Trends and prospects of technical support for separating beehive frames from the hive body

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Abstract. Despite the active introduction of innovations, some types of routine work in apiaries continues to be done with considerable effort. The removal of the beehive frame is one such work. The frame separator consists of an upper plate, sidewalls containing protrusions, a through hole for an axis of rotation or a lower plate. The principle of operation of the proposed device is – when installing two devices on top of the upper plate of the beehive frame, each of the two shoulders of the frame is passed through the space formed by sidewalls and the lower plate, which interconnects them, or the axis of rotation, until the lower plate or the axis of rotation comes up against the outer contour of the side bar of the beehive frame. With devices installed on opposite parts of the upper bar, the beehive frame is placed in the hive body. The technical problem solved by the claimed invention is to ensure synchronous separation of the beehive frame from opposite sides of the hive body, reduce the user's movements to remove the beehive frame from the hive to a minimum, reduce the probability of breaking the shoulders and the upper bar of the beehive frames.

1. Introduction

Beekeeping is a specific agricultural activity, including housing, breeding and selection of bees to produce bee products and for the purpose of pollination of entomophilous plants in open and protected ground [1]. Beekeeping is intermediate between crop production and livestock production in the agricultural system and is critical not only to the economy, but also to the environment – bees not only produce honey, but also provide the main pollination of entomophilous plants [1,2,3].

On the one hand, beekeeping compares favorably with other types of economic activity and agriculture, in particular with relatively low costs for organizing the material and technical base [1]. On the other hand, there are many factors that slow down the adoption of modern technologies – personal, economic, and institutional. The significance of these factors varies for the beekeepers [4].

The beekeepers are essential in saving the bee populations, and nowadays they have to check their beehives regularly and mainly manually to ensure the health of the colonies [2].

To increase productivity and reduce the level of manual labor, it is necessary to constantly introduce advanced technological techniques and technical means for collecting and processing bee products. The larger the apiary, the more difficult it is for the beekeepers to work without special equipment [5].

It is known that the higher the level of automation and mechanization of the main processes in beekeeping, the lower the honey productivity of one bee colony [6]. Each bee colony needs an individual approach, that is why a complete exclusion of manual labor in beekeeping is impossible.
Not only mechanization and automation, but also the organized work of the beekeeper contributes to achieving high production rates and reducing production cost. That is why the beekeepers increasingly prefer technical solutions that can facilitate their work, minimize time and physical costs [5].

Prolonged interference with the life and work of the bee colony acts as a stress factor affecting the health of bees and the quality of bee products [7].

Different researches show that, regardless of the ambient temperature, for the colony to survive the in-hive microclimate of a beehive at the central brood area must be kept at the average optimum temperature of 35 °C [3]. Honeybees will instinctively reduce any possibility of heat loss due to unwanted cavities, air draught heat loss, large entrance or gaps, unwanted air flow in winter [8].

That is why the removal of the beehive frame, including for an inspection of bee colonies and pumping out of honey, is an extremely painstaking process that requires very careful attention [5].

The speed of this operation is significantly affected by the fact that the bees will use propolis, a sticky wax-like resin that acts as a superglue, to seal all cracks and crevices and holes of any shapes in the hive [8].

The use of known devices does not ensure synchronous separation of the beehive frame from opposite sides of the hive body, does not ensure uniform lifting of the beehive frame from the hive body