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Rearing queen bees

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Introduction

As a beekeeper you may have purchased queen bees from a commercial queen breeder and have wanted to understand the process to produce queen bees or to produce your own queens. This Primefact describes the process to produce queen cells and mated queens using two methods of 'starting' queen cells using queen-less hives:

- nucleus box
- Swathmore swarm box

These systems are used for their simplicity, reliability and use of standard equipment to produce small or large numbers of queen cells. With patience, practice and knowledge of beekeeping you can successfully produce your own queens.

The queen

Through the queen, via her progeny, the productivity, temperament and behaviour of the colony can be manipulated by the beekeeper.

Techniques of rearing queen bees have been developed to allow beekeepers to reproduce good stock to replace old or undesirable queens in their colonies, or to start new colonies.

A queen is slightly larger than a worker bee, having a large pea-size thorax and long tapered abdomen. She differs from the other female bees (workers) in that her reproductive organs are fully functional, while those of the worker bees are not. There is usually only one mature queen in the colony at a time and she is responsible for reproduction in the colony. A mature queen may lay up to 2000 eggs a day in bursts, but averages 700–1000 a day when conditions are favourable. A queen can live for several years, although under commercial conditions she is usually replaced every 1 or 2 seasons to ensure her vigour, which translates to colony health. After emerging from her cell, she mates on the wing six to ten days later with up to 20 drones. She will not mate again after she begins laying eggs.

A marked Italian queen bee (green dot on thorax)

Races of bees

Honey bees (*Apis mellifera*) are native to Europe, the Middle East and Africa. In their natural environment bees have developed local races or breeds adapted to different climatic and environmental conditions.

Early imports of bees into Australia included a variety of races. The bees in common use by beekeepers today are all of European origin. Recent imports of European races have come from North America and New Zealand.

Italian bees (*Apis mellifera* subspecies *ligustica*) are the most common race of bees in NSW. They vary a great deal, depending on the area of origin. Italian queens are usually uniformly coloured, ranging from leathery brown to a golden yellow. Some strains have a black tip on the abdomen.

Italian worker bees have three to five yellow bands on the abdomen. Their temperament varies from docile to moderately bad tempered. Italian bees develop large, populous colonies with a large brood nest.

Caucasian bees (*Apis mellifera* subspecies *caucasia*) have queens that are usually black, but some have yellow or red colouring on the side and underneath the abdomen. Workers are grey to black, depending on age. Silver-grey bands on

young workers are bands of dense hairs which wear off with age, revealing the dark colour beneath.

Caucasians are docile bees that form strong colonies. They winter as small colonies, breeding very rapidly in early spring. They are alleged to drift and rob more than Italians, they use more of the gummy bee glue called propolis, and they work better in cooler conditions. Their whiter wax on new combs is favoured for comb honey production.

Carniolan bees (*Apis mellifera* subspecies *carnica*) are similar in colour and temperament to Caucasians. Queens are generally brown with yellow bands on some segments. Workers are grey, turning black with age. They are the most docile of the three races, with early imported strains having a strong swarming tendency. Carniolans winter as small colonies, breeding fast in early spring to form large colonies in summer.

Hybrids are a combination of races of honey bees. Most hives have some degree of crossing between races (hybrids).

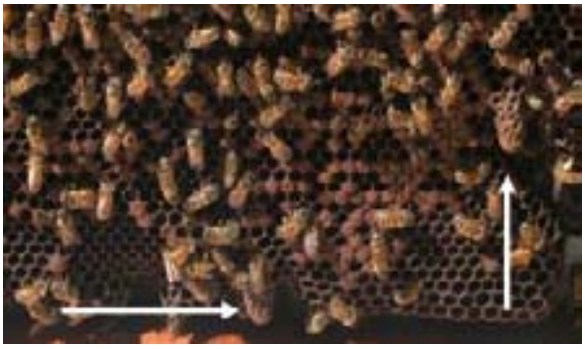
Natural queen replacement

A colony of bees in the wild, or in an undisturbed domestic hive, will raise queen bees for three reasons: to replace a lost queen, to replace the queen when swarming, and to replace or supersede a failing queen.

