Place a queen excluder on this new box. The original box with the brood combs minus the queen goes on top of the queen excluder. Move the combs to one side of the box and fill the space at one side with drawn combs. Place the inner cover and outer roof. In a week or so a super is placed between the two boxes. Adding a super immediately. Beekeepers usually add a super directly between the two brood boxes, however, the more space (separation) there is between the two brood, the more likely is it they will make queen cells in the upper box. Swarm cells usually are at the bottom of the frame. After 7-9 days, the upper box is inspected for the developing queen cells, and any found are destroyed or usefully used.

NOTE: Begin Demareeing as soon as the colonies become strong and crowded and during the swarming season.

Swarm queen cells. These queen cells are being raised by the workers for the purpose of swarming.
Swarms cells usually are at the bottom of the frame

Photo credit: www.bushfarms.com

11. Unite weak colonies: Weak colonies will not build-up a population adequately and produce little honey. For best results unite weak colonies to strong or medium colonies with good queens (after killing the poor queen).

12. Once the nectar flow is over, move hives to other areas to follow honey sources during the course of year. Cultivated crops, forests and meadows can provide a good source for foraging.

13. Protect bees from poisoning by insecticide sprays when hives are located near cultivated crops: To protect bees from insecticides spray damage, block the entrance of the hive with a mesh net to confine the bees during the spray period, and place empty super on the hive to provide space and ventilation. Keep the period of confinement as short as possible. If the period of confinement is to be more than one day, provide a feeder with syrup and container with water. The best method is to move the colonies out of the area and move them back when the period of toxicity is over. To reduce the chance of bee losses, do not move bees to another area that is about to be sprayed.

14. Retain good bees in the apiary: Raise queens from your best colonies for requeening and increasing the number of your hives, and select from non-swarming strains.

15. Keep a few spare young queens in nuclei raised in the season to be available for immediate use in an emergency to replace missing or failing queens during the nectar flow. When the hive becomes queenless, bees occupy themselves in constructing queen cells and raising a new queen. The effect of this is the dropping of hive population at 1500 bees per day. It requires 15 -16 days for the new queen to emerge, and about 7-10 days to mate and start laying eggs.

The eggs in the brood cells take twenty-one days to develop into adult bee, and another twenty-one days to become foragers.

16. Manage hives in autumn (August or early September) to produce well-populated colonies of young bees by feeding a light sugar syrup and supplementary protein. Provide bees with an ample supply of food for the winter period (in mild warm climates about 3-4 frames of honey equivalent to 7-8 kg of sugar, and 1-3 frames of pollen for each hive) and protect them from winds and cold. Colonies that go into winter with a strong population, plenty of honey and pollen and young queens will build strongly in early spring and take advantage of early honey flows. Treat against Varroa mites. Fumidil-B treatment in autumn for Nosema disease is recommended.

Suggested reading

Books

Oliver Field, Honey By The Ton. London, 1983

Internet sources

Spring management of bees

Swarming-**It's prevention &** control

How to Reduce **Bee** Poisonings from Pesticides

Fall Mgmt - MAAREC

Extracting Your Honey

When it comes time to extract your honey it is important that you have everything ready before you got out to the apiary to collect your supers. Examining your hives a day or two before you begin, will give you an idea of how much honey is in your supers.

Setting Up Your Honey House

First you will need to decide where you will be extracting and bottling your honey. You can easily turn your garage into your honey house by backing out the cars and cleaning up a space where you can set up your uncapping tank and extractor. Sweep up the fl oor and put down a drop cloth to catch the honey drips. Posi-tion the uncapping tank next to the extractor to minimize honey drips while transferring frames from the uncapping tank to the extractor. Posi-tion a 5 gal pail with honey gate under your extractors honey gate. Place the double sieve on top of the 5 gal pail to strain your honey. Have hand wipes or a damp cloth available to wipe off your hands. A bucket of water and a wash cloth works well also. Keep a supply of newspapers on hand to place over honey drips on your drop cloth this way you don't track the honey ev-erywhere. It is important to make sure your honey house is warm, the hotter the better! The warmer it is, the easier your honey can fl ow, which means less time in the extractor and makes for ease in bottling.

Equipment Checklist for Removing Supers

- ☐Bee Suit
- ☐Veil
- ☐ Gloves
- ☐Smoker
- ☐Smoker Fuel
- ☐Hive Tool ☐
- Bee Brush ☐
- Frame Grip
- ☐Honey Robber®
- ☐Fume Board
- ☐Old Towel or Plywood Sheet to Cover Supers
- ☐Cart or Wheelbarrow to Haul Supers
- ☐Trash Bags for Lining Cart or Wheelbarrow

Gathering Your Supers

Secondly you will need to gather your supers. Supers full of honey can weigh 40-60 pounds. Using a cart or wheelbarrow will save you time as well as wear and tear on your back. Line the bottom of the cart or wheelbarrow with trash bags to catch dripping honey. Gather your smoker, smoker fuel, hive tool, bee brush, frame grip, Honey Robber®, fume board and old towels or plywood. Place it all in your cart or wheelbarrow. Place the smoker fuel inside the smoker so it is ready to go once you reach the apiary.

