Low-input Beekeeping

A strategic approach to professional beekeeping

by

Peter Frühwirth

Suggested citation:

FRÜHWIRTH, P. (2023): Low-input beekeeping - a strategic approach to professional beekeeping. Pfarrkirchen, Austria.

Imprint:

Author: Prof. Dipl.-Päd. Dipl.-Ing. Peter Frühwirth; Altenhof 64, A-4142 Pfarrkirchen im Mühlkreis

In German published April 2023
In English published October 2023

© Peter Frühwirth; cover photo by the author.

Keywords: low-input beekeeping, low-cost beekeeping, resource conservation, sustainability, mode of management.

Executive Summary

The aim of low-input beekeeping is to achieve an optimum yield of bee products with the least possible expenditure of time and money, while at the same time conserving natural resources and showing consideration for the bee colony as an individual. Despite the great diversity of business structures, the low-input strategy can be implemented on a business-by-business basis in European commercial beekeeping, because low-input is a strategy that applies to all business types. A selection of cost factors, production steps and work processes relevant to beekeeping, such as working time, vehicles, feed, protein feed and feeding, as well as various steps in the operation and colony management are discussed in terms of their potential for implementing a low-input strategy. The logistics and management of apiaries are seen as an opportunity to reduce costs, labour time and environmental resources. The discussion of the low-input strategy must include the fundamental distinction between companies with and without external labour. This can make a big difference in the evaluation of different processes on an individual company. The energy sources used in beekeeping will play a role in the public debate on climate change and energy self-sufficiency. The issues of sustainability, transport routes and carbon footprint per unit of product have not yet reached the level of serious consideration in commercial beekeeping. A low-input strategy can provide positive arguments in the climate and environmental debate. Low-input beekeeping systems can claim several positive system benefits, for the environment and climate, for the beekeeper himself and for the colony from an ethical point of view. These are formulated as "3x3 Low-Input Benefits". In order to express the low-input strategy in economic terms, it is necessary to develop standardised methods for calculating the contribution margin of beekeeping.

1 Introduction

Low-input beekeeping is not a new way of working, not a set of instructions on what exactly to do and when. Rather, it is a fundamental strategic approach to critically reviewing and optimising the cost drivers of individual beekeeping practices. Business owners wishing to establish a commercial beekeeping operation should be encouraged by the discussion of low-input to choose a method of management with the greatest potential for minimising real costs and time.

Low-input beekeeping is thus understood as a universal approach to reducing the use of external resources, or preventing their use in the first place, and to becoming aware of the systemic time requirements that vary according to the method of management. The former includes fuel costs, including the carbon footprint, and the latter includes travel time and the increasingly critical shortage of labour.

2 Aims and inspiration

The aim of low-input beekeeping is to obtain an optimum yield of bee products with the least possible expenditure of time and money, while at the same time conserving natural resources and showing consideration for the bee colony as an individual.

The following authors have contributed significantly to the development of a low-input strategy in beekeeping:

STEINWIDDER, A. (2013) has defined the following for agriculture: "Compared to agricultural systems that rely heavily on external inputs (high-input strategies), low-input agriculture tries to minimise the use of external resources on the farm, to keep production costs as low as possible (low-cost strategy) and to achieve efficient use of the farm's own resources". The "low cost" or "low input" strategy therefore focuses strongly on costs (machinery and energy, buildings, feed and labour) and, in cattle farming, individual animal performance is no longer in the foreground".

PÖTSCH, E. M. (2007) places the main criteria for low-input farming systems in a triangle of relationships and effects: ecological [minimum negative externalities (low impact on soil, water and atmosphere); maximum positive externalities (landscape, habitat, biodiversity)], economic [successful products; cost reduction] and social [self-confidence, social acceptance and integration, meaningful employment; image of agriculture; rural population]. In his work, PÖTSCH poses the question: What could be the elements and strategies of low-input farming systems and what are the consequences of implementing these elements and strategies in practice? Due to the diversity of farm structures (size, production focus, location, production conditions, financial situation...), there is no general and fixed set of low-input elements that covers all different aspects and conditions. Therefore, farm-specific elements must be implemented ... which take into account the natural and structural conditions, the interests and skills of the farmers, as well as the agricultural policy conditions ... . Such systems must also be resource efficient, socially acceptable, economically competitive, and environmentally sound.

It follows that all three aspects of sustainability - environmental, economic, and social - must be considered in low-input beekeeping. They belong together if sustainability in beekeeping is to be fully realised and the products of low-input beekeeping are to be enriched with this value.

Of course, the elements of low-input systems that have so far been developed only for area-based agriculture need to be adapted to the specifics of commercial beekeeping. While in agriculture the focus is usually on reducing external resources and input costs, in beekeeping special attention must be paid to the resource of working time, including the social aspect, as well as to comprehensive protection of environmental resources (CO_2 footprint, fossil energy sources).

