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Honey bee nutrition and supplementary feeding

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INTRODUCTION

This agnote is written to give beekeepers an overview of honeybee nutritional requirements and the role of various carbohydrate and protein supplements in the management of honeybee colonies.

The honey bee (*Apis mellifera)* collects a number of substances to ensure its survival.

- nectar, which the adult bees convert into honey and store in beeswax cells
- pollen, which provides most of the protein, amino acids, fats, vitamins and mineral requirements of a bee's diet
- water, which bees collect to help in maintaining the temperature and humidity of the hive and diluting stored honey to consume
- propolis, which is a naturally occurring glue-like substance that bees use in sealing cracks and crevices in the hive to assist in temperature regulation of the hive and to maintain colony hygiene.

Honey bee nutrition is principally concerned with the quality and quantity of nectar and pollen collected and stored.

NECTAR/HONEY

Nectar is secreted by glands at the base of the flowers, known as nectaries. Field bees collect nectar from blossom in the field. At this stage, the nectar has a high level of sucrose sugar with some laevulose and dextrose and a high moisture content, with traces of other substances such as minerals, vitamins, pigments, aromatic substances, organic acids and nitrogen compounds.

Bees convert this nectar into honey in a series of steps.

When the nectar is initially collected, it is stored in the honey sac of the returning field bee. An enzyme called invertase is added to the nectar while in the bee's honey sac. Invertase converts the nectar, primarily a sucrose solution, to a mainly laevulose and dextrose solution.

The ripening nectar is then stored in the beeswax cells where the moisture content is reduced to 13–18% by the manipulation and fanning of the house bees. When honey is ripe, bees cap the cells with beeswax.

Stored honey is the colony's major carbohydrate or energy source. Honey is consumed by the colony to maintain brood temperatures, to enable workers to fly and for any activity by any individual bee requiring energy when fresh nectar is not available.

> "The performance of bees is truly astonishing. The fuel consumption of a flying bee is about ½ mg honey per kilometre, or 3 million km to the litre. In providing one kilogram of surplus honey for market, the colony has had to consume something like a further 8 kg to keep itself going and the foraging bee has probably covered a total flight path equal to six orbits round the earth — at a fuel consumption of about 25 g of honey for each orbit".
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> *Honey — A Comprehensive Survey*
> Edited by Eva Crane (1975)

The presence of stored honey or fresh nectar is essential for the colony's survival. Without this, the colony will starve, as often happens in late winter and early spring.

The presence of fresh nectar will stimulate the colony to expand its brood nest. The population in the hive will grow, which will ensure a strong hive capable of collecting even more nectar and converting it to honey.

Strong hives are the essence of successful beekeeping.

POLLEN

Pollen is the major source of protein for honey bees. It is largely used to feed developing larvae and young bees to provide structural elements of muscles, glands and other tissues. It is also used in the production of royal jelly, which is a speciality food produced by worker bees that is fed to the queen, developing queen larvae, and worker larvae up to 72 hours of age.

When a colony is actively breeding, or during periods of heavy wax production (such as during a heavy honey flow), the demand for pollen is high. Wax glands use a lot of protein and a lack of pollen or pollen with low nutritional values will have significant management implications.

Pollen is the male germ of a flower. Field bees collect pollen from anthers of flowers and attach the grains to their back legs, which act as pollen baskets. In the process of collecting pollen, bees inadvertently carry out the function of pollination of the various plants they visit.

Pollen is made up of various substances, including proteins, fats, lipids, carbohydrates, vitamins, minerals and many others.

A major factor which has been found to limit rapid increase in colony population is the insufficient supply of suitable pollen. A pollen with less than 20% crude protein cannot satisfy a colony's requirements for optimum production.

The protein component of pollen is composed of a series of amino acids. DeGroot (1953) identified a number of amino acids that are essential for the normal growth and development of bees (see the table below).

Amino acid	Ideal ratio from de Groot (g per 16g N)
Threonine	3
Valine	4
Methionine	1.5
Leucine	4.5
Iso-leucine	4
Phenylalanine	2.5
Lysine	3
Histidine	1.5
Arginine	3
Tryptophan	1

Bees can compensate to some extent for pollens with lower than desirable levels of amino acids by consuming more pollen, and if the pollens have protein of high value, bees can excrete the surplus amino acids. With low value pollens bees cannot physically consume enough pollen to make up the requirements of what is considered as a desirable level of amino acids. Thus, both the quality and quantity of pollen collected by honey bees are equally important.

