CANADIAN

Best Management Practices for

HONEY BEE HEALTH

Industry Analysis & Harmonization

The report entitled Canadian Best Management Practices for Honey Bee Health was commissioned for discussion purposes by Agriculture and Agri-Food Canada (AAFC) on behalf of the Bee Health Roundtable, an industry-government forum.

The content of this report does not necessarily reflect the opinions or interests of the entire Bee Health Value Chain Roundtable (VCRT) membership or AAFC, nor does it necessarily reflect the opinions or interests of all parties interviewed during the researching of this report. The recommendations resulting from the report are not binding on any participant of the VCRTs or AAFC.

INTRODUCTION

Best Management Practices (BMPs) for the honey bee industry are developed by different levels and divisions of government, various organizations, institutions and stakeholders. Content ranging from regulations for pest and disease treatment thresholds to management of colonies during pollination services are included. While in many cases these recommendations are readily available, their authors are varied and the publications are provided by diverse sources. Some recommendations will apply to the Canadian nation as a whole, while others will only relate to specific areas of the country. The BMPs discussed in this document refer to those that pertain to honey bee health. Traceability aspects like food safety, beekeeper safety and environmental safety are not included within this BMP document.

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HIVE EQUIPMENT AND APIARY MANAGEMENT

Maintenance of the beekeeping equipment within an operation is an important aspect to sustaining healthy bees. Renewing materials that are susceptible to contamination buildup and wear and tear and utilizing good maintenance practices can help reduce exposure to pests, diseases and chemicals, as well as extend the life of hive parts and other equipment. In addition, maintaining clean apiaries and employing hygienic practices in aspects of apiary management can also help to reduce the exposure to and spread of pests and diseases.

EQUIPMENT

Comb Replacement

It is recommended that beekeepers replace a portion of frames from the brood chamber each year with fresh foundation or drawn comb from honey supers. Culling frames reduces colony exposure to pesticide residues that accumulate in the wax over time. This helps prevent the sub-lethal effects of pesticides on bees as well as reducing the risk of contaminating honey. Replacing frames also helps reduce the amount of pathogens and disease spores that also accumulate on the wax over time. This is particularly important in the prevention of American foulbrood (AFB) and Nosema infections. Replacing frames can also help to slow the development of antibiotic resistance in AFB and miticide resistance in Varroa mites.

Replacing frames at a rate of 2-4 frames per year is ideal. This is generally done during spring cleaning of colonies. Older frames with thick, dark comb and with more than 10% drone cells should be replaced first. Ideally, no brood frame in the hive should be older than 5 years of age.

Replace a portion of older brood frames containing dark, thickened or drone cell sized wax at a rate of 2-4 frames/year with fresh foundation or honey super drawn comb.

Regional Differences

In areas of the country such as Newfoundland where Varroa mites are not present and agricultural pesticide use is low, replacing old frames does not have as big of an impact on reducing pesticide and miticide residues in wax. However, the same comb replacement practices are still recommended as they help reduce AFB and Nosema spores and other pathogens, as well as slow the development of antibiotic resistance in AFB.

Equipment Management

In the interest of biosecurity, it is recommended that beekeepers disinfect beekeeping equipment that comes in contact with bees. This includes the disinfection of dead-out hive boxes and frames and regular disinfection of tools, such as hive tools and smokers. Used equipment should be disinfected (irradiation, acetic acid, ozone) before being re-used in the operation. Irradiation in particular is highly recommended to prevent AFB transmission, whereas acetic acid fumigation is a routine preventative method to guard against Nosema.

Beekeeping equipment should be sterilized regularly when moving between bee yards. Hive tools should be scraped clean and heated to a high temperature, as should smoker bellows. Leather gloves can be exchanged for disposable gloves or used in conjunction with rubber gloves for ease of sterilization. Special precaution should be taken around equipment with greater risk of contact with wax and honey that may contain AFB spores.

Equipment that comes in contact with live colonies should be disinfected regularly through scraping and the application of heat.

Regional Differences

Access and proximity to irradiation facilities varies across the country. In addition, many facilities will only irradiate large amounts of beekeeping equipment (for example, a tractor trailer load of equipment at the minimum). Beekeepers located far from an irradiation facility, or with too few colonies to use their services, may have to rely on other means of disinfecting equipment, such as acetic acid, ozone fumigation or wax dipping.

Purchasing Equipment

It is recommended that beekeepers purchase only new equipment from known and reliable sources to avoid introducing disease spores, toxins or pesticide residues into their operation. If used equipment is to be purchased, it should be done with caution, making sure it is sterilized and accompanied by the proper inspection permits for its sale.

Purchase only new, unused beekeeping equipment from known and reliable sources to avoid potential disease spores, toxins or pesticides residues.

Regional Differences

Access and proximity to beekeeping equipment suppliers varies across the country. Beekeepers should contact their local or provincial beekeepers' associations to find known and reliable suppliers in their area. Some of these associations also manage classified advertisements where used equipment can be bought and sold. Buying used equipment should be done with caution, and with proper inspection permits in accordance with provincial requirements.

APIARY SETUP & HIVE PLACEMENT

Recommended hive placement criteria include a dry area with access to clean water and abundant forage for good honey production. Hives should be kept dry by keeping bottom boards up off the ground and free of vegetation to provide air circulation and avoid moisture. Placing hives outside of low-lying areas is also recommended to avoid flooding and settling of cold air. Sun exposure is important – hives should be situated with southern sun exposure and should be painted with light-coloured paint to reflect heat. Protection from wind, livestock and wildlife will help to prevent stress on the colony as well as equipment damage. Electric fences are recommended in areas where livestock or wildlife such as bears may be present. Yards should only contain the number of colonies that can be sustained by nearby floral resources and should be organized to avoid drift between colonies (for example, use different paint colours for different hives or orient hives in different directions).

Important features of an apiary include:

- Dry location
- Southern sun exposure
- Access to clean water
- Access to abundant forage
- Wind protection
- Protection from livestock, wildlife
- Exclusion from public attention/vandalism
- Year-round vehicle access
- Room to work comfortably and expand hive numbers

Regional Differences

The hive placement considerations listed above are guidelines only and will vary depending on the province, climate and specific topography of the location in question. Areas that are more flat and open, such as the Prairies, will make the inclusion of shelter and windbreaks more important. In wooded or more northern areas where there is a higher risk of bear and other wildlife damage, electric fences are recommended. The available forage in the area will also vary based on the province and how intensively the surrounding area is used for agriculture or urban development. Beekeepers should take all of these factors into account when deciding where and how many hives to place in a yard. Provincial regulations and urban by-laws may also dictate additional rules on hive placement.

OUTDOOR WINTERING

To prepare colonies for outdoor over-wintering, it is recommended that beekeepers ensure that colonies are healthy and populous and have adequate food stores. Colonies should ideally have a large cluster, an abundance of young bees and a young, fertile queen. Colonies should be fed with 70% (2:1) sugar syrup and should weigh 80-90 lb (36-40 kg) if single brood chambers are used and 120 lb (54 kg) if double brood chambers are used. In addition to winter syrup stores, colonies should have 3-6 well-filled frames of pollen. Screened bottom boards should be closed and entrance reducers installed to keep out cold drafts and prevent mice from entering the hive. An upper entrance should be provided to encourage air movement and to remove excess moisture. Colonies should be tipped forward to drain water that may collect on the bottom board. Winter wraps and insulation to provide warmth retention and wind protection are also recommended for outdoor over-wintering and should be left on until night temperatures are above 0°C.

Single brood chamber colonies should weigh 80-90 lb (36-40 kg) going into outdoor wintering; double brood chamber colonies should weigh 120 lb (54 kg).

Regional Differences

Due to the longer, colder winters in western provinces and more northern areas of Canada, there are a number of additional aspects to be considered. Colonies should be placed in areas with extra wind protection and fed prior to re-location if moving is a requirement. Colonies are not generally over-wintered in single brood chambers and require extra feeding. Colonies with full food stores should weigh 140-160 lb (63-73 kg) if double brood chambers are used and 160-180 lb (73-82 kg) if triple brood chambers are used. The most common method of wrapping and insulating colonies is in groups of four with open upper entrances for outdoor wintering.

INDOOR WINTERING

Over-wintering colonies indoors requires strict control of temperature, air circulation and ventilation in order to remove heat, excess moisture and carbon dioxide while providing fresh air. Light exclusion is also important to keep bees inactive. Using a light source with a red filter can provide visual support that bees do not react to. Recommendations are detailed and extensive for the planning and construction of indoor wintering facilities and can include temperature control systems, thermostatically controlled fans, heating and refrigeration units, light traps, window coverings, double door entrances and red lighting. A back-up power supply is recommended in case of emergency. Indoor over-wintering facilities are generally kept at temperatures between -1°C and 7°C, and relative humidity should be kept between 50 and 70%. These temperature ranges ensure consumption of honey stores is at a minimum. Hives should be organized with adequate space (1 m row spacing) and perpendicular to air ducts to encourage air circulation. Feeding of colonies to prepare them for winter should be done before they are moved indoors. If colonies are to be stacked, care must be taken to leave room for entrance feeders, hive-top feeders or for colonies to be opened for in-hive feeders. Colonies should be moved indoors once outdoor temperatures are cold, typically in late October or early November.

Indoor wintering requires strict control of temperature, air circulation, ventilation and lighting.

Regional Differences

While the temperature controls of indoor over-wintering facilities are generally maintained within the same range regardless of location, differences can exist in the duration that colonies remain indoors. Due to the longer winter in western provinces and northern areas, beekeepers in these provinces are required to take additional steps and feed colonies more in order to prepare for winter. Single brood chambers should weigh 85-100 lb (39-45 kg) and double brood chambers should weigh 140-150 lb (62-68 kg).

Key Points to Remember

Equipment & Tools

- Replace a portion of brood frames each year with fresh foundation or honey super comb.
- Equipment that comes in contact with live colonies should be disinfected (hive tool, smoker, etc.).
- Leather gloves can be exchanged for disposable gloves or used in conjunction with rubber gloves for ease of sterilization.
- Purchase new, unused beekeeping equipment from known and reliable sources to avoid potential disease spores, toxins or pesticide residues. Used equipment should be accompanied by proper inspection permits and purchased with caution.

Apiary Setup

- Place hives on stands in dry areas with access to southern sun, clean water and abundant forage and with protection from wind, livestock, wildlife and vandalism.

Outdoor Wintering

- Colonies should be healthy and populous going into winter with an abundance of young bees and a young, fertile queen.
- Feed colonies with 70% sucrose syrup and ensure 3-6 frames of pollen are present in the brood chamber.
- Single brood chamber colonies wintered outdoors should weigh 80-90 lb (36-40 kg), double brood chamber colonies should weigh 120 lb (54 kg).
- Provide an upper entrance, tip colonies forward and close screened bottom boards for outdoor wintered colonies.
- Wrap outdoor wintered colonies with an insulative barrier until overnight temperatures are above 0°C.

Indoor Wintering

- Indoor wintering requires strict control of temperature, air circulation, ventilation and lighting. Back-up power supplies are recommended in case of emergency.
- Maintain temperatures between -1°C and 7°C and relative humidity between 50 and 70%.
- Place hives in rows 1 m apart (approx. 3') and perpendicular to air ducts for indoor wintering.

PESTICIDE EXPOSURE PREVENTION

Honey bees can be exposed to pesticides through a variety of routes. Bees returning to the hive with contaminated food and water can, in turn, expose the queen, the brood and younger workers to pesticides from the environment. Insecticide exposure is a primary pesticide concern; however, fungicides and herbicides can also have harmful impacts on honey bees. There can also be serious sub-lethal or chronic effects from these routes of exposure. Pesticides administered by beekeepers should be applied in moderation and according to label directions.

