COUNTERING THE IMPACT OF CLIMATE CHANGE ON BEEKEEPING IN GEORGIA

Guidelines for

Extension Specialists, Trainers and Beekeepers

2025

These guidelines have been developed for extension specialists and trainers working with beekeepers in Georgia, as well as being a resource for beekeepers themselves, aiming to help them navigate the challenges posed by climate change by providing practical recommendations on all aspects of beekeeping to help ensure the resilience and sustainability of the honey sector.

Given that beekeeping plays a vital role in Georgia's economy, as both a primary and secondary source of income for many households, addressing the challenges posed by climate change is crucial for ensuring the resilience and sustainability of honey production.

The five chapters offer practical recommendations that empower beekeepers to manage the adverse effects of extreme weather and climate change. From adjusting to temperature extremes and managing hive microclimates to ensuring bee health and implementing best practices for bio wax production, these strategies aim to safeguard bee populations and enhance productivity. Furthermore, the guidelines introduce the process of bio (organic) honey certification, providing beekeepers with valuable insights into transitioning to sustainable, organic practices.

These guidelines represent current good practice adapted to the Georgian context. They should be seen as a living resource to be supplemented, added to and updated as research and information in the field of climate change and it impact on bees develops further.

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Executive Summary

These guidelines have been developed to help beekeepers in Georgia mitigate and adapt to the adverse impacts of climate change on beekeeping practices. Climate change leads to extreme and unpredictable weather, greatly impacting beekeeping and those dependent on honey production.

In Georgia, beekeeping is integral to agriculture and the ecosystem and honey production is a primary source of income for many beekeepers and an important secondary source of income or contributor to household food security for many more. Therefore, countering the negative effects of climate change on beekeeping and providing beekeepers with the tools to mitigate these negative effects and adapt to them, is vitally important for rural society, food production systems and biodiversity across Georgia.

Comprising five comprehensive chapters, these guidelines offer practical recommendations to assist beekeepers in managing the effects of climate change on their operations.

Chapter 1: Focuses on essential beekeeping practices for managing temperature extremes and increased humidity within the hive. It explains the symptoms and effects of heat, cold stress and humidity on bee colonies, emphasizing the importance of controlling hive microclimates to mitigate environmental stresses. Special attention is given to strategies for maintaining optimal hive conditions, including temperature regulation, ventilation, and insulation, to ensure the health and productivity of bee colonies.

Chapter 2: Emphasizes the importance of nutrition adapted to local climates for maintaining healthy bee colonies, offering strategies to adjust feeding based on floral resources, temperature, and seasons. It also covers strategic hive placement, transhumance, swarm prevention, and regular inspections to promote bee productivity, resilience, and consistent honey yields, helping beekeepers manage colonies effectively in response to shifting weather patterns.

Chapter 3: Focuses on optimizing treatment methods in a changing climate. It includes early detection and diagnostic tools, building resilience against environmental shifts, managing chemical treatments with optimal scheduling, and exploring best practices for storing and administering veterinary medicines in extreme temperatures.

Chapter 4: Focuses on best practices for beeswax production, emphasizing the importance of producing high-quality beeswax to ensure hive health, honey quality, and colony sustainability. It outlines methods for minimizing contamination risks, as well as exploring the effects of climate change on beeswax, climate smart beeswax and the need for careful management of beeswax resources to support long-term hive health.

Chapter 5: Introduces bio certification for honey production, offering an in-depth overview for beekeepers interested in transitioning to or starting a bio honey operation. It examines the incentives, disincentives and decision making involved in choosing bio certification. It explains the concept and requirements of bio beekeeping.

By integrating the strategies outlined in these guidelines, beekeepers in Georgia can mitigate and adapt to the impacts of climate change on their operations, ensuring better resilience and sustainability of bee populations and the ecosystem services they provide. This comprehensive approach not only deals with immediate weather-related challenges but also underpins long-term adaptation and success in beekeeping.

Inclusion

Climate change affects everyone, regardless of their demographic or geographical location. However, it disproportionately affects marginalized people with fewer resources and less power. Marginalized people are often more concentrated on marginalized land with poorer soil, steeper slopes or limited access to water. They may struggle to access resources and afford alternatives, such as better built hives when local weather conditions impact colonies. They may lack the ability to relocate or change locations when faced with production challenges. They cannot or do not know how to access knowledge or finances to adapt to the effects of climate change and cannot or do not feel the agency or legitimacy to engage with local decision-making concerning issues or resources.

Trainings must, therefore, consider the social, economic, and environmental factors impacting the perspectives and needs of beekeepers in each area. This involves understanding the barriers that hinder or alter the level of access or needs of beekeeping communities. Factors such as gender, ethnicity, age, wealth, religion, geographical location (from lowland to upland areas), and types of farms (small, medium, large; household operation, semi-commercial, fully commercial) all influence the extent to which beekeepers can access resources, information, networks, and finance, or participate in household, community, or local decision-making processes.

Extension specialists and trainers play a pivotal role in ensuring inclusion throughout the training process. This entails implementing the following:

Inclusive invitations: Trainee selection should ensure a true representation of all producers in each locality. Invitations to individuals from diverse backgrounds, ensuring representation across genders, ethnicities, and socio-economic layers, agro-ecological zones and apiaries of different sizes should be a prerequisite. Ensuring the inclusion of smaller producers and household enterprises, which ensures household food security, is essential. Trusted community figures can be engaged to ensure participation in harder-to-reach areas.

Language access: Training sessions and materials should be conducted and available in first languages that ensure the comprehension and full participation of Azerbaijani and Armenian farmers.

Tailor training to ensure inclusion: The training environment should acceptable and safe from each participant’s cultural perspective. The training should be held in locations accessible to participants from different geographical areas. Training times and dates should be scheduled to be convenient for all; and take into consideration when people are most busy during the day or season or are unavailable (e.g. call to prayer, Ramadan, working in the field, harvest time, planting time, looking after children, elderly dependents, working in other jobs).

Introduction

These guidelines are tailored for extension specialists and trainers aiming to equip beekeepers with effective strategies to navigate the challenges posed by climate change. They can also be used by beekeepers themselves as a source of information and guide. Trainers can utilize detailed ancillary training materials throughout the training in conjunction with the guidelines to enlarge upon and explain the techniques, models or technical areas described in the manual.

Beekeepers find themselves at the forefront of the adverse impacts of climate change seeing the immediate consequences in their beekeeping operations. Environmental shifts bring about undesirable consequences that severely affect beekeeping and honey production.

The inherent challenges beekeepers already face in managing bee colonies are exacerbated by climate variations.

Extreme and unpredictable weather, temperature fluctuations, habitat degradation, high levels of humidity, and reduced quantity and quality of forage and water resources, lead to stresses which directly impact bee health and productivity.

Traditional beekeeping practices may yield limited results in the face of current climate challenges and beekeepers need new strategies to adapt to their evolving circumstances.

The enfolding climate crisis is compelling extension specialists, trainers and beekeepers to find and embrace practical, affordable, and sustainable production methods. Equipping beekeepers with insights into managing temperature stress, enhancing bee immune systems, fostering healthy hive environments, and optimizing productivity, allows for the development of a more resilient and ultimately more sustainable beekeeping sector, ensuring more robust bee colonies, environmental stewardship, and the welfare of beekeepers and their communities.

Effective communication between extension specialists, trainers and beekeepers is indispensable in fostering a collaborative alliance. To facilitate this partnership, this guide has been developed with the Georgian Beekeepers Union for extension specialists, beekeeping trainers, and beekeepers. It serves as a roadmap, guiding them in effectively communicating climate-resilient, sustainable beekeeping practices tailored to address the pertinent issues faced by male and female beekeepers in communities across Georgia.

CHAPTER 1
Managing the Hive for Weather Extremes

Chapter 1 aims to teach beekeeping practitioners how to identify stress symptoms caused by fluctuating temperatures and humidity within hives, focusing on the risks of heat and cold stress and high humidity and the importance of ventilation and insulation to maintain optimal hive conditions. Beekeepers will also learn how to place hives to ensure access to diverse forage, reducing the effects of fluctuating floral resources.

Climate change is causing increasingly unpredictable weather patterns, significantly impacting beekeeping, which relies on stable weather and blooming cycles.

Beehives are crucial in shaping the microclimate for bees, providing a controlled environment that directly affects colonies. Hives act as barriers against diseases and regulate temperature and humidity. Effective hive management allows beekeepers to better cope with climate change. By understanding the relationship between hives and the effects of climate, beekeepers can make informed decisions to improve colony welfare and protect bee communities.

Extreme weather affects honey flows and available forage, causing heat and cold stress. Unseasonal rains increase hive humidity, disrupting feeding, breeding, and colony behaviour, weakening bees and making them more vulnerable to disease.

By the end of this chapter, participants will understand the risks posed by extreme weather, be able to identify the impacts of fluctuating temperatures and humidity on bee health and honey production, recognize stress symptoms, and learn how to adapt their practices to mitigate these effects on their apiary.

Learning Objectives

Participants will:

Understand the impact of extremes of temperature and humidity on bee colonies, including how high and low temperatures, as well as fluctuating humidity, affects bee behaviour, health, and hive conditions

Recognize the importance of the hive microclimate, learning how to manage temperature, humidity and airflow to create optimal conditions that promote colony health and productivity

Learn to use climate-adapted hives to mitigate the effects of extreme weather, focusing on how insulation and ventilation systems support colony resilience to temperature extremes and humidity fluctuations

Explore effective hive management practices to cope with the impacts of climate change, including strategic hive placement, transhumance, ventilation, moisture control and adapting hive use to different geographical areas

Extremes of Temperature and Humidity

Climate change is leading to an increase in the frequency and intensity of extreme temperatures and humidity events, resulting in more frequent and severe heatwaves, droughts, cold spells, and higher and lower levels of humidity across Georgia.

Climate change is increasing the prevalence of parasites such as *Varroa destructor*[1] and *Tropilaelaps* mites which pose a serious threat to the entire beekeeping industry by creating milder winters and higher average temperatures, which disrupt the natural broodless periods in bee colonies. Both mites rely entirely on bee brood to reproduce and cannot survive long outside a hive without a host; broodless periods in winter are critical for breaking their life cycle. When warmer winters prevent this natural break, mite populations can persist and grow, ultimately weakening the effectiveness of treatments applied by beekeepers in late autumn.

In a broader context, climate change can lead to poor brood development, stress on the colony and increased disease risks. The challenges posed by such conditions include the potential for reduced pollination efficiency, decreased honey production and hive losses.

Extreme temperature refers to unusually high or low temperatures sustained over long periods, including at night, and occurring at unpredictable times of the year. Extreme humidity levels refers to levels of moisture in the hive, due to weather conditions, which are detrimental to bee well-being.

Table 1: Heat, Cold and Humidity Stress in Beekeeping: Symptoms, Impacts and Beekeeper Actions

	HEAT STRESS	COLD STRESS	HUMIDITY
Definition	Occurs when high temperatures and humidity exceed bees' ability to regulate their body temperature.	Occurs when temperature drops below bees' tolerance level. Bees swarm is not able to keep optimal temperature in hive.	Occurs when the moisture levels in hives become either too **high** or too **low** usually due to environmental conditions
Optimal Hive Temperature and Humidity	32–36°C (inside hive). Foraging requires >12°C without wind or rain.	<10°C to below zero	45-60% relative humidity
Signs and Symptoms	- Bees cluster outside the hive - Bees fan wings vigorously at the entrance - Reduced foraging - Bees bearding[2] on the hive exterior - Decreased hive activity - Less pollen/nectar collection - Increased water collection - Premature uncapping of brood - Queen reduces egg-laying - Higher mortality, especially in younger bees	- Bees cluster tightly inside the hive - Reduced activity inside and outside the hive - Increased honey consumption - Sluggish, slow-moving bees - Limited foraging - Queen reduces egg-laying - Higher mortality, especially in older bees - Condensation inside the hive - Bees unable to fly or fly short distances	**High humidity:** - Excessive condensation, mould, or mildew on hive surfaces - Dampness or wetness on hive walls - Bees clustering to avoid damp areas or swarming due to discomfort - Reduced activity, sluggish or disoriented bees - Bees fanning wings lethargically **Low humidity** - Increased water collection behaviour - Decreased foraging - Signs of dehydration in bees - Less comb production

[1] Varroa destructor is an external parasitic mite responsible for Varroosis, a disease that affects both adult bees and brood. It is the primary vector of *Deformed Wing Virus* (DWV), which causes wing deformities, reduced body size, and shortened lifespans in infected bees, ultimately weakening colonies and potentially leading to collapse if not controlled.

[2] Accumulating on the hive exterior in a beard-like shape

	HEAT STRESS	COLD STRESS	HUMIDITY
Impact	- Decreased foraging - Dehydration - Reduced brood rearing - Increased disease risk - Higher mortality rates.	- Decreased activity - Reduced foraging - Dehydration - Reduced brood rearing - Increased disease risk - Higher mortality rates.	**High humidity:** - Increased disease/parasites risk - Higher mortality rates - Poor brood development and stunted larvae - Reduced hive cleanliness **Low humidity:** - Brood desiccation (drying out) - Reduced larval survival - Reduced brood rearing - Higher mortality rates
Beekeeper`s Action	- Ensure proper hive ventilation - Provide a nearby water source - Offer shade for hives (See Figure 1 below)	- Ensure proper hive ventilation - Provide access to water - Offer insulation or windbreaks for hives.	- Ensure proper hive ventilation - Provide a nearby water source to prevent dehydration in dry conditions - Offer shade in hot weather or insulation in cold weather - Install moisture absorbers (e.g., rice bags) during damp periods - Monitor for mould and remove affected comb when needed

The Importance of the Microclimate in the Hive

The microclimate for bees refers to the environmental conditions within and around the colony that directly impact their well-being and behaviour. Key factors include temperature, humidity, and ventilation. Managing these factors is essential for colony health and productivity, especially as climate change introduces increased temperature and humidity variations, raising stress, weakening immunity, and increasing the risk of pests and diseases.

Temperature is a crucial factor for hive health. High temperatures cause heat stress, leading bees to fan, reduce foraging, and uncap brood cells which can result in dehydration (drying out) and increased mortality. Uncapped brood can be a sign of heat stress, when bees try to reduce the temperature for larvae. Bees can even unseal already capped brood (balk brood) to cool the brood. However, it is important to note that there can be other reasons and factors for uncapped brood, such as poor hygiene or wax moth infestation. Cold temperatures cause cold stress, forcing bees to cluster tightly, reducing activity and increasing honey consumption, which raises the risk of starvation and winter losses. Maintaining proper temperature regulation is essential for a stable and productive colony.

Humidity also plays a critical role in the hive microclimate. Prolonged high or low humidity outside the optimal range of 45% - 60%, can stress the bees, weakening their immune systems and making them more vulnerable to disease. Excessive humidity promotes pathogens, fungi, and mould growth, increasing the risk of diseases such as *American foulbrood*[3], *Nosema*[4] or *Chalkbrood*[5]. Low humidity and lack of access to water can lead brood desiccation[6]. Larvae require stable humidity to develop

[3] American foulbrood (AFB) is a fatal bacterial disease of honeybee brood caused by the spore-forming bacterium Paenibacillus larvae.

[4] Disease of bees caused by a microsporidian (Nosema apis) that invades the stomach and midgut causing dysentery and varying degrees of paralysis in the affected host.

[5] Chalkbrood disease is caused by the fungus Ascosphaera apis. The fungus rarely kills infected colonies but can weaken it and lead to reduced honey yields and susceptibility to other bee pests and diseases.