When raising queens, beekeepers will manipulate a colony to duplicate one of these three natural circumstances.

Emergency cells are prepared by bees when the normal laying queen is accidentally killed or lost. Workers will select a few very young worker larvae which they convert into queen cells by tearing down neighbouring cells and building an extension to form a vertical cell. The selected larvae are fed extra supplies of rich food called ‘royal jelly’ and raised as queens. Emergency cells may be anywhere in the brood nest, although a central position on the comb is common. They are often in groups of two to three cells.

Swarm cells are raised by a colony intending to swarm. The bees prepare special queen cell cups in which the queen lays eggs. Virgin queens emerge about two days after the swarm (half the colony, including the old queen) have departed. Young larvae in swarm cells are very well fed with royal jelly and queen bees produced from swarm cells are usually larger than queens produced from emergency cells. A colony will prepare 15 to 25 swarm cells, usually around the edges of the brood combs, often overhanging the bottom bar of the frames.



Natural emergency cells raised by queenless hive

Supersedure cells result in well fed, large sized queen bees and are prepared to replace an old or failing queen in a colony. As with swarm cells, the bees prepare queen cell cups in which the queen lays eggs, and the young larvae are well fed on royal jelly. Normally a colony will produce only a small number of supersedure cells at one time. Once the supersedure queen has mated and starts to lay she can co-exist with her mother in the same hive for a short period of time.

Artificial queen rearing

To rear queen bees artificially you must be able to develop in the bees a need to create a new queen, using one of the **three reasons** mentioned earlier. Swarm and supersedure impulse are preferred, because they produce high quality queens.

Conditions for rearing queens

Successful queen rearing demands suitable conditions. Attempting to rear queens at the wrong time of year will **result** in poor quality queens.

Ideal conditions **are** a light nectar flow and good supplies of at least three sources of pollen.

If pollen is in short supply it can be supplemented with high quality pollen that has been collected and stored. Should nectar be deficient it can be supplemented with sugar syrup. If the bees are close to swarming, conditions are probably ideal for rearing quality queens. Some beekeepers feed cell-rearing colonies regardless of conditions. To ensure optimum feeding of queen cells this is highly recommended.

Supplementary feeding

Queen rearing hives can be given sugar and water in equal parts by volume. The feeding rate is about one litre every 4 to 7 days.

Select a feeder that is easily refilled, and that can be manipulated without too much trouble.

Use of in-hive frame feeders or outside bottle type feeders are recommended, but all syrup must be taken up by the bees in less than three days, otherwise syrup can ferment, causing digestive problems.

Wooden frame sugar feeder

Wooden block entrance sugar feeder

Pollen can be provided by placing a quantity of powdered pollen on a small sheet of tin or board directly over the area of the colony containing the queen cells. Provide more pollen as it is removed by the bees.

It is important that both purchased and self-collected pollen is irradiated before feeding back to hives to eliminate the transfer of bee diseases.

Breeding stock

Breeding stock is the mother stock used to produce production queens with desired traits. The primary aim of rearing queens is to improve production colonies. Breeding from unselected stock defeats this aim. Breeders can be selected from your own apiary or bought from reputable queen breeders.

Constant breeding with one line of bees with only one or two breeders each generation will result in inbreeding, which will eventually lower the performance of the queens. A closed breeding system should involve a minimum of 500 colonies, with as many breeder queens as possible. For commercial queen breeders, selection of breeders should be made on the basis of accurate records. Production is usually the primary selection criterion. Other factors that are considered include brood rearing ability, disease resistance, docility, swarming history, hygienic behaviour and colour of the bees. Many of these factors are often reflected through the colonies' productivity.

The type of bees selected will depend largely on your own requirements. If you intend to buy breeder queens, make sure you make your requirements known to the queen breeder.

Buy unrelated queens for successive years. If a breeder queen is used two years running, there is a good chance that the second year's daughters will mate with drones from the first year's daughters, which constitutes direct inbreeding.