ENVIRONMENTAL PESTICIDE RISK

Environmental exposure to pesticides can be detrimental to bees. Communication between growers and beekeepers is crucial in order to reduce the risk of pesticide exposure. Actions are required on the part of both the beekeeper and the grower in order to prevent hive and crop losses. Having knowledge of where and when pesticides will be applied can also aid in protecting hives. If a natural water source is not available or may have been contaminated by runoff, providing supplemental water that is clean and free of contaminants can assist in preventing pesticide exposure. Providing favourable pollinator habitats can also help ensure that the nutritional needs of bees are being met in order to better help them fight off and detoxify contamination issues.

When providing colonies for pollination services, beekeepers are encouraged to remove colonies as soon as pollination is complete. This will help to reduce exposure to any insecticides that are applied post bloom. If the colonies cannot be removed promptly, beekeepers can place a soaked cloth at the entrance of the hive to disrupt the flight of the bees for up to 12 hours. Prevent overheating of the hive and do not confine the bees for any longer than 12 hours.

Beekeepers are encouraged to report to Health Canada (www.hc-sc.gc.ca/contact/cps-spc/pmra-arla/infoserv-eng.php) any incident related to the use of a pesticide that is suspected to have harmed the health of bee colonies. The collection of bee samples suspected to have been affected by pesticide poisoning must be completed quickly since many pesticides degrade rapidly after the bees' death.

The majority of pesticide risk Best Management Practices (BMPs) are directed toward growers. They are advised to avoid spraying during the daylight hours and to avoid spraying during flowering periods. In addition, they are encouraged to use proper equipment that is effectively calibrated and with deflector shields installed. Growers should always follow all directions on pesticide labels and can also reduce poisoning incidents by being aware of weather conditions and reducing drift. These recommendations also help to minimize soil and water contamination. Beekeepers should discuss the available BMPs with growers and maintain open communication throughout the growing season.

Regional Differences

Currently, the "Drift Watch" program, which facilitates the mapping of apicultural operations and crop production, as well as facilitating communication between cash crop growers and beekeepers, is only being employed in Saskatchewan. This program is used to mitigate pesticide exposure to honey bee colonies.

IN-HIVE RISK

In addition to environmental and agricultural pesticides, in-hive treatments are also a risk to bees. Proper application of acaricides, antibiotics and supplements in accordance with label directions is important to minimize the overuse of chemicals and additives in the hive. Regularly cleaning out and replacing older frames can also diminish the buildup of chemicals within the hive.

Regional Differences

Currently, in Quebec and Ontario, samples of suspected bee kills from pesticides can be sent in for analysis and documentation, free of charge. Quebec will continue this service in provincial labs, however this service may not be available in future years in Ontario.

Pesticides administered by beekeepers should be applied in moderation and according to label directions.

Key Points to Remember

- Bees returning to the hive with contaminated food and water can, in turn, expose the queen, the brood and younger workers to pesticides from the environment.
- Communication between growers and beekeepers is crucial in order to reduce the risk of pesticide exposure.
- If a natural water source is not available or may have been contaminated by runoff, providing supplemental water that is clean and free of contaminants can assist in preventing pesticide exposure.
- Beekeepers are encouraged to report to Health Canada any incident related to the use of a pesticide that is suspected to have harmed the health of bee colonies.
- Regularly cleaning out and replacing older frames can also diminish the buildup of chemicals within the hive.

INTEGRATED PEST MANAGEMENT ASPECTS

The approach to integrated pest management (IPM) is consistent throughout the provinces. The four main components of an IPM approach are pest awareness, monitoring, utilizing thresholds and implementing solutions.

Pest Awareness

Being aware of the pests and diseases that affect honey bees in Canada is key to an IPM approach. In order for an IPM strategy to be successful, it is not only important to be aware of the pests and diseases themselves, but also important to have an understanding of how these pests and diseases can impact colony health. In addition, understanding how these pests and diseases are affected by factors like location and environment will aid in their control. Beekeepers are encouraged to stay up-to-date, be aware of changes and investigate the particular characteristics of new and current pest threats. Knowing what pests to look for and the risks they pose to honey bee colonies is crucial to managing pests and diseases effectively.

It is important to understand that there is a compounding effect when more than one pest or disease is present, and this situation will increase the need for intervention. While any one pest or disease can be detrimental on its own, a combination of threats can be particularly damaging and will diminish the ability of bees to manage threats effectively.

Monitoring

Monitoring for pests and diseases is a very important aspect of an IPM approach. Monitoring is not only beneficial from an economic stand-point, but it can help prevent the spread of pests and diseases to other colonies in the operation. As a pest population increases, it can cause damage to a colony and, in turn, cause an economic loss. Knowing the levels of pests and diseases in an operation allows the beekeeper to make decisions about when treatments should be applied and which treatments should be used. If treatments are not needed, money is saved and the development of antibiotic and chemical resistance can be slowed as less exposure to the chemicals occurs. Treating only when necessary can increase the number of seasons a chemical can be used before resistance develops.

Utilizing monitoring tools such as sticky boards, alcohol washes, ether rolls and sugar dusting to determine Varroa mite levels is integral to an effective IPM approach. It is also important that monitoring is done often. Regular monitoring can track changes in pest population levels and indicate when they are above economic thresholds. Checking pest levels before and after a treatment is also important to ensure that treatment was effective.

Visual inspections of the brood chamber on a regular basis will help identify brood diseases, potential pest problems, population changes, queen problems and other irregularities.

Thresholds

Through research, inspection and regular monitoring, treatment threshold levels can be established for honey bee pests and diseases. Thresholds are typically provided in the pest and disease treatment recommendations provided in BMP documents for different provinces and regions. Thresholds are guidelines that assist the beekeeper in making decisions about when and what to treat for. No threshold is absolute; it is a warning that intervention may be needed. Thresholds can be affected by time of year, environment, colony strength and apiary management. For example, while a queenright and queenless colony may have the same level of phoretic Varroa mites, established through monitoring, the Varroa levels in the brood will also need to be considered. In this case, the queenright colony may have a much higher Varroa infestation than the queenless colony that has little or no brood.

Thresholds are guidelines that assist the beekeeper in making decisions about when and what to treat for. No threshold is absolute; it is a warning that intervention may be needed.

Solutions

Implementing effective solutions is the final step of an IPM approach. The focus is to manage the levels of pests and diseases in the operation, as opposed to eradicating them. However, several steps can and should be taken to minimize the spread of pests and diseases, diminish chemical exposure to honey bee colonies, maintain the health of the bees and provide optimal living conditions within the management of a honey bee operation.

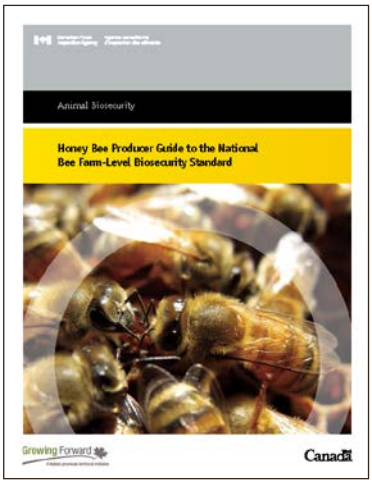
Management practices that are part of an effective IPM strategy may include:

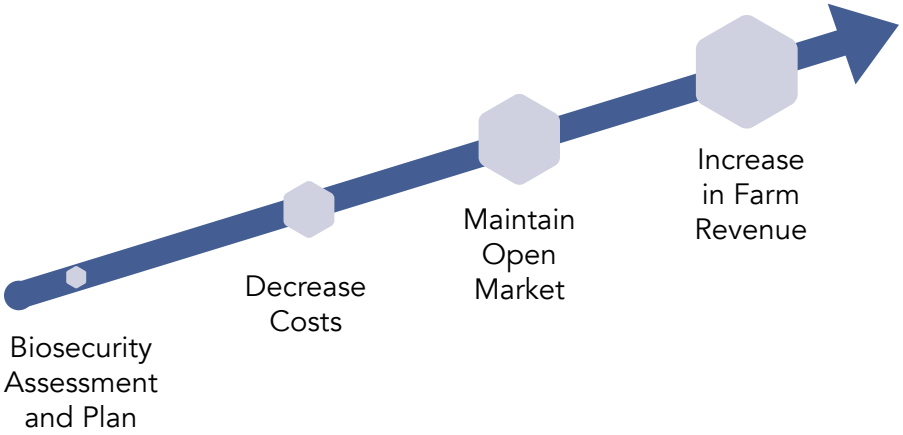
- Alternate chemical controls (do not rely on one single product to treat for a pest or disease)
- Follow label directions (don't over-treat or under-treat, as both can lead to resistance), only use registered treatments and be aware of the environmental effects on treatment applications (temperature dependence)
- Keep accurate records to help track changes and identify trends in pest and disease populations
- Maintain strong colonies; deal with sick hives promptly, don't combine a sick colony with a strong one, isolate sick and/or weak colonies, employ young, healthy queens and check colonies regularly
- Use tested and proven hygienic stock, and buy bees/queens from a reliable, local source
- Disinfect dead-outs and maintain bee-tight equipment
- Protect hives from bears, skunks, raccoons and other wildlife (fencing), and protect hives from environmental conditions (winter wraps, wind blocks)
- Use cultural management techniques to assist in reducing pest threats (screened bottom boards, drone brood removal, queen arrest methods, removing old comb, using hygienic stock)
- Test for chemical resistance (monitor before and after treatments, Pettis test)
- Reduce robbing opportunities and avoid open or barrel feeding
- Conduct management practices in high-risk yards at the end of a working day
- Avoid purchasing used equipment unless inspected and certified
- Provide clean feed and water sources to assist in maintaining bee health
- Employ optimal stocking rates for available forage provisions (do not put more colonies in a yard than the surrounding area can support)

Key Points to Remember

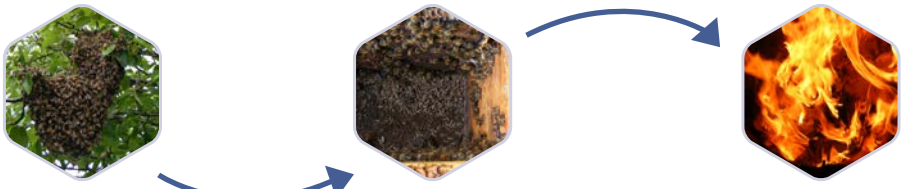
- The approach to IPM is consistent throughout the provinces. The four main components of an IPM approach are pest awareness, monitoring, utilizing thresholds and implementing solutions.
- Beekeepers are encouraged to stay up-to-date, be aware of changes and investigate the particular characteristics of new and current pest threats. Knowing what pests to look for and the risks they pose to honey bee colonies is crucial to managing pests and diseases effectively.
- Knowing the levels of pests and diseases in an operation allows the beekeeper to make decisions about when treatments should be applied and which treatments should be used.
- Utilizing monitoring tools such as sticky boards, alcohol washes, ether rolls and sugar dusting to determine Varroa mite levels is integral to an effective IPM approach.
- Thresholds are typically provided in the pest and disease treatment recommendations provided in BMP documents for different provinces and regions.
- The focus is to manage the levels of pests and diseases in the operation, as opposed to eradicating them.