With this paper, the author has for the first time formulated the idea of a low-input beekeeping system. A further development and more detailed formulation of the underlying approach and its implementation possibilities is desired. Of course, this work is also based on the author's more than 40 years of experience and the developments that have shaped his beekeeping and colony management during this time.

The author therefore regards the concept of low-input beekeeping as a "work in progress" to which creative minds with their individual farm situations can constructively contribute.

3 A colourful world of beekeeping

In the German-speaking regions of Europe, beekeeping is almost frighteningly diverse. From time to time, new trends emerge, adding to the inhomogeneity and, in the long term, leaving their mark on working methods, hives and equipment.

In the rest of Europe, beekeeping is much more homogeneous, at least as far as hive systems are concerned. Here, commercial beekeeping is mainly characterised by its size, the number of hives available and marketing channels.

As diverse as commercial beekeeping is, low-input beekeeping can be implemented in business-specific forms throughout Europe. This is mainly because low-input beekeeping should be seen as a strategy for all types of companies.

4 Working time as an input factor

The scarcity of resources must be considered when considering working time as an input factor. It is therefore important to make efficient use of working time in times of scarcity, i.e., during seasonal peaks. In the off-season, a high input of working time, if it does not impede the work processes, may well be low-input from the point of view of the company as a whole. An example: If, for example, the production of nuclei is relatively time-consuming during peak periods, it may be advantageous to postpone this type of colony multiplication to a time when the workload is less intensive. This may even lead to a net increase in working time compared to other types of making nuclei, but overall, the peak workload is minimised. And it becomes low input because, for example, an external helper is not needed during the peak workload. This is money that does not have to be paid externally.

When discussing the low-input strategy, the fundamental distinction between companies with and without external labour must be taken into account. This can mean a big difference in the assessment of different facts, or even a diametrically opposed assessment of individual measures.

If, as in the first case, the company has well-trained staff, it must try to keep them on the farm throughout the year for the sake of sustainability (securing know-how). This is almost impossible in the beekeeping off-season. In this case, it may make sense to carry out non-economic activities such as making hives etc. on the farm. It is better for the skilled workers to work inefficiently in this area than not at all.

In a family business without external labour, such work could also be done on the farm in the sense of low input, but in this case the question arises whether this "free" time in the off-season would not be better invested in real leisure time, i.e., recreation/holidays in the sense of a minimum quality of life. In other words, it would be better to buy the ready-made frames and pay money outside for physical and mental regeneration.

Minimising external costs in a low input strategy must not be at the expense of the quality of life of the business owner and his family. This is an important factor to keep in mind. Time for regeneration is crucial to create the 'mental space' from which impulses for company development can develop.

5 Low-input approaches

According to PÖTSCH, E. M. (2007), a selection of elements and strategies for low-input beekeeping with a focus on honey production are discussed below. Specific activities such as pollen production, honey wine production or vinegar production should be considered separately.

5.1 Working time

Working time is probably the most important input factor in commercial beekeeping. People are aware of this, but hardly anyone can give exact figures because no records are kept. Good work organisation and self-management help to avoid the work trap and make the most efficient use of time. Low-input beekeeping also tries to eliminate individual tasks from the outset.

In particular, the way in which colonies are managed and the associated number of visits to the apiaries should be questioned. Particularly for commercial beekeepers, whose apiaries are often scattered throughout the region, travelling time is a major part of the total working time.

5.2 Vehicles

The company vehicle is one of the costliest inputs, from purchase to maintenance and fuel costs. Most commercial beekeepers rely on four-wheel drive vehicles. The most used vehicles are vans with the highest possible payload, pick-up trucks or small trucks up to 7.5 tonnes. The introduction of the standard excise duty on small trucks has significantly increased the cost of purchase.

Since the increase in diesel prices and the introduction (and increase) of the CO_2 tax, running costs have risen massively.

Few companies keep accurate logbooks. However, this is a good starting point for analysing the number of kilometres driven on the farm and their seasonal distribution.

5.3 Feed

There are two main types of feed available: Crystalline sugar and fodder syrup.

From the point of view of the low-input approach, factors such as the type of bee management (organic or conventional), the number of workers available (company manager alone, available family workers, external workers, technical equipment) play an important role in the choice of feed.

In an organic apiary, the cost of feed will be the determining factor in the choice of crystalline sugar. Winter fodder made from organic fodder syrup from Austrian sugar beet is, if the organic idea is to be consistently implemented, about 42% more expensive than Austrian organic sugar. This means that as few financial resources as possible are shifted out of the country (cost minimisation). In this case, the not inconsiderable additional costs of syrup compared to the process with granulated sugar are the labour costs. In other words, costs that do not have to be paid externally and therefore remain on the farm, otherwise they would be irretrievably lost.