Importing of breeding stock from certain overseas countries is allowed through the Eastern Creek Quarantine Station in Sydney. If you are interested contact AQIS at www.aqis.gov.au for current conditions and costs. Under no circumstances should you import breeding stock without contacting AQIS as this could introduce diseases and parasites of bees not currently present in Australia.

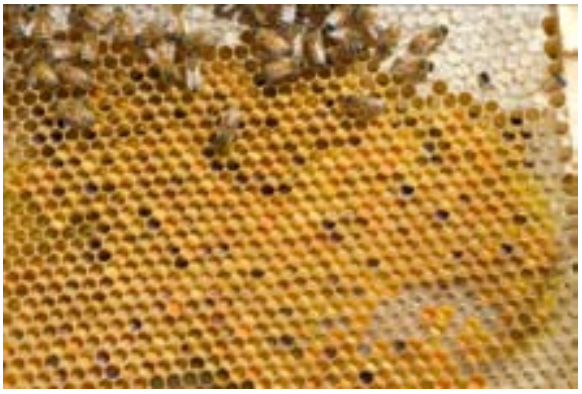
Equipment for queen rearing

Most systems of queen rearing use standard beekeeping equipment, but some specialised equipment is required.

Artificial queen cells are essential. The cell bars are made to fit in place of a frame in a colony, and the plastic or wax cells are attached to the bar with hot beeswax, twenty cells are usually attached to each bar.

Strong, disease and pest free active colonies of bees are essential for rearing good quality queen bees. Two or three- deck colonies are used, they should have six to eight frames of brood and at least two boxes full of bees. Queen excluders will also need to be fitted.

A frame of fresh pollen from three plant sources



Plastic queen cells, bars and holders

A number of three to five frame nucleus boxes will be needed for starting cells and mating queens. If using the 'Swathmore' method, you will need a three to five frame nucleus box with a fully vented or screened bottom with 25 mm to 50 mm riser between the box and bottom.

The queen rearing process

Starting cells: Starter colonies must be prepared prior to a graft being placed into them. In the two starting systems discussed here, the colony is manipulated into accepting grafted larvae because they are 'queen-less' and as in nature they will attempt to replace their queen, under the emergency queen rearing impulse.

1. Nucleus box

Turn a strong double hive around to face the opposite direction.

Place a 4 frame nucleus box at the back of the hive with the nucleus entrance facing the direction the hive entrance used to face.

Find the queen in the double hive, put her to one side in the double hive, do not place the queen in the nucleus box.

Nucleus box

Into the nucleus box, in order place:

- a feeder filled with sugar syrup
- one frame of mainly pollen with some honey
- two frames of unsealed larvae and young bees from two other brood frames – shake the bees into the nucleus box
- pollen or protein supplement fed on top bars of frames if required.

Remove the pollen frame to provide room for shaking; *do not shake the queen into the nucleus*.

Replace the frames taken from the hive with frames of worker brood comb.

Leave for a minimum of 5 hours after making up the nucleus colony. Graft two bars of cells (maximum of 40 cells/nucleus) with larvae less than 36 hours old from a breeder queen and return the cells to the nucleus box.

The following day, check the success of the graft. One bar of started cells can be transferred to the double hive and it can be treated as a feeder hive by using the following method.

Move nucleus hive to one side, turn the double hive around to its original position.

Remove the three middle frames and one wall frame from the super.

Place the feeder from the nucleus against the wall of the super and refill; feed extra pollen or protein supplement on the top bars.

Place the remaining three frames from the nucleus into the super. Place the frame holding 20 cells in the middle of the super. Additional bars of started cells should be placed in other hives prepared as cell feeders, with a maximum of 20 cells per feeding colony. Make sure there is a queen excluder between the brood chamber and the super.

2. Swathmore swarm box

This method requires a three or four frame nucleus box with a gauze bottom, 25 mm to 50 mm risers and the entrance closer in the closed position.

Stock the 'Swathmore' box with one frame of honey and one frame of pollen.