NATIONAL BEE BIOSECURITY STANDARDS



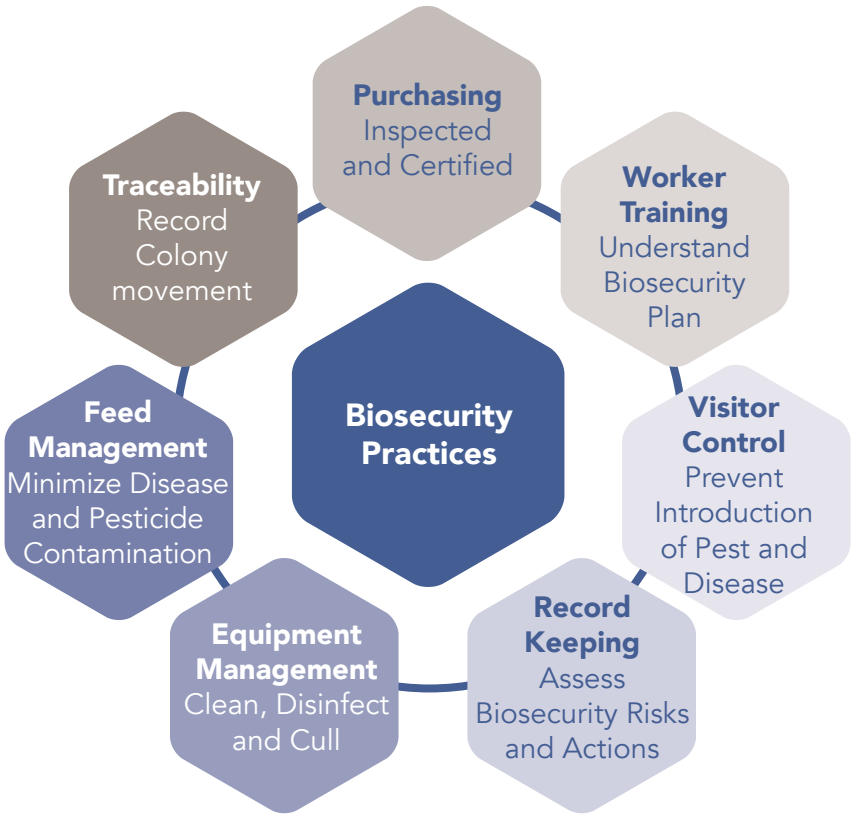


Key Biosecurity Concepts



Biosecurity Aspects

National Bee Biosecurity Standards for Honey Bees are a set of guidelines to implement on-farm biosecurity.



MONITORING, THRESHOLDS AND PEST & DISEASE TREATMENTS

Beekeepers have the responsibility to maintain and sustain healthy honey bee colonies. Protecting bees from diseases, parasites, viruses, predators and pests has become a vital aspect of the beekeeping industry. It is important to understand how to succeed in keeping healthy honey bees. Establishing an effective approach to maintaining bee health requires an integrated strategy to ensure effectiveness.

Monitoring is important to detect pests and diseases and determine which treatment is best to use and when to use it.

MONITORING FOR PESTS & DISEASES

Monitoring is the detection and assessment of pests and diseases. It is important to identify pests and diseases and to determine their level of infection to know whether treatment intervention is necessary to prevent colony damage or loss. Monitoring helps beekeepers decide on the type of treatment that is required and when to apply it, as well as how effective it was. Beekeepers and staff should be trained in pest and disease diagnosis, monitoring procedures and appropriate sample collection when laboratory diagnosis is needed. The accurate and prompt diagnosis and control of pests and diseases will help ensure colony health and high productivity. It is important to use the same monitoring method throughout the season and to keep a record of the results.

Monitoring helps:

- Determine the level of infection to know whether treatment intervention is necessary to prevent colony damage or loss
- Decide on the type of treatment that is required and when to apply it, as well as evaluate if the treatment was effective
- Prevent the rapid growth and spread of pest and disease populations
- Provide an accurate and prompt diagnosis of pests and diseases to help ensure colony health and high productivity

- Avoid unnecessary treatment applications
- Prevent development of treatment resistance
- Prevent honey contamination

There are a number of indications that further monitoring may be needed. Some of these include:

- Decreased colony productivity
- Abnormal or spotty brood pattern
- Abnormal behaviour: trembling, twitching, not flying, robbing
- Dead or sick bees/larvae inside or outside the hive
- Dysentery
- Visual Varroa mites
- Deformed wings
- AFB scales
- Chalkbrood mummies
- Presence of small hive beetles or wax moth
- Wild life problems: mice, ants, skunks, bears and raccoons

Monitoring Methods

Varroa mites

Use the same monitoring methods throughout the season and keep a record of the results.

Sampling for Varroa mites should be done at least twice a year, early spring and late summer, as well as before and after a treatment in order to evaluate treatment efficacy. The best method for tracking Varroa growth is to start with early spring monitoring and continue to monitor every three or four weeks. Adult bees with deformed wings and Varroa mites on brood and adult bees are signs of a problematic infestation.

Method	Sample Size	Materials Needed	Directions
Alcohol Wash	½ cup (300 bees)	• 70% alcohol • Collection jar • Mesh screen • Water • White wash tub	1. Sample bees from the brood chamber. 2. Place 300 bees in a jar with alcohol. Use enough alcohol to cover the bees. Seal tight. 3. Shake vigorously for 2 minutes. 4. Pour bees onto a mesh screen that has been placed over a white wash tub. 5. Rinse the bees with strong stream of water. 6. Count Varroa in the wash tub. Results: # mites/100 bees
Ether Roll	½ cup (300 bees)	• Ether spray • Clear glass jar	1. Sample bees from the brood chamber. 2. Place bees in the jar and seal tight. 3. Briefly open jar to spray ether until bees are just damp. Reseal the lid. 4. Gently shake the jar for 1-2 minutes. 5. Count Varroa that stick to the sides and bottom of the jar. Check under the lid as well. Results: # mites/100 bees
Sugar Dusting	½ cup (300 bees)	• Tablespoon • Icing sugar • Wide mouth jar • Lid (with mesh screen built in) • White wash tub • Water	1. Sample bees from the brood chamber. 2. Place 300 bees in the jar and seal with meshed screen lid. 3. Add 1-2 tablespoons of icing sugar through the screen. 4. Place the jar of sugar dusted bees in the sunlight for 3 minutes to activate the process. 5. Invert the jar over the wash tub to allow Varroa to fall through. 6. Add water to the wash tub to dissolve the sugar. 7. Repeat steps 4-6 until Varroa no longer fall through the mesh. 8. Count the Varroa in the wash tub. Results: # mites/100 bees
Sticky Board	Colony: natural mite drop	• Sheet of thick paper • Mixture of oil and petroleum jelly or insect trap paste	1. Cover the sheet of paper with a layer of the mixture of cooking oil and petroleum jelly or the insect trap glue. 2. Place the board with sticky side up on the bottom board and cover it with a screen. 3. Leave the sticky board in for 1-3 days. 4. Count the number of Varroa on the sticky board and divide by the number of days the board was left in. Results: # mites/24 hours

Alcohol Wash

Ether Roll

Sugar Dusting

Sticky Board

Failing to monitor and control colony health problems can result in the rapid growth of pest and disease populations and their spread to other colonies

Signs of Other Diseases & Pests

American Foulbrood (AFB)

The regular inspection of brood frames is important in order to identify any signs of AFB and to minimize spread of this disease.

Signs of AFB:

- Colony weakness
- Brood cappings are greasy and sunken with puncture holes
- Foul odour
- Presence of scales that are hard to remove
- Ropiness test: a small stick is used to swirl the contents of a cell of dead brood, and a ropy mass is observed when withdrawing the toothpick

European Foulbrood (EFB)

This bacterial disease is less serious than AFB, affects the uncapped brood and generally only appears under conditions of nutritional stress.

Signs of EFB:

- Larvae are discoloured and often twisted in the cell
- Sour odour
- Scales are easily removed

Chalkbrood

This fungal disease is more commonly seen in the spring and fall. High incidences of chalkbrood usually indicate poor hygienic behavior, stress due to weather, poor management or co-infection with other diseases. A genetic predisposition to chalkbrood infection will also result in higher disease incidence.

Signs of chalkbrood:

- Larvae are mummified with a white or grey colour
- Chalkbrood mummies are found in cells, in front of the hive or on the bottom board

Sacbrood

This disease is caused by a virus and affects brood.

Signs of sacbrood:

- Affected larvae disintegrate into a brown watery solution that is held together by the larval outer skin

Nosema

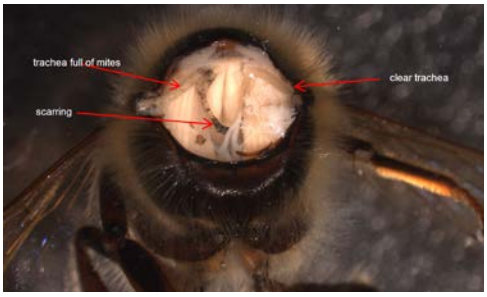
Nosema is a fungal disease, infecting the midgut of adult bees. It is caused by two different species of fungi, *Nosema apis* and *Nosema ceranae*.

Signs of Nosema:

- Faecal discharge can be seen inside the hive on the tops of frames as well as outside on the front of the hive; this is seen more commonly with *N. apis* than *N.ceranae*
- Slow spring buildup of colonies if the infection is high
- Crawling bees
- Low honey production
- Laboratory diagnosis is needed to determine the level of infection
- Sample 50-100 adult bees (from the entrance or honey frames) in a jar with 70% alcohol and send to a laboratory for assessment

Honey Bee Tracheal Mite (HBTM)

Unlike Varroa mites, tracheal mites are not visible with the naked eye.



Signs of HBTM:

- Slow population buildup
- Adult bees crawling in front of the hive, uncoordinated and incapable of flight
- Lethargic bees
- Sample 50-100 adult bees (from the entrance or honey frames) in a jar with 70% alcohol and send to a laboratory for assessment

Wax Moth

Larvae of several different moth species can cause damage to unoccupied comb or weak colonies.

Signs of wax moth:

- Webbing and black droppings
- Thinned areas of brood cappings and tunneled holes in wax

Small Hive Beetle (SHB)

A colony inspection is needed to detect the presence of this honey bee pest. Adults are typically found on the underside of the inner cover, tops of frames and on the bottom board. Inspection must be done immediately upon opening the hive before beetles run and hide.

Signs of SHB:

- Visual sightings of beetles
- Larvae can be seen clustering to feed on the comb or seen exiting the hive to pupate in the soil
- Fermented honey
- Physical, oil-based traps can provide indications of adult SHB presence

Viruses

In addition to sacbrood, there are a number of viruses that affect honey bees, many of which are associated with Varroa mites. Some of these include Kashmir Bee Virus (KBV), Israeli Acute Paralysis Virus (IAPV), Chronic Paralysis Virus (CPV), Acute Bee Paralysis Virus (ABPV), Deformed Wing Virus (DWV) and Black Queen Cell Virus (BQCV). Research on KBV has shown it to be a highly contagious and virulent pathogen in the presence of Varroa mites. The mites act as a vector for the virus, and stress from Varroa parasitism lowers the immune system of the bees and increases susceptibility. This virus appears to affect pupae more than other stages.

Signs of viral infections:

- Weak colony
- Increased numbers of dead and dying bees
- Bees that appear to be trembling and uncoordinated
- Hairless bees
- Newly emerged bees may appear opaque
- Bees infected with DWV are small with shrivelled, malformed wings
- Samples of bees can be collected and sent to a lab for diagnosis

Regional Differences

In British Columbia, wax moth has only been reported in southern areas of the province.

In Quebec, best management practices (BMP) recommend a veterinarian submission of a refrigerated sample of comb to a lab for diagnosis of EFB and AFB. A section of brood frame, roughly 100 cm^2, can be cut out and sent in to the lab.

PEST & DISEASE THRESHOLDS

At a certain level, pests and diseases and the damage caused by them can be tolerated by a colony. However, when the number of pests or level of disease reaches a point where treatment is required, both for economic and health reasons, a treatment threshold is reached. In many cases, thresholds have been established through scientific research and are usually geographically specific. The emphasis is on controlling the pest, not eradicating it. Treatments and management techniques should be implemented before threshold levels are reached, to prevent economic loss. Thresholds are lower when more than one pest or disease is present (meaning a lower level of infestation or infection will require treatment intervention) due to the increased stress the colony is under.