[6] Desiccation, the drying out of the brood, is sometimes mistaken by beekeepers for chalkbrood, thus understanding whether high or low humidity is affecting the hive, will help determine treatment options.

properly, especially for maintaining the quality and effectiveness of brood food. In addition, when humidity levels fall outside the optimal range, it can signal to the queen that environmental conditions are unfavourable for colony growth. As a result, she may reduce egg laying to avoid overpopulation during times of stress, impacting on brood and colony development.

Airflow is the third key factor. Adequate airflow helps regulate temperature and humidity, preventing overheating and disease-causing mould. Without proper ventilation, high humidity can build up, further increasing disease risk. Proper ventilation allows the bees to cool the hive and protect the brood during warm weather.

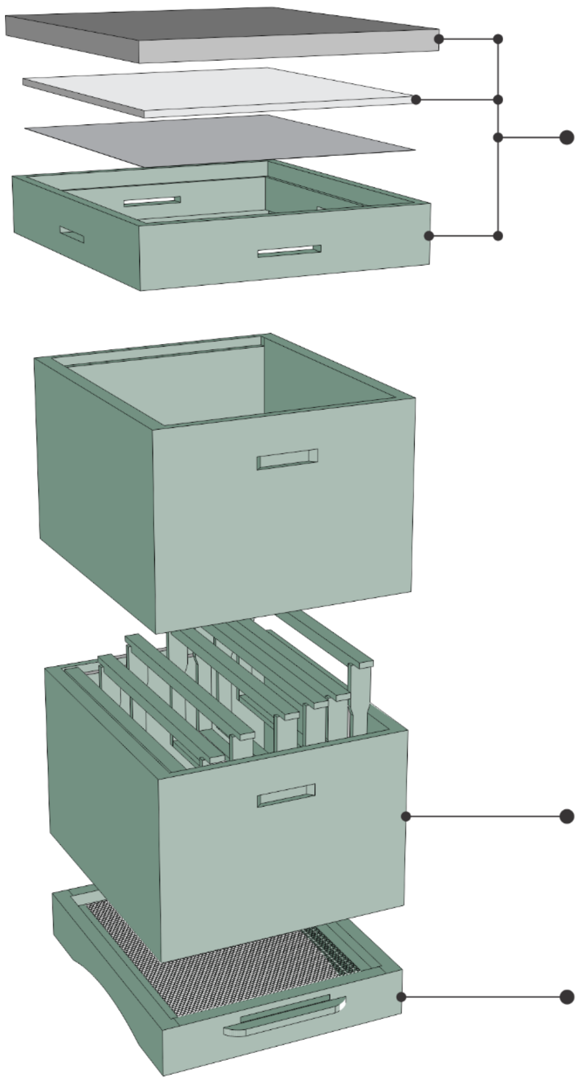
Hive Management and Using Climate Adapted Hives and to Cope with the Effects of Climate

Hive management strategies including transhumance, building shelter and applying external insulation thus moving or protecting hives from heat, cold and exposure to harsh temperatures, direct sunlight or strong winds. Management strategies also include consideration of the availability of forage resources which will feed and strengthen the colony against environmental stress.

An important hive management option is the use of a climate-adapted beehive, which is a specially designed hive intended to mitigate the effects of climate change on beekeeping, incorporating features and components to address the challenges posed by fluctuating weather patterns. Climate-adapted hives mainly rely on quality materials and construction with incorporated and effective insulation and ventilation, to regulate internal temperature and manage humidity levels.

Table 2: Advantages of Climate Smart Beehives

ADVANTAGES OF CLIMATE SMART BEEHIVES	
Temperature Control	Insulation and ventilation prevent overheating in hot climates and retain warmth in cold climates, reducing heat and cold stress among bees.
Humidity Control	Proper airflow reduces excessive humidity, preventing pathogen growth and diseases like Nosema and chalkbrood. Ideal humidity levels of 50-60%, are maintained to ensure colony health.
Disease Reduction	Ventilation and hygiene, due to the removable and ventilated bottom board, which can be easily removed for cleaning, help prevent diseases like American foulbrood and Varroosis by reducing pathogen accumulation. They also provide improved mechanisms for controlling varroa mites.
Forage Storage	Adequate storage space ensures honey and pollen reserves during lean periods, supporting bees when nectar flow is low.
Swarm Prevention	Proper ventilation, space, and forage storage, reduce environmental stressors that trigger swarming, maintaining colony stability.
Moveability	Lightweight, well-built and well-ventilated hives allow easy relocation to areas with better environmental conditions and forage, ensuring honey production and minimizing transport stress on bees.



TOP COVER

it is constructed with ventilated foam plastic and double plywood, offering excellent thermal insulation. It is lightweight and convenient for transportation.

HIVE BODY

is built to standard dimensions for perfectly fitting frames.

UNIVERSAL BOTTOM BOARD

The universal bottom board ensures optimal airflow within the hive, reducing humidity and regulating temperature. It is easily removable for cleaning, supporting better hygiene within the colony. Additionally, it includes an integrated pollen collector.

Figure 1: Diagram illustrating the climate adaptation features of a climate-adapted hive

Temperature control

Climate change increases the risks of both heat and cold stress to bee colonies. High temperatures cause heat stress, leading bees to fan their hives, reduce foraging and uncap brood cells, resulting in dehydration and higher mortality. Cold stress forces bees to cluster tightly, reducing activity and increasing honey consumption. If food reserves are insufficient the risk of starvation rises, which leads to weakened resistance to disease.

When it comes to maintaining the ideal internal temperature, particularly in regions with extreme fluctuations, climate-adapted hives rely on insulation and ventilation.

Proper hive design with adequate ventilation and insulation helps colonies adapt as does providing manmade shade or shelter in addition to intelligent hive placement.

Ventilated bottom boards and insulated top covers prevent overheating in hot conditions. Without proper ventilation, bees become less active, reducing productivity as they focus energy on temperature regulation instead of foraging and brood care.

Figure 2: Ventilated hive bottom board from where bee colony enters in a hive brood

In cold climates, additional external insulation will further help retain warmth in addition to built-in insulation, while overhanging covers prevent snow from blocking hive entrances, allowing bees to move freely.

Figure 3: Illustration of Beehive Shelter and External Insulation

Hive placement

Not restricted to climate adapted hives, hive placement plays a crucial role in ensuring the safety and wellbeing of bees. Careful consideration of location, such as positioning hives near windbreaks and shaded areas, provides essential protection from harsh weather conditions. Elevating hives on stands, particularly in flood-prone areas, offers further protection from potential water damage during heavy rains. Transhumance, the relocation of hives to alternative locations at different altitudes, to mediate for hot or cold weather as well as allowing access to seasonal forage, is an effective climate adaptation strategy, as climate change affects the timing and patterns of flowering in honey plants, which in turn impacts the availability of nectar and pollen for bees. By relocating hives, beekeepers can ensure bees have consistent access to varying forage sources, critical for honey production.

Humidity Control and Disease Reduction

While some degree of humidity is natural and necessary for certain hive activities, such as nectar and honey ripening, excessive humidity resulting from environmental factors like frequent rains, and sudden temperature drops, increases the risk of disease within the hive. Ideal hive humidity should range between 50 to 60 %. The signs of high humidity are easy to observe in the hive such as wet wood surfaces or new mould as well as reduced flights, fanning, or spoiled pollen stores.

Changes in temperature and humidity have a profound impact on the growth and activity of bacteria, fungi, and disease spores within a beehive. Poor ventilation, combined with high humidity and temperature fluctuations, can lead to condensation buildup. This moisture may leak into brood cells and pollen stores, degrading food quality and creating an ideal environment for microbial growth. *Warm, humid conditions* accelerate the development of fungal pathogens, whilst *cool, humid conditions* in the brood area promote the spread of diseases like *Ascosphaera apis* (chalkbrood) and gut parasites such as Nosema, which thrive when bees are stressed by low temperatures and excess moisture.

Climate change intensifies these risks through unseasonal warmth, milder winters, and wetter springs, all of which disrupt nectar flow, brood cycles, and other aspects of the colony’s seasonal rhythm. Warmer winters shorten or eliminate natural broodless periods, allowing Varroa destructor and Tropilaelaps mites to reproduce continuously. Meanwhile, heat and cold stress reduce the bees’ hygienic behaviour and brood care, creating ideal conditions for *Paenibacillus* larvae, the bacterium responsible for American foulbrood (AFB)—one of the most contagious and lethal bee diseases. Stressed and weakened colonies are also more likely to drift or rob from infected hives, further facilitating the spread of AFB spores between colonies and apiaries.

Climate adapted beehives with their ventilation system, allow for better airflow within the hive, which helps to reduce moisture and prevent high humidity levels in both high and low temperatures. Reducing the number of diseases and parasites that accumulate in the hive environment is also made easier with proper ventilation. By minimizing the chances of high humidity, diseases like Nosema and chalkbrood are less likely to spread, ultimately bolstering the hive's ability to defend itself against pathogens. American foulbrood and Varroosis are two illnesses that climate-adapted hives prevent from spreading by encouraging airflow which discourages bacterial growth.

Forage Management

Variations in weather patterns impact the availability of flowers and the flow of nectar, which impacts bee foraging behaviour. Climate-adapted hives provide enough storage space for honey and pollen reserves during lean years to meet changes in foraging behaviours. They are also lightweight and thus easier to move and transport to areas with adequate forage.

Swarm Control

Swarming is a natural process where a strong colony that has become overcrowded in the hive, breaks into two, with one colony exiting with the old queen, to establish a new colony. Beekeepers can capture swarms to create new colonies, but prefer to control hive composition, by managing hive populations and preventing swarming. Swarming reduces honey production by depleting the colony's worker population, which decreases nectar foraging. After swarming, the colony undergoes a brood break while a new queen establishes herself, further delaying honey collection. This disruption often results in lower honey yields, especially if swarming occurs during peak nectar flow.

Temperature plays a key role in triggering and influencing swarming behaviour in bee colonies. Swarming typically occurs in late spring to early summer, when temperatures are warm enough to support the survival of a new colony. Rising temperatures, along with increased nectar availability and expanding brood, signal to the colony that conditions are favourable for reproduction. Warmer weather encourages foraging and queen egg-laying, which unless managed by the beekeeper leads to overcrowding, a major factor that prompts bees to prepare for swarming.

Unseasonal high temperatures, especially those driven by climate change, can shift swarming seasons earlier or extend them longer than usual. This can lead to poorly timed swarms where there is a lack of available forage and reduce swarm survival.

The possibility of swarming is reduced in well-managed hives with enough room, ventilation, and food supplies, maintaining the productivity and strength of the colony.

See Chapter 2 for more information on Maximizing Honey Production through Strategic Hive Placement and Foraging Management

Adapting Hive Use to Geographical Area

Geographic diversity necessitates adaptable hive techniques. Beekeepers need to modify their hive management techniques to fit the unique circumstances of various geographical areas. Table 3 below includes the information on hive selection based on climate.

See Annex 1 - Climate Map of Georgia

Table 3: Hive Selection Based on Climate

CLIMATE ZONE	REGION	HIVE MANAGEMENT
Transitional climate from moderately humid subtropical to dry mountainous climate	• Samtskhe Javakheti • Shida Kartli • Mtskheta-Mtianeti	Insulated hive designs in colder climates to shield colonies from subzero temperatures. Thick insulation and double-walled construction help preserve higher temperatures within the hive.
Moderately humid subtropical climate	• Shida Kartli • Kvemo Kartli • Mtskheta-Mtianeti, Kakheti	To avoid heat stress, hives in hot and dry climates need enough ventilation and shade. To lessen the impact of severe temperatures, beekeepers can use techniques like shade screens, raised stands
Humid subtropical climate	• Ajara • Guria • Samegrelo Zemo Svaneti • Racha-Lechkhumi Khvemo Svaneti • Imereti	Conditions with high humidity present problems including mould growth and elevated disease pressure. In humid locations, the danger of hive infections is decreased by using ventilated hive designs that assist air flow within the hive and regulate humidity levels

CHAPTER 2
Managing Nutrition for Optimum Well Being

Chapter 2 looks at gaining insights into the critical role of nutrition affected by a changing climate for maintaining bee colony health, including bolstering their immunity and resistance to disease, along with strategies for adjusting feeding practices based on factors like flora, temperature, and resource availability.

Climate and local weather conditions influence the bloom period and the availability of food for honey bees. Long-term shifts in climate and weather patterns, will significantly impact bee health by altering resource availability. Extended wet periods prevent bees from foraging, leading to a reduction in stored supplies. During prolonged droughts, bees consume more resources than they can collect. Unusually warm winters increase bee activity and brood rearing at times when floral resources are scarce or absent, potentially depleting winter stores too soon and resulting in late-winter mortality.

This chapter explores the strategies and considerations involved in feeding bees, from assessing their nutritional needs, to applying feeding techniques tailored to varying weather conditions and seasonal changes. By understanding the nutritional requirements of bee colonies and employing effective feeding practices, beekeepers can ensure the well-being of their hives and optimize productivity throughout the year.

Learning objectives

Participants will:

Understand the nutritional needs of bees in a changing climate, recognizing how seasonal changes, and changes due to changing, unseasonal or extreme weather affect blooming patterns, and nectar availability, impact bee nutrition and health. Identify signs of nutritional stress and learn how to respond with appropriate feeding interventions

Follow general feeding recommendations for overwintering, learning how to assess honey stores using the "hefting" method and ensure sufficient reserves for winter

Understand the use of foraging management practices to safeguard and boost productivity, in the face of climate related challenges, exploring transhumance, hive placement on site and regular hive inspections.

Understanding Nutritional Needs

As the seasons change, so do the nutritional requirements of bees. Added to this is are the effects of the increased unpredictability of local climates. Factors like blooming patterns, nectar accessibility, and brood production schedules all play a role in determining these fluctuating needs. To ensure the health of their colonies, beekeepers must be attuned to these seasonal variations and adjust their feeding methods accordingly. However, there are times when bees may face nutritional challenges due to nectar scarcity, unfavourable weather conditions, or disruptions in their environment. In response to these stressors, the bees may exhibit signs of malnutrition, such as reduced brood production or heightened foraging activity. In these cases, prompt action must be taken to provide the bees with additional nourishment.

Evaluating and Managing Colony Food Reserves

Evaluating the condition of bees through regular hive inspections provides valuable information on their nutritional needs and overall health. Signs of condition loss in bees, such as shrunken abdomens, sluggish behaviour, weak brood patterns, or reduced foraging, may indicate the need for dietary supplementation to maintain energy levels and colony vitality. Ensuring proper nourishment is vital for optimal brood development and colony growth. By carefully monitoring brood patterns, larval health, and queen productivity, beekeepers can make informed feeding decisions that reflect the nutritional adequacy of their hive resources.

Based on these assessments, beekeepers should maintain appropriate food reserves within the hive to support colony functions. **During the active season**, beekeepers should aim to have around 4.5 kg per hive of stores, **which is equivalent to about two full frames**. It ensures the colony has a reliable energy source for brood rearing, foraging, and daily activities. This reserve also protects bees against sudden weather changes or nectar shortages, helping to maintain colony stability and health. Without sufficient stores, colonies risk stress, reduced productivity, or even starvation. **For winter**, it is recommended to have **13-18 kg, or approximately six to eight full frames**, to ensure the bees' survival and provide enough resources for spring development. One way to assess the stores without opening the hive is through the hefting technique. *See Annex 2 - Hive Assessment and Feeding Techniques*

Additional Feeding Strategies

Despite the benefits of artificial feeding, leaving sufficient natural honey in the hive is recommended, especially for organic producers, who are more limited in using synthetic options and are encouraged to reserve extracted honey specifically for the purpose of additional feeding.