Shake into the box, bees from four frames of unsealed brood from a strong colony, *making sure the queen is not shaken into the box.*

After shaking the bees into the box, make sure the entrance is closed, place the lid on the box and store the box in a cool dark place for 4 to 5 hours, then graft up to 40 queen cells and place the cell bars in a frame.

A firm bump onto the ground before opening the box will dislodge the bees and make it easier to

Swathmore swarm box

place the frame containing the grafted cells between the frames of honey and pollen. A few bees may escape.

Place the box in a cool dark place overnight.

The following morning or 16 to 20 hours after the cells were grafted, check the cells by smoking under the lid and removing the frame holding the cell bars. Do not bump the box at this stage.

The started queen cells are then distributed to cell feeding colonies, no more than 20 queen cells per feeder colony.

The bees in the Swathmore swarm box can be returned to the original colony or to a cell feeding colony.

Cell feeding colonies

Once queen cells have been started in the Swathmore or nucleus box, a queen right cell feeding or cell building hive is used to rear the queen cells to mature cell stage utilising the supersedure behaviour of the colony. Any strong colony will rear started queen cells. Ensure the queen doesn't have access to the queen cells.

Hives suitable for feeder or cell builders are:

- 6–8 frames of brood
- disease free
- queen is 6–12 months old
- excluder between brood box and super
- well maintained
- strong with good tempered bees covering frames in both boxes.
- Strong double hives full of bees of all ages and with an abundant supply of fresh pollen and nectar – a double hive is required for each cell feeding colony.

Preparing cell feeding colonies

The cell feeding colony is made up the day before it is required.

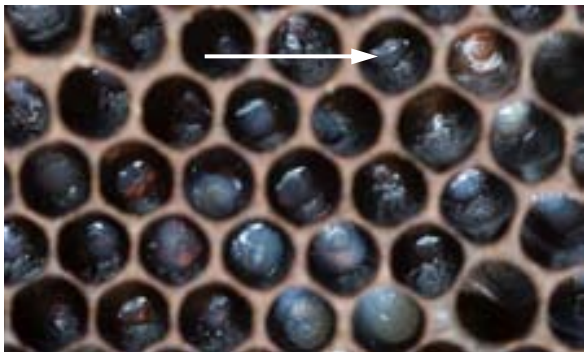
The queen is found and confined to the brood chamber with a queen excluder.

Two frames of unsealed larvae 3–5 days of age are placed in the centre of the super above the excluder. A space is left between the frames to make room for the frame holding the bar of grafted queen cells.

On the day after grafting, a cell bar frame containing one bar of the started queen cells from the colony the cells were started in is placed between the frames of brood in the super. No more that 20 queen cells should be placed in each feeder colony to ensure that each cell will be well fed.

The bar of cells is removed from the feeder colony 10 days after the cells were grafted and distributed with one queen cell per mating nucleus. Queens will emerge from the cells 1 to 2 days after being placed in the mating nucleus.

Once a cell feeder colony is prepared, a batch of cells can be produced without any further colony management. If successive batches of cells are to be introduced, they can be added after the first batch of 20 cells are sealed, i.e. 5 days after grafting the first batch of cells.



Ideal aged larvae to graft

Cell feeding colonies in continuous use should be manipulated every 7 days. The queen and older brood are left below the excluder. Frames containing unsealed larvae 3–5 days of age are moved above the excluder near the queen cells to attract young nurse bees of a suitable age (5 to 15 days old) to feed the queen cells. If required, support hives may need to be maintained in the same or a different apiary to provide frames of bees, brood, pollen and honey to the cell feeder colonies.

Brood moved above the excluder should be inspected 2 days after being moved and any self-raised queen cells destroyed.

Numbering the lid of the cell builder and using it as a record of the cells that are raised in allows you to keep track if more than one batch of cells are being reared at the one time.

