Better-B practical recommendations

Guidance for hive construction based on thermo-hygro-mechanical properties

The Better-B Consortium November 2026 Recommendation n°10

The Better-B project is a four-year Horizon Europe project funded by the European Commission that began in June 2023. The project aims to improve honey bee resilience by restoring balance within the colony and between the colony and its environment. The consortium comprises 16 partners and two associated partners coming from 14 countries. This document is part of a series translating our results into clear recommendations for a diverse target audience. Depending on whether a recommendation is practice-oriented or policy-supporting, it is classified as a "Practical Recommendation" or a "Policy Brief," respectively.

Summary

Increasingly frequent droughts and extreme temperatures create additional challenges for bee colonies and beekeepers. The effects of climate change and extreme weather events could be mitigated by focused innovations in hive structure and properties, and apiary organization. Based on field measurements, technical characterization and beekeeper surveys, practical tools for beekeepers are provided: hive or apiary modifications can be used to modulate heat or moisture exchanges according to local environmental conditions. The aim is to improve colony resilience while remaining compatible with diverse beekeeping practices and objectives (e.g., cool/warm the hive).

The problem

Hive designs and materials vary considerably across Europe and are strongly influenced by local climate and beekeeping practices, including sedentary and migratory beekeeping. However, beekeepers have limited technical guidance to help them adapt hives to environmental conditions. There is a need to identify effective solutions that can provide a significant improvement in colony conditions while requiring only limited changes to existing practices and equipment. For example, some beekeepers may have limited possibilities for providing shade when colonies are transported to temporary apiaries exposed to full sun. In the absence of clear technical guidance, some beekeepers modify their hives based mainly on personal experience or trial and error. While these experiments can provide valuable insights, an inadequate choice or use of materials may have unintended consequences for the colony, particularly in terms of temperature and moisture regulation.

The evidence

The Better-B survey confirms that temperature changes are a major concern for beekeepers: 66% of those who had modified their hives identified temperature changes as an important factor influencing their decisions. Experiments conducted using instrumented hives further illustrate the scale of the problem: under strong solar radiation, metal roofs can reach 80°C, while temperatures at the top of the frames can reach 50°C. In addition, commonly used aluminium bubble foils do not necessarily provide effective thermal insulation. This type of material requires a good understanding of its properties and behaviour, and therefore educational training. The results also show that the thermal behaviour of a hive depends not only on its design, but also largely on its insulation. High temperatures and inadequate insulation can increase thermal stress on colonies and contribute to damage to wax combs. Yet only 13% of surveyed beekeepers reported using temperature or humidity measurements to evaluate their hive modifications. This highlights the need for a better understanding of heat transfer and how different materials and modifications affect hive temperatures.

Practical recommendations

These recommendations address objectives expressed by beekeepers regarding the control of temperature inside the hive. However, by modifying the hive climate, they may potentially lead to adverse side effects, such as an increase in Varroa mite populations. The following recommendations concern wooden hives and they are grouped according to four different objectives, with practical recommendations at hive and at the apiary level.

1. Prevent overheating in summer

To reduce solar exposure and prevent problems such as wax comb melting, place hives under dense shade whenever possible. The roof can also be painted white or another light colour or protected with an effective cover. Alternatively, install insulating material, at least 2 cm thick, above the frames or directly beneath the roof. A feeder may be left beneath the roof to create an insulating air gap, but in that case, an aluminium bubble sheet must be placed above the feeder otherwise the air gap is ineffective. The east- and west-facing hive walls can be painted white or another light colour or protected internally with insulated divider boards. At apiary level, hives may be arranged closely along an east–west axis so that they provide shade to one another, keeping approximately 10-30 cm between colonies.

2. Limit heat loss during winter in northern Europe

To reduce heat loss and the risk of winter colony losses, place insulating material at least 2 cm thick above the frames or the inner cover or the feeder. Insulated divider boards or external insulation may also be used. Hives can be tightly packed together, for example in rows, so that they provide some mutual insulation and limit airflow between them.

3. Promote winter brood interruption in temperate regions

Where winter cooling is intended to encourage a brood-free period for Varroa control, avoid measures that retain heat within the hive. Place colonies in a shaded location or alternatively, hives can be arranged closely along a north-south axis so that they shade one another, with approximately 5 cm between them and no more than 30 cm. Remove insulating material and air gaps beneath the roof, including those created by empty feeders. The roof and south-facing wall can be painted white or another light colour. A roof cover may also be used if it protects the roof from sunlight while still allowing it to cool. Insulated divider boards should be removed, and an open floor may be used.

4. Stabilise hive temperature throughout the year

To facilitate colony thermoregulation throughout the year, protect the roof from solar radiation by providing dense shade or using a white or light-coloured roof or removable covering. Combine this with at least 3 cm of insulation, preferably positioned above the frames or inner cover. To further stabilise the temperature inside the hive, heat transfer through the hive walls can be reduced by using insulated divider boards, external insulation, or closely grouped hives. The hive walls may also be painted white or another light colour.

Quick notes on thermal insulation

- An insulating material is a material with a low thermal conductivity (< 0.5 W/m/K), such as wood fibre, polystyrene, bubble insulation, etc. For effective insulation, use insulating material at least 2 cm thick.
- Alternatively, dividers may consist of an air cavity only, provided that its surfaces are covered with a double face infrared-reflective material (e.g. aluminium film). Beekeepers should pay attention to the performance of the aluminium films they use, as not all products offer the same thermal performance.

Further reading

Ruffio E. (2025). Better-B Deliverable 3.6: Hygrothermal model of empty hives (https://zenodo.org/records/20815417).

Ruffio E. (in preparation). Better-B Deliverable 3.7: Extreme temperature algorithm.

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