In addition to maintaining basic food reserves, supplemental feeding becomes essential when natural forage is insufficient. Additional feeding is often essential when natural forage is limited, especially as climate change, widespread Varroa infestations, and other stressors like pesticide exposure and disease pressure reduce the bees' ability to collect enough nectar and pollen. Late frosts, prolonged rains, or droughts can disrupt bloom cycles, leaving colonies without the resources needed for brood rearing or winter preparation. Furthermore, since beekeepers harvest honey, the bees' primary energy source, feeding helps replenish those stores. Without adequate support, colonies risk starvation, weakened immunity, and reduced productivity. Supplemental feeding helps maintain colony strength and stability through periods of stress or scarcity.

Additional feeding of bees is typically done in ***three*** main situations:

- After the honey harvest ***in the autumn*** to help colonies build up sufficient winter stores.
- ***In early spring*** to stimulate brood rearing and colony development before natural forage becomes available.
- During periods of ***nectar dearth*** when bees risk starvation.

Types of Additional Feed

Honey is a natural food source for bees and is often used in supplementary feeding when available. Using honey as a supplement ensures that bees receive a familiar and balanced food source, but beekeepers must be cautious about introducing honey from external sources, as it can be contaminated and spread pathogens like Nosema or American Foulbrood. Honey from different sources may also vary in its nutritional composition and digestibility. For instance, honeydew or goldenrod, can be harder for bees to digest in regions with harsh winters, as they crystalize and thicken, potentially leading to digestive issues.

Sugar syrup is a common form of supplementary feed for bees, often used when natural nectar sources are scarce. It provides bees with a quick and easily digestible energy source. Sugar syrup is safe, also naturally sterile and free from the disease risks potentially posed by honey. Sugar syrup can be adjusted in strength depending on the colony's needs—light syrup is ideal for stimulating brood rearing, while heavy (thick) syrup is used to build up winter stores. The primary advantage of sugar syrup is that it can be easily prepared and is typically less costly than honey, though it lacks the micronutrients found in natural nectar. Additionally, sugar syrup's mild scent reduces the likelihood of robbing[7] behaviour between colonies, making it a safer option for feeding.

Invert syrup[8] is excellent for building winter stores, however it requires specialized equipment to produce at the beekeeper level. It is generally available from beekeeping suppliers. Inverted syrup is considered to be the best option for additional feeding after honey. Unlike common sugar which consists of sucrose, inverted syrup is broken down into glucose and fructose, just like honey. This makes it easier for bees to digest and is also less prone to crystallization, making it a reliable and versatile feeding option, even in cooler weather. There are homemade recipes using white sugar combined with citric acid or invertase enzyme, but these typically vary greatly in quality and consistency compared to factory-produced syrups[9].

Candy is another form of supplementary feed, **especially useful during the winter** or when bees cannot forage due to cold weather. It provides a solid sugar source that is easily accessible to bees when temperatures are too low for them to gather liquid syrup. Typically, candy is made from a mixture of sugar and water, with some recipes adding invert sugar or honey to enhance its acceptability for the bees. Ready-made candy is available for purchase from beekeeping suppliers and companies, but it

[7] Robbing in bees refers to the behaviour where worker bees invade other colonies to steal honey, often during nectar scarcity. It can lead to fighting, colony weakening, and disease spread. Prevention includes maintaining strong colonies, avoiding spills, and using entrance reducers or robbing screens.

[8] The term comes from the optical rotation of the sugar solution: sucrose rotates polarized light in one direction, but when it's hydrolysed (inverted), the mixture of glucose and fructose rotates it in the opposite direction—hence, it's inverted.

[9] The challenge with homemade versions is controlling HMF (hydroxymethylfurfural) levels, which can rise due to overheating and become toxic to bees. Similarly, it's difficult to maintain optimal acidity (pH), which further affects bee safety. Homemade versions have a much shorter shelf life, often fermenting within 1 to 3 weeks, whereas professionally manufactured invert syrups can last 6 to 12 months if stored properly.

can also be made at home. Various candy recipes exist, with some including pollen, while others may even contain flour, though it is crucial to avoid yeast, as even small amounts in extracted honey can spoil an entire honey harvest.

Fondant and dry sugar are mainly used as emergency feed for bees during cold periods when liquid syrup is not suitable. Bees prefer syrup because it's easier to consume and process, but in low temperatures, syrup can ferment, freeze, or increase hive moisture. Fondant and dry sugar are harder for bees to digest and require hive humidity to soften. These feeds are lifesaving in emergencies such as when stores run out in winter but are not ideal for regular feeding.

Administrating Additional Feed

Feeding should be tailored to seasonal conditions, colony needs, and local climate. Regular inspections, sound judgement, and flexible planning are key to maintaining strong, healthy colonies throughout the year. Monitoring food reserves is critical for colony survival, especially during winter and early spring. Hefting is a useful quick-check method. However, visual inspections are essential during warmer winter days (every 2–3 weeks) to avoid isolation starvation, where bees consume stores on one side of the hive and become stranded away from others. Inspecting and repositioning frames or providing feed above the cluster can prevent starvation that can occur in spite of sufficient stores being present.

There are three main types of feeders:

- **Rapid feeders** are useful for delivering large volumes of thick syrup in autumn and promote fast consumption, though they can drown bees if poorly designed and are unsuitable in cold conditions.
- **Contact feeders** are better for controlled, smaller feeds, especially in spring; however, syrup can crystallize in cold temperatures and may not be taken readily.
- **Frame feeders** are internal and work well in nucleus colonies or for comb building, but they occupy space and require opening the hive to refill them. (See Examples in Annex 2)

Administration According to Season

In spring, light syrup can be provided using contact or frame feeders if colonies are weak and at risk of starvation. Feeding should only be done when daytime temperatures exceed 10°C. At lower temperatures, bees stay in a tight cluster and can't move around to reach or use the food. Overfeeding early in the season should be avoided since it can cause excessive brood rearing, which may be unsustainable if weather conditions worsen. *Feeding must be based on actual store assessment and colony strength, not by calendar date.*

In autumn, heavy sugar syrup either invert syrup or honey should be fed after honey harvest, ideally rapid feeders should be used in the evening when flying has stopped and temperatures are mild, above 12–15°C. This encourages bees to store food without excessive brood rearing. All colonies should be fed simultaneously to avoid triggering robbing. Feeding too early should be avoided unless bees need to draw comb or late swarms require support. This period often coincides with Varroa and Tropilaelps mite treatments, so any medication used should be checked for compatibility with feeding.

In winter, syrup feeding is unsuitable due to cold. Candy (not fondant) should be placed directly above the bee cluster on the inner cover. Bees will slowly consume candy without stimulation, which helps conserve energy. Regular checks on warmer days help prevent isolation starvation, and additional candy can be added as needed. Bees also need access to water, often from condensation within the hive, to metabolize candy.

Temperature plays a critical role in feeding. Liquid feed should only be offered when ambient temperatures are consistently above 10–12°C. Below that, bees cannot process syrup, and it may ferment or crystallize. Candy is preferred in colder periods as it remains accessible and does not spoil. The correct level of humidity (50%-70%) within the hive supports candy digestion, and ventilation must be managed to balance moisture and prevent mould.

To avoid robbing, feed colonies at the same time, late in the day and reduce hive entrances with blocks or grass to make them easier to defend. Never spill syrup or leave it in the open. Robbing signs include fighting at entrances, erratic flight, and bees trying to access other hives. If it starts, immediately reduce entrances, cover hives, or relocate vulnerable colonies. Closing boards can help contain hive scent and reduce wasp attraction.

Table 4. Preparation and Administration of Additional Feeds

SYRUP TYPE	RATIO *SUGAR /WATER*	PURPOSE & APLLY TIME	PREPARATION STEPS	FEEDING QUANTITY PER COLONY
Light Syrup	1:1	Stimulate brood rearing (spring/summer)	1. Mix 1 part sugar with 1 part warm water. 2. Heat the water gently and stir until sugar dissolves. 3. Allow to cool before feeding.	1–3 litres per week (based on colony size)
Heavy Syrup	2:1	Build up winter stores (the autumn /winter)	1. Mix 2 parts sugar with 1 part warm water. 2. Heat the water gently and stir until sugar dissolves. 3. Allow to cool before feeding.	10–15 litres total over a few weeks
Invert Syrup	1.5:1 (after inversion)	Quick energy & easy digestion (spring/ the autumn), especially in cool weather	*Homemade:* 1. Mix 7 kg sugar with 3.5 litres water. 2. Add 1.5–3 tsp citric acid or 30–60 ml lemon juice. 3. Heat to 70–80°C for 30 minutes (do not boil). 4. Cool completely before feeding. *(Enzyme option: Add invertase after cooling and let sit 24 hrs.)*	1–3 litres per week, or as needed
	Minimal water (thick paste)	Winter feeding (cold temps, below 10°C), when liquid feeding not possible	*Homemade (simple version):* 1. Boil 1 kg sugar with 200 ml water to 117°C. 2. Let cool until thick but mouldable. 3. Pour into trays or shape and place on top bars.	0.5–1 kg per colony, replenish as needed

RECOMMENDATIONS:

- use white, refined sugar for syrup and avoid brown sugar as it tends to cause bee dysentery
- avoid adding unfamiliar additives such as yeast
- if you have available equipment process invert syrup
- avoid yeast content and unknown substances in candy
- use fondant or dry sugar only in emergencies
- usage of antibiotics is strictly prohibited

Foraging Management

Appropriate feeding strategies are essential to maintaining bee colonies. The optimal placement of hives, whether stationary or through transhumance, is essential for maintaining healthy and productive colonies, especially in the face of climate change. As shifting weather patterns and changing floral availability disrupt foraging opportunities, placing hives in areas with reliable resources and microclimates can mitigate these challenges.

Relocating hives to follow blooming cycles and ensure consistent access to forage helps counteract climate-related stresses, such as altered nectar flows and droughts. By adapting hive placement to evolving environmental conditions, beekeepers can sustain honey production despite unpredictable climate fluctuations. This section explores the main factors beekeepers need to consider when feeding their colonies.

Strategic Hive Placement

Strategic hive placement is crucial for maximizing honey production, colony health, and overall beekeeping efficiency. By positioning hives in or moving them to areas rich in floral resources or with favourable microclimates, beekeepers can reduce competition for nectar, minimize foraging distances, and boost resilience and productivity. Understanding local floral diversity and nectar availability helps beekeepers choose optimal locations that align with bees' foraging behaviour. For example, by relocating hives to higher altitudes i.e. transhumance, beekeepers can extend the blooming period of species like Robinia Pseudo Acacia, ensuring a continuous nectar flow. Seasonal variations also affect foraging patterns, and beekeepers can adjust their hive management and harvesting schedules to take advantage of regional nectar flows, further enhancing honey production.

Transhumance

Transhumance refers to the seasonal movement of beehives to follow the availability of nectar and pollen sources. In Georgia, this practice is deeply rooted in beekeeping traditions and plays a vital role due to the country's diverse landscape, which includes mountains, varied altitudes, and microclimates. These conditions create varied flowering periods, enabling beekeepers to relocate their hives throughout the season for continuous access to fresh forage.

Typically, the transhumance cycle begins in lowland areas during early spring, where acacia and fruit trees bloom. As the season advances, hives are moved to mid-altitude regions for linden and chestnut blossoms, and later to high mountain zones such as Ajara, Svaneti, Racha, or Samtskhe-Javakheti, where alpine plants flower in late summer. In the autumn, beekeepers often return their hives to the lowlands to take advantage of the goldenrod bloom. This strategic movement enables the production of high-value honeys like chestnut and alpine honey, which are increasingly sought after in both local and export markets.

As noted in Chapter 1, in addition to supporting diverse honey production, transhumance is also an effective climate adaptation strategy. It helps beekeepers manage the risks of unpredictable weather, reduce forage shortages, and maintain colony health and productivity amid shifting flowering times caused by climate change.

Placing Hives Correctly on Site

Having chosen a suitable apiary site and acquired hives, beekeepers should place them on the site. The hive should be kept on the ground, on sturdy stands that bring the tip of the brood box level with the hands, making it easy to manipulate the frames during inspections. Inspecting many hives set at the wrong height can be uncomfortable and lead to back problems. A hive will be very heavy when the colony reaches its maximum size and has stored a large amount of honey, so it should not be placed on anything that will buckle under the weight.

The apiary arrangement should allow enough space to stand next to each hive during inspections. It is best to stand with the frames parallel to the body and avoid standing directly in front of the entrance to the hive, as that will block the bees' flight path. When bees are old enough to start foraging, they spend time learning the location of their hive by flying in larger and larger circles while facing toward the entrance. If hives are arranged in a long straight row, returning foragers will find it difficult to identify their hive and may drift into another one. A forager with a full honey crop will be accepted into the wrong colony, meaning that colonies at the ends of straight rows of hives tend to collect noticeably more honey than those in the middle. To prevent drifting, hives should be placed with their entrances facing in different directions.

Hives can be arranged randomly, in a large circle or semicircle with the entrances facing the centre, or in groups of two on a wide square with the entrances facing outward. The last arrangement allows beekeepers to stand behind the hives during inspections, out of the way of bees flying in and out. Two hives facing the same way can be placed on one stand without great danger of drifting.

Regular Hive Inspections

At each new site, beekeepers should evaluate foraging activity, colony condition, health and brood development, through scheduled hive inspections. To preserve bee productivity, early diagnosis of nutritional deficits, pests and illnesses and enables timely intervention and management techniques.

The table below outlines key recommendations for locating and arranging hives to enhance productivity and ease management.

Table 5: Key Recommendations for Foraging Management

RECOMMENDATIONS	
Strategic Forage Management	- Assess regional floral diversity and temporal nectar availability to inform optimal hive placement. - Deploy hives to minimize inter-colony competition and foraging distances, thereby enhancing productivity. - Align hive management practices, including harvesting and transhumance, with seasonal nectar flow dynamics.

RECOMMENDATIONS	
Transhumance	- Relocating hives to higher altitudes can extend blooming periods and ensure continuous foraging, while also adapting to climate changes by providing access to varying forage throughout the season. - Use lightweight, climate-adapted hives for long-distance transportation, ensuring ease of movement. - Employ transhumance mesh for ventilation during transport, reducing bee stress and maintaining hive health.
Placing Hives on the Site	- Use sturdy stands to keep hives off the ground, positioning the brood box at a comfortable working height to ease inspections. - Ensure stands can support the hive's weight, especially when full of honey, to prevent structural failure. - Arrange hives with space to stand beside them for easy inspection. Avoid blocking the hive entrance to prevent disrupting bee flight paths
Preventing Hive Drifting	- Avoid placing hives in a straight row to help foragers locate their specific hive more easily. - Position entrances in different directions or arrange hives in a circle, semicircle, or in pairs with entrances facing outward. - Two hives can share a stand without significantly increasing drifting risks.
Regular Hive Inspections	- Conduct scheduled inspections at each site to assess foraging activity, colony health and brood development. - Detect pests, diseases, or nutritional deficits early to implement timely intervention and management techniques, preserving bee productivity.

Planting Bee-Friendly Flora

Beyond simple feeding and smart forage management, strategically planting bee-friendly plants is a simple way that beekeepers can increase productivity and supplement when there is a forage gap. Climate change is leading to increased variability in flowering times and increased risk, for example when unseasonal rains or frosts impede access to or destroy blossom. Growing bee friendly flora in a controlled environment is thus a way to help mitigate that risk.