Threshold levels vary depending on the time of the year, colony strength, apiary location and management. Colony strength affects threshold levels. A strong colony has more brood than a weak colony and therefore could have more Varroa reproduction. Also, colony conditions affect threshold levels. A colony that is queenless will reach a point when there is no capped brood and all Varroa in the colony are phoretic (living on the adult bees). When monitoring a queenless colony with a sticky board, beekeepers can expect to see more Varroa than if monitoring a queenright colony where a proportion of the Varroa would be under the cappings.

AFB – A threshold does not exist for AFB infections. Steps are required to be taken if any symptoms of infection are seen at any time, based on provincial guidelines.

Nosema – Nosema infections are caused by the fungal species No*sema apis* and *Nosema ceranae*. Infections above 1 million spores/bee require treatment. However, it must be noted that this is an older threshold estimate based on infections with *N. apis*. As a result, this threshold may not be reflective of the current knowledge and understanding of Nosema infections, including infections with *N. ceranae*.

HBTM – Honey bee tracheal mite infestations greater than or equal to 10% require treatment.

Varroa mites – While all provincial BMPs recommend treatment for Varroa mites, the treatment thresholds are not consistent. Treatment is generally recommended in both the spring and fall. Treatment in the fall is required when infestations are 3% or greater (3 mites/100 bees) using an alcohol wash monitoring technique. Treatment thresholds for the spring differ among the provinces, as do thresholds based on daily mite drop using a sticky board.

The treatment thresholds listed above assume that only one parasite or disease is present. When colonies are infected with more than one parasite or disease, they are more at risk and treatment thresholds are lower.

Regional Differences

In Ontario, treatment thresholds for Varroa infestations in the spring are 1% (1 mite/100 bees) using an ether roll monitoring technique, 2% (2 mites/100 bees) using an alcohol wash or a mite drop of 9 mites/day using a sticky board. In the fall, treatment thresholds are 2% (2 mites/100 bees) using an ether roll, 3% (3 mites/100 bees) using an alcohol wash or a mite drop of 12 mites/day using a sticky board.

The treatment thresholds assume that only one parasite or disease is present. When colonies are infected with more than one parasite or disease, they are more at risk and treatment thresholds are lower.

In Manitoba, treatment thresholds for Varroa infestations are 1% (1 mite/100 bees) using an alcohol wash in the spring and 3% (3 mites/100 bees) using an alcohol wash in the fall. If monitoring is done later in the fall, the treatment threshold is 10% (10 mites/100 bees) using an alcohol wash. This higher threshold is due to Varroa moving out of the brood cells and onto the bees in late fall when brood rearing has stopped or slowed considerably. Using a conversion from alcohol wash infestation levels to mite drops using a sticky board, 1% infestation corresponds to a mite drop of 0.5-1 mites/day, and 3% infestation corresponds to a mite drop of 18 mites/day.

In Alberta, treatment thresholds for Varroa infestations in both the spring and fall are 3% (3 mites/100 bees) using an alcohol wash or a mite drop of 10 mites/day using a sticky board.

In Quebec, treatment thresholds for Varroa infestations using an alcohol wash are not given, only thresholds in daily mite drops using a sticky board. In both the spring and the fall, treatment is required when there is 1 or more mites/day using a sticky board. In the summer, a treatment "booster" is recommended if a mite drop of 10-25 mites/day is found. If 25 or more mites/day are found in the summer, treatment is required.

In Saskatchewan, it is recommend to sample for Varroa in early spring. If levels are 3% or higher, treatment should be considered. If the sampling is done later in the spring or early summer (from May to July), Varroa levels above 1% will require treatment in the fall after honey supers have been removed.

PEST & DISEASE CONTROLS

When treating for pests and diseases, it is important to always follow the directions on the product label. Proper application of treatments will minimize colony damage and maximize treatment efficacy. Following directions will also prevent the target pest from developing chemical resistance. Resistance is a serious problem since it limits the options available to maintain colony health and develops quickly over a period of months. Improper and prolonged use of chemical treatments can leave residues in hive products. Rotating chemical applications and using them according to the label directions can keep these risks at a minimum.

Only products registered in Canada (with provincial exceptions) may be used for the treatment of honey bee diseases or pests. Genetic, cultural and physical control methods do not require registration and can help diminish the risk of chemical contamination.

AFB – Chemicals registered for the control of AFB include oxytetracycline and tylosin. Beekeepers should follow the product label to ensure beekeeper safety and to decrease the development of resistance. If treating colonies prophylactically, oxytetracycline should be applied in both spring and fall. Extender patties should not be used to avoid the development of antibiotic resistance. Tylosin should only be used in consultation with a provincial apiarist when AFB is actively present in a hive. It should only be used during the fall to avoid residues.

Oxytetracyline and tylosin are the only two control products currently registered for the control of AFB; tylosin should only be used in the fall and in consultation with a provincial apiarist.

Recommendations for AFB prevention include re-queening colonies with hygienic genetic stock, replacing 2-4 brood frames (or 20%) annually with foundation or drawn comb, disinfecting dead-out colonies with irradiation and decontaminating boxes and equipment through scorching. Hive tools, smokers and gloves should be regularly cleaned of wax and propolis and disinfected. Used beekeeping equipment should be inspected and sold only with a permit to avoid the spread of disease. Empty dead-out equipment should be cleaned up and removed from apiary sites. Robbing of live colonies should be avoided by ensuring colonies have proper food stores and taking action during periods of nectar dearth.

EFB – Controlling EFB can be achieved by removing and burning infected comb and replacing it with clean comb or new foundation. This is done in conjunction with antibiotic treatment using oxytetracycline. Beekeepers should follow the product label instructions. Management practices to help prevent EFB include re-queening every one to two years, replacing brood frames after five years, preventing robbing by keeping yards clean of old equipment and feeding hives directly rather than open or barrel feeding. Hospital or quarantine yards for EFB-infected colonies can be established for segregation. If feeding honey and pollen, it should be clean and disease-free. It is recommended that hive tools, smokers and gloves be cleaned after each inspection and that bee suits be cleaned regularly.

Chalkbrood – No registered treatment exists for chalkbrood. Recommendations include maintaining strong, healthy colonies, replacing infected combs with new comb, providing good colony ventilation and re-queening colonies with hygienic genetic stock. Incidences of chalkbrood may be more prevalent during spring months.

Sacbrood – No registered treatment exists for sacbrood. Recommendations include maintaining strong, healthy colonies, replacing infected combs with new comb and re-queening colonies with hygienic genetic stock.

Viruses – No registered treatments exist for honey bee viruses. Recommendations include maintaining strong, healthy colonies, controlling Varroa mites and Nosema, disinfecting dead-out combs and equipment and re-queening with hygienic genetic stock. Equipment used for queen rearing should be disinfected or brand new when possible. This includes queen cups, grafting tools and grafting bars.

Equipment used for queen rearing should be disinfected or brand new when possible.

Tracheal mites – Tracheal mites can be controlled through the use of formic acid, either in 65% liquid form or commercially available Mite Away Quick Strips® (MAQS®). Other recommendations include re-queening with tracheal mite-resistant genetic stock every two years. Treatments should be administered in accordance with product label instructions. Formic acid applied to colonies for Varroa treatment will also function as a tracheal mite treatment.

Varroa mites – Currently, three synthetic chemical controls for Varroa mites are registered in Canada: plastic miticide-impregnated strips containing amitraz, fluvalinate or coumaphos. Synthetic chemical strips can be used in colonies in either spring or fall outside of a honey flow in accordance with label instruction withdrawal periods. Mite resistance to coumaphos and fluvalinate is recognized throughout much of the country. Testing these products for resistance via the Pettis test and monitoring colonies and mite levels closely is highly recommended if either of these products are considered for use. Mite resistance to synthetic chemicals can be avoided through proper product use according to product label instructions, diversifying Varroa mite treatments and following an IPM strategy. Registered organic chemicals recommended for use in the treatment of Varroa mites include formic acid, thymol and oxalic acid. Formic acid can be used at 65% to fumigate colonies at doses and intervals available in provincial guidelines. Formic acid is also commercially available at 46.7% in MAQS®. MAQS® are registered to be used during a honey flow in accordance with product label instructions. Formic acid is an effective treatment for Varroa mite control in spring, summer (MAQS®) and fall, though environmental conditions and temperature must be considered. It is recommended that only strong colonies that contain six or more frames of brood covered in bees be treated with formic acid. Thymol is commercially available as Thymovar®. Its application should take into account temperature, as too high or too low of temperatures can cause reduced efficacy. Oxalic acid can be used for mite control through vaporization or mixed with sugar syrup and trickled onto colonies. Oxalic acid should be used in late fall when colonies have little or no brood and only

Formic acid applied to control Varroa mites will also control tracheal mites simultaneously.

as a follow-up to another form of mite treatment. Mixed sugar syrup and oxalic acid should not be stored as the acid changes in composition and can become toxic to bees. Provincial guidelines and product application and safety procedures should be followed for all treatments.

Diversify mite treatments and incorporate an integrated pest management (IPM) strategy to reduce the development of mite resistance and prolong the efficacy of control products.

Cultural management techniques are not recommended as the sole method of controlling Varroa populations in colonies. However, the use of cultural management strongly assists in maintaining low Varroa mite levels, allowing beekeepers to alternate between treatments from season to season. Managing Varroa mite levels in colonies throughout the beekeeping season provides beekeepers the option to use organic chemicals in place of synthetic chemicals under certain conditions. Alternating treatment methods assists in slowing the development of chemical resistance in mites, as well as prolonging the efficacy of registered products. Recommended cultural management techniques include drone brood removal, the use of screened bottom boards, breaking the brood cycle and the use of hygienic and disease-resistant genetic stock.

When treating an apiary for Varroa mites, all colonies should be treated at the same time. Non-registered formulas and products, such as essential oils, should not be used in colonies to treat for Varroa mites. The efficacy of an unregistered product in controlling mites does not indicate that a product has been proven safe for use.

Only use registered products to control mites.

Nosema – The only chemical registered for the control of Nosema is the antibiotic fumagillin. Beekeepers should follow the product label for instructions on product use for both safety and to decrease the development of resistance. If administering treatment in the late winter (February/March), the spring treatment label recommendations should be followed. Medicated feed should be kept out of direct sunlight to avoid chemical breakdown. Sugar syrup containing fumagillin should be fed to colonies directly, not using open or barrel feeding. Open feeding may result in the medication settling and inaccurate doses being applied. When medicated syrup fed to colonies in the fall is not being taken down, the colony may be sprayed with the treatment.

Feed medicated syrup to colonies directly rather than through an open feeding system to ensure accurate doses are applied to each colony.

Non-chemical control recommendations for Nosema include reducing moisture in the hive, improving air circulation, ensuring proper nutrition, re-queening colonies, culling old frames to reduce Nosema spores in the hive, control of Varroa and overall reduction of colony stress. Frames and comb can be disinfected with irradiation, acetic acid or ozone to kill Nosema spores. To prevent the spread of Nosema to queens, mating nucleus (nuc) colonies should be disinfected. Worker bees selected for queen attendants should be young nurse bees and taken from healthy colonies free of Nosema infections.

Small hive beetle – The only chemical product registered for in-hive control of small hive beetle is coumaphos. However, it is not recommended that beekeepers use this chemical due to its relative toxicity to both bees and humans and the risk of wax contamination. Many traps are available that are designed to capture small hive beetle adults and larvae. While these traps may reduce adult beetle populations, they will not eliminate infestations. Small hive beetle traps are more effective as monitoring tools rather than as treatments.

Beekeepers are recommended to maintain strong, healthy, populous colonies for optimal control and management of small hive beetle. Queen issues should be addressed early and comb surface area that is not covered by a hive's population should be reduced. Dead-out equipment should be promptly removed from the apiary, as should wax scrapings and debris. Honey houses should be kept clean and extraction lines sanitized regularly before and following extraction. Supers should be extracted promptly, within three days of removing them from the hives. Any honey spills should be cleaned immediately.