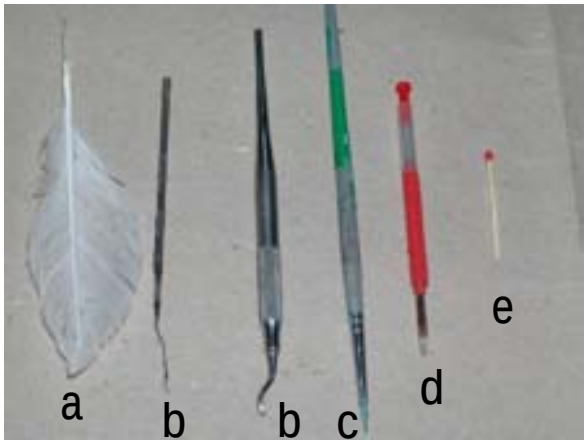
When checking your graft and transferring to your cell builder, mark the cell bar with the number of the cell builder on the back of the bar in front of the graft date (e.g. 5–10/10).

Removing ripe cells from cell builder

Grafting

Transferring of worker larvae at 12–36 hours old, by the use of a grafting tool into plastic cell cups is called grafting. A number of grafting tools can be used and include:

a) carved duck or goose feather
b) metal grafting needle
c) 00 point brush
d) Chinese grafting tool
e) Finely carved matchstick.



Examples of grafting tools

Grafting out of dark combs assists in seeing the very small larvae, as will the use of a cool light or magnifying lamp (e.g. x10 magnifying lamp as used by craft people). The use of a room out of direct sunlight will ensure that larvae don't dry out and improve success rates.

The age of grafted larvae plays a major part in the quality of the resulting queens. The younger the larvae the better the queens. Select the smallest larvae possible, preferably larvae just hatched from the egg. A larva 0 to 24 hours old is the same length as an egg. Grafting of eggs themselves is extremely difficult and is not recommended.

Introducing plastic queen cell cups into strong colonies about one day before grafting allows the bees to clean, polish and warm the cells.

Grafting method

Place the frame containing the larva onto a support board at an angle of about 30 degrees, with a cool light shining into the cells so each larva can be clearly seen.

Place the nib or needle of the grafting tool under the royal jelly under the middle of the larva.

Scoop up some royal jelly with the larva on top of the jelly.

Then place the tip of the nib in the centre of the bottom of the queen cell cup, and roll the nib away from the larva so it is left lying in the middle of the base of the cell cup.

If you experience problems seeing the larva, shave the cell walls down close to the foundation with a sharp knife, then remove the larva.

If you think you have damaged a larva while transferring it, try again with a new larva.

It is important for larval survival that each larva is placed in the middle of the bottom of the cell cup.

Move your hand along the cells as you graft into them to keep your place on the bar.

Quickly check your bar when you have finished grafting, then regraft any you think are damaged or too big.

Some beekeepers prime cell cups with a small drop of royal jelly diluted with an equal volume of tepid water, but this should be unnecessary if royal jelly has been removed and transferred with the graft. Double grafting, which is regrafting into one day old started cells after removing the larvae, is worth considering for production of breeding stock only. Research has shown there is no benefit obtained from double grafting larvae.

An egg on the tip of a match; the next two smallest larvae are the ideal age for grafting

Placing grafted cells into a starter hive

A magnifying lamp to help grafting

Grafting using a Chinese grafting tool

When grafting more than one bar, wrap the grafted bars in a moist towel to prevent dehydration until ready to place bars into holders and into starters.

Note: Grafting of the ideal size larvae is a skill that some people have trouble mastering. The use of commercially available queen raising kits may help where grafting is not required, especially if you have poor eyesight. EZI queen and Jenter are two systems available at beekeeping supply agents.

The use of a non-grafting kit requires the beekeeper to follow the rest of the processes but the grafting process is not required.

Checking graft

The morning after grafting (around 16–20 hours), remove cell bars and check the number of cells that have been accepted. Accepted cells have larvae in a pool of royal jelly and a wax extension on the rim of the cell cup.

Next place the bar of 20 cells or less into the feeder hives. Accepted cells may be moved from one bar to another to make up 20 cells.