A large amount of nectar in Georgia is collected from gardens, evinced by the high proportion of fruit tree pollen to be found in Georgian honey [10]. Beekeepers can therefore also augment natural forage by establishing a variety of flowering plants that produce nectar and pollen all year round and can increase bee output. The health of bees is supported, and foraging chances are improved by choosing native, non-invasive species that are compatible with the local climate.

Table 6: List of Plants Arranged According to Season

SEASON	PLANT
Winter/ Spring	Almond, Apples, Clovers, Dandelion, Gooseberry, Gum Tree, Holly, Maple Tree, Needle Bush, Oranges, Rosemary, Thyme, Acacia, Blueberry, Borage, Bramble, Buckwheat, False Acacia, Knapweed, Lavender, Lucerne, Maillots, Oil Seed Rape, Rata Tree, Sainfoin, Thistle, Mountain Laurel, Privet, Rhododendron
Summer	Avocado, Coconut Palm, Mesquite, Tupelo, Cotton, Fireweed, Fuchsia, Lime Tree, Heather, Ivy, Sunflower, Sweet Chestnut, Ragwort, Spurge
Autumn	Goldenrod, Tulip Tree, Ragwort, Spurge

Common bee friendly plant families commonly found in gardens across Georgia include: *Carrot, daisy, borage, cabbage, bellflower, hemp, teasel, eleagnus, pea, gooseberry, mint, lily, meadow roam, loosestrife, mallow, willow herb, phlox, primrose, rose, citrus, valerian.*

Planting Climate Adaptive Species

Through thoughtful planting strategies that reflect seasonal needs and climate realities, beekeepers in Georgia can strengthen their colonies, reduce risks, and contribute to a more resilient ecosystem. Beekeepers should prioritize native, non-invasive plant species and carefully consider their regional climate zone and how different plant species respond to climatic extremes. Preference should be given to species that are hardy, capable of withstanding cold, rain, and heat, and that can adapt, reproduce, and spread effectively with a focus placed on establishing resilient, long-lived plants.

Trees in particular are easier to maintain and more likely to thrive under varying conditions. Trees that bloom in early spring are especially important, as they provide vital nourishment when colonies are rebuilding after winter. In Georgia's lowland regions, the availability of flowers in late autumn is increasingly significant. With milder winters, bees remain active longer, and a lack of appropriate forage

[10] Based on GBU research *Decoding Honey: Comprehensive Analyses of Georgian Honey and Consumer Preferences*, approximately half of the honey harvested in Georgia contains fruit tree pollen, either as a dominant, accompanying, or notable isolated component.

during this period can cause colonies to consume their stored honey prematurely, leading to potential starvation and a greater dependency on costly additional feeding.

Table 7. Major Nectar-Producing Trees in Georgia: Flowering Periods and Honey Yields

COMMON NAME	LATIN NAME	FLOWERING PERIOD	FLOWERING DURATION (DAYS)	ESTIMATED HONEY (KG/HA)	YIELD CLASS
Willow *(standing)*	*Salix*	March–April	20–25	100–150	Moderate
Maple	*Acer*	April	7–10	30–70	Low
Barberry	*Berberis*	April–May	20–25	70–100	Low
Sea Buckthorn	*Hippophae rhamnoides*	April–May	10–20	10–40	Low
White Acacia *(False Acacia)*	*Robinia pseudoacacia*	May	10–15	300–1000	High
Colchic Oak	*Quercus hartwissiana*	April–May	10–15	10–30	Low
Gleditsia *(Honey Locust)*	*Gleditsia triacanthos*	May	10–14	50–150	Low–Moderate
Amorpha	*Amorpha fruticosa*	May–June	20–25	100–250	Moderate
Tree of Heaven	*Ailanthus altissima*	May–June	10–14	100–300	Moderate
Oleaster *(Russian Olive)*	*Elaeagnus* spp.	May–June	10–15	100–200	Moderate
Christ's Thorn	*Paliurus*	May–June	15–20	50–100	Low
Linden *(Caucasian)*	*Tilia caucasica*	June	10–15	700–1100	High
Chestnut	*Castanea*	June	18–20	150–250	Moderate
Silk Tree *(Persian Acacia)*	*Albizia julibrissin*	June–July	15–20	200–500	Moderate
Japanese Pagoda Tree	*Sophora japonica*	July	15–20	300–600	High
Evodia ***(Bee Tree)***	*Tetradium daniellii*	July–August	35–40	800–2000	High
Sumac	*Rhus*	August–September	15–20	30–60	Low
Eucalyptus	*Eucalyptus globulus*	September–November	30–45	200–500	Moderate

CHAPTER 3
Colony Treatment

The link between extreme temperatures and high humidity within the hive to weakened resistance and susceptibility to and increased incidence of disease was described in Chapter 1.

Chapter 3 provides a detailed overview of disease management strategies that can be employed by beekeepers, from daily good management and resilience building practices, to early disease detection and types of treatment. By integrating these strategies, beekeepers can help safeguard their colonies against the pests and diseases, exacerbated by climate change.

It also focuses on how heat and cold affect the efficacy of veterinary medicines and emphasizes the importance of adapting treatment methods, dosages, and application techniques to fluctuating weather.

It is vital to recognize that, numerous medications can lose their potency or decline in quality when subjected to high or low temperatures. To achieve the best outcomes, beekeepers must carefully modify dosage and administration techniques. This section offers helpful advice on how to control the use of veterinary drugs during extreme temperatures.

Learning objectives

Participants will:

Explore effective strategies for managing bee diseases and pests through sustainable management graduating from monitoring and early detection, management and treatment.

Learn how to optimize treatment methods, including early detection and diagnostic tools, and managing chemical treatments with optimal scheduling.

Explore best practices for treatment and administration and storage of veterinary medicines in extreme temperatures, with a focus on managing their use in high and low temperature conditions.

Optimizing Treatment Methods in Changing Weather Conditions

Highly changing weather patterns make it crucial to adopt a dynamic approach to treatment. Creating greater resilience in the face of these challenges focuses on adaptable strategies that beekeepers can employ to effectively navigate fluctuating climate conditions. Good management and prevention form the basis of sustainable care for bees. By staying one step ahead and administering treatments pre-emptively, beekeepers can ensure the continued well-being of their bees. The principles **of Integrated Pest Management (IPM)** *(See Annex 3)* are mainstreamed into the advice below focussing on monitoring and early detection and management methods as the key part of thoughtful beekeeping before moving on to mechanical, biological, organic and finally in a last case scenario chemical treatments. IPM takes a targeted approach towards bolstering the resilience of honeybee colonies against threats from diseases and pests, ultimately promoting their long-term survival. One of the key aspects of IPM strategy is to reduce possible stresses for bee colony. As discussed in Chapter 1 and 2, climate change effects ultimately increases the risk and susceptibility of bee colonies to diseases. Implementing the good management practices outlined in Chapter 1 and 2 reduces these impacts and stressors increasing colony resilience.

Early Detection and Diagnostic Tools

Regular inspection and early detection of diseases are fundamental practices in colony management and treatment. Beekeepers should learn to recognise the early signs of disease to take prompt action. In addition to visual observation, beekeepers can use various tools to enhance effectiveness in monitoring and detecting potential issues, tools such as disease testing kits, mite monitors, record keeping and hive health analytics software. These can greatly enhance a beekeeper's ability to evaluate hive conditions and determine appropriate courses of action. By utilizing data-driven monitoring, beekeepers can take proactive measures to manage pests and diseases specific to their hives.

The table below provides a full spectrum of disease management strategies.

Table 8. Overview of Disease Management Strategies

DISEASE MANAGEMENT STRATEGY		DESCRIPTION	RECOMMENDATIONS
CULTURAL	Monitoring & Early Detection	Regularly inspect hives for pests and diseases to take timely action.	**Regular Inspection**: inspect hives to identify pests (e.g., Varroa mites, small hive beetles, wax moths) and diseases (e.g., American foulbrood, Nosema). **Monitoring Tools:** Use tools like sticky boards, alcohol washes, or sugar rolls to monitor Varroa mite levels. **Visual Recognition:** Learn to recognize early signs of infestations or infections to take timely action.
	Cultural & Management Practices	Improve colony health and reduce stress through good beekeeping practices.	**Hive Placement**: Locate hives in well-ventilated, sunny areas with good airflow to reduce humidity and deter pests. **Minimize Stress:** minimize colony from stresses like heat and cold stress, especially during transhumance. **Strong Colonies**: Maintain strong, healthy colonies through proper nutrition, queen management, breed selection and regular hive inspections.

DISEASE MANAGEMENT STRATEGY		DESCRIPTION	RECOMMENDATIONS
			Sanitation: Keep hive equipment clean and free of debris. Replace old or damaged comb regularly. **Hive Manipulation**: Rotate frames, replace old comb, and manage hive space to reduce pest habitats.
MECHANICAL	Mechanical & Physical Controls	Use physical barriers and traps to reduce pest populations.	**Screened Bottom Boards**: Use screened bottom boards to help control Varroa mite populations by allowing mites to fall through. **Brood Break:** Temporarily interrupt the brood cycle to reduce Varroa mite reproduction by caging the queen or splitting colonies. **Drone Comb Removal**: Varroa mites prefer drone brood, so removing and freezing drone comb can help control mite populations. **Entrance Reduction:** Use entrance reducers or traps against pests.
	Biological Control Methods	Use natural predators or biological agents to control pests	Beneficial fungi or bacteria, predatory mites against Varroa. Unfortunately, currently unavailable within beekeeping. However, the research is being ongoing to explore the potential impact of using Nematodes against them.
CHEMICAL	Organic Chemical Treatments	Apply treatments only when necessary, using organic chemicals.	**Organic Medicines:** Use approved miticides or treatments (e.g., oxalic acid, formic acid, or thymol-based products) only when necessary and according to label instructions. **Rotation**: Rotate treatments to prevent pests from developing resistance. **Avoid Synthetic Medicines:** Avoid using synthetic chemicals during honey flow to prevent contamination.
	Selective & Minimal Chemical Treatments	Apply treatments using synthetic chemicals as the last resort	**Last Resort**: only apply synthetic chemicals when pest levels exceed economic thresholds. **Attention to Lebel:** only use the synthetic medicine that is allowed to use in beekeeping such as fluvalinate, amitraz, coumaphos and others. Check the list with the GBU. **Attention to Dosage:** imply dosage according to label instruction. **Attention to Storage Requirements:** Always store medications according to the guidelines provided by the medicine manufacturer. **Rotation & Records:** Rotate treatments to prevent pests from developing resistance. Keep detailed records of pest levels and treatments applied. **No Antibiotics:** do not use antibiotics. Usage of antibiotics in beekeeping is forbidden as it directly contaminates honey. Antibiotics are given through feeding, always check artificial feedings such candy or additives to feeding syrup.

Optimal Treatment Scheduling

By utilizing weather forecasts to guide treatment schedule, treatment effectiveness can be maximized by scheduling treatments during periods of consistent weather or favourable environmental conditions, achieving better treatment results and reducing stress on bee colonies.

Managing Chemical Treatment in Beekeeping

Due to the widespread impact of Varroa mites, organic and synthetic chemical treatments have become a necessary tool in beekeeping. However, their effectiveness can be significantly influenced by environmental factors, particularly temperature. As such, it is essential for beekeepers to be mindful of these conditions when applying treatments. Understanding how temperature affects the stability and absorption of veterinary medicines is crucial to ensuring successful outcomes. The following sections, explore how temperature influences medication uses and provide guidelines for managing treatments in both high and low-temperature conditions.

Chemical treatments are the most commonly used method for controlling pests like Varroa and Tropilaelaps in beekeeping. These chemical treatments can be divided into two categories: organic and synthetic. Organic treatments include organic acids such as *oxalic acid* and *formic acid*, as well as essential oils like *thymol*, which are effective antibacterial and antifungal agents. These treatments are permitted in organic (bio) production and are often cost-effective solutions. Synthetic treatments involve pesticides such as *Flumethrin, Tao Fluvanilate, Amitraz,* and *Coumaphos*. While these have been effective for some time, resistance can develop over time. Additionally, they carry toxicity risks, especially Amitraz and Coumaphos, and their residue levels are strictly regulated. Most veterinary medicines for Varroa contain these chemicals, so beekeepers should always check the product contents to ensure safe and effective use. Only organic chemicals can be used in bio honey production.

Table 9. Overview of Organic Chemical and Synthetic Chemical Treatment and Use in Beekeeping

	ACTIVE INGREDIENT	MITE TARGET	APPLICATION METHOD	EFFECTIVENESS
Organic Chemical Treatment	**Oxalic Acid**	Varroa, Tropilaelaps	Applied as a spray or vapor. The drench method involves mixing Oxalic acid with sugar syrup and applying directly onto the bees. The best solution is vaporization that requires a vaporizer. The treatment is usually applied in autumn between population decrease and dormant (broodless) period.	Effective, especially when brood population is declining.
	Formic Acid	Varroa, Tropilaelaps	Applied using pads or strips placed inside the hive. Can be used during active brood rearing periods but needs to be done carefully as it can be harsh on the colony if not applied properly. High content formic acid (>50%) needs additional protection clothing, goggles, acid resistant gloves and respirator.	Effective in all seasons, but temperature sensitive (10^0C-29^0C).
	Thymol	Varroa, Tropilaelaps	Applied in the form of strips or pads soaked in thymol, placed inside the hive. It can also be used in the form of a gel or liquid. Thymol works by disrupting the mites' metabolism. It is most effective in warmer temperatures but can be harsh in hot weather.	Effective, especially in warmer temperatures, but can cause bee stress in extreme heat.
Synthetic Chemical Treatment	**Flumethrin**	Varroa	Applied using plastic strips that are placed inside the hive. Typically left in place for a few weeks to ensure mites are eradicated.	Effective, but mites can develop resistance.
	Tao Fluvanilate	Varroa	Applied via strips placed in the hive, similar to flumethrin. Used in controlled doses over time.	Effective but must be monitored for resistance.
	Amitraz	Varroa, Tropilaelaps	Applied through strips or gel placed inside the hive, or as a liquid treatment directly onto the bees. The strips are typically left in the hive for 1-2 weeks to ensure mite eradication.	Highly effective, when brood is absent, but resistance can occur.
	Coumaphos	Varroa, Tropilaelaps	Applied as a solution or strips inside the hive. It is often used in late summer to control mite populations.	Effective but carries toxicity risks.

Treatment in Extreme Temperatures

This section focusses on the treatment considerations for bees during extreme temperatures. It highlights the importance of adjusting practices based on temperature to ensure proper medication use and optimal treatment outcomes. Extreme heat and extreme cold impact veterinary medicine efficacy; this section explains how to adapt practices to these conditions; managing dosages, application methods, and storage as well as supportive actions described in Chapter 1 such as external insulation in cold temperatures and shade and water availability in hot weather which increase the efficacy of the treatment.

Managing Treatment and Veterinary Medicines Use in High Temperatures

This table highlights important factors to consider when managing treatment and administering veterinary medicines in high temperatures. By following these practices, beekeepers can help protect the health of their colonies and ensure the proper use of veterinary medications in challenging conditions.