Honey house humidity should be maintained below 50% and wax cappings should be stored in beetle-tight containers. Following extraction, supers should be frozen at -12°C for 24 hours or kept in a cold room (under 9°C) for eight days to kill adults and larvae. A lamp placed on the ground can be used to attract larvae, which can then be killed or removed from the honey house.

Beekeepers should be familiar with small hive beetle and how to properly identify adults and larvae. Provincial apiarists must be notified if any small hive beetles are found.

Maintaing strong, healthy, populous colonies and practicing good biosecurity is a beekeeper's best defense against small hive beetle.

Regional Differences

AFB

In Alberta, the treatment of AFB-infected colonies is dependent on the severity of infection. Colonies with heavy AFB infection should be burned, including the bees, bottom board and frames. Hive boxes, inner covers and hive covers may be disinfected. Honey should not be extracted and a comb sample should be sent to the provincial apiarist for antibiotic resistance testing. Colonies with medium, clinical AFB infections should be shaken onto frames with strips of 1" foundation in clean hive boxes. After three to four days, the bees should be shaken onto frames with full size foundation in another clean box and fed if nectar is scarce. Frames from the original shake should be burned. All infected comb should be burned and hive boxes, inner covers and lids decontaminated. A colony with a light infection of AFB will have few (1 or 2) capped cells showing signs of AFB on one or two frames and very few brood cells containing AFB-infected pupae. Colonies lightly infected with AFB should have infected frames burned and replaced with foundation and should be treated with oxytetracycline. Colonies that experience persistent AFB issues should be sampled and the samples submitted to the provincial apiarist for antibiotic resistance testing. If antibiotic-resistant AFB is identified, recommendations for the use of tylosin will be employed immediately though the provincial apiarist.

In British Columbia, antibiotics are not to be used prophylactically but only used when AFB is identified in a colony, in colonies in the same apiary or nearby. Colonies containing AFB infections should be burned, including all hive materials.

In Manitoba, combs with visible signs of AFB should be removed and destroyed or rendered for wax. Frames from infected hives that do not show any signs of disease should be disinfected using irradiation or burned as well. Samples should be provided to ministry laboratories for resistance testing. Antibiotics should be applied to the colony following the removal of combs.

In Ontario, prophylactic treatment of colonies using oxytetracycline is recommended. The application of antibiotics is not a curative treatment but inhibits the development of AFB spores. Infections with AFB can still take place with the use of antibiotics. Colonies identified as having any signs of AFB should be closed off, doused in diesel fuel to kill bees and burned in a hole dug in the ground. All frames and the bottom board should be burned. Inner covers, hive boxes, hive lids and queen excluders may be re-used but should be well scorched with an open flame before re-using. Equipment may also be disinfected through irradiation. Apiaries where AFB is identified are placed under quarantine for two years, restricting the movement of

colonies and equipment out of the yard. Neighbouring colonies may require antibiotics to be administered as well. Resistant genetic stock is not a recognized or accepted practice of AFB control in Ontario.

In Quebec, complete elimination of colonies infected with AFB is considered the easiest and most effective manner of controlling AFB. However, provincial BMPs recognize that burning is not the most economical method of control. Bees of the infected colony can also be shaken onto newspaper in front of a new hive box with two frames of clean, drawn comb. These bees are left for 12 hours, after which they should be shaken again in front of a full box of clean comb and treated with antibiotics. Frames from the original hive should be burned, as should the newspaper and two frames from the original shake. All other hive components should be disinfected. An opportunistic oxalic acid treatment can be applied to the shaken bees if Varroa mite levels are high. The use of antibiotics requires obtaining a veterinary prescription in Quebec, largely to prevent residues from being found in honey and to help prevent or slow antibiotic resistance from developing.

Honey Bee Tracheal Mites

British Columbia recommendations suggest dipping strips of cardboard in mineral oil and hanging them between brood frames to assist in the control of tracheal mites.

Varroa mites

In Saskatchewan, it is recommended that Apivar® strips (amitraz) be used for spring treatment of Varroa mites rather than fall.

Nosema

In British Columbia, provincial BMP documents do not recommend prophylactic use of fumagillin. Avoiding application when infection levels are below the treatment threshold will slow the development of antibiotic resistance.

In Manitoba, provincial BMPs recommend having combs #2, 5, 7 and 9 empty prior to fall feeding for the storage of medicated syrup.

Key Points to Remember

Monitoring

- Monitoring is a tool for the diagnosis of pests and diseases – it can help prevent the spread of these pests and diseases while also helping the beekeeper to decide on the best treatment option and when to use it.
- Early diagnosis will prevent the spread of diseases and pests.
- Beekeepers and staff should be trained in the diagnosis of the different honey bee pests and diseases.
- Use the same method of monitoring throughout the entire season.

Thresholds

- No treatment threshold exists for AFB infections – steps are required to be taken if any symptoms of infection are seen at any time.
- Nosema treatment thresholds need to be updated in light of current knowledge and understanding of Nosema infections.
- Honey bee tracheal mite infestations greater than or equal to 10% require treatment.
- Varroa mite levels of 3% or higher (3 mites/100 bees) in the fall require treatment; spring Varroa treatment thresholds vary across the country with different mite reproduction cycles.
- Treatment thresholds are lower when colonies are infected with more than one parasite or disease.

Treatments & Control

- Follow label instructions for use of registered control products.
- Oxytetracyline and tylosin are the only two products currently registered for the control of AFB.
- Tylosin should only be used in consultation with a provincial apiarist.
- Re-queen with hygienic stock, replace 20% of brood chamber frames with foundation or honey super comb and disinfect dead-out colony equipment with irradiation and scorching.
- Diversify mite treatments and incorporate an IPM strategy.
- Be mindful of temperature sensitivity and efficacy with organic chemicals.
- Use cultural management techniques to maintain low Varroa mite levels; not effective as a treatment alone.
- Feed medicated syrup to colonies directly rather than through an open feeding system.
- Although it is registered, it is not recommended that coumaphos be used for the control of SHB.
- Traps are more effective as a monitoring tool than a treatment for SHB.
- Freeze or store supers in a cool area to kill wax moth and SHB larvae following extraction.

INTEGRATED PEST MANAGEMENT

VARROA MITES

	Late Winter/ Early Spring	Spring Buildup	Major Nectar Flow	Harvest	Fall	Late Fall
Cultural Control	Insert screened bottom board	Use hygienic & disease-resistant stock; break up brood cycle; drone brood removal				
Monitoring	Pettis test for resistance	Sample 10% of colonies/apiary before & after treatment spring & fall		Sticky board; alcohol wash; ether roll; sugar dusting		
Chemical Control	Diversify treatments; amitraz, fluvalinate, formic acid, thymol		MAQS® (46.7% formic acid) during flow	Alternate between organic & synthetic chemical treatment		Oxalic acid broodless colonies

AMERICAN FOULBROOD

	Late Winter/ Early Spring	Spring Buildup	Major Nectar Flow	Harvest	Fall	Late Fall
Cultural Control	Replace 2-4 frames from brood chamber	Keep apiaries tidy; remove dead-out equipment & sterilize	Use hygienic & disease-resistant stock; avoid robbing		Practice good biosecurity; sterilize tools/equipment regularly	
Monitoring	Regularly inspect brood frames; observe colony for weakness, greasy, sunken & perforated cappings; smell for foul odour; watch for brown scales in cell bottom			Conduct ropiness test on suspicious larvae		
Chemical Control	Treat colonies with oxytetracycline according to provincial guidelines; burn & shake frames/ colonies according to provincial guidelines			Use tylosin only in fall & in cooperation with provincial apiarist		

NOSEMA

	Late Winter/ Early Spring	Spring Buildup	Major Nectar Flow	Harvest	Fall	Late Fall
Cultural Control	Replace 2-4 frames from brood chamber; sterilize dead-out equipment/frames	Reduce moisture; improve air circulation	Use hygienic stock; reduce colony stress	Ensure proper nutrition		
Monitoring	If *Nosema apis*, faecal discharge may be observed	Observe for spring buildup	Sample 50-100 older bees from supers, outer frames or entrance; send to lab for diagnosis			
Chemical Control	Fumagillin; if administering in late winter, follow spring directions	Feed colonies individually rather than through open feeding (barrel)		Medication not taken down in fall can be applied through drench		

INTEGRATED PEST MANAGEMENT

TRACHEAL MITES

	Late Winter/ Early Spring	Spring Buildup	Major Nectar Flow	Harvest	Fall	Late Fall
Cultural Control		Re-queen with hygienic & tracheal mite resistant stock every 2 years				
Monitoring	Indications may include high winter loss or slow spring buildup	Sample 50-100 older bees from supers or outer frames; send to lab for diagnosis		Bees may appear lethargic, crawling in front of hive or unable to fly		
Chemical Control				Treat with formic acid if infestation is above 10%		

SMALL HIVE BEETLE

	Late Winter/ Early Spring	Spring Buildup	Major Nectar Flow	Harvest	Fall	Late Fall
Cultural Control	Keep apiaries tidy; remove dead-out equipment	Reduce empty comb space	Maintain strong colonies; address queen issues early	Keep honey house tidy; relative humidity < 50%	Clean extracting line before & after use; flash freeze supers	
Monitoring	Observe underside of inner cover, frame tops & bottom board immediately after opening hive	Larvae may be observed clustering in feed on comb; watch for oozing, fermented honey		SHB traps are effective tools for monitoring		
Chemical Control	Coumaphos is registered for control but is not recommended for use					

QUEEN HEALTH, COLONY INCREASES AND BREEDING

Queen health and honey bee breeding are important aspects to consider when trying to maintain healthy, genetically diverse honey bee colonies. Genetic diversity and selective breeding of honey bees impact the sustainability and health of honey bee populations. The adaptations to regional environmental factors, such as climate, vegetation and prevailing diseases, can all affect the longevity of honey bee colonies.

QUEEN HEALTH

Queen health during development and proper mating after emergence are both important factors to ensure the quality and productivity of the colony. Early exposure of larvae to royal jelly is known to improve development, and it is recommended that the cups where the larvae will be grafted into be primed with royal jelly before grafting. The use of queen cells from colonies that are swarming or superseding is not recommended, as the performance may be affected due to the potentially smaller size and poor development of the queens. In addition, the use of swarm cells can perpetuate characteristics that are not desirable.

In order to ensure the best queen mating, queen cells need to be introduced into mating nucs before emergence. These nucs come in a variety of shapes and sizes, though the use of standard equipment makes management easier in case frames of brood or food are needed. Drone frames can also be used in colonies in or near the mating yard to supply drones and improve mating. When choosing drone-producing colonies, remember to use colonies with desirable characteristics.

Queen Replacement

Healthy queens are important to ensure the quality and productivity of the colony.

It is recommended that queens be replaced every 1 or 2 years to maintain functional and productive colonies. Colonies should be re-queened every other year to ensure colonies are working at full capacity and to ensure optimal control of queen quality and longevity. It is recommended that beekeepers acquire local queens, as they are more likely to be adapted to local environmental conditions as well as local pest and disease strains. In addition, buying from local breeders helps minimize the risk of introducing pests and diseases through imported queens. Queens should be purchased from reputable, local breeders that have proper government inspection permits. Consult supplier lists that are issued annually by some provincial apiarists or other honey bee regulating authorities, and always investigate before purchasing if the seller is unfamiliar. Early in the season, queens may need to be ordered from international breeders. Honey bees are defined as a regulated animal under the Canadian Health of Animals Regulations and must be imported under permit from a Canadian Food Inspection Agency-approved (CFIA-approved) country and with a CFIA-recognized health certificate from the country of origin.

The approved international sources for queens are:

- New Zealand
- Australia
- USA (including Hawaii)
- Chile

Acquire queens from known, certified sources.