Checking a graft the next day

Transporting queen cells

Queen cells are delicate, and you must take care when handling them. Mishandled cells can result in dead or deformed queens. The safest time to move queen cells for distribution to colonies for hatching and mating is on the tenth day after grafting.

Always keep sealed queen cells in the vertical position, as they hang in the hive. If they are inverted, the delicate wing buds may be damaged.

The safest way to transport cells is in a nucleus box with honey, pollen and bees. Make sure no queen is present, or your queen cells may be destroyed.

Portable incubators or insulated boxes have also been developed for transporting queen cells for long distances without live bees as escorts. The cells should be packed in warm sawdust, foam rubber or other protective packing to avoid damage from vibrations.

Mating queens

If young virgin queen bees are allowed to emerge together they will attack each other and destroy unhatched queen cells. To prevent this occurring, introduce queen cells on the tenth day after grafting (i.e. 1–2 days prior to emerging) into individual queenless colonies.

6-way ideal depth mini mating nucleus (note the queen cells placed between frames)

A standard 10-frame hive split into 2 x 4-frame nucleus colonies (note the plastic sugar feeders)

A small colony called a nucleus is normally used for mating queens but queen cells can be placed directly into productive queenless colonies. A wide range of designs of mating nuclei are in use. Some are specially designed for queen rearing and are based on half length and shallow depth frame sizes. For small beekeepers, standard full-depth three or four frame nuclei are suitable for mating virgin queens. Many commercial beekeepers make up nuclei in standard material above a nucleus or split board. This facilitates the introduction of a new queen and causes less disturbance to the production hive. Beekeepers also kill old queens in weak or declining hives or use a standard single box with two or three frames of brood with bees and two frames of sealed honey and pollen, making up the balance with dry comb or foundation. This works well if hives are spread out to allow queens to orientate when mating. All nuclei and standard equipment should have ventilation in the lid or bottom board to allow units to be locked in while being made up and for easy transport to another site a minimum of 2 km from the original hives.

Ten-day-old mature cells are placed between two combs in the brood area, taking care not to squash the cells or place them out of the vertical position. The virgin queen will emerge on the eleventh or twelfth day after grafting, and will mate ten days later. Provided the weather has been fine the young queens will start laying about twelve days after emerging from the cell.

Virgin queens mate with up to 20 drones. To ensure highly productive, long-lived queens there must be sufficient mature age drones available when virgins are ready to mate. Drone brood takes 24 days to hatch and drones mature at 16 days of age and after 28 days decline in fertility to die at around 55 to 60 days old.

Drone mother hives should be placed one to two kilometres from the queen mating apiary to provide drones for mating with the virgin queens. Drones should be unrelated to the virgin queens. Drone mother colonies should receive as much attention as a cell feeder hive. For every queen mating nuclei colony, you will require 10 drone mother colonies. Drone mother colonies must have drones hatching when starting to graft queen cells. A full frame of drone brood will produce around 700 mature drones.

The layout of the apiary for mating queens is very important. A site protected from wind, with good landmarks such as small shrubs, aids mating; spreading out the nuclei and ensuring entrances are on different sides of a hive unit improves mating success. Painting hives different colours and painting shapes on the sides of nuclei also aids queen bees in returning to the correct hive after mating flights.

Caging and introducing queens

Old queens must be found and removed before new queens are introduced.

Nuclei with young laying queens can be built up into productive colonies, or the queen can be

A well protected, spaced out mating apiary

removed and replaced with a new ripe queen cell. Alternatively, the nucleus can be united to a hive to be re-queened. Current research indicates that queens that are caught 28 days after emerging from the cell and caged for mating are less likely to be superseded than younger queens when introduced into a new colony.

New queens can be introduced into a colony using mailing cages, Miller cages or by papering on a nucleus hive.

Mailing cages which are timber or plastic and used to mail queens from the queen supplier can be used to introduce the queen once she arrives. Hive bees eat through the candy and release the queen in 24–48 hours.