Table 10: Key Considerations for Treatment and Administering Pharmaceuticals to Bees During High Temperatures

Factor	High Temperatures Considerations
Temperature Thresholds	Understanding specific temperature thresholds at which pharmaceuticals degrade is crucial. Beekeepers should refer to product labels or manufacturer instructions for handling and storage temperatures.
Dosage Adjustment	Adjust dosages in response to heat-induced stress, as high temperatures affect bees' metabolism, making them more vulnerable to illness. Modifications to dosages ensure successful treatment outcomes while accounting for physiological stress.
Reduced Absorption	Heat stress can reduce the ability of bees to absorb drugs given by feed or water. Beekeepers should explore alternative delivery routes, such as direct application or vaporization, to ensure effective drug absorption.
Application Timing	Administer treatments during the cooler hours of the day (early morning or late evening) to avoid heat-related strain on bees and improve drug absorption. Monitor weather forecasts to apply the product during milder temperatures or cloud cover.
Storage	Use insulated storage containers to protect medications from temperature fluctuations. Avoid direct sunlight, which can heat up storage containers, leading to medication deterioration. Store medications in shaded areas or use UV-resistant packaging.
Water Availability	Ensure a plentiful supply of fresh, clean water close to beehives throughout the summer. Proper hydration supports bee health, recovery from heat exhaustion, and improved drug absorption.
Shade Provision	Create shaded areas around hives using natural or man-made structures to protect bees from direct sunlight and heat stress. Shade cloths or tree coverings can be used while administering medication to the hives.
Monitoring and Symptom Recognition	Beekeepers should monitor hive activity, behaviour, and brood growth for signs of heat stress or adverse drug reactions. Early detection of health problems allows for prompt intervention and adjustment of treatment plans.

Managing Treatment and Veterinary Medicines Use in Low Temperatures

This table highlights important factors to consider when managing treatment and administering veterinary medicines in cold temperatures. By following these practices, beekeepers can help protect the health of their colonies and ensure the proper use of veterinary medications in challenging conditions.

Table 11: Key Considerations for Treatment and Administering Pharmaceuticals to Bees During Low Temperatures

Factor	Low Temperatures Considerations
Medication Stability and Storage	Store medications in heated or insulated containers to maintain effectiveness. Regularly monitor the temperature of storage spaces to ensure pharmaceuticals remain within prescribed ranges. Utilize thermometers or temperature sensors for real-time data and swift interventions if temperatures drop too low.
Dosage and Application Methods	Low temperatures decrease bees' metabolic rates, which may hinder their ability to digest drugs effectively. Adjust dosages or timing as necessary to ensure the drugs can still provide their intended therapeutic effects.
Alternative Administration Route	In cold weather, bees eat less, making feeding or watering with medication less effective. Beekeepers should consider alternative methods, such as injections or direct application, to ensure proper medication absorption.
Optimal Timing for Treatment	Administer treatments during the warmest part of the day (midday or early afternoon) when hive activity and metabolic rates are highest, maximizing drug absorption and minimizing cold stress.
Weather Factors	Monitor weather forecasts and schedule medication administrations during warmer, clearer days. This ensures bee comfort and promotes proper medication absorption with reduced wind chill factors.
Protecting Medication During Application / Handling Precautions	Prevent drugs from freezing during application by using insulated transport containers. This will maintain medication efficacy and reduce exposure to cold temperatures during handling.
Quick Application	Simplify the administration process to minimize time spent outside in cold weather. Quick application reduces bee stress and helps guarantee the best possible treatment outcomes.
Hive Insulation	Insulating hives helps retain heat and stabilize interior temperatures in cold weather. Beekeepers can use blankets or foam boards to insulate hives and protect colonies from temperature fluctuations.
Wind Protection	Bees experience increased cold stress and heat loss from hives in windy conditions. Erect windbreaks or shelters around hives to protect colonies from chilly breezes and maintain warmth during medication administration.
Post-Treatment Monitoring	After treatment, monitor for signs of adverse reactions, such as changes in hive activity or behaviour. Early detection of negative effects allows for prompt modification of treatment plans.
Follow-Up Care	Provide extra food or insulated hives to help bees recover from cold stress. Regularly monitor hive health and take necessary action to enhance colony resilience in cold weather conditions.

Chapter 4

Wax Production and Use in the Hive

Chapter 4 looks at beeswax production by honeybees for comb construction, its importance in supporting honey production and its susceptibility to chemical contamination from antibiotics and pesticides. Quality beeswax is essential for hive health, honey quality, and effective brood management and can be promoted through practices such as avoiding adulterated foundation, selective comb harvesting, replacing old comb and sustainable harvesting techniques like solar melting.

Beeswax holds a vital role in beekeeping, serving as the foundation for hive construction and food storage by honeybees. However, its significance is amplified in the face of fluctuating weather patterns and extreme conditions. As climate change brings about unpredictable weather shifts, beeswax becomes essential for maintaining hive integrity, insulation, and food preservation.

This chapter explores the critical importance of correct beeswax production, sustainable harvesting and solar melting, and processing practices that ensure clean and uncontaminated wax.

Learning objectives

Participants will:

Understand the importance of high-quality beeswax and the role it plays in the hive and in honey production.

Explore the different types of beeswax, including capping beeswax, brace comb, and beeswax from foundation sheets.

Recognize the implications of adulterated beeswax and learn strategies to ensure the purity and effectiveness of beeswax for optimal hive management.

Understand the importance of proper preliminary processing techniques, including filtering and cleaning methods, and explore the role of solar melters in decontaminating beeswax.

Explore best practices for traceability and sourcing beeswax

The Importance of High-Quality Beeswax

As a key raw material, beeswax plays a crucial role in beekeeping efficiency and sustainability. Beeswax foundation should provide a strong honeycomb structure, ensuring durability during honey extraction while supporting effective brood management and colony health and be uncontaminated.

Beeswax foundation acts as a storage unit for honey, pollen, and bee bread, preserving essential nutrients for the colony's survival. Properly processed beeswax prevents contamination, keeping honey pure and fresh. Its natural antibacterial properties help maintain hive hygiene by inhibiting pathogen growth.

High-quality beeswax fosters a clean environment for brood rearing and food storage, reducing disease transmission and supporting colony well-being. Regularly replacing old frames and beeswax sheets disrupts the Varroa mite life cycle, lowering infestation levels and minimizing the risk of severe diseases like American foulbrood. Additionally, regular **beeswax replacement** reduces chemical contamination from pesticides, antibiotics, and environmental pollutants, further safeguarding colony health. **Proper beeswax production** is vital therefore not only for hive maintenance but also for overall colony productivity.

Beeswax and the Circular Economy

Beeswax and beeswax foundation production exemplifies a **circular economy**[11], as it can be reused multiple times to create beeswax foundations.

Importantly, this circular value chain extends beyond individual beekeepers. Even though direct cooperation between beekeepers may be limited, the system itself creates an interconnected network where beeswax circulates through buying, selling, or exchanging. Beeswax foundation can be produced by beekeepers using small-scale moulds, but it is more commonly processed at beeswax processing units or purchased or exchanged at beekeeping and veterinary supply shops. Barter exchange remains a common practice among small-scale and medium-scale beekeepers who lack sufficient beeswax for foundation production. This has clear benefits: a beekeeper is not fully dependent on their own beeswax harvest and can obtain it from others when needed, increasing operational flexibility and resilience.

However, this also introduces certain risks. The widespread exchange of beeswax raises concerns about contamination, quality, and authenticity. Low-quality or adulterated beeswax can negatively impact colony health and compromise the quality of harvested honey. Thus, while the shared use of beeswax reinforces the circular system, it also demands stricter quality control, traceability, and standards to protect both bees and consumers.

Climate Adapted Beeswax Foundation

Climate-adapted beeswax foundation is developed through an integrated approach that combines climate-adapted beekeeping practices, beeswax processing techniques, and foundation printing methods to address the challenges posed by climate change. Designed to endure temperature extremes and high humidity, these foundations help maintain comb stability, reduce deformation, and

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[11] The circular economy is an economic system focused on minimizing waste and optimizing resource use through reusing, recycling, and refurbishing products to extend their lifespan and reduce environmental impact. Beeswax is an excellent example of this in beekeeping, as it can be recycled through proper cleaning, filtering, and processing to create new foundation sheets, candles, or cosmetics. This process reduces waste, decreases dependence on synthetic alternatives like paraffin and stearin, lowers costs, and fosters sustainability within the industry

support consistent brood development. A key factor in their effectiveness is the use of pure, high-quality beeswax, free from chemical additives like paraffin and stearin, as well as antibiotic residues, pesticides and disease spores. This approach ensures hive health, protects honey quality, and supports sustainable, circular beekeeping systems adapted to local climates.

Types of Beeswax

High-quality beeswax production is essential for the hive and the honey it generates. Beekeepers need to be aware of how crucial it is to produce beeswax correctly in order to minimize waste and guarantee the quality of their honey. Beeswax is a valuable by-product of honey extraction, and beekeepers can harvest three main types: capping beeswax, brace comb (also known as burr comb), and beeswax from foundation sheets.

Capping Beeswax

Capping beeswax is the highest quality form of beeswax, produced by bees as a thin, light-colored layer used to seal honey-filled cells in the honeycomb once the honey is fully ripened. It is collected during the uncapping process that precedes honey extraction and should be stored separately from other types of wax due to its exceptional purity. Secreted by young worker bees, this beeswax contains mainly esters of fatty acids and long-chain alcohols, with minimal impurities, making it especially valuable for high-end applications in cosmetics, pharmaceuticals, and food-grade products. Unlike old, dark brood combs that yield lower-quality wax in smaller amounts, capping wax offers a clean, premium-grade material ideal for specialized uses.

Brace Comb

Brace comb, found outside the intended frame areas, often on top of frames, can also produce high-quality beeswax if properly cleaned. It is built entirely by the colony and is purer and fresher than wax from foundation sheets in frames. Beekeepers can collect brace comb during hive inspections, but caution is needed, as it may contain brood, including queen cells, or even the adult queen.

Beeswax from Frames

Beeswax from frames consists of both naturally built wax and the artificial foundation inserted into the hive. This wax can be separated from the foundation by gentle scraping. The separation can help to avoid mixing with paraffin if it was used in the foundation. Sorting beeswax in this way helps beekeepers minimise contamination risks, particularly if the quality and safety of the beeswax foundation used in the hive are uncertain.

The Implications of Adulterated Beeswax

Beeswax is one of the most sought-after products in the beekeeping industry. Beekeepers often require more beeswax than they can produce, making it one of the most frequently adulterated products worldwide. To meet demand, producers both locally and globally often mix beeswax with substitutes like stearin or paraffin, creating a cheaper but less effective and environmentally harmful foundation.

Many countries, including Georgia, import beeswax foundation regularly. However, because beeswax is considered an input rather than a final product, its quality and authenticity are often not inspected at the border. This lack of regulation has a snowball effect on the industry, as low-quality foundations continue to circulate. Beekeepers seeking cost-effective options may unintentionally harm their colonies. It is estimated that **one-third of the recycled beeswax in the industry contains paraffin**.

Impacts of adulterated foundation

Unlike beeswax, **paraffin has a weaker structure**. A foundation with up to 50% paraffin content compromises honeycomb strength, affecting its ability to support honey weight. Although foundations with more than 30% paraffin are rarely found, their impact can be difficult to detect in normal conditions

Climate change and its resulting temperature fluctuations exacerbate the issue. Poor-quality foundations are vulnerable to heat stress. With paraffin's lower melting point (47°C) compared to beeswax (62–65°C), foundations containing high paraffin content are more prone to structural weakening. This issue becomes particularly critical during transportation and transhumance, where prolonged exposure to high temperatures can compromise their integrity.

Research has shown **the impact of paraffin and stearin on brood development.** Beeswax containing stearin negatively affects brood survival, with particularly harmful effects on queen bee larvae, potentially disrupting royal jelly production. The use of stearin in beeswax has not been confirmed in Georgia. However, due to the lack of effective control over both imported and domestically produced beeswax, its presence cannot be ruled out.

Therefore, it is crucial for beekeepers to remain **cautious** and **avoid low-quality beeswax foundations** containing paraffin, as they can compromise hive integrity and colony health.

Avoiding Beeswax Contamination

Contaminated beeswax poses a significant threat not only to the health of bee colonies but also to the entire honey harvest. Beeswax can easily transfer chemical residues into honey, including synthetic substances that are strictly regulated or entirely prohibited. **While certain pesticide residues have established maximum limits, there is zero tolerance for antibiotics in honey**. Additionally, residues from synthetic chemicals such as pesticides and antibiotics are highly resistant to thermal processing, making them difficult to eliminate and allowing them to persist in beeswax for extended periods.

Beyond chemical contamination, beeswax can also harbour spores and pathogens responsible for various bee diseases, including European Foulbrood (EFB), chalkbrood, Nosema, and, most critically, American Foulbrood (AFB)—one of the most devastating diseases in beekeeping. The risk of cross-contamination is particularly high when beeswax is reused without proper processing.

This issue is further intensified by **the circular nature of the beeswax industry**. The lack of traceability, along with inadequate quality and safety controls for beeswax foundation, leaves beekeepers unaware of the quality of the inputs they are using. This increases the risk of disease outbreaks and honey contamination, threatening both colony health and overall industry sustainability.

Therefore, beekeepers should carefully manage every stage of the beeswax processing chain to ensure quality and colony health. This includes:

- **Proper Preliminary Processing –** Harvest beeswax correctly from their own apiary, sorting it by quality, heating it appropriately, and storing it under clean conditions.
- **Sourcing High-Quality Beeswax –** Obtain additional beeswax only from trusted beekeepers or reputable producers to avoid contamination with adulterants or residues.
- **Reliable Beeswax Foundation Production –** Work with a trusted beeswax processing enterprise that follows good hygiene practices and uses proper heating, filtering, and engraving equipment to maintain wax purity and structural integrity.

By following these steps, beekeepers can minimise contamination risks and maintain the health and productivity of their colonies.

Ensuring Proper Preliminary Processing

Proper preliminary processing of beeswax is essential to produce a climate-adapted beeswax foundation. The wax must be thoroughly cleaned and filtered to remove impurities. Using a double boiler for melting beeswax and a fine filter, such as cheesecloth, a nylon stocking, or a specialized wax filter, is recommended. For optimal purity, the process should be repeated once or twice with progressively finer filters.

At the same time, it is important to consider the presence of chemical residues. Beekeepers often use synthetic pesticides and, in some cases, banned antibiotics. Research shows that these substances, particularly antibiotics, are highly resistant to thermal processing. The most effective method for breaking them down is ultraviolet radiation, which solar beeswax melters can provide.

The Role of Solar Beeswax Melters

Solar melters have long been used in beekeeping, particularly in sunny regions, due to their simplicity, low cost, and effectiveness. However, they have not traditionally been seen as a tool for decontaminating beeswax. These melters integrate a filtering system that effectively removes debris and impurities while using solar heat and UV exposure to help break down contaminants.

As a sustainable, energy-efficient, and cost-effective tool, solar beeswax melters are well-suited to Georgia’s climate. The construction design of most solar melters is relatively simple, allowing beekeepers skilled in woodworking to build them with ease. Those without such skills can purchase ready-made solar beeswax melters from beekeeping suppliers or have one custom-built by a carpenter using readily available online plans (contact GBU for assistance). While the melting process is slower than traditional thermal methods, it offers superior purification, significantly reducing the risk of honey contamination.

See Annex 4 - Wax Processing using a Solar Melter

Choosing a Reliable Beeswax Processor

There are various methods for processing beeswax foundation, ranging from handcrafting to professional manufacturing in factories. While a solar melter effectively cleans beeswax from impurities, chemical contaminants, and disease spores, it is still advisable for beekeepers to use the services of professional beeswax processors rather than relying on hand-printing methods. Professional processors offer additional purification steps, higher precision, and faster engraving, ensuring better quality foundations.

However, choosing a reliable beeswax processor is crucial. Beekeepers should verify that the processor:

- Conducts proper thermal processing and filtering of beeswax
- Maintains clean equipment, tools, and facilities
- Uses appropriate temperatures to purify beeswax without degrading it

A secondary thermal process at a high temperature, ideally 125°C (but no higher, to avoid damaging the beeswax), helps eliminate disease spores and some chemical residues. If an autoclave is used, it significantly enhances sterilisation. However, not all contaminants can be removed this way, reinforcing the importance of preliminary processing with solar melters.