Queen Care

Purchased queens are shipped in queen cages that are plugged with queen candy (icing sugar, syrup and glycerin mixture) and are accompanied by 5 or 6 attendants.

Recommendations for queen care:

- Place queen in a colony immediately if possible
- Remove attendants from the cage before introducing
- To increase acceptance, the colony should be queenless for 3-5 days before the new queen is introduced
- Cage entrance should be filled with enough candy so that the workers take 1-2 days to release the queen
- Insert the queen cage between frames of brood
- Empty, drawn comb should be provided so the queen can start laying immediately

If immediate queen introduction is not possible:

- Keep queen and attendants in the cage
- Provide queen candy for food and spread a drop of water on the mesh of the cage each day
- Keep the cage entrances corked so the queen cannot be released
- Avoid mesh-to-mesh contact with other queen cages to avoid conflict
- Keep temperature around 18°C
- Maintain proper ventilation
- Do not keep queens in cages outside of a colony for more than 7 days
- Queen cages can be placed in a special holding frame in a strong, single, queenless colony with a high population of young bees

Regional Differences

In Alberta, provincial BMP documents mention that the queen can be released directly into the colony after treating her with sugar syrup and a light spray of vanilla extract or other aromatic substance that is believed to mask foreign odours. The colony should be queenless for at least three to five days before attempting this. In the early spring, new queens should be on hand when the colonies are unwrapped or moved outdoors from indoor over-wintering facilities. When the first spring inspections are made in April and May, re-queen colonies immediately if necessary.

In addition, Alberta BMP documents mention that swarming and supersedure cells can be used if only a few cells are needed.

NUCS, PACKAGES & SPLITS

To increase numbers early in the season or to replace winter losses, it is recommended to acquire bees from reputable, local producers with proper government inspection permits.

Bees can be purchased in the form of:

- Nucleus colony (nuc)
- Full-sized colony
- Package

If it is necessary to acquire bees from international producers, they must be imported from a CFIA-approved country and with a CFIA-recognized health certificate from the country of origin to help lower the risk of pest and disease transmission. The approved international sources for packages include New Zealand and Australia.

The specifications for ordering bees will be different depending on whether a nuc, a full-sized colony or a package is being purchased.

Nucs: smaller than a full-sized colony and usually include a queen and a number of frames of brood, honey and pollen. Shipped in smaller boxes (cardboard, wooden or plastic) that hold generally 3-5 frames, usually 2 frames of brood, 1 frame of feed (honey and/or pollen) and 1 empty or drawn frame.

Full-sized colony: a complete unit. Standard-sized hive box with frames of brood, honey and pollen, the queen and all worker bees.

Packages: usually weigh 1.0 to 1.5 kg and contain around 8,000 to 12,000 bees. Packages are shipped in a wooden or screened box with a sugar syrup feed source. Another option is a tubular container with a gelled feed source.

Package or Nuc Installation

After receiving a package or nuc, appropriate introduction and installation are important in order to have a productive colony in the future.

It is recommended that nucs and packages be introduced into new or disinfected hive equipment immediately. If they are not able to be introduced immediately, the package or nuc should be kept in the dark at a temperature of around 18°C and properly ventilated. Storage is not recommended longer than 7 days. Once installed, food stores should be checked and supplemented, when needed, with uncontaminated sugar syrup and irradiated pollen. Check the health status of the new colony regularly and keep records of the origin of the bees. Because packages come with no frames of brood, honey or pollen, it takes longer for them to build up than a nuc would.

Splits

In addition to purchasing bees, beekeepers can increase their numbers or replace winter losses by making splits of their existing colonies. A split is made in much the same way as a nuc – a number of frames of brood, honey and pollen are removed from a strong, full-sized colony and placed in a new hive box. The frames can also be placed into a smaller nuc box to allow them to build up. If the split is placed in a standard hive box, additional empty or foundation frames are added as well to fill the box. A queen is often purchased beforehand and introduced into the split. In order to prevent drifting of foragers back to the original hive, the entrance of the split can be stuffed with grass or the split can be moved to a different yard.

Regional Differences

In British Columbia it is recommended that international packages be ordered in the fall so that they are delivered between March and May. Locally produced packages and nucs are available starting in May and June. The packages should arrive approximately 10 to 12 weeks before the nectar flow in order to have strong colonies able to take advantage of it. In northern areas, the nectar flow does not start until July, while the nectar flow in southern areas starts in mid-June. Beekeepers in southern areas are less dependent on packages as wintering is easier and cheaper.

In Quebec, locally produced nucs are available starting in mid-May. Packages should be ordered into the province between mid-March and mid-April and should weigh 1.8 kg (14,000 bees).

In Ontario, queen and nuc producers need to be inspected to obtain a Queen and Nuc Permit. The operation is inspected for tracheal mites, Varroa and AFB. If AFB is found, the colonies are destroyed and the bee yard is quarantined for 2 years. Producers are required to label their nucs with a sticker that has the inspection number on it. It is a requirement of the Bees Act that the queen and nuc producer supply a list of those beekeepers to whom they have sold bees to and the number of queens, queen cells, nucs or colonies sold. To export to the USA, a visual inspection is performed and a certificate is given to the beekeeper. The beekeeper must then take the certificate to the CFIA, where it is certified by a CFIA veterinarian. The certified certificate is then faxed to the US Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) in Baltimore 10 days before the shipment.

For nucs sold in Ontario, the standard is a 4-frame nuc that consists of a queen, 2 frames of brood (½ to ¾ of which is capped) with adhering bees, 1 frame of feed with adhering bees and 1 frame of foundation or empty comb. Extra bees are added to ensure the brood will be kept warm. Spring nucs are available throughout the month of May into early June and will consist of an overwintered queen and her own brood. A summer nuc is one sold in mid-June or after with a newly mated queen and possibly boosted with brood from other hives.

QUEEN REARING & BREEDING

In order to have healthy and productive colonies, it is necessary to have high-quality queens that have desirable characteristics. As mentioned above, these queens should be acquired from reputable, local producers that have proper government inspection permits. Another option is for beekeepers to breed and rear their own queens. "Rearing queens" refers to the actual raising and production of queens, while "queen breeding" refers to the testing, evaluating and selecting of bee stock with desirable genetic traits. In addition to production and ease of management traits, queens should be bred for pest and disease resistance. This is part of an effective integrated pest management (IPM) strategy.

There are a variety of different methods for rearing queens. These include frame manipulation methods that do not involve the grafting technique, such as the Miller Method, Ally Method and Modified Barbeau method, as well as others that involve queen confinement, such as Jenter and Nicot kits.

For large-scale queen rearing, methods that involve cell builders and grafting are recommended.

Cell builders (prepared before grafting is conducted):

- Cell starters: a queenless colony with enough resources (syrup/honey, pollen and young bees) to be able to start producing the queen cells quickly
- Cell finisher: a queenright, double colony that will mimic a swarming situation, causing the bees to take their time to draw out and feed the queen cells and raise larger, better developed queens. The resident queen in this finisher colony has to be contained in the bottom box by a queen excluder to prevent her from moving up to the top box and destroying the developing queen cells

A variant of the cell builder method that is based off of the same principles is the Cloake board system. A double colony is used, with the queenless starter being the top box where the grafting frames are located and the queenright finisher being the bottom box. Between the boxes is a queen excluder to prevent the queen from moving up to the top box and the Cloake board. Queen excluders are also located above the Cloake board to prevent a virgin queen from entering and below the bottom box to prevent the resident queen from swarming. The Cloake board is kept in or pulled out to either block or allow the queen pheromone to move between boxes, mimicking a queenless or queenright state, respectively.

Grafting

- Larvae are removed from colonies with desirable characteristics using a variety of grafting tools and placed in artificial queen cups (wax or plastic).
- The queen cups are attached to a grafting bar that can be inserted into a modified frame. These frames can then be introduced into a cell builder.
- Only one-day-old larvae are used. Different tools are available for grafting. Special care and gentle handling must be used to avoid damaging the larvae, including keeping the frames warm and covered with a wet towel to ensure larvae do not dry out.

Special care should be taken when managing young larvae for grafting. Avoid desiccation and direct sun light.

Harvesting queen cells:

- Harvest queen cells 10 days after grafting
- Keep cells around 30°C and avoid colder or warmer temperatures, as these might damage the developing queen
- Queen cells can be sold or used in splits, in full-sized colonies for re-queening or introduced into mating nucs
- Check for acceptance and eggs 2 weeks after introduction; marking queens can also be done at this time

Colour Code:

Colour	Ending	Remember
White	1 or 6	Will
Yellow	2 or 7	You
Red	2 or 8	Raise
Green	4 or 9	Great
Blue	5 or 0	Bees

Mark queens according to the international colour code based on the queen's age and when it was born.

In addition to the queen rearing methods and techniques described previously, production of drones is important to ensure that queens are properly mated and with drones of desired genetic stock. Drone frames can be used in colonies with desired characteristics to ensure the area is flooded with high-quality drones.

Regional Differences

In Ontario, the Ontario Bee Breeders' Association (OBBA) has developed a reputation of high standards for the selection of disease-resistant honey bees that enable beekeepers to achieve diverse goals as producers. The Ontario Resistant Honey Bee Selection (ORHBS) program trains queen breeders to manage their selection data in a program that allows them to prioritize chosen selection criteria and compare the results. To achieve different goals, the breeders need to prioritize different characteristics, all of which are graded with a 5 point system.

The most common characteristics are:

- Over-wintering ability: able to maintain a population of bees and consume a low amount of resources over winter. Colonies can be used for pollination services and early nuc production
- Spring buildup: development in colony population to recover from over-wintering population loss and increase honey production
- Low swarming tendency: highly heritable, reduces the risk of colonies unsuccessfully re-queening themselves and the resultant loss of preferred genetics; prevents the uncontrolled movement of bees and the potential spread of pests and diseases
- Low defensive behaviour: highly heritable, the calm reaction of honey bees to normal management of a colony
- Honey production: selection for increased yield by monitoring weight increases over a short amount of time (intense honey flow for 1-2 weeks)
- Comb stability: ease of moving frames of bees. Management is more efficient when frames are easily transferred and shaken without bees running on the frame or flying into the air
- Hygienic behaviour: the ability of bees to identify diseased and parasitized brood and remove it from the colony
- Tracheal mite resistance: breeder colonies are heavily monitored for tracheal mites to ensure a resurgence of susceptible honey bees does not occur
- Queen longevity: queens that lay fertile eggs, maintain a solid brood pattern, do not swarm and maintain low disease levels over a long period of time can often be bred. Queens three years of age should be considered for grafting
- Colonies that present signs of disease – such as chalkbrood, sacbrood and other viruses – and that have poor or spotty brood patterns are not selected from

In Saskatchewan, the Saskatraz Project was developed with a focus on breeding for honey production, mite tolerance and resistance to brood diseases using Russian and German breeding lines. The progeny of selected breeders are continually outcrossed and subjected to recurrent selection to preserve the selected gene pool.

In Alberta and Quebec, BMP documents identify the most desirable characteristics for queen breeding as gentle temperament, good wintering ability, low swarming and good honey production. Other characteristics include disease resistance, the lack of a tendency to propolize, compactness of the brood nest and desirable storage patterns.

Key Points to Remember

- It is recommended that beekeepers acquire local queens, as they are more likely to be adapted to local environmental conditions as well as local pest and disease strains.
- Consult supplier lists that are issued annually by provincial apiarists or other honey bee regulating authorities to find reputable, local suppliers.
- New Zealand, Australia, USA (including Hawaii) and Chile are the approved international sources to acquire early-season queens.
- The international sources approved to acquire packages are New Zealand and Australia.
- If nucs or packages cannot be installed immediately, keep them in a dark and well-ventilated area at 18°C.
- Purchasing from local producers is recommended to avoid the risk of introducing new pests or diseases.
- Queen rearing refers to the actual raising and production of queens, while queen breeding refers to the testing, evaluating and selecting of bee stock with desirable genetic traits.
- Harvest queen cells 10 days after grafting, keep them at 30°C and introduce immediately to a colony or mating nuc.
- Breeding programs such as the ORHBS program and the Saskatraz Project are based on the selection of desirable characteristics that are beneficial to the beekeeping industry.