Kostenvergleich* Futtermittel für 15 kg eingelagertes Winterfutter

Biologisch			Konventionell		
Futtermittel	€/Volk	Differenz in %	Futtermittel	€/Volk	Differenz in %
Österr. Biozucker	€ 25,00		Österr. Zucker Feinkristall	15,88	
Sirup aus österr. Bio-Zuckerrübe (BioVitabee)	€ 35,46	**+ 41,8**	Sirup aus österr. konvent. Zuckerrübe (Agenabon)	18.90	**+ 19,0**

* Preisbasis 2023, Palette bzw. Container

On conventional companies, the cost difference is less than half (19%). Factors such as existing technical equipment (forklift trucks), cleaning, risk of spoilage, tendency to predation, limited storage capacity, etc. may lead to a decision in favour of feed syrup.

As sugar is usually bought and stored early, adequate protected storage capacity is required. This is even more the case when large price increases are expected, as has often been the case in recent years.

In the case of small quantities, e.g., for feeding saplings, where mixing in a large tank is not worthwhile, feed syrup can also be advantageous for organic beekeeping in the sense of "ready at hand". Syrup in containers can also be stored outdoors during the season.

5.4 Protein supply

Low input in the sense of low cost can also mean avoiding the use of external inputs such as protein feed. The lack of pollen supply in the months after the summer solstice is becoming an increasing problem for building up vital winter colonies, especially in areas dominated by arable farming. Three-cut meadows, which were common until the 1970s, have largely disappeared with the abandonment of cattle farming. We no longer have lapping pastures with a varied, continuous pollen supply.

In other countries, this problem has probably existed for a much longer time and to a much greater extent. Over the last 10 years, the number of suppliers and the variety of protein feed mixes has increased steadily. The origin of the protein components and therefore the prices vary considerably.

Intercropping with species that flower as early as possible after the main crop, e.g., winter barley, can help alleviate the problem of summer protein deficiency. Innovative new seeding techniques, such as drone seeding of intercrops into the still-standing main crop, allow flowering and thus pollen supply relatively soon after the main crop is harvested, at the critical time of main protein demand.

Cooperation between beekeepers and farmers can be an option to avoid high input costs. A financial contribution to the costs of drone seeding is more cost effective than the use of high-quality pollen feed dough. This is because the desired positive effect on winter bee rearing can only be expected from the use of feed doughs with sufficient added sterile pollen, although these are in the upper price segment. In addition, "natural" pollen collected by the bees themselves can in any case be considered more effective than the use of protein feed doughs.

In more intensive arable areas, cooperation between beekeepers and farmers in intercropping is therefore an increasingly important factor in low-input beekeeping.

5.5 Low Lost Input/Output

“Lost output" refers to bee products that are left behind in the production process or that cannot be extracted by standard production methods or that can only be extracted at great expense due to their properties. This includes honey that sticks to the wax from uncapping machines, or skimmed honey, which is produced when the surface of the honey is skimmed off in honey storage tanks and is not used.

Melezitose in honeydew honey is notorious. Due to its higher content of triple sugars (melezitose is composed of two molecules of glucose and one molecule of fructose), this honeydew honey tends to crystallise quickly in the honeycomb after it has been brought in. If it still has a gel-like consistency (crystals with a jelly-like coating), the honeycombs can be pressed with special presses (e.g., Mori press) and a certain percentage of melezitose honey can still be extracted. However, this involves the destruction of the combs, a high level of labour and the need for an efficient wax-melting plant.

In regions where melezitose honey is more likely to be found, it may be worth considering other extraction methods to produce high quality products (diversification of the product range). Melezitose honey, even that which has crystallised hard, can be easily and with little effort liquefied with water and extracted from the combs. This honey solution can be used to make a full-bodied honey wine (mead) or honey vinegar. If you want to avoid the costly cellar technology required for this and, above all, the development of the necessary know-how, it is advisable to work with experienced contract producers. The advantage is that you avoid high investment costs and a lot of working time. Especially as melezitosis does not occur regularly.

The "low output" costs also include the wax that remains in the pomace when it is melted down. Although this is small in volume terms, losses can be minimised by using a special technique. Here again, contractors offer their services to avoid having to invest themselves. The labour time saved through contracting can be attributed to the low input.

In this context, the question arises as to whether low input costs, such as wax pomace, could not be converted into income through further utilisation. Wax pomace is the nutrient medium for wax moth larvae, which in turn can be used as feed for birds and in fish farming. The development of suitable rearing facilities for wax moth larvae using the raw material wax pomace should be considered as an option, especially for organic fish producers and beekeepers.

Losses also include food residues from bee colonies that have died in winter. There are many reasons for colony losses in winter: Varroa mites, too high a virus content, drone brood or queen losses, very late and difficult to digest honey flows, heavy infestation with Nosema spores, etc. The amount of feed left over from winter can be very high. The quantities of leftover feed are often considerable.

For reasons of epidemic hygiene, it must be destroyed when the combs are melted down. There are limits to minimising the "lost" cost of feed. This is most likely to be possible with an optimal strategy - adapted to the company and therefore individually designed - to keep the development of the Varroa population as flat as possible. For the other causes mentioned, there are hardly any starting points.