Traceability and Sourcing of Beeswax

Additionally, beekeepers should consider the type of processing equipment used—cold-stamped or hot-stamped—when selecting beeswax foundations. While there is no scientific evidence confirming differences in the final product, practical experience suggests each method has its own advantages.

Hot-stamped foundations are faster, more cost-effective, and ideal for high-volume production in peak seasons (spring/summer), but they are less durable for winter storage.

Cold-stamped foundations, though slower to produce, are more durable and better suited for off-season production and long-term storage.

See Annex 5: Comparison of Hot and Cold Stamped Beeswax Foundation Processing

Sourcing Additional Beeswax

Another important consideration when using a beeswax processor's services is traceability and sourcing of the beeswax. Often, beekeepers need to source additional beeswax foundation, either from the processor or other beekeepers. Being able to trust the quality of the beeswax is crucial, but it is unlikely that the beeswax will come with a laboratory report. To reduce risks, beekeepers can take a few approaches:

Source from a Trusted Beekeeper — Choose beeswax from a beekeeper you know and trust, who follows good apiary management practices, including proper treatments and preliminary beeswax processing.

Use Certified Organic Beeswax — Use beeswax from a bio-certified apiary, as these operations adhere to strict standards for testing both beeswax and honey. However these are very rare currently in Georgia.

See Chapter 5

Recent Laboratory Testing — Select beeswax from a beekeeper who has recently conducted laboratory tests for safety parameters, focusing not just on quality but specifically on safety concerns like antibiotics, pesticides, and heavy metals.

If none of these options are available, consider discussing the apiary management practices directly with the beekeeper or beeswax processor to understand their approach and mitigate potential risks.

The advice given in this Chapter relating to beeswax is summarized in the Table below.

Table 12: Best Practices for Sourcing, Processing, and Managing Beeswax

CATEGORY	RECOMMENDATION
Climate Change Considerations	Climate change exacerbates contamination risks, as temperature fluctuations can accelerate chemical degradation and weaken beeswax structures containing paraffin. Beekeepers should be especially vigilant in sourcing additional beeswax, choosing beeswax printing method and storing beeswax under stable conditions.
Preliminary Processing	Use a double boiler and fine filters (cheesecloth, nylon, or specialized filters). Repeat the process for better purification. Employ solar melters for additional decontamination, as UV radiation helps break down chemical residues. Solar melters are energy-efficient and well-suited for warmer climates. They ensure better and safer purification compared to traditional thermal methods, making them a sustainable processing option
Beeswax Contamination	Avoid beeswax containing paraffin or stearin, as they weaken the honeycomb and may harm brood development. Regularly replace old beeswax foundations to reduce contamination risk.
Circular Economy	Reuse beeswax efficiently by creating beeswax foundations. Regular replacement helps maintain hive hygiene, disrupt Varroa mites, and prevent the spread of disease.
Beeswax Harvesting	Prioritize capping beeswax (highest quality). Store separately and clean properly. Collect brace comb cautiously to avoid removing queen cells. Separate wax from foundation sheets to minimize contamination risks.
Processing Method	Choose professional processing over hand-printing to ensure better purification and engraving. Choose a processor that maintains clean equipment and uses proper thermal processing, and effective filtering methods.
Thermal Processing	Ensure beeswax is processed at 125°C (but no higher) to sterilize and eliminate disease spores while preserving beeswax quality. If available, an autoclave can enhance purification.
Hot-Stamped vs Cold-Stamped	Hot-stamped: faster, cost-effective, but less durable. Best for high-season use. Cold-stamped: more durable, better for long-term storage, but slower and costlier. Choose based on production needs.
Traceability	Verify beeswax origin through documentation or direct communication with the supplier. Ensure that the processor follows strict hygiene and quality control measures to maintain beeswax purity.
Sourcing Beeswax	Obtain beeswax from trusted beekeepers with good apiary management. Choose bio-certified beeswax or beeswax with recent laboratory tests confirming safety (free of antibiotics, pesticides, and heavy metals).

CHAPTER 5:
Bio Honey Production

Chapter 5 aims to provide a full picture of bio/organic[12] honey production with a detailed overview of what bio honey is, the rationale for producing it, and what is involved in the full bio certification procedure including pertinent terms, certifying bodies, the certification process and the requirements of the bio standard itself.

It is essential for beekeepers who want to produce bio honey to have a clear understanding of their rationale and incentives for conversion to bio honey production. Beekeepers should have a clear view of the feasibility of entering the process, the entities involved, the support they need, the investment required in terms of time and money and the potential gains monetarily, environmentally or otherwise. For example, a beekeeper may only be able to gain access to a market if their honey is bio certified, another may be convinced of consumer demand and subsequent market advantage for a higher value honey or another be dedicated to environmental sustainability and ethical production and products.

Therefore this section begins with an examination of the factors to consider when deciding whether to proceed to bio production before proceeding to a detailed breakdown of the full process as it currently stands in Georgia.

Bio beekeeping supports the eco system and sustainable colony management, however bio beekeeping is also subject to all the climate related challenges outlined in these guidelines, therefore the chapter ends by highlighting the implications of the stricter requirements in feeding, movement of hives and treatment in the context of climate change impact.

Learning Objectives
Participants will:

Understand Bio beekeeping and explore the factors for deciding whether to invest in Bio honey production, including economic, environmental, and market considerations.

Learn about the stages of the Bio certification process, including the timeline and steps required for achieving and maintaining bio certification.

Identify the key requirements for Bio beekeeping, focusing on bio standards for hive management, pest control, feeding, and product handling.

Understand the practicalities of shifting to Bio Beekeeping, including the conversion process, costs, and timeline, and how to manage the transition successfully.

Recognize the climate change-related implications for Bio certified apiaries, including the challenges posed by changing weather patterns, feeding restrictions, and pest management under bio certification.

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[12] In most cases, "organic" and "bio" are interchangeable, particularly in Europe, where both fall under the same regulations. "Bio" is more commonly used in non-English-speaking countries. In Georgia, organic standards are based on European regulations, making "Bio" the preferred term.

What is Bio Beekeeping?

Bio beekeeping is a part of the organic farming system, focusing on sustainable agricultural practices that promote the health of agro-ecosystems and human well-being. It differs from conventional beekeeping by using natural methods at all stages of bee product production and processing, avoiding synthetic chemicals or treatments. In bio beekeeping, bees are provided with organic food sources, and beekeepers avoid using artificial substances in hive management. This approach ensures the production of healthier bee products and contributes to environmental conservation, unlike conventional beekeeping, which may rely on chemicals and non-organic practices.

Deciding Whether to Invest in Bio Honey Production

The decision for beekeepers to shift towards bio honey production is influenced by various factors that involve both economic considerations and environmental benefits. By weighing these aspects, beekeepers can better understand the potential benefits of organic honey production, and whether it is right for them Below is a breakdown of key considerations:

Table 13: Considerations for Whether to Commence Bio Honey Production or Not

	PROFIT	COST
ECONIMIC ASPECT	**Bio honey sells for a premium -** Typically, organic honey prices are approximately 40% higher than conventional honey (5-6 USD per kg for conventional, 8.5 USD for bio honey). Demand is high in the EU and international markets, improving export opportunities. Bio certification also increases the competitiveness and prestige of the product.	**High Initial Costs** – Obtaining bio certification involves significant costs, including inspection, certification fees, and laboratory analyses. The conversion period (first year) can cost approximately 16,000 GEL for an individual beekeeper with 100 hives (e.g., beeswax replacement, treatments, inspections, and lab tests). Additionally, consultancy services may require an extra 4,000 GEL.
	Post-certification income potential – After bio certification, honey harvests are expected to bring higher revenue due to the premium pricing, even though productivity might be reduced due to the limitations on treatment and management during the conversion. Ongoing costs are lower than during the conversion phase, leading to increased profits after full conversion.	**Loss in Productivity** – During the conversion period, beekeepers may face a loss in honey production. In the first year, honey harvest typically amounts to only **30-40%** of the usual yield, as a significant portion is needed for feeding and overwintering the bees. This results in a financial loss or break-even situation in the first year due to the high conversion costs.
	Profit after bio certification – After completing the conversion, beekeepers can anticipate a profit, earning an average of 30% more than conventional apiaries. By the third year, overall profitability is expected to surpass that of conventional operations due to higher market prices and reduced costs following the transition period *(See Annex 6 - Expenses Involved in Bio Certification)*	**Regulations and Restrictions** – Beekeepers must follow strict bio standards, including hive location restrictions and limited treatment options, which can reduce productivity and pose challenges in apiary management.

CONSUMER PREFERENCES	TARGET MARKETS	LOCAL MARKET DYNAMICS
	Bio certification is often focused on export markets where consumer demand for bio-certified products is higher	In Georgia, local consumer awareness of bio certification is relatively low. Local consumers may not prioritize certification, as bio-honey is typically associated with imported products rather than domestically produced ones.
	Beekeepers should consider their target market when deciding on certification. If focusing on export, bio certification could significantly increase product appeal	While the local market may not be impacted by bio certification, increasing awareness about the environmental and health benefits of bio honey can be part of an effective marketing strategy

ENVIRONMENTAL IMPACT	ECOSYSTEM PROTECTION	HONEY QUALITY
	Bio certification mandates sustainable practices that minimize chemical pollution, thus ensuring better health for bees and surrounding ecosystems	Bio honey is guaranteed to be pure, free from harmful chemicals or pesticides. This appeals to consumers seeking natural, chemical-free products
	By adhering to bio beekeeping methods, beekeepers contribute to ecological conservation and the protection of biodiversity	The purity of bio honey not only increases its market value but also fosters consumer trust in the product's quality

The Stages of Bio Certification Process

The stages involved in achieving bio certification give an idea of how much commitment is involved once entering the bio certification process.

Stages of Bio Certification

8	After the successful completion of the transitional one-year period, deciding on product certification
7	Taking samples and sending them to an accredited laboratory
6	Unannounced inspections during the one-year transition period
5	First planned inspection, detection of non-conformities, start of transition period
4	The signing of the contract between the beekeeper and Caucascert
3	Consideration and confirmation of the application by Caucascert
2	Filling out application and production plan forms
1	Getting to know the bio certification process, standard requirements, and service prices

Figure 4: Stages of Bio Certification

See Annex 7: The Timeline/Scheme of Bio Certification in Georgia

The Main Requirements for Bio Beekeeping

The process of bio certification for beekeepers involves strict guidelines to ensure compliance with bio standards, focusing on sustainable practices that prioritize bee health, apiary management, and the use of organic materials.

The main requirements for successful bio certification are apiary location, feeding practices, pest management, wax replacement, and certification procedures. Beekeepers must adhere to these standards to achieve certification and maintain the organic status of their honey, with special considerations only in exceptional circumstances and strict record-keeping required throughout the process.

1	The foundation must be made from wax obtained by the bio method
2	The beehives must be made of natural wood. It is allowed to paint the beehive with bio-paint or beeswax. It is necessary to use stainless steel wire when assembling a beehive frame
3	Harvesting bee products requires additional caution to avoid harming or destroying bees and larvae present on the foundation. Actions that may harm bees, such as clipping the wings of a queen bee, are strictly prohibited. It is forbidden to use chemical repellents (deterrents) when extracting honey
4	Smoking should be minimal, using natural agents; non-organic beekeeping within an organic unit is allowed with proper documentation
5	Hives should be placed in ecologically clean areas, at least 3 km from pollution, ensuring sufficient food for bees
6	Apiaries should provide both saltwater (1g salt per 10 liters) and fresh water for bees, with hives numbered for identification. Bee colonies should have enough honey, with additional feeding allowed using bio or non-bio products in specific circumstances. Non-bio sugar can only be used under exceptions, and all feeding practices must be recorded
7	Bee health is maintained through good practices like selecting locally-adapted bee species, regular inspections, and proper hive care. In organic beekeeping, allowed vet drugs include lactic acid, acetic acid, formic acid, sulphur, essential oils, steam, and flame. Beekeepers must practice good selection methods to improve the resilience of their apiaries and help counter the impacts of climate change. Records of health practices and treatments used must be kept.
8	Bee products must retain their organic status during storage, transportation, and processing. Organic and non-organic products must be separated, marked, and documented
9	Beekeepers must use an Integrated Pest Management (IPM) approach in an apiary. Use natural treatments like acetic acid, lactic acid, formic acid, and essential oils and ensure proper dosage of organic treatments to manage pests. Synthetic chemicals are prohibited
10	Bee products can be classified as organic if the standards are met for at least one year. During the transition, existing beeswax should be replaced with organic beeswax. If full replacement isn't possible within a year, the certification body may extend the conversion period. If organic beeswax is unavailable, conventional beeswax can be converted after two stages of verification: laboratory analysis of both beeswax and honey. In challenging circumstances, non-bio colonies or hives may be allowed, and feeding with organic honey or syrup may be permitted during adverse weather. Documentation must be maintained to confirm compliance.

Figure 5: Overview of the Main Elements of Bio Beekeeping

Bio Certification in Georgia

The certifying body in organic beekeeping is Caucascert LLC, It promotes the development of organic agriculture in Georgia, the export of local organic products to EU countries, and the protection of the rights of consumers of organic products. Being bio certified by Caucascert is recognized globally as meeting international and EU bio standards. Please *See Annex 8* *- Green Caucasus Bio Honey Production Standard Caucascert* is the authorized body responsible for monitoring, controlling, and certifying organic production in Georgia. However, to avoid conflict of interest, Caucascert is not permitted to provide direct implementation services for bio standards to producers.

Beekeepers can implement and integrate organic (bio) standards in their apiaries either independently or with the support of consultancy services. These services typically include training, development of record-keeping systems and guidance on adopting organic production methods and management practices.

Currently, the main organization offering such services is *Elkana – the Biological Farming Association*. Established in October 1994, Elkana is a Georgian non-governmental organization that provides sector-specific training and consultancy in organic certification, Geographical Indication, and rural tourism standards. Elkana has successfully supported numerous farmers and businesses, including those in the beekeeping sector[13] in obtaining organic certification.

[13] In 2022, Elkana assisted the Jara Beekeepers Association in establishing an internal control system and training inspectors.

Practicalities of Converting to Bio Beekeeping

The conversion to bio beekeeping involves several steps, including consultancy, replacement of beeswax foundations, and the use of bio vet medicines. Below is a table outlining the practicalities, timeline, and costs associated with this conversion process.

WHO	Elkana provides consultancy services for bio beekeeping, including conversion planning, training on bio beekeeping, bio certification application, and documentation facilitation.
WHAT	Conversion to bio beekeeping, including replacing non-bio beeswax foundations with bio beeswax, using bio veterinary medicine, and obtaining annual bio certification.
HOW	Elkana will consult, come to check, and provide services such as planning, training, and documentation support.
HOW LONG	The conversion period is one year. Replacing beeswax foundations may take one season or two seasons if done gradually.
HOW MUCH	*For a Beekeeper with 100 Hives* **First-Year Costs**: 19,300 GEL **Subsequent Years Costs:** 8,300 GEL
HOW OFTEN	Bio certification is an annual process, requiring payment of the certification fees each year.

Figure 6: Practicalities, timeline, and costs during conversion process

See Annex 6 - Expenses Involved in Bio Certification and Annex 7 - Bio Certification Timeline in Georgia

Climate Change Related Implications for Bio Certified Apiaries

As discussed in earlier chapters, climate change has a substantial impact on bee colonies, affecting their nutrition, immune systems, disease prevalence, and overall productivity. These challenges are even more pronounced for apiaries practicing bio or organic methods, which have stricter operational requirements that can limit the beekeeper's ability to effectively manage their colonies. Below are the key challenges and considerations for bio-certified beekeepers facing the effects of climate change.