No complete study has been conducted into the role that fats, vitamins and minerals play in honey bee nutrition. Deficiencies or imbalances may well exist.

For this reason, it is desirable that bees have access to more than one floral source of pollen so as to balance any shortfalls a particular floral species may have.

COLONY POPULATIONS

Economic honey production levels can only be achieved with colonies containing a population of at least 45–50,000 adult bees and 36–45,000 developing bees in the brood cycle [Kleinschmidt, 1986].

To achieve these levels, colonies require good stimulating quantities of nectar and pollen.

The level of body protein also appears to be directly associated with longevity. Bees with high levels of body protein live longer than bees with lower body protein levels. The longer a bee lives, the more opportunity it has to collect greater quantities of nectar/honey.

Thus, attention to the nutritional status of bees will assist in modifying normal population fluctuations and enable the beekeeper to maximise production.

MANAGEMENT STRATEGIES

The ability of the beekeeper to manipulate nutritional conditions in the hive by moving the hive to alternative floral sources or by supplementing or substituting protein or carbohydrates will make the difference between harvesting average honey crops and harvesting excellent honey crops. The greater the hive population, the more honey it will store, given a suitable nectar flow.

Beekeepers have traditionally approached the various floral species with a variety of management practices. For example, species such as Ironbark and Yellow box produce some of Australia's finest honey crops, but they are seriously deficient as a pollen source for honey bees. This usually means that hives working these honey flows will decline — both the population of the colony and the length of time an individual bee lives. Thus, the potential for the hive to collect and ripen nectar and to store honey diminishes.

This has been overcome by sourcing build conditions prior to these expected honey flows. "Build" conditions are those which will supply the hive with a stimulating nectar supply and quantities of good quality pollen. These same conditions are also sourced after a honey flow or if colonies show signs of decline during the target honey flow, the bees may be moved to build conditions again. Otherwise, if left too long on low nutritional levels, particularly pollen, the

colony will take too long to recover to take advantage of any further honey flows.

Knowing the crude protein and amino acid profiles of sources of pollen will enable the commercial beekeeper to make more informed decisions on what actions they are able to take to maintain high nutritional and population levels in their apiaries.

SUBSTITUTES AND SUPPLEMENTS

To stimulate brood rearing, beekeepers have a choice: they can either move hives onto breeding conditions prior to major honey flows, taking advantage of various flowering species, or they can artificially stimulate their hives with supplementary feeding.

This is largely an economic decision as there are costs associated with both moving bees and feeding substitutes and supplements. The term 'supplements' suggests that there is already some naturally occurring pollen and/or nectar in the area for the bees and the beekeeper is making up the shortfall by feeding the hive strategic supplements. Supplements should contain the nutritional components that are deficient in the field as well as make up the required volume a colony may consume.

'Substitutes' suggests that either nectar or pollen, or both, are completely deficient in the field. Honey or nectar substitutes are usually in the form of sugar, preferably as sugar syrup. Large quantities of thick syrup are suitable for feeding to bees to store for winter, whereas small quantities of thin syrup fed regularly stimulates the colony to expand the brood area. If the purpose is to stimulate the colony and increase population numbers , then attention to the protein components of the diet is also essential.

Protein supplements come in a variety of forms. Some beekeepers trap pollen in the field and store for feedback to their hives at a later date. Protein supplements fed to bees should contain at least 5% bee-collected pollen to make the mixtures more attractive to the bees.

CARBOHYDRATE SUPPLEMENTS

If a colony is critically short of stored honey or requires stimulation, feeding sugar syrup to hives will either keep the hive alive (as in winter) or stimulate the colony to rear more brood.

In many cases feeding sugar syrup to a hive will increase the number of field bees foraging for pollen. This may be of benefit in crop pollination situations where bees collecting pollen are more efficient pollinators than nectar collecting bees. Some crops do not provide significant quantities of nectar, and stimulation from sugar syrup may significantly increase the overall pollination efficiency of a colony of bees. A three-year trial in New Zealand indicated that feeding one litre of syrup per day per colony in the morning resulted in a greater amount of pollen being collected by bees.

If it is not consumed immediately, feeding sugar syrup requires bees to process the syrup by reducing the moisture content and storing it in combs.