6 Method of bee management

Methods of bee management are probably a dime a dozen. They can best be categorised as beekeeping with only full-supers, only shallow supers and mixed operations. It should be noted here that this chapter was written from the perspective of Central European beekeeping.

Within these three categories, from the point of view of the working time factor, the main focus is on the critical consideration of comb management in the management of colonies if one wants to achieve low-input beekeeping.

Colony management

In a low-input apiary, the colonies are managed with:

- as little labour as possible per colony,
- as few interventions as possible,
- as few trips to the apiaries as possible.

The ability to do this is influenced by, among other things, the type or structure of the brood chamber. Do you work with a large brood chamber, or with 2 brood chamber units with full-supers, or do you work with shallow supers in the brood chamber.

In general, it can be said that working with whole units (f. e. shallow-super beekeeping) offers many possibilities for implementing the low-input strategy. Handling of individual combs should be avoided as far as possible to reduce labour time. Also in the brood chamber, after the first spring measures, no interventions based on single comb handling are necessary, except for the building frames (see also "the brood chamber"). Exaggerated: The beekeeper really has nothing to do in the brood chamber. This not only saves a lot of time but is also good for the bee colony.

In very simplified terms, the following are just a few of the times and possibilities:

Swarm inspection:

Inspect the underside of the top brood box; simply tilt up, no individual comb inspection. However, this only works with the desired high level of safety with shallow supers.

In the sense of a consistent implementation of low-input, it must be considered whether the bee can be switched to non-swarming or reliably low-swarming genetics Then it can be calculated whether the possible positive effect of swarm control justifies the possible negative effects (a few swarms) of control.

The brood chamber:

Until the beginning of the honey dew flow or until the beginning of June, two types of intervention in the brood nest are usually sufficient: tipping control and changing the drone combs. Otherwise, nothing is touched in the brood chamber units. From the beginning of the honey dew season, there is really nothing to do in the brood chamber, apart from changing the building frames, if there is a building drive.

In low-input beekeeping, however, the use of building frames must be critically questioned. In fact, the frequent changing of frames contradicts the low-input principle. In the high season (when the colonies are growing and honey is being harvested) it means additional labour and fuel costs travelling to the apiaries, and additional labour and energy costs for using the drone combs. It is important for the company to find a method of safely reducing the Varroa population. If the "building frame" measure can be eliminated, a big step towards low-input optimisation has been achieved.

No need to look for the queen, no need to see the queen. The strength of the colony and the progress of development will tell you enough. At most, a brood comb is lifted slightly from the centre to assess the brood nest structure.

Young queens:

If low-input beekeeping is practised consistently, it should be considered whether it is not also possible to co-operate with a trusted breeder from whom queens are purchased. Such arrangements (number, price) can be a win-win situation for both sides: better planning and sales security for the one, significant time savings and good F1 genetics for honey production for the other.

If you select your own queens and want to sell them, there is no way around the very labour-intensive process of queen breeding.

Comb renewal:

The forage combs removed during the early spring inspection are replaced with unincubated combs and the second time with foundations. The extension of foundations can be done in the honey supers. In the case of particularly heavy flower crops (rape, acacia), the brood chamber can also be extended with a combination of foundations and unincubated combs, provided that a single large brood chamber is not used. Otherwise, the comb renewal takes place while building nuclei.

Building nuclei:

When managing with two brood chambers, whole supers should always be used in the building of nuclei. This can be done very well with shallow supers.

There are three possible times: 1. during the upward development; 2. when the end of the honey dew flow is foreseeable and 3. when the last honey super is cleared. The following is an example of the suction method, in German called “Saugling”. However, it is true that the described procedure at times 1 and 2 is not very compatible with the low-input approach (intervention in the brood chamber, working time).

During the upward development there are always colonies that run away from all the others. In an operation with two brood chambers, one super is swept off and placed on top of the honey chamber (above the queen excluder) as a sucker. Instead of this super, the brood chamber is again completed with a super with unincubated combs. If this colony had already produced queen cells, a young queen can hatch earlier in the nucleus created as a sucker (“Saugling”).

When the end of the honey dew flow is foreseeable, ideally 2 to 3 weeks before, nuclei can also be created according to the method described above.

In cases 1 and 2, the brood chamber sitting above the honey chamber, now full of young nurse bees, is placed on a floor board within the next two days and taken to a separate apiary for nuclei.

In case 3, when the honey dew flow is over, the removal of the last honey supers is combined with the formation of nuclei. De facto it is an artificial swarm without the work of sweeping, without longer open colonies and therefore without the risk of predation (low input!). You take hives to the apiaries (floor boards + supers with unincubated combs + bee escape board + lid) and a appropriate number of queens in transport cages. One nucleus per three to four colonies is expected. The queen is placed between the empty combs of the new nucleus. The honey supers filled with bees are placed on the bee escape board. Depending on the number of bees in the hive, three to four honey supers are placed in this way. The next day, the empty honey supers and the new hives (all the bees have gone down through the bee escape board to the queen) are collected. These hives should be fed as soon as the bees have flown in.