Miller cages are made of wire gauze and timber construction with a small entrance which is filled with queen candy. They are reusable and fit easily between frames.

Papering on a nucleus hive is done by killing the old queen in the brood box and then shaking all the bees out of the second box, placing two sheets of newspaper between the two boxes, and then adding contents of the nucleus colony, making up the balance with frames from the old hive. A variation of this used by commercial beekeepers is to paper a single box with a young queen on top of the old hive and allow the bees to unite; 90% of the time the young queen survives and the old queen is killed.

A range of mailing and introducing cages

JZBZ's cages with banking bar and mailing box

Banking

Banking of mated queens allows the beekeeper to store queen bees until required. Reasons for banking queen bees include wet weather, saving queens for a large order, and allowing the introduction of queens over a period of weeks. Queens can be successfully banked for up to 21 days with minimal losses and damage to the stored queens. Queens can be banked using either:

- the mailing cages they arrive in, or
- wooden bars with ten compartments.

Five wooden bank bars holding 10 queens each

Queen bees are banked in individual cages without escort bees in queen-right hives above an excluder or in queen-less hives. Hives used for banking queens should be strong, disease free and be fed pollen and sugar syrup, and have frames of sealed brood added on a regular basis to maintain large numbers of young bees in the colony.

Banking of queens is a useful management practice but not without risks. Advice from your queen and equipment suppliers should be sought before banking queens.

JZBZ banking bar with cages

Records

Timing is very important for efficient queen bee rearing. Cells must be distributed ten days after grafting or they will hatch and the young queens will destroy each other. In addition, you need to keep track of where the cells are. For evaluation purposes you will also want to know from which breeder each queen originates. Your record system will have to fit your needs and may be as simple as an entry in a diary. Information you could consider includes:

- grafting date
- distribution date
- date the queens emerged
- number of cells started by bees
- mother queen (breeder)
- feeder hives location
- distribution of laying queens
- mating apiary site numbers
- date the queen bees were caught.

There are two alternatives for record keeping.

The first is to keep your information with the cells by writing on the hive, cell bar and nucleus colony. A simple code can be constructed using letters to denote the breeder and numbers to identify the date of grafting. On a bar of cells, D 4/10 would mean cells grafted on the fourth of October from the breeder coded D. On a nucleus colony it would mean a hatching date of 15/10 and the queens may be laying ten days later on 25/10 or soon after. The same code can be extended to re-queening using 'I' for Italian queens and 'C' for Caucasian so the brood box marked with 'I/D 10/07' has an Italian queen grafted from breeder D and introduced in October of 2007.

The second alternative is to use a card or record book to record your information. A typical book could be set out as follows.

Graft Date	Breeder	No. of Cells	Feeder	D'bution Date	D'bution Location
10/8/07	Italian-D	65	19+3+24+6	20/8/07	Yard-4

More detailed records may be needed for evaluation of queen performance. Information on the production, brood rearing, docility and swarming of colonies headed by queens being evaluated will have to be recorded. A card for each colony can be used to record this information in a simple manner. Queens being evaluated should be marked or identified to allow accurate recording and determination of age and so on. You can glue numbered discs to the queen's thorax or mark it with a paint pen. An international colour code is used to identify queen bees produced in a particular year. The colour code can be extended with coloured pins or paint to record data on the outside of the hive.

Queens can also be marked by clipping the tip off one or both of the forewings.

International colour code for marking queen bees

Year ending in	Colour
1 or 6	White or grey
2 or 7	Yellow
3 or 8	Red
4 or 9	Green
5 or 0	Blue

What Next?

Now that you have read this Primefact and you have gathered up all the equipment you need and feel you have the knowledge to rear queen bees – *have a go*!

Practice grafting and making up cell-building hives, starters and nucleus hives. It also helps to work with and gain knowledge from other beekeepers and queen breeders in your district.

Contact NSW Beekeeping Association, your local beekeeping group, or the Australian Queen Bee Breeding Association for queen breeder contacts in NSW. They can direct you to beekeepers in your area who may help to further your skills in the basics of queen rearing.

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