HONEY

Feeding honey to a hive in some circumstances is possible, although bees do not seem to do as well on honey compared to sugar syrup. It may be better financially for the beekeeper to sell the honey and buy sugar. If honey has candied in combs then these combs can be stored and given to colonies as required.

Feeding honey to a hive is not desirable if the aim is to stimulate the hive. The colony will reduce the brood area, the bees will become more defensive and robbing activity will increase.

There are risks associated with feeding honey to colonies, the main one being the possible spread of American foulbrood. AFB spores are readily transferred in honey, so you must know the source of any honey you are feeding to bees and be mindful that AFB spores will persist in honey and elsewhere for 35 years or more. It is important that the honey should not contain any bee disease organisms.

TYPE AND CONCENTRATION

White cane sugar (sucrose) is the most readily available sugar substitute for fresh nectar. It may be fed dry or in a syrup form.

Feeding other types of sugar may cause digestive problems. The attractiveness to honey bees of different sugars varies. In an Israeli experiment (published in 1996) involving sucrose, glucose, fructose and invert sugar, fed to hives of the same strength and under similar conditions, sucrose and invert sugar were found to be the more attractive sugars for honey bees.

Feeding high-fructose corn syrup is popular in North America, mainly due to its low price.

At times beekeepers have been able to obtain waste sugar from sweet factories or other sources but the problem with these sources is that additives to the sugar may be toxic to your bees.

White cane sugar probably remains the safest and most reliable nectar substitute for honey bees.

The concentration and quantity are equally important. For colony stimulation in spring or when queen rearing, feed small quantities (1–2 L) every few days of a 1:1 concentration of sugar and water by volume. To provide stores for winter, a colony should be fed in the autumn with quantities of 5 to 10 litres on a regular basis (weekly) until the colony has sufficient processed sugar stored.

For winter stores a ratio of 2 parts sugar to 1 part water is used to provide a dense syrup. Do not feed a sugar syrup mix thinner than a 1:1 ratio as bees have to do too much work to retrieve the sugar and the process may actually damage the colony.

SUGAR FEEDERS

There are a number of methods of feeding sugar to a colony.

Sugar fed in a dry form can be used in an emergency. The sugar is heaped, perhaps ½ kg to 1 kg, on the inner mat of a hive. The amount depends on the strength of the colony, as it does in all supplementary feeding situations. This method has been used through winter when the colony is running short of stored honey and it would be detrimental for the beekeeper to interfere with the colony.

The amount of honey stored in the hive may be determined by tilting the beehive forward. If the hive is excessively light, lift the lid and place the dry sugar on the inner mat. Check within a week to determine whether the colony requires further sugar supplies.

The disadvantage of this method is the dry sugar can be scattered around the hive and lost to the bees. This method works best when conditions are humid.

Feeding sugar in syrup form is the most popular and probably most effective method. There are a multitude of different types of sugar syrup feeders and the exact detail depends on what materials the beekeeper has and which commercial feeders are available.

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Bottom board feeder

A bottom board feeder or ‘Alexander’ feeder replaces part of the bottom board. The bottom board is slid forward and a tray containing sugar syrup is replaced in the gap provided. This feeder is dependent on purpose-built feeders and loose bottom boards. This method is not widely used and only small quantities of sugar syrup can be supplied at each feeding.

Boardman feeder

A jar placed on a special feeding frame at the entrance of a hive has been popular but has some major restrictions. These containers are often referred to as Boardman feeders. They are only useful for very small quantities of sugar syrup in a situation where stimulation of a colony is required. They should be refilled each day if used. These feeders may encourage robbing due to their location at the hive entrance.

Division board feeder

Division board feeders are purpose-made frames that will hold syrup. They may hold only one to three litres but this may be useful in a queen-rearing apiary where stimulation of the hive is desired. Unfortunately, the colony is exposed for the frame feeder to be filled; this may be very harmful to a colony of bees during cool or cold weather. An existing frame must be removed to place the division board feeder into the hive. Timber shavings, a wire screen or twigs should be placed in the feeder to prevent bees being drowned while taking up the sugar syrup.