Advantages are: You don't need any hives for nuclei (low input!), about half of the varroa mites are removed from the economic colony (case 1 and 2), you have a complete super with fresh unincubated combs in the nucleus in one step. The varroa mite can be controlled optimally in the young colonies when the capped brood has emerged. In case 3, the varroa treatment can be carried out immediately. Oxalic acid evaporation is a fast, simple, gentle and highly effective method.

Varroa reduction during the season:

It has already been mentioned in the section on the brood chamber that the use of frames is to be critically questioned, as it contradicts the low-input strategy with the necessary use of labour and energy.

Varroa reduction is usually carried out with two frames suspended in rotation to remove covered drone brood. In recent years, this has become an integral part of the operation on many companies. Removing capped wild brood from the deep floor board would greatly improve the effect of flattening out the development of the Varroa population but is even more labour intensive. More on this under "Deep or flat floor board" below.

Honey harvest:

Low-input beekeeping also means working with bee escape. The insertion of the bee escape and the addition of a further honey super underneath are combined into one operation. A further reduction in labour input is achieved when the blowing off the bees is combined with the placing of one or two honey supers.

Unless an overwhelming last crop (forest, sunflower) has filled the brood chamber with honey, this honey is left there. In this way the colonies have sufficient reserves for the first weeks until the start of refeeding and open food in case of varroa control with formic acid after the harvest.

Varroa treatment after harvest:

When the formic acid is evaporated, e.g., with the Nassenheider Professional, the feeder is also taken along. When turned upside down, it serves as an evaporation chamber. If there is sufficient transport capacity, the removal of the evaporator can be combined with the first feeding.

If other methods of Varroa control are used or other procedures are discussed, the extent to which these can be combined with other work at the apiary should always be considered. The aim is to exploit the potential for reducing working time and journeys as far as possible.

Clustering space:

Nowadays, the brood area is often moved to the middle of the hive before the start of feeding, in the hope that it will be better for hibernation. If you are honest and observe your colonies closely, you will find that the beekeeper's idea of the correct colony location is quite indifferent to the bees. A look at the varroa underlay in winter shows that some sit on the right, some on the left and some in the middle. Good and reasonably strong colonies overwinter well wherever they are. In low-input beekeeping, this intervention is therefore unnecessary. Less work, fewer trips, less disturbance of the temperature balance, more rest for the bee colony.

Feeding and feed control:

Feeding with concentrated sugar solution or syrup reduces the number of feedings and therefore the number of visits. In mid-September, the weight of the colonies is checked by lifting them and, if necessary, they are fed again. In the other colonies, the cover of the ascent to the feed trough is removed so that the bees can lick out the feeder. Especially if you use syrup, there is no need to wash it afterwards, saving you the hassle of washing it at home. The type of feeder is important in reducing the amount of work involved in feeding to a minimum.

Period from the end of building season to the spring of the following year:

From the last removal of the building frame, all work in the brood chamber is superfluous. You only work "above", i.e., removing honey, possibly evaporating formic acid, and feeding. Below, the bees take care of everything themselves. There will be a few exceptions. If the colony shows signs of inhomogeneity, this should of course be investigated (possible loss of queen etc.). Young colonies or nuclei need more care.

Autumn and winter:

From late autumn and through the winter, trips to the apiaries can be kept to an absolute minimum, provided precautions have been taken. Roofs sufficiently weighted; entrance of hive wedges that do not hinder removal the deadfall in warm weather. Check only after gales. An exception are the trips for residual mitigation of mites, which are also used for status checks.

Deep or flat floor board:

If you really want to practise low-input beekeeping, you will choose a flat floor board, respecting the bees' space between the floor board and the lower edge of the combs. A deep floor board needs a slatted ack (comb building barrier), which must be installed and removed throughout the year. These steps, possible trips and material are unnecessary with a flat floor board.

Only those who can sell the beeswax at a good price and/or add value by value by processing it, and perhaps even have regular buyers for it, will work with the deep floor board and the regular harvesting of the wild combs built into it. However, the labour involved is considerable and will only be economically viable up to a certain number of beehives. For some, the ongoing skimming of varroa mites over several months may also be a factor in working with a deep floor board.

Conclusion:

Each type of operation has its own potential for implementing the low-input strategy. Whether you work with a large brood chamber, with whole frames in two brood units, or in a shallow-super operation. It is up to each individual beekeeper to find out how far and how consistently low-input can be implemented, because each beekeeper works differently, has his or her own preferences and operates in different hives and climatic regions.

6.1 Feeding

In recent years, methods of colony management have emerged that make supplementary or emergency feeding in early spring – seen over the years – necessary again and again.