COLONY EXPANSION

Factors that will affect colony quality and production

<table>
<tr><th>Winter</th><th>Early Spring</th><th>Spring Buildup</th><th>Nectar Flow</th><th>Fall</th></tr>
<tr><td rowspan="2">• Plan the number of queens, packages or nucs needed</td><td>• Assess over-wintered colonies
• Feeding management</td><td colspan="2">• Queen breeding and rearing season
• Local bees and queens available
• Split to increase numbers</td><td rowspan="3">• Unite strong colonies with weak colonies
• Start feeding for winter stores</td></tr>
<tr><td colspan="3">• Estimate number of queens and bees needed
• Have queens available</td></tr>
<tr><td colspan="4">• If necessary, order from international producers
• Local bees are recommended</td></tr>
</table>

HONEY BEE NUTRITION

Honey bees require nutrients from the environment to grow at the individual and colony level. The sources for these nutrients should be diverse and abundant in order to provide all the essential elements for sustainable health. Healthy honey bee colonies with proper nutrition can defend against pests and diseases more effectively.

NUTRITIONAL MANAGEMENT

Honey bees require carbohydrates, proteins, lipids (fats), vitamins and minerals for proper growth and development. They acquire these by foraging for nectar and pollen. Nectar is produced by flowers to attract pollinators. It is mainly composed of water and different sugars (though trace amounts of vitamins and minerals are also present) and is the main source of carbohydrates for honey bees. Nectar is collected by bees and ripened into honey, which is stored in the hive. Pollen grains are the main source of protein for honey bees (including all 10 essential amino acids), as well as lipids, vitamins and minerals. In addition to nectar and pollen, honey bees also forage for water. Besides its physiological uses, water is used by bees to maintain a constant temperature and humidity within the hive and to liquefy crystallized honey.

While honey bees forage for nectar and pollen from flowers, beekeepers are often required to feed colonies throughout the year for a number of reasons. Early in the spring, feeding can help tide colonies over until natural sources of nectar and pollen are readily available. Spring feeding can also be used to stimulate brood production and colony growth. In the fall, feeding is necessary to provide bees with enough stores to last through the winter. During times of nectar or pollen dearth, feeding is also necessary. Colonies that run out of pollen will slow or cease brood production and the population can begin to decline. Colonies that run out of honey stores and do not have access to nectar will starve. Starvation is a very common cause of colony death.

Colonies that run out of pollen will slow or cease brood production and the population can begin to decline. Colonies that run out of honey stores and do not have access to nectar will starve.

Pollen Type	Crude Protein	Amino Acids
Pear	26.2	9/9
Vetch	24.0	9/9
White Clover	23.9	8/9
Lavender	19.4	8/9
Corn	14.5	9/9
Willow	14.6	8/9
Pussy Willow	21.9	9/9
Blueberry	13.9	9/9
Sunflower	12.9	9/9
Buckwheat	11.0	9/9
Canola	23.8	9/9
Red Clover	20.0	9/9
Black Locust	15.0	9/9
Dandelion	13.8	9/9
Bird's-Foot Trefoil	19.7	8/9
Sweet Clover	20.5	9/9
Apple	27.4	7/9
Alfalfa	20.8	9/9

*There is a 10th amino acid that is present in everything, so it was not included in this table

Sugar Syrup

The best option for feeding bees is sugar syrup. Sugar syrup should only be made with white, refined sugar. Brown sugar, raw sugar and molasses should not be used as they contain indigestible components that can cause dysentery when fed to bees. Liquid invert sugar should also not be used as it is produced through acid hydrolysis and contains acids that are toxic to bees. While high-fructose corn syrup (HFCS) is an option, it is generally regarded as being unsuitable for bees, and sugar syrup is preferable. If HFCS is used, a higher fructose content is recommended and the beekeeper must be able to store large quantities of it and at an elevated temperature to prevent crystallization. Frames of honey from the brood box cannot be extracted and can be given to colonies as food. However, only frames from disease-free colonies should be used as many honey bee pests and diseases can be spread this way. Dry sugar and fondant are other options for feeding bees. These are generally not recommended and only used in emergency situations when feeding sugar syrup is not an option. Dry sugar is often ignored by bees and may even be thrown out the hive entrance. Both require that the bees use water to dissolve them in order to be consumed. As a result, dry sugar and fondant may not be accessible to the bees, even if placed directly in the hive. With both dry sugar and fondant, bees do not store any of the feed – they only eat it. This makes these feeds only temporary solutions for colonies with low stores.

Sugar syrup can be made at a concentration of 2:1 (2 parts sugar to 1 part water, by weight) or 1:1 (equal parts sugar and water, by weight). The thinner, 1:1 sugar syrup is generally used in early spring to feed colonies that are low on reserves and are in danger of starving. Spring feeding can also be used to stimulate brood production, pollen foraging and colony growth. The thicker, 2:1 sugar syrup is used in the fall to provide bees with enough stores to survive the winter. Since bees will need to process and ripen syrup before it can be stored, feeding them 2:1 syrup means they have less work to do. Each colony should be fed 15 L of 2:1 sugar syrup in the fall to prepare them for winter. Feeding should begin as soon as supers are removed and should be completed before the temperature gets below 10°C as bees will stop taking down sugar syrup once it gets too cold.

Feeders

Sugar syrup can be fed to bees in a number of different ways.

- Hive-top feeders & inverted pails – ideal for spring or fall feeding as they hold large amounts of syrup, do not require the bees to leave the hive (helpful when the weather outside is cold or rainy), can be changed/re-filled without exposing the colony and do not encourage robbing.
- Division board or frame feeders – do not require the bees to leave the hive and are useful for spring feeding and for queen rearing.
- Resealable plastic bag – a more economical option, though it requires changing/re-filling quite often.
- Boardman feeders – not recommended as they do not hold very much syrup, bees will not break cluster to feed from them if it is cold, they encourage robbing and they are exposed to the sun, which can make the syrup runny and damage any treatments mixed in the syrup.
- Open feeding – often through barrels of sugar syrup. While this method of feeding is an easy option for beekeepers with many colonies, it is generally not recommended. Open feeding encourages robbing behaviour, can spread disease and generally favours strong colonies taking most of the syrup. It will also feed any colonies in the general area.

Feeding should begin as soon as supers are removed and should be completed before the temperature gets below 10°C as bees will stop taking down sugar syrup once it gets too cold.

Water

Water is important not only for honey bee health but also for the maintenance of the hive temperature and humidity and for liquefying crystallized honey. Clean, accessible water sources should be provided if there are no natural streams, ponds and wetlands nearby. Water can be provided in almost anything – a trough, bird bath, kiddie pool, bucket, rain barrel, poultry water dispenser, etc. It is important that twigs, straw or other floating material be placed in the water to give the bees something to land on and prevent drowning. In addition, the water source should be covered or not placed in the bees' flight path to prevent bees from defecating in it and spreading disease. The water source should be put out in the yard early in the season to train bees to it and should be kept clean and filled all season. Bees can become a nuisance at neighbours' pools, especially if they are saltwater pools. Providing a clean, constant water source will help to prevent this.

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Regional Differences

Because the climate can vary greatly across the country, the times when spring and fall feeding are needed will also vary. This is not only a result of differences in temperature and weather conditions but also the result of differences in blooming times of local plants, shrubs and trees. Beekeepers must be observant of local climate patterns and the availability of nectar and pollen in order to know when supplemental feeding may be necessary. In general, supplemental feeding may be required in late winter/early spring when brood production has begun but there are little or no flowering plant sources available. This, however, can often be mitigated or all-together prevented with proper fall feeding. After the initial spring bloom, there is often another dearth period until mid-summer. Fall feeding should commence as soon as supers are removed in the fall and completed before temperatures fall below 10°C. The timing of this feeding may vary across the country.

In Ontario and Quebec, supers may be removed as late as mid-September and feeding should be started at this time. Feeding should be completed by mid-October, though warmer parts of these provinces may be able to feed until late October.

In the prairie provinces, temperatures fall to 10°C earlier in the year due to a shorter growing season. Feeding should start as early in September as possible and should be completed by the beginning of October. In more southern parts of these provinces, feeding may finish closer to mid-October.

POLLEN SUPPLEMENTS & SUBSTITUTES

In addition to supplemental feeding of sugar syrup, beekeepers may need (or want) to feed protein supplements to their colonies. Like sugar syrup, protein supplements may be needed during times of dearth when no pollen is available – the main source of proteins for honey bees. This may happen in late winter/early spring when brood rearing has begun but little or no flowering plant sources are available. Protein is needed for proper growth and development of nurse bees, including the development of glands necessary to feed and raise brood. Feeding protein supplements during a time of dearth can prevent the cessation of brood rearing and the resultant decline in population. In addition, feeding protein supplements in the spring can stimulate brood rearing and colony growth. This can be useful to build up populations for pollination or to be able to take advantage of nectar flows later in the season.

Types of Pollen Substitutes

Pollen supplements are those that contain some amount of pollen while pollen substitutes do not. Pollen is the most attractive protein source to bees and its addition to a protein supplement can greatly increase the supplement's attractiveness and the chance of it being used. Other pollen substitutes include brewer's yeast, soybean flour, skim milk powder, egg powder and torula yeast. Brewer's yeast is the closest to pollen in terms of protein content and is higher in vitamins and minerals. Egg powder and soybean flour are other good options in terms of protein content, though soybean flour is less attractive to bees. The soybean flour used must be expeller processed to remove excess fat. Torula yeast is another good option, though it is harder to obtain. Skim milk powder should be low in lactose, as this is toxic to bees.

Preparation & Application

The protein supplements listed above can be fed to bees as a dry powder. This method, however, is not recommended as it can be ignored by the bees or thrown out the hive entrance, similar to feeding dry sugar. The best way of feeding protein supplements is to mix them with sugar syrup and create a paste or patty that can be rolled flat between two pieces of wax paper. The wax paper prevents the supplement from drying out. This protein patty should be placed on the frames above and to the sides of the brood area to ensure it is used by the bees. Slicing a few slits in the wax paper will help the bees to access the protein patty. There are many different recipes that can be found online or in beekeeping manuals and resources. The majority of these recipes call for combining one or a number of the above listed pollen substitutes with sugar syrup. Any unused protein supplement should be stored in the freezer. Protein supplements, with or without pollen, can also be purchased instead of being made.

While adding sugar syrup to a protein supplement will help ensure it gets used by the bees, adding pollen will increase the attractiveness greatly. Pollen can be trapped and collected by the beekeeper or it can be purchased. It is recommended that a pollen supplement contain at least 5% pollen, though more pollen makes it even more attractive to bees. When trapping pollen, keep in mind that not all pollen is equal in nutritional value. Protein content varies in different types of pollen, as does the particular amino acids present. Pollen trapped and collected for later use should ideally have around 20% protein content and should contain all 10 essential amino acids. Pollen should be dried and frozen to maintain its nutritional value.

Using pollen in protein supplements carries a number of risks. Pollen can contain AFB and Nosema spores and can also be contaminated by pesticides. When trapping pollen, only use colonies that are strong and disease-free. If purchasing pollen, ensure that it is also disease-free and that it comes from a reputable source. Irradiated pollen can also be purchased in some places. Treating with oxytetracycline in icing sugar is often recommended if you are feeding a pollen supplement to help prevent AFB infections.