Top feeder

Top feeders come in a variety of designs and sizes and are probably the main method of feeding quantities of sugar syrup to a hive. Various size buckets or jars with small holes in the lids are inverted over the top frames or a hole in the lid of a hive. An empty hive body can be placed on the hive and jars or buckets placed in this hive body. The lid of the hive is placed on the hive over the feeders. If syrup feeding is conducted on a regular basis some beekeepers cut a 5–10 cm diameter hole in the middle of a lid to enable easier feeding of colonies. Specially made top box feeders can also be constructed to feed larger quantities of syrup to bees. Syrup can also be placed in various sized plastic bags, punctured with a number of small nail holes, and placed on the top bars. This is also a useful method for feeding syrup on an occasional basis.

Bulk feeding

Outdoor feeding in bulk containers has been used in emergency situations (such as in drought) to save the beekeeper time. This practice is not recommended during standard management procedures for a number of reasons.

Exposing syrup to hungry colonies incites robbing. This will make hives become defensive and bees aggressive.

Stronger colonies that may have sufficient stores may collect larger quantities of syrup than weaker colonies that require the sugar.

By feeding syrup in an open feeder you may well be feeding the neighbour’s beehives as well as your own.

PROTEIN SUPPLEMENTS

The need to feed bee-collected pollen or protein supplements will depend a lot on the amount of brood in the hive, the amount of stored pollen, current and future nectar and pollen conditions and demands to be placed on the hives.

If hives are critically short of pollen and either have a large brood nest or are expanding their brood nests, then the beekeeper needs to consider the various options available to avoid a reduction in bee population numbers due to shorter lived

bees. This ultimately results in weaker colonies that are not suitable for working honey flows or crop pollination.

One option is to physically move the apiaries onto a naturally occurring pollen source. If this is not feasible due to the cost and inconvenience of moving the bees or because a suitable pollen source is not available, then feeding pollen or protein substitutes may need to be considered.

Prolonged feeding of protein supplements will result in short-lived bees. Two generations of brood can be satisfactorily obtained before this situation develops. Feeding supplements or pollen should begin approximately 6 weeks prior to an expected natural source of pollen being available.

> " Prolonged feeding of protein supplements will result in short-lived bees "

Various sources of information suggest that feeding a protein supplement will decrease the amount of foraging for pollen by field bees. On the other hand, it has also been stated that when a natural source of pollen becomes available then consumption of pollen substitutes diminishes. There may well be a combination of these two factors occurring concurrently.

The presence of drone brood has been one measure of the colony's nutritional status, since drone brood appears during periods of ample pollen availability and is reduced when pollen is in short supply.

POLLEN AS A SUPPLEMENT

Naturally-collected pollen is the best source of protein for honey bee nutritional requirements but this pollen can vary in protein according to the floral source. Protein levels vary from 6% to 40%; the minimum protein level required for honey bees is 20%. If the aim is rapid breeding and expansion of the hive population to work a heavy honey flow, crude protein levels of 25–30% are required. The balance of amino acids is also important, as discussed earlier. Thus a single naturally occurring pollen may be deficient in one or more components required for honey bee nutrition.

Adequate nutritional requirements are met when the colony is collecting pollen from a number of different floral sources and sufficient quantity is maintained. One colony over a 12-month period will consume 25–50 kg of pollen, depending on the size of the colony and the availability of pollen.

Storing pollen in combs to feed back to colonies at a later date has been practised for many years. This involves removing combs of pollen from hives during periods when the colony is storing a large surplus and placing these combs back into colonies during periods of dearth. Storing the combs can become a problem due to waxmoth and mice damage. It is advisable to store pollen frames in a freezer or cold room.

Alternatively, pollen traps can be placed on a beehive where the bees are forced to enter though a series of screens that scrape the pollen off the back legs of the returning field bees and the pollen is caught in a collection tray underneath. The pollen is then stored by either freezing or drying the pollen. Some beekeepers store the pollen by keeping the pollen in buckets, pouring just enough honey over the pollen to soak the pollen, then sealing the bucket until required.

- Trapping pollen during the swarming season has been shown to reduce the swarming incidence of colonies.
- Bees are more attracted to pollen fed back to the colony than to supplements and will consume them more readily.
- Pollens with high nutritional values should be trapped in preference to pollen with lower values. If the nutritional value is high enough, pollen is quite often fed directly back to a hive when required without the addition of other substances.

CAUTION

As with honey, pollen can carry and transmit bee diseases. If trapping and storing pollen yourself, check that hives are disease free; if you are buying pollen, use only pollen that has been sterilised by gamma irradiation.