It cannot be ruled out that the increasingly early onset of vegetation due to climate change and the associated early start of colony development with early brood rearing will place greater demands on feed stocks. We now know from experience that the earlier start of vegetation development does not continue continuously. In March and April, longer cold spells are likely to intervene, sometimes even late frosts in May.

If not, enough food was given in the previous autumn, or if the method of management does not permit a sufficiently large storage of food above the bee or brood nest in autumn, the method of colony management must be seriously questioned. With regard to the method of management, the question should be allowed whether the beekeeper is not sometimes standing in his own way. Operating methods are often emotionally charged ("the only right one"; "has always worked so far"). The ability to critically examine one's previous actions and habits is required.

Supplementary feeding in spring is an immense expense, especially in terms of labour time and fuel costs, but also in terms of feed, which must be kept in stock or even purchased at short notice. In low-input beekeeping, the aim is to precisely avoid such situations or to prevent them from arising in the first place.

There are also developments that practice feeding in early spring in specially placed supers as an integral part of colony management. This is not only diametrically opposed to the low-input idea, but also risks a shift of feed into the first spring honey. During the upward development of the bee colonies, a transfer of the forage openly in the combs up into the later honey chamber cannot be ruled out.

6.2 Wax management

Beeswax is a high-quality and very sensitive commodity. It is no coincidence that people speak of the "long memory" of beeswax. Due to its fatty properties, wax has a high appropriation capacity for substances occurring in the environment and for those used in beekeeping. Only in the case of wax produced on one's own farm does one have extensive supremacy over the internal quality.

Low-input beekeeping therefore uses its own wax. Companies with their own closed wax cycle have realised this.

Every comb, even small ones, should be fed into the wax cycle to keep the low lost input factor low. De-capping wax melters, in companies with more colonies also de-capping machines, and comb storage hygiene can optimise wax management.

7 Logistics and apiary management

The choice of locations for the bee colonies is based on

- the intended kind of honey flow
- the distance from the farm
- Accessibility with existing vehicles
- ergonomic and labour-saving aspects
- Topography and exposure
- Landowner agreement.

Getting all these aspects right is often a challenge.

In addition, the distance to the farm location also plays a role. If the distance is long and the route may be difficult, it should be possible to make a "round trip" to several hives in a day to optimise logistics in low-input beekeeping. The number of colonies on such a round trip is also determined by the available transport capacity in terms of space and load (e.g., boxes for setting up, removal of honey supers, feeding).

The size of an apiary also depends on the availability of labour during critical periods. In a one-person operation, about 20 colonies per stand will be optimal, especially for the period from the end of July to September (work on the open colony, feeding, predation). If two people are working, the number of colonies can also be somewhat larger. In any case, the number of colonies will be limited by the amount of pollen available at this time of year, depending on the location. A factor that will probably become even more important in the future. See also "Protein supply" under "Low-input approaches".

In extremely productive early harvesting regions, higher numbers of colonies per site may be economically viable (e.g., along major rivers).

In the case of migratory beekeeping, especially long-distance migrations, the fuel cost factor is relevant today - and will be much more so in the future. the future. We also do not yet know how the planned phase-out of the internal combustion engine will affect the types of vehicles commonly used in commercial beekeeping.

For example, in their work on US honey production, KENDALL, A. et al. point out that greenhouse gas emissions (kg CO_2 per kg of honey processed) vary widely between beekeeping operations, depending on transport distances within the farm and the transport route for raw honey to the processing industries. Farms with short transport distances and their own bottling and packaging facilities produce relatively low-carbon honey.

VÁSQUEZ-IBARRA, L. (2022) address Life Cycle Analysis (LCA) as a valuable method to evaluate environmental impacts of beekeeping in Chile. The results show that feeding has the greatest impact in all categories, followed by transport of hives.

The issues of sustainability, transport routes and CO_2-footprint per unit of product have not yet reached the level of serious consideration in commercial beekeeping. A low-input strategy can provide positive arguments in the climate and environmental debate. As soon as professional beekeeping is confronted with a critical discourse driven by different social groups, it becomes difficult All too quickly, one finds oneself in a defensive situation. Experience in other areas of agriculture shows how that honest and technically comprehensible arguments for maintaining the status quo are doomed to failure.

A low-input beekeeping, which is also optimised in terms of logistics and apiary management has a better starting position in the environmental debate.

8 Digitalisation in beekeeping

Electronic hive scales have become the standard in commercial beekeeping. They provide information on the development of the honey yield, enabling more effective colony management and a reduction in the number of trips required (distances, travel times).

However, the development of more in-depth analysis to increase the efficiency of honey production and minimise the use of external resources is only in its early stages. Particularly in terms of practicality for the beekeeper and the cost of the technology.