Feeding Restrictions and Climate Change

Limited Feeding Options: Bio certification imposes restrictions on additional feeding, which is often used to support bee colonies during the overwintering period, particularly when natural forage is scarce. While exceptions are allowed in extreme cases, they are difficult to justify and use.

Honey Storage and Income Reduction: Beekeepers must therefore save some of their harvested honey for feeding bees, which reduces their income. Additionally, not all types of honey, such as honeydew or goldenrod honey, are suitable for winter feeding, as they can cause digestive problems for bees.

Challenges with Bio Sugar Syrup: While bio sugar syrup could be a potential solution, it is expensive and not widely available in the Georgian market, making it less practical for many beekeepers.

Transhumance and Hive Management

Regulated Transhumance: Bio-certified beekeepers must adhere to strict regulations regarding transhumance (the practice of moving hives to different locations). Any movement of apiaries must be approved by the certification authority in advance, and thorough records must be kept. These regulations can limit a beekeeper's flexibility in responding to environmental changes.

Strategic Hive Placement and Forage Management: Beekeepers must be more strategic in their approach to hive placement and forage management to ensure adequate nutrition for their colonies throughout the year. This includes managing the environment around the apiary and being mindful of available forage resources.

Treatment Restrictions and Pest Management

Limited Treatment Options: Bio-certified apiaries face restrictions on treatment methods. While some mechanical methods from Integrated Pest Management (IPM), such as queen caging and brood removal, are permitted, they may stress the bees. Beekeepers must justify their necessity and maintain detailed records.

Prohibition of Synthetic Chemicals: Unlike conventional beekeeping, which allows synthetic chemicals for pest control, bio-certified apiaries must use only organic chemical treatments. Beekeepers need to adhere to recommendations for organic chemicals as described in Chapter 3, ensuring correct dosage, timing, and frequency of use.

Chemical Rotation for Effectiveness: To maintain the effectiveness of organic treatments against pests, beekeepers must rotate chemicals periodically, which requires careful planning and monitoring.

Bio-certified beekeepers face unique challenges when managing their apiaries under the influence of climate change. They must adapt their practices to meet the certification standards while also finding creative solutions to mitigate the impacts of climate change, particularly in terms of feeding, hive management, and pest control.

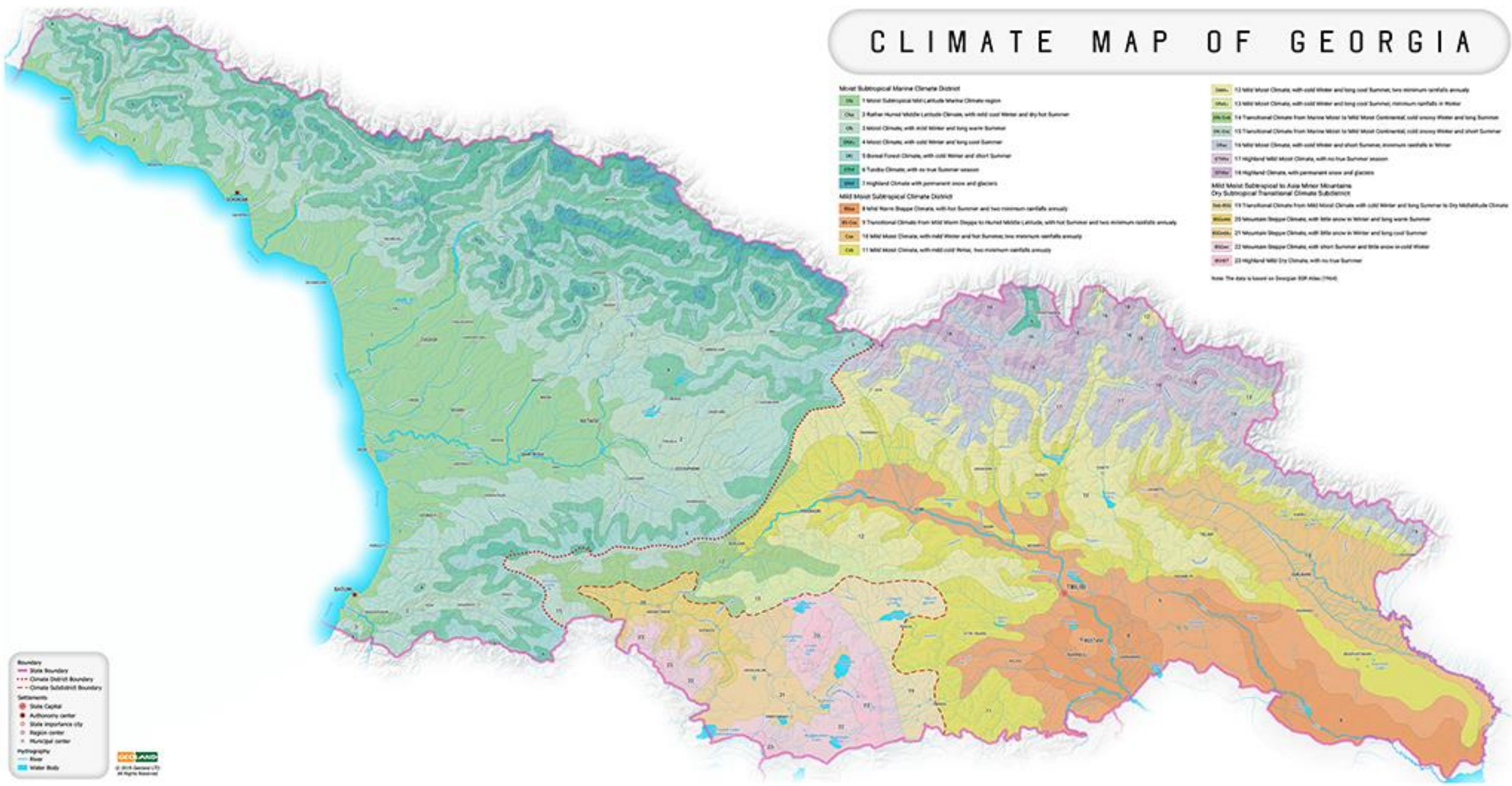
Conclusion:

These guidelines have been meticulously crafted to help extension specialists support beekeepers in Georgia by providing strategies to mitigate the impacts of climate change on beekeeping. Given that beekeeping plays a vital role in Georgia's economy, as both a primary and secondary source of income for many households, addressing the challenges posed by climate change is crucial for ensuring the resilience and sustainability of honey production.

The first four chapters offer practical recommendations that empower beekeepers to manage the adverse effects of extreme weather and climate change. From adjusting to temperature extremes and managing hive microclimates to ensuring bee health and implementing best practices for bio wax production, these strategies aim to safeguard bee populations and enhance productivity. Chapter 5 introduces the process of bio (organic) honey certification, providing beekeepers with valuable insights into transitioning to sustainable, organic practices.

By applying the guidance outlined in these chapters, beekeepers in Georgia can effectively adapt to climate challenges, enhance their operations, and contribute to the long-term sustainability of beekeeping, fostering ecological health and supporting rural communities throughout the region.

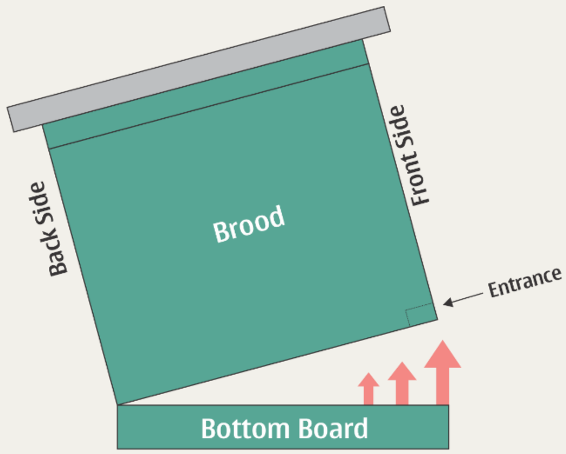
Annex 1: Climate Map of Georgia



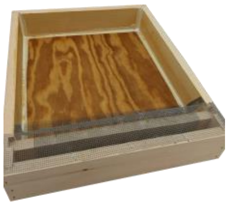
Annex 2:

Hive Assessment and Feeding Techniques

HEFTING TECHNIQUE FOR ESTIMATING HONEY STORES IN BEEHIVES



Description	A technique to estimate honey stores by lifting and gauging the weight of a hive.
Purpose	Assess whether the colony has enough honey reserves, especially in winter or scarcity.
How It Works	Lift one side (commonly used) or the entire hive (for small hives) to feel its weight and compare it to expected weight.
When to Perform	Periodically, especially in late autumn or early spring, to monitor food reserves.
Importance	Prevents starvation, avoids unnecessary hive inspections, and supports colony health.
Experience Required	Beekeepers need practice to accurately judge hive weight and interpret results.
Weight Guidelines* *(depends on a hive type)*	**Heavy Hive**: >19 kg (full honey stores). **Normal**: ~13-18 kg (adequate honey stores). **Light Hive**: <13 kg (may need feeding).
Limitations	Provides only a rough estimate; not a substitute for detailed hive inspections.

FEEDER TYPES	
   	
Contact Feeders	A contact feeder jar is a simple and popular method for feeding bees syrup directly inside or on top of the hive. It typically consists of a glass or plastic jar with a perforated lid (small holes poked or drilled into it). When filled with syrup and inverted over the hive, the liquid stays inside the jar due to vacuum pressure but slowly drips when bees make contact with the lid, allowing them to safely access the syrup without drowning. Contact feeders are often placed over the inner cover or directly above the brood nest inside an empty hive box for easy access and minimal disturbance. Like honey jars, can be purchased or homemade from plastic containers with small holes.
 	
Rapid Feeders (Miller & Ashforth)	The Miller and Ashforth feeders are types of top hive feeders designed to provide bees with large volumes of syrup safely. Both sit above the brood boxes and allow bees to access feed without leaving the hive, minimizing exposure and reducing the risk of robbing. A Miller feeder typically has a central access area and internal ridges or floats to prevent bees from drowning, while an Ashforth feeder is a simpler tray-style design with divided sections to control syrup movement and offer safe feeding points. Both are ideal for efficient, large-scale feeding, especially in spring when quick colony buildup is needed.
  	
Frame Feeder	A frame feeder is a type of internal hive feeder that fits within the hive's frame setup, replacing one or more frames to provide syrup to the bees. It typically consists of a plastic or wooden frame that holds syrup, with small holes or a mesh section for bees to access the liquid. Frame feeders are positioned in the centre of the brood nest, allowing bees easy access to the feed without the risk of drowning. They are an excellent option for feeding bees during the active season or when there's a shortage of nectar, as they provide a safe and convenient feeding solution while preserving the hive's structure. Frame feeders are also beneficial because they are less prone to robbing compared to external feeders.

Annex 3:

Integrated Pest Management Method

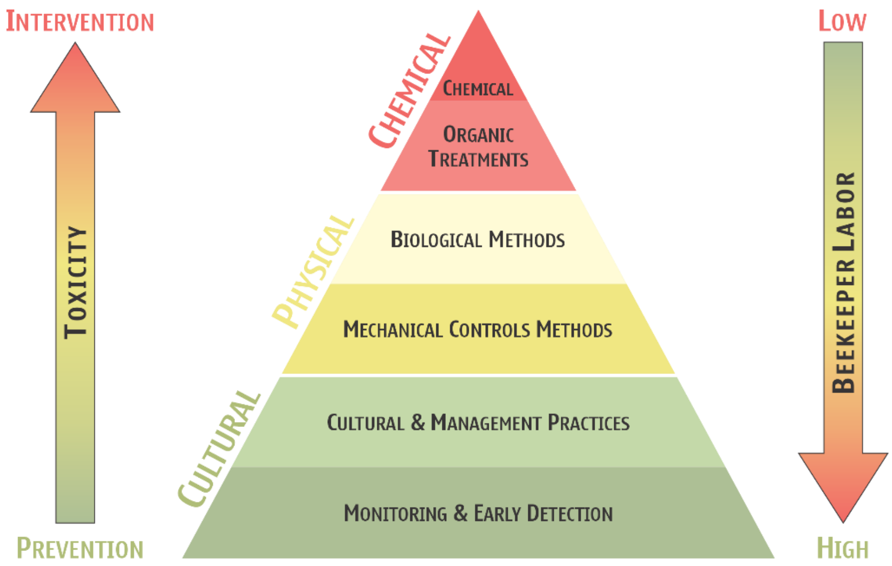


Figure 7: The IPM Pyramid

Beekeepers place a high priority on effectively managing pests and diseases, as these factors greatly impact the well-being of their bees. One of the most effective and modern method to confront these obstacles is the implementation of Integrated Pest Management (IPM) in beekeeping. IPM integrates various strategies to ensure a balanced, environmentally sustainable, and effective approach to protecting bee colony health.

At the bottom is located Cultural Controls focusing on good beekeeping practices that reduce stress and enhance colony health. This includes proper apiary placement, adequate nutrition, and minimising environmental stressors such as heat and cold, often through climate-adaptive hives and other strategies. Monitoring and early identification are also commonly regarded as key components of cultural control tactics.

The next level is Physical and Mechanical Controls that involve using physical barriers and traps to reduce or exclude pest populations in a hive. These include screen bottom boards to eliminate fallen mites, and various in-hive traps for small hive beetles. Activities such as drone-trapping of varroa mites, entrance reduction, brood break and keeping hives in good physical repair to prevent the ingress of beetles, wax moths, and robbing bees are also important components of physical control. IPM also incorporates biological control methods, such as beneficial fungi, bacteria, and predatory mites. However, these approaches are not yet widely applicable in beekeeping, though research is making progress in exploring the potential use of nematodes against Varroa mites and other pests.

Chemical treatments in Integrated Pest Management should be used selectively and only when necessary. Unfortunately, the widespread presence of Varroa mites worldwide and their significant impact on bee colonies often force beekeepers to rely on chemical treatments. However, in IPM a chemical control can be divided into two approaches, starting with organic chemical more environmentally friendly and less toxic treatments before resorting to stronger synthetic options.

Organic chemical treatments, such as oxalic acid, formic acid, and thymol-based products, should be the first line of defence. These treatments must be applied according to label instructions and only when necessary. To prevent resistance, it is crucial to rotate treatments and avoid using synthetic chemicals during honey flow to prevent contamination. The method is considered as less harmful chemical treatment in beekeeping and thus it is permitted in organic/bio production (See Chapter 5).

Synthetic chemical treatments should be a last resort, applied only when pest levels exceed economic thresholds. Beekeepers must ensure that only approved miticides, such as fluvalinate, flumetrhin, amitraz, and coumaphos, are used, following strict dosage and storage guidelines. Treatments should be rotated to prevent resistance, and detailed records of pest levels and applied treatments must be maintained. Additionally, antibiotics are strictly prohibited in beekeeping, as they contaminate honey. Care should also be taken with artificial feedings, such as candy or syrup additives, to ensure no antibiotics are present.