Other substances may be considered if sufficient collected pollen is not available. For example, pollen can be purchased from beekeeper supplies for this purpose. The cost of trapping and storing or buying pollen can be quite high, but other substances may be used solely as a substitute for pollen or as a supplement with pollen. Including at least 5% pollen into any recipe for feeding bees protein supplements is highly recommended to increase the attractiveness of the mix to the colony and to stimulate the hypopharyngeal glands of worker bees. Fresh or stored pollen stimulates the hypopharyngeal glands of older nurse bees to produce royal jelly for feeding to young developing larvae and the queen bee.

POLLEN SUBSTITUTES

A number of different substances have been trialed, by many researchers and beekeepers, looking at many factors.

- Attractiveness to bees. If the bees are not attracted or are repelled by the material it is of little value, although this can often be overcome by the addition of sugar or irradiated honey or pollen.
- Availability. Some substances have proven to be useful supplements but their availability is unreliable.
- Cost. If the cost of the components is excessive, then feeding supplements may well not be an economic proposition.
- Nutritional values. The substance must have protein and amino acids at the desired levels to achieve honey bee nutritional requirements.
- Toxic substances. High levels of some substances such as oil, salt and starch have been blamed for killing bees. It is counter-productive to be feeding colonies substances that may well kill bees and brood. Substances with high levels of crude protein are also toxic to honey bees.

As research continues, costs of substances change, nutritional values vary, and the availability of those substances fluctuates, so do the recommendations for recipes for mixing and preparing protein substitutes. Substitutes need to include ingredients that balance honey bee nutritional requirements to avoid high levels of toxic substances.

Some of the ingredients considered include soya flour, canola flour, linseed flour, sunflower flour, torula yeast, brewers yeast, bakers yeast, vitamin and mineral supplements, fish meal, peanut flour, skim milk powder, powdered casein, sodium caseinate, lactalbumin, pollard.

All ingredients, including flour, must be fine-milled to a particle size of under 500 microns. The nutritional values of the various substances vary significantly.

Soya flour

Soya flour has been used and recommended by many sources, but not all soya flours are equal. The flour must be expeller processed to remove its high oil content (15%). Solvent-extracted flour will have residues toxic to the bees. Using high-fat soya flour is not a problem if the final mixture of ingredients has a fat level of around 7% or lower.

Protein levels for soya flour have been recorded at 50%. It is deficient in one amino acid, tryptophan. Soya flour on its own is not very attractive to bees and the processing of the flour is not always up to the standard required to safely use for feeding colonies of bees, but it is one of the cheaper supplements. It is most important to store soya flour in a cold room to prevent the oil component from going rancid.

> “ One colony over a 12-month period will consume 20–40 kg of pollen, depending on the size of the colony and the availability of pollen ”

Canola and sunflower flour

Canola and sunflower flour must also be treated to remove their high oil contents. The protein contents are not as high as soya flour and they are said to be not as attractive to the bees. Sunflower flour minimises what bees eat as it has repellent properties. It is best to avoid this ingredient in protein supplements.

Sorghum and triticale flour

Sorghum and triticale flour have been found to be highly attractive to bees but they are not recommended as the dominant ingredient in a mix due to their very low crude protein levels.

Torula yeast

This is generally more attractive to bees than soya flour although the nutritional quality of the yeast varies according to the origin. Protein levels around 50% and fat contents at 7% are quite acceptable. The amino acids are not at acceptable levels, thus torula yeast on its own is unsatisfactory.

Brewers yeast and bakers yeast:

These yeasts are more attractive than soya flour, their protein levels are around 50% and generally they provide a more balanced set of amino acids than torula yeast. Bakers yeast is more expensive than torula yeast and brewers yeast.

Vitamin and mineral supplements

These have been added to recipes at 1–3% of the mix but the benefit of this addition is not fully understood as little research has been conducted in this area of honey bee nutrition.

This is not a complete list of all substances that have been used or are in use for feeding to bees. It is a list of ingredients that have been considered and used by a few researchers and beekeepers in recent times.

To mix large batches of protein supplements, the availability, quality and cost of each ingredient must be considered.

MIXING AND FEEDING POLLEN AND SUBSTITUTES

Whether you are feeding bees for maintenance or for breeding is a prime consideration when determining the quantity of supplements to feed to each hive.