Precision beekeeping is an emerging area of agriculture that aims to protect bees, support beekeepers and optimise beekeeping production thanks to digital infrastructures. The digitisation of beekeeping first involves Internet of Things systems, with the development of sensors to collect and transmit bee-related data. Data analysis then comes into play, providing models that link the data to the biological states of the hives, sometimes thanks to artificial intelligence (HADJUR, H. et al; 2022). In their paper, they describe recent advances in precision beekeeping as systems and services. Different types of sensors, networks and energy sources in precision beekeeping are discussed. The collection and use of data is described and the performance of precision beekeeping services is evaluated. The sustainability of the proposed solutions is also assessed, taking into account their scalability, efficiency and economic costs.

It is expected that in the future, digitalisation will provide further impetus for optimising low-input beekeeping that is cost-effective and, above all, simple and practical..

9 Energy

The energy used in commercial beekeeping can also be counted among the factors of low-input beekeeping in a broader sense. Cooling units (honey and comb storage), wax extraction and processing (steam wax melters, decapping wax melters, wax clarification and disinfection equipment), energy requirements for extracting, sieving and filling honey, as well as air dehumidifiers and water heating (cleaning), to name but a few processes, require a high input of electricity energy.

Specific production sectors such as mead production (hot water, room heating), vinegar production (refrigeration, drive units) and pollen production (drying) also have often underestimated electricity requirements.

In low-input beekeeping systems that have been thought through to the end, energy sources should be included. The electricity available from the grid ultimately comes from a pool of electricity that includes all energy sources (water, wind, sun, coal, gas, nuclear). This is also the case when electricity is billed via the so-called green tariffs of an electricity supplier. The electricity circulating in the grid does not have a "label". At present, it is not possible to filter out a specific source of energy from the individually purchased electricity. Green electricity tariffs are certainly a step in the right direction, because the electricity provider must also provide corresponding proof of production for the entire amount of green electricity sold. In low-input beekeeping, however, one wants to go a step further.

Photovoltaics, solar hot water, wood in various forms, heat pumps, with appropriate electricity and buffer storage and control systems will become increasingly important in low-input beekeeping in the future.

In the public debate about sustainability, climate protection, carbon footprint and energy self-sufficiency, professional beekeeping and its products are only at the beginning. Low-input beekeepers who integrate energy issues into the design of their production processes will be better placed to meet the resource conservation demands that are sure to be placed on the beekeeping sector and will be able to translate this into marketing.

10 The "3x3 Low-Input Benefits" as System Benefits

Low-input beekeeping systems can claim several positive system benefits, for the environment and climate, for the beekeeper himself and for the bee colony from an ethical point of view.

1 **Environment and climate:**

1.1 *Carbon footprint*: Conservation of resources; reduction of fuel costs (variable costs); longer life of the vehicle fleet; reduction of fossil energy sources.

1.2 *Added value for biodiversity:* Flowering fields; cooperation with farmers for flowering crops in summer, with new technologies; optimised protein supply for vitality of bee colonies; other insect´s benefit.

1.3 *Value of bee products: The* concern for sustainability and respect for the livelihoods of humans and bees enriches the bee product with the value of sustainability, in addition to its known intrinsic qualitative values.

2 **Bee colony:**

2.1 *Individuality of the bee colony* (independence of the bees): leaving more decisions to the bees (the bee colony) without hindering the optimal success of the beekeeping.

2.2 Bee's welfare: understanding the bee colony as an individual; giving the bees more rest; less intervention.

2.3 *Optimum before maximum*: Do not maximise marginal costs, as the production system (product quality and bee colony) may become more vulnerable to errors and unforeseeable side effects.

3 **Beekeeper:**

3.1 *Time management* (time for yourself): Flattening of work peaks; more time for oneself; more time for creative ideas; more time for information and training; allow seasonal free spaces for personal development (beekeeping should not cover everything).

3.2 *Time for alternatives* (open spaces): Diversification of the product range; marketing activities; income opportunities outside beekeeping; range of options is very individual.

3.3 *Free space for* involvement: Free space for the exercise of civic responsibility in the humanistic sense for a prosperous development of (beekeeping) society.

11 Succession in beekeeping

A well-managed low-input apiary, where the "3x3 low-input benefits" are expressed in the life and management of the family running the apiculture, may be more attractive for succession. For a younger generation growing up with climate change, sustainability in all its facets has a deeper meaning than for the baby boomer generation, whose lives were shaped by the idea of building and securing the family income. Young people also want to incorporate sustainability into the way they work and live. The low-input strategy certainly provides an opportunity to do so.

12 Management indicators and data

Commercial beekeeping is a data vacuum. On the one hand, there are hardly any key figures on the different production branches and methods of bee management, and on the other hand, there are no standardised methods for calculating profit margins. Although individual professional beekeepers keep their own individual profitability calculations, these are rarely transferable to other enterprises.

In order to be able to quantify the low-input strategy in figures from an economic point of view, it is essential to have standardised contribution margin calculations for the different production branches. These also needed to take the next step towards practical implementation in the form of working groups.