Timing of Application

While the protein will increase brood production and cause an increase in population size, this will take time. The protein supplements must be fed to the colony early enough in the spring to give them time for the increased brood being reared to emerge as adults and for the population to start to increase. It is recommended that protein supplements be fed at least 6 weeks prior to the time when the increased population is required, either for pollination services or to take advantage of a later nectar flow. It is also important to continue providing bees with protein supplements once you have started until natural pollen sources are available. If pollen supplements are stopped when natural pollen sources are not available, the bees may cease the brood rearing they began and consume the eggs and larvae.

Regional Differences

Similar to supplemental feeding of sugar syrup, the timing of feeding protein supplements will likely vary from province to province based on the particular climate. While feeding with protein supplements may be needed in late winter/early spring in some parts of the country, other parts may have an abundance of early blooming plant and tree species to provide pollen (for example, willow and poplar species).

While it is not necessarily specific to any province, the larger shift in land use to agricultural land in the prairie provinces has resulted in the clearing of many of these early-blooming tree species that may be found in other parts of the country. As a result, feeding of pollen supplements may be necessary in early spring in the prairie provinces while it may not be as necessary in other parts of the country that are not as heavily used for agriculture.

In parts of the country where there is a shorter growing season and where honey production is limited to a single floral source that blooms only for a short period in the summer, it is recommended that beekeepers feed protein supplements early in the spring to boost colonies to be able to take advantage of the short nectar flow. This may also be the case when colonies are used for pollination early in the season.

On the other hand, in parts of the country, such as Ontario, where nectar and pollen are more-or-less available all season, it is not always necessary to feed protein supplements and may even be detrimental. Protein supplements contain ingredients that are not digestible to bees and may cause dysentery and stress on the colony. The stimulated growth of the colony may also outpace available forage in the area and require continued feeding by the beekeeper to maintain the larger population.

HABITAT

Honey bees require plants, shrubs and trees in the area surrounding their hives that bloom throughout the year to provide nectar and pollen. Abundance is important, but even more important is the diversity and quality of the nectar and pollen provided. A wide variety of plants should be available that bloom at different times of the year without any significant gaps. At least some of the plants should be substantial nectar-producing plants and the pollen produced by these plants should contain high levels of crude protein and all of the 10 essential amino acids. Diversity is important, as any one plant may not contain all of the essential amino acids. Knowledge of the available forage in the area is important when selecting a spot to place hives. Beekeepers should have an idea of the carrying capacity of the surrounding area when making decisions on where and how many hives to keep in a particular location. This is particularly true in urban areas where there may be many other beekeepers in the area and little available forage to sustain many colonies.

While bees will generally find available forage in the area – flying 5 km to find it – there are times when there will not be enough flowering plants in the area to sustain a growing colony. This can be an issue in urban areas or in agricultural land where much of the wildflowers and forested areas have been cleared. Monoculture farming systems are particularly deficient, with the large reduction in floral diversity resulting in not only a lack of food for honey bees, but a lack of food and habitats for native pollinators as well. This can be remedied by leaving pieces of unused land wild (and encouraging neighbours, farmers and other people in the community to do the same) for wildflowers and other forage plants to grow. This can include fencerows, property borders, ditches, roadsides, land surrounding streams and other waterways, etc. In addition to unused land, strips can be specifically planted in agricultural land to create pollinator corridors. Chosen plants can include wildflowers and other annuals as well as perennials, shrubs and trees. Though the initial set-up and planting may be more expensive and labour-intensive to include perennials, shrubs and trees, these plants will be beneficial in the long-run to ensure that forage is available in following seasons to support honey bees as well as native pollinators. Maintaining these plantings is also recommended to ensure they are not overrun by undesirable weeds. This is particularly important in gardens and urban areas where aesthetics is a factor.

Along with forage, it is important that honey bees have access to a clean, uncontaminated water source. This can be a problem in monoculture farming systems where more intensive pesticide use is common. These pesticides can be collected by bees in nectar or pollen and can also leach into the soil and water, contaminating the environment.

Regional Differences

Choosing flower, shrub and tree species to plant in unused land and pollinator corridor strips will vary depending on the province. Species should be chosen that are native to the particular province when possible and that are well adapted to the climate there. Non-native and ornamental species can also be chosen, though beekeepers should make sure they are not known to be invasive. Provincial and local publications are available for most parts of the country with information regarding native and non-native species that can be planted to attract honey bees and other pollinators. Most local greenhouses and nurseries will also have similar resources and may have native wildflower seed mixes that beekeepers and those interested can purchase.

Species that are native to the particular province and that are well adapted to the climate there should be chosen when possible. Non-native and ornamental species can also be chosen, though beekeepers should make sure they are not known to be invasive.

Key Points to Remember

Nutritional Management

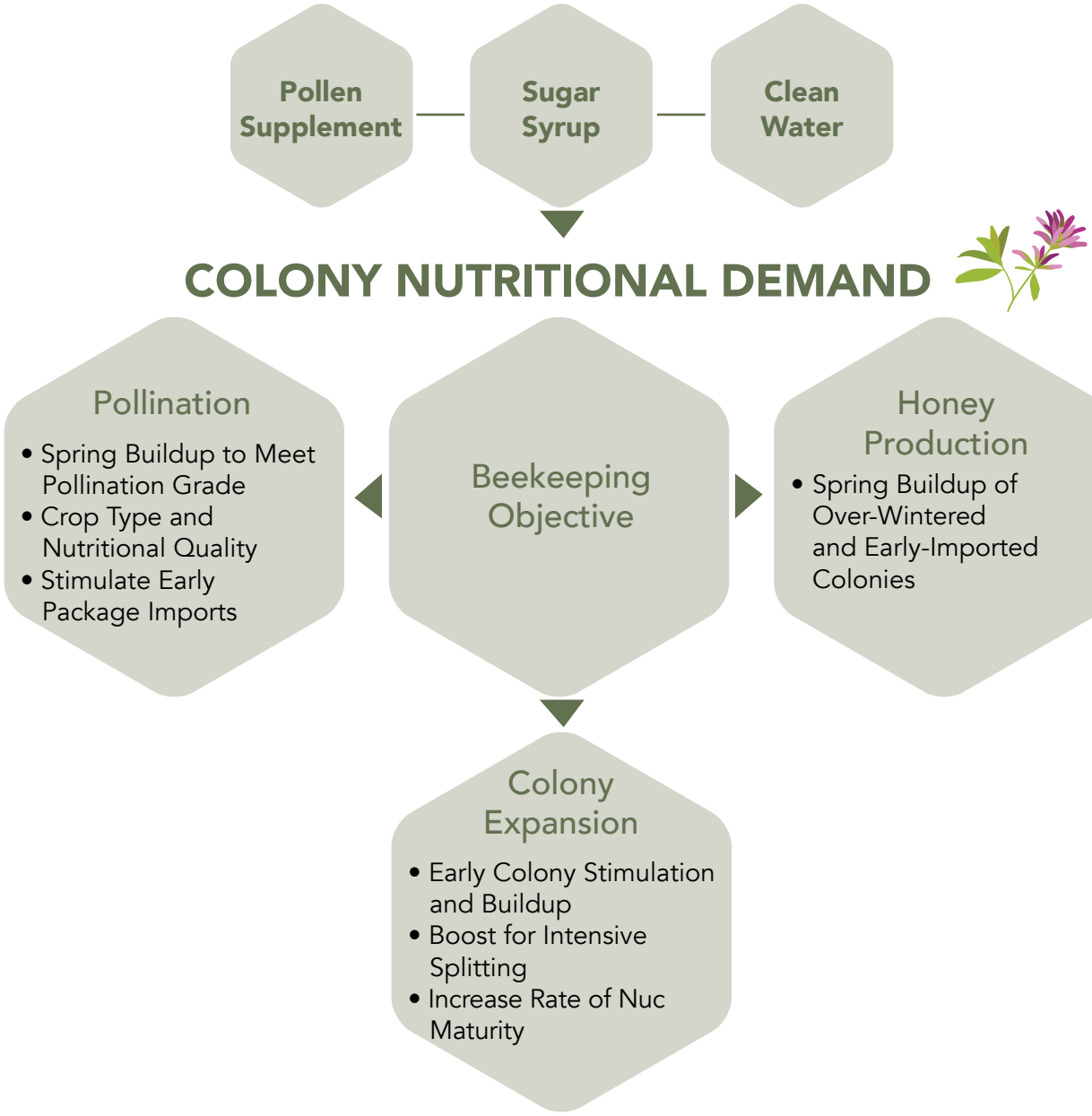
- Honey bees acquire all the essential nutrients for growth and development from nectar and pollen.
- Nectar is the main source of carbohydrates; pollen is the main source of protein, lipids, vitamins and minerals.
- Feeding sugar syrup is used to stimulate brood rearing in the spring, prepare colonies for winter in the fall and to prevent starvation during periods of nectar dearth.
- Sugar syrup made with pure sucrose (white, refined sugar) is the best option for feeding bees.
- Water is essential – a clean, accessible water source should be provided when no natural sources are available.

Pollen Supplements & Substitutes

- Feeding protein supplements is used to stimulate brood rearing in the spring and to prevent population decline during periods of pollen dearth.
- Pollen is the most attractive protein source to bees – adding it to protein supplements greatly increases the supplement's chance of being used.
- Not all pollen is equal in nutritional value – protein content and the number of essential amino acids vary from one pollen source to another.
- Pollen trapped and collected for later use should ideally have around 20% protein content and should contain all 10 essential amino acids.
- Pollen can contain pesticide residues and disease spores – only use irradiated or disease-free pollen.
- When feeding a protein supplement, feeding must be continued until natural pollen sources are available.

Habitat

- Honey bees require abundant and diverse forage in the area that blooms throughout the season without any significant gaps.
- The carrying capacity of the surrounding area must be taken into account when deciding where and how many hives to place in a yard.
- Encourage neighbours, farmers and other community members to leave pieces of unused land wild for wildflowers and other forage plants to grow.
- Providing a clean, uncontaminated water source is especially important in areas where intensive pesticide use is common.



	Early Spring	Late Spring	Nectar Flow	Late Summer	Fall	Winter
Sugar Syrup Feeding (sugar: water)	• Light colonies • Stimulate brood rearing (1:1 or 2:1)	• Early intensive splits • Pollination colonies (1:1 or 2:1)	Only in: • Poor seasons or locations • Intensive colony expansion	• Late splits in seasonal dearth (1:1 or 2:1)	• 15 L per full-sized colony (2:1)	• Emergency feeding not needed with correct fall feeding
Pollen Supplement Feeding	• Brood rearing stimulation • Insurance for poor weather that prevents pollen access	• Pollination colonies (lowbush blueberries/ cranberries)	Only in: • Poor seasons or locations • Intensive colony expansion	• Late splits in seasonal dearth	• No evidence of colony or economic benefit	• Stored fall pollen sufficient until early spring
Water Supply	Provide a clean water source, especially if lack of natural source or contamination is suspected					

HONEY HARVEST PRACTICES

Honey harvesting is a major component of beekeeping operations. The removal of honey should be conducted in a manner that prevents contamination and the spread of pests and diseases.

METHODS OF HONEY REMOVAL

The facilities, equipment and methods used for honey extraction vary greatly depending on the beekeeper's budget and the size of the operation. Regardless of size, care should be taken when removing honey from hives. The methods used for removal of honey supers and extraction should consider the possibility of contamination, the risk of drifting and potential for robbing. It is recommended to refrain from extracting honey from the brood chamber and to refrain from feeding bees anything that could contaminant honey. In regards to possible small hive beetle infestations, honey should be extracted shortly after removal from the hives and honey supers subsequently frozen or kept in a refrigerated or cold storage unit.

It is recommended to refrain from extracting honey from the brood chamber.

Regional Differences:

The use of fume boards and chemicals such as butyric anhydride for honey harvesting are more commonly recommended and used in Alberta.

Key Points to Remember

- The removal of honey should be conducted in a manner that prevents contamination and the spread of pests and diseases.
- The methods used for removal of honey supers and extraction should consider the possibility of contamination, the risk of drifting and potential for robbing.

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