There is a wide range of opinions on the quantity that should be fed to a hive, although a quantity of 500 grams per hive per week is probably considered adequate for a strong colony in most circumstances. A smaller colony covering 3 frames may only require 100 grams every two weeks.

Once feeding has begun it may well be detrimental for the hive if subsequent supplies of protein supplements are not available to the developing bees. An expanding brood nest stimulated by the addition of protein supplements continues to require a source of protein until a natural source of pollen is available in the field.

Food for the bees can be in the form of cakes or patties or loose in a powder form.

Pollen on its own can be fed to a hive in a powered form without any additional substances. Usually to extend the pollen it is mixed with other substances such as soya flour or torula yeast or both. The minimum quantity of pollen should be 5% of the mix.

Pure icing sugar or white sugar is added to make the mixture more attractive to bees.

The quantity of sugar may represent 50% of the dry mix depending on the bees' requirements and the relative attractiveness of the mix. Using sugar as an ingredient in patties will cause the patty to set like concrete. If sugar is used, ensure a 70:30 sugar to water ratio. This will inhibit mould growth on the patties once mixed. Honey may be substituted for the sugar but again, be mindful of the risk of spreading bee diseases through honey. Ideally the honey should be sterilised by gamma irradiation. Patties made with honey stay more pliable and are easier for the bees to consume.

If pollen patties are being made but not being fed immediately to honey bee colonies, they must be stored correctly to prevent deterioration of the ingredients. A food preservative may be added at the time of mixing to help alleviate this problem and/or the patties should be stored in a freezer.

Feeding dry mixes can be done by measuring the required amount and placing it on the inner cover of each hive. Another method is by providing an external bulk feeding station where bees fly and gather their requirements, this method may save labour. Although there is no control over the quantity each colony collects. Hives with a high requirement for a supplement may not be able to collect sufficient supplement.

Inclement weather may prevent or reduce flight and you may well be providing a free lunch to all the other bee colonies within flying distance of your apiary.

Feeding in a cake or patty form allows a more accurate amount to be fed to each hive according to their requirements.

Methods of mixing vary according to each operation, the amount to be mixed, and equipment available. Large volumes of supplement can be mixed with an industrial dough mixer. Mix all the dry ingredients thoroughly and then add water until a thick dough is created. Measure out into 400 to 500 gram patties, placing them between sheets of greaseproof paper. Patties can be stored in the freezer until required.

The patties should be placed directly on top of the brood nest and under the queen excluders to allow easy access.

RECIPES

There are a multitude of different recipes available but the following provides a general guide:

pollen	5%	plus
sugar	20–50%	
yeast (torula)	20–50%	
flour (soya)	20–50%	
vitamin supplement	1–3%	

Increasing the amount of pollen and sugar will make the supplement more attractive to the bees. One of the main failures of feeding supplements in the past has been a general lack of attractiveness to the bees.

Cost and availability of ingredients will largely determine what combination of ingredients you use.

It is important that you do not concentrate on cheap ingredients — it is better to consider the most effective ingredients that will provide the honey bee nutritional requirements at the lowest unit cost.

Commercial supplements

Buying prepared patties or protein cakes may well be an attractive proposition. Many of the commercially available protein supplements have proven to be attractive to bees and provide adequate honey bee nutritional requirements, and their availability is reliable. You also do not have the problem of buying all the necessary ingredients and finding a suitable mixing machine.

They may be considerably more expensive, but you only need to buy the quantity that you will use at any one time.

CONCLUSION

Circumstances under which feeding supplements benefits colonies vary from location to location.

There is still a lot not understood concerning honey bee nutritional requirements under various management circumstances. Feeding sugar syrup has been proven to be highly beneficial in stimulating colonies and particularly keeping colonies alive. The feeding of sugar syrup is practised widely in many beekeeping countries, whereas feeding pollen substitutes is not as widely practised. There will be a range of circumstances where protein supplement costs versus returns will be your major consideration. Try leaving 10% of the hives in an apiary without supplements to gauge the return on your investment in this activity. After a few years of feeding supplements you should gain an appreciation of the circumstances in which you will benefit by investing in protein supplements and when not to feed supplements.

Paying attention to honey bee nutrition is just one of the more important aspects of successful beekeeping. Ensuring that hives are populated by young productive queen bees is equally as important as paying attention to the management of honey bee nutritional requirements.

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