In Austrian agriculture, these "working groups" have proved very successful for certain production directions with the farm branch evaluations. For example, there are working groups for milk production. Working groups are groups of 10 to 25 farmers, regardless of farm size, farming method, performance level and type of farming. The records are used to calculate management ratios to identify dormant potential. Other benefits include optimising production, improving profitability, increasing labour efficiency and exchanging experiences.

13 The term „low-input“

“Low-input", as described above, is about minimising external resources and production costs while optimising the success of the business, conserving natural resources and improving the quality of life from the hole family in the business.

While the term "low-input agriculture” is well established in the German and English literature on agricultural production systems, the concept of a "low-input" strategy in beekeeping is new.

LOWORE, J. and BREADBEAR, N. (2012) come closest with their article "Extensive Beekeeping", which, however, deals mainly with socially and environmentally adapted extensive beekeeping in developing countries.

The term "smart beekeeping” has already been used and is also intended for the operational strategy discussed here. In simple terms, smart beekeeping today stands for digital support for business management to optimise honey production and bee health. The core elements are the digital recording of parameters in the bee colony which, when analysed should improve colony management and thus the success of the business.

14 Notes

Where authors are not explicitly mentioned in the text, the publications listed in the bibliography have inspired the author and contributed to the development and formulation of this publication.

Special thanks are due to Josef Stich, who worked intensively on the draft. Many of his comments, views and experiences have been incorporated. Josef Stich has been working with the low-input strategy in his beekeeping for many years and has contributed valuable thoughts to the present work. He also drew my attention to contradictions that seem to creep in when an author's head is full of searching for the right formulation.

The original German paper was translated into English (UK) with the support of DeepL and with the support of my son Bernhard.

15 Literature

BOURN, D., NEWTON, B., CAMPBELL, H. (1999): Strategies for 'Greening' the New Zealand Honey Industry: An Evaluation of the Development of Organic and Other Standards; Studies in Rural Sustainability Research, Report No. 8, Department of Anthropology, University of Otago; ISBN 0-9582015-4-4.

BRETSCHNEIDER, J. und KRÖDEL, A. (2022): Was bedeutet Humanismus? - Definition und Bedeutung; Juraforum-Lexikon; https://www.juraforum.de/lexikon/humanismus; retrieved 31.3.2023.

CLARK, M. and TILMAN, D. (2017): Comparative analysis of environmental impacts of agricultural production systems, agricultural input efficiency, and food choice; Environ. Res. Lett. 12 064016; https://doi.org/10.1088/1748-9326/aa6cd5.

HADJUR, H., AMMAR, D., LEFÈVRE, L. (2022): Toward an intelligent and efficient beehive: A survey of precision beekeeping systems and services. Computers and Electronics in Agriculture, 2022, 192, pp.1-16.

KENDALL, A., YAN, J., BRODT, S., KRAMER, K. J. (n.d.): Carbon Footprint of U.S. Honey Production and Packing; Report to the National Honey Board; University of California, Davis.

LOWORE, J. and BREADBEAR, N. (2012): Extensive Beekeeping; Bees for Development Journal, Edition 103 - June 2012; Monmuth, UK; https://issuu.com/beesfd/docs/103_bfdj_jun2012/s/13062058; accessed 31.3.2023.

PÖTSCH, E.M. (2007): Low-Input Farming Systems and livestock production - grassland and dairy farming in Austria. Proceedings of the Summer University at Ranco, Italy; JRC Scientific and Technical Reports, ISBN 978-92-79-08007-4, 33-38.

PRIES, F., DE L RÚa, P., SANCANA, A. P., HATJINA, F., GARIBAY, S. (2022): Sustainable beekeeping and breeding; Minipaper 07 in Bee health and sustainable beekeeping; EIP-AGRI Focus Group.

STEINWIDDER, A., STARZ, W., PODSTATZKY, L., KIRNER, L., PöTSCH, E.M., PFISTER, R., GALLNBöCK, M. (2009): Ergebnisse zur saisonalen Low-Input Vollweidehaltung von Milchkühen im österreichischen Berggebiet. Beiträge zur 10. Wissenschaftstagung Ökologischer Landbau, Zürich, 11-13 February 2009, Tagungsband 2, 62-65.

STEINWIDDER, A. (2013): Low-Input-Systeme im Grünland - Stärken und Schwächen; Wintertagung des Ökosozialen Forums 2013, p. 23-24; ISBN: 978-3-902559-89-0.

VÁSQUEZ-IBARRA, L., IRIARTE, A., VILLALOBOS, P., RENGEL, F. M., REBOLLEDO-LEIVA, R., ANGULO-MEZA, L., GONZÀLES-ARAYA, M. C. (2022): A wide environmental analysis of beekeeping systems through life cycle assessment: key contributing activities and influence of operation scale, International Journal of Agricultural Sustainability, 20:5, 790-805, DOI: 10.1080/14735903.2021.1984108.