Once you are out to the hives light your smoker and put your veil and gloves on. Lightly smoke the bees before you remove the top cover. Once you remove the top cover and inner cover you want to lightly smoke the bees again. Use your hive tool to loosen the supers from the hive bod-ies, which the honey bees will have glued together with propolis. Do not remove the supers yet, just loosen them. Use your hive tool to loosen all the frames in the super so you can quickly remove the frames once you

draw done the bees with the Honey Robber®.

Next you will want to grab your fume board, with the fume pad facing up place it on the ground. Open your Honey Robber® and draw a letter x or s on your fume pad. Once you place the fume board on top of the hive the smell will drive the bees down into the hive and off the honey supers. The bees usually vacate the supers in 5-10 minutes.

After the bees have vacated the supers you can begin to pull the frames out of the supers with your frame grip. Check for any lingering bees, using your bee brush to gently brush them off. Remove the super and place it on your cart of wheelbarrow. Cover the top of it with an old towel or sheet of plywood to keep the bees out. Repeat as necessary for each honey super.

Once you have finished removing your honey supers place the inner and top cover back on the hive. Grab your fume board and other hive tools and return to the honey house. You may want to leave your fume board outside overnight to eliminate some of the odor left from the Honey Rubber. Be sure to keep the doors to your honey house closed to keep any unwanted honey bees out.

Equipment Checklist for Extracting Honey

- ☐Electric Uncapping Knife
- ☐Uncapping Scratcher
- ☐Uncapping Tank with Metal Grid, Wooden Bar and Honey Gate
- ☐Five Gallon Plastic Pail with Honey Gate for Collecting Honey from Uncapping Tank
- ☐Five Gallon Pail to Hold Extracted Honey
- ☐Stainless Steel Double Sieve ☐Extractor
- ☐Drop Cloth for Floor (a plastic sheet works well)
- ☐Table or Stool to Elevate Uncapping Tank
- ☐Hand Wipes or Bucket of Water and Rags for Cleaning off Hands
- ☐Newspapers to Cover Honey Drips
- ☐Kitchen Spatula to Scrape Honey from Sides of Extractor

Extracting Your Honey

Place your honey supers next to your uncapping tank. Make sure the metal grid in the uncapping tank is in place in the bottom of the uncapping tank. Firmly attach the wooden cross bar with the point of the nail facing up. Plug in your uncapping knife.

Take a frame from your super and place it on the cross bar nail this will allow the frame to pivot without falling off. Run the uncapping knife down the frame. Be careful not to hold it on one spot to long or it will burn. If there are areas on the frame that you cannot reach with your knife, use the uncapping scratcher to gently pierce the wax capping.

Once you have uncapped both sides of the frame place it in the extractor. Slide the frame into the groove on the bottom of the frame holder so they are properly in place. Once you have filled the extractor with frames you are ready to begin extracting. Open the honey gate. Make sure you have a 5 gal pail with your double sieve below the honey gate so the honey can pour out into the pail.

When extracting honey with a tangential extractor you will load up your frames in the extractor and begin to crank. You want to extract part of the one side then stop the extractor and reverse each of the frames. Then extract all of that side. Again stop the

the pail and fill your bottles. Continue until all the honey is gone.

After you have fi lled your honey containers you will want to add labels. See our June 2010 article “Selling Your Honey” for labeling types.

extractor lift out the frames and re-verse the frame back to fi nish extract-ing the fi rst side. The reason you do this is because if you removed all of the honey from the one side fi rst, the uneven weight extracting the second side could damage your frame or wax cells. By extracting only part of the fi rst side and reversing the frame to the second side it allows you to get the honey out without damaging the frames or tearing the wax cells apart. If you have a radial extractor, you can extract both sides of the frames in one step, without reversing. Just be sure to leave your honey gate open. Using a soft kitchen spatula, run it down the extractor sides to force all of the honey to the bottom of the extractor so it can run out the honey gate and into your pail.

Back at the uncapping tank you will find honey remaining on the wax cap-ping. It may take a while to gather at the bottom of the uncapping tank.Place a 5 gal pail under the honey gate of the uncapping tank to allow the honey to run out.

Put a lid on the honey bucket and let it settle for a day or two so the air bubbles can work their way to the top. To clean the extractors use warm to hot water, and a soft cloth. You don't want to use anything rough a abra-sive on your extractor. If the extractor is still not clean you may want to use a small amount of dish soap.

Bottling Your Honey

Once your honey has set for a day or two you can begin bottling. The warmer the temperature the easier the honey flows. Bottle your honey in a warm room or raise the temperature for this process. Raise the honey pails up to a convenient height like a table or counter top. Place garbage bags un-derneath the honey gate to catch any honey drips. Have your bottles ready and slowly open the honey gate on