Annex 4:

Wax Processing using a Solar Melter

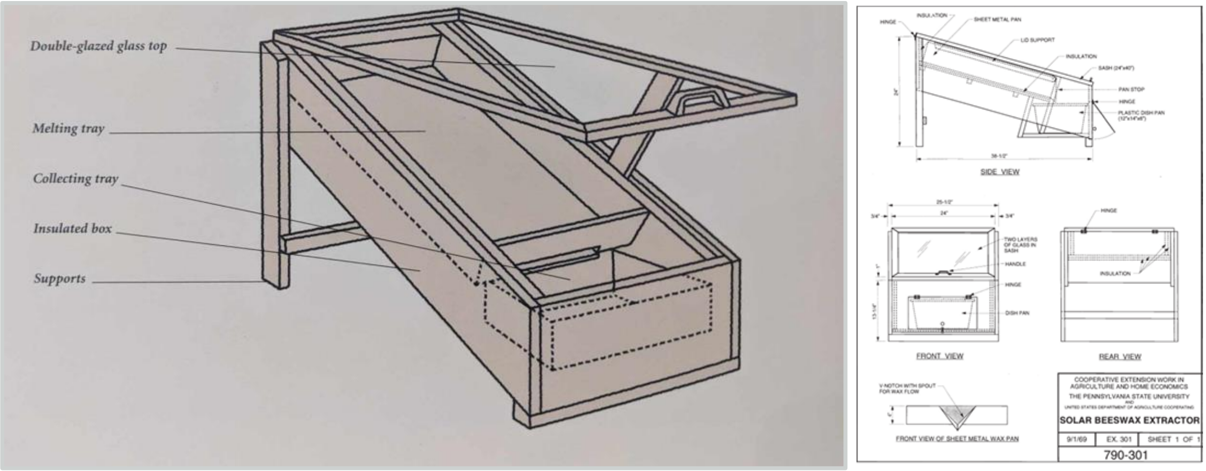


Figure 8. Solar Beeswax Melter Scheme

Processing wax is an essential part of beekeeping, and solar melting shows promise as a sustainable technique with technical, financial and environmental advantages. Beekeepers can efficiently melt the wax by utilizing solar power, which lowers energy expenses and lessens their environmental impact. Given that wax processing uses a lot of energy, some strategies to improve the sustainability of beeswax production are as follows:

- Promote the use of materials with low environmental impact.
- Promote the use of renewable energy sources.
- Promote waste reduction in the beeswax production process.
- Promote the production of beeswax as close as possible to the apiary.

Figure 9. Solar Beeswax Melter

Extracting Beeswax

Using solar energy instead of fossil fuels or electricity to melt beeswax is an environmentally responsible way to process wax. Using reflective surfaces to focus sunlight and produce heat, solar wax melters progressively melt beeswax into a liquid state for purification or additional processing.

The solar wax melter is a box covered with a piece of glass, Plexiglas, or other plastic sheet and made airtight. It is put in a sunny location and tilted at a right angle to the sun's rays. The sun heats the interior of the box, as it would in a greenhouse, melting the wax inside, which collects into a pan. For greater heating efficiency, use two pieces of glass or Plexiglas, separated by a 6.4 mm gap. The inside of the box contains a metal tray, fashioned from sheet metal, onto which the wax comb and scraps are placed. The melter will render cappings, new burr comb, and old comb, but it will not melt the frames of old comb completely. Inside is a large "melting" tray, which holds the wax. A gap at the lower edge allows molten wax to flow through into a collecting tray. The inside of the collecting tray is smeared with a release agent, such as washing up liquid, so the resulting wax block can be removed easily.

To build your solar extractor, you can use a discarded double-glazed window as the top and make a wooden box below to fit the unit, with draught excluders to ensure a tight seal. At one end add some supports, roughly 16-20 cm, to set the extractor at an angle of about 40 degrees from the horizontal. Next, find a large metal tray for the melting tray. It should fit loosely into the bottom of the box and cover about three-quarters to seven-eighths of its length. Cut an opening in one of the short sides of the tray and, if possible, bend the sides to funnel the wax towards the opening. Packing insulation material under and around the melting tray will improve the extractor's efficiency. Finally, place a collecting tray at the lower end of the box, under the edge of the melting tray, so that it sits level. The edge of the melting tray must overhang the collecting tray to ensure molten wax is not spilled inside the box.

Set up the extractor to face the sun's position at midday to give maximum exposure, and make sure that it will not be shaded by surrounding vegetation. You can move it around the sun moves but this is generally not practical.

Now place pieces of comb into the melting tray. Crude wax pieces can be put inside a secured piece of filter cloth. This retains the cocoons and much of the dirt, while allowing the wax to melt and pass through the filter. The cloth can be discarded afterwards or used for fire lighters.

The extractor works best on clear hot, sunny days and you will be surprised at the speed with which the collecting tray fills up. However, the wax will still melt on a duller, warm day, so keep checking the tray to see if it is full. The stop the extractor, open the top, wait for the wax block to cool completely and solidify before trying to remove it from the tray or you could spill molten wax and loose your harvest.

Annex 5:

Comparison of Hot and Cold Stamped Beeswax Foundation Processing

Table 14: Comparison of Hot-Stamped and Cold-Stamped Beeswax Foundation Processing Methods

Processing Method	Hot-Stamped	Cold-Stamped
Processing Description	Beeswax is heated, sterilized, filtered, and stamped into sheets using engraved metal rollers.	Heated beeswax is formed into a smooth band, cooled, cut into sheets, and then stamped.
Equipment	Uses a single machine (excluding heating/sterilization).	Requires multiple machines (banding, cutting, engraving).
Production Speed	Faster, high production capacity	Slower, with lower production capacity.
Durability of Beeswax Foundation	More fragile, prone to breaking in cold temperatures. Best for immediate use.	More durable, suitable for long-term storage.
Pros	Faster, cost-effective, ideal for high demand.	More durable, better for off-season production.
Cons	Less durable, not ideal for winter storage, harder to control thickness.	Slower, requires more equipment, higher cost
User Profile	Large-scale production in peak season (spring/summer).	Off-season production (winter), better for long-term storage.

Annex 6:

Expenses Involved in Bio Certification

Bio certification is an annual process, with certification costs totalling 4,800 GEL. The total first-year cost for converting to bio beekeeping is 19,300 GEL, which includes consultancy services, beeswax replacement, bio veterinary medicine, and bio certification fees. From the second year onward, costs drop to approximately 8,300 GEL annually, as bio beeswax replacement is no longer needed, and the consultancy fee may be eliminated if not required.

Table 15: Bio Certification Fees (From the Caucascert Ltd Price List):

Description	Cost (GEL)
Application Review (Non-refundable)	400 GEL
Inspector's Travel (100 km)	100 GEL
Inspector's Travel (approximately 800 km)	800 GEL
Inspector's Daily Allowance (Minimum 2 days)	150 GEL
Inspection Fee (100–149 hives, 5 hours)	2,000 GEL
Decision on Certification	200 GEL
Unannounced Inspections and Laboratory Analysis	10% of inspection cost + 80 GEL
VAT (18% on all costs)	18% of the total
Total Bio Certification Cost:	**4,800 GEL**

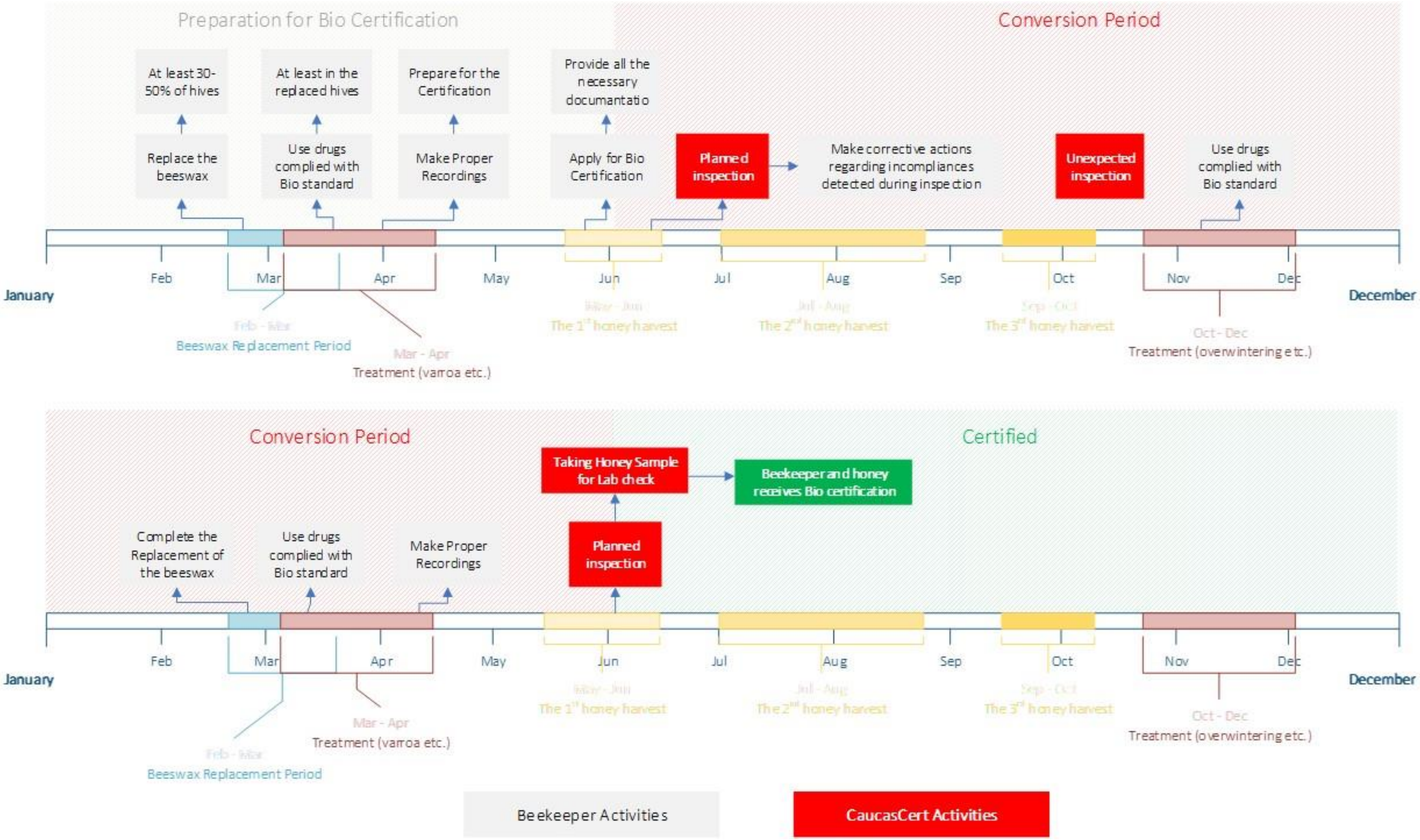
Cost Breakdown

Description	First-Year Costs	Second-Year Costs
Consultancy (5 working days)	**3,500 L**	**0 GEL (if not required)**
Beeswax Foundation Replacement (100 hives)	**8,000 GEL**	**500 GEL**
Bio Veterinary Medicine (30 GEL per hive)	**3,000 GEL**	**3,000 GEL**
Bio Certification Fees (annual)	**4,800 GEL**	**4,800 GEL**
Total Cost	**19,300 GEL**	**8,300 GEL**

First-Year Costs: **19,300 GEL (approximately 7,000 USD)** which includes all the costs for consultancy, beeswax replacement, bio veterinary medicine, and bio certification. Second-Year Costs: 8,000 GEL, as beeswax replacement and consultancy costs are eliminated, leaving only the annual costs for bio veterinary medicine and bio certification.

Annex 7:

Bio Certification Timeline in Georgia



Annex 8:

Green Caucasus[14] Bio Honey Production Standard

1.1.1.1	Origin of animals for beekeeping, preference shall be given to the use of Apis mellifera (Caucasia in our case) and their local ecotypes
1.1.1.2	Nutrition With regard to nutrition, the following rules shall apply: (a) at the end of the production season hives shall be left with sufficient reserves of honey and pollen for the bees to survive the winter; (b) bee colonies may only be fed where the survival of the colony is endangered due to climatic conditions. In such case, bee colonies shall be fed with organic honey, organic pollen, organic sugar syrups, or organic sugar
1.1.1.3	Health care With regard to health care, the following rules shall apply: (a)for the purposes of protecting frames, hives and combs, in particular from pests, only rodenticides used in traps, and appropriate products and substances authorized pursuant to Articles 9 and 24 for use in organic production shall be permitted; (b)physical treatments for disinfection of apiaries such as steam or direct flame shall be permitted; (c)the practice of destroying the male brood shall only be permitted for the purpose of isolating the infestation of Varroa destructor; (d)if, despite all preventive measures, the colonies become sick or infested, they shall be treated immediately and, if necessary, may be placed in isolation apiaries; (e)formic acid, lactic acid, acetic acid and oxalic acid, as well as menthol, thymol, eucalyptol or camphor, may be used in cases of infestation with Varroa destructor; (f)if a treatment is applied with chemically synthesized allopathic products, including antibiotics, other than products and substances authorized pursuant to Articles 9 and 24 for use in organic production, for the duration of that treatment, the treated colonies shall be placed in isolation apiaries and all the wax shall be replaced with wax coming from organic beekeeping. Subsequently, the conversion period of 12 months laid down in point
1.1.1.4	Animal welfare with regard to beekeeping, the following additional general rules shall apply: (a) the destruction of bees in the combs as a method associated with the harvesting of apiculture products shall be prohibited; (b) mutilation such as clipping the wings of queen bees shall be prohibited.
1.1.1.5	Housing and husbandry practices With regard to housing and husbandry practices, the following rules shall apply: (a)apiaries shall be placed in areas which ensure the availability of nectar and pollen sources consisting essentially of organically produced crops or, where appropriate, of spontaneous vegetation or non- organically managed forests or crops that are only treated with low environmental impact methods; (b) apiaries shall be kept at sufficient distance from sources that may lead to the contamination of apiculture products or to the poor health of the bees; (c)the siting of the apiaries shall be such that, within a radius of 3 km from the apiary site, nectar and pollen sources consist essentially of organically produced crops or spontaneous

[14] Green Caucasus is a common certification and quality system, which is jointly developed and operated by two independent private Armenian company *ECOGLOBE LLC* and Georgian *CAUCASCERT Ltd*. Green Caucasus Organic Standard is an integral part of Green Caucasus.

	vegetation or crops treated with low environmental impact methods which cannot affect the qualification of beekeeping production as being organic. That requirement does not apply where flowering is not taking place, or the bee colonies are dormant; (d)the hives and materials used in beekeeping shall be made basically of natural materials presenting no risk of contamination to the environment or the apiculture products; (e)the beeswax for new foundations shall come from organic production units; (f)only natural products such as propolis, wax and plant oils may be used in the hives; (g)synthetic chemical repellents shall not be used during honey extraction operations; (h)brood combs shall not be used for honey extraction; (i) beekeeping shall not be considered as organic when practiced in regions or areas officially designated as regions or areas where organic beekeeping is not practicable
1.1.1.6	Record keeping obligations. Operators shall keep a map on an appropriate scale or geographic coordinates of the location of hives to be provided to the control authority or control body demonstrating that the areas accessible to the colonies meet the requirements of this Regulation. The following information shall be entered in the register of the apiary with regard to feeding: name of the product used, dates, quantities and hives where the product is used. The zone where the apiary is situated shall be recorded together with the identification of the hives and the period of moving. All the measures applied shall be recorded in the register of the apiary, including the removals of the supers and the honey extraction operations. The amount and dates of the collection of honey shall also be recorded.

These guidelines were developed by the Alliances Caucasus 2 (ALCP2) programme, a Swiss Development Cooperation (SDC) project in cooperation with the Austrian Development Cooperation (ADC) and Sweden, implemented by Mercy Corps Georgia.

The views expressed in this document may not necessarily reflect the views of the Swiss Development Cooperation, the Austrian Development Cooperation, the Swedish International Development Cooperation or Mercy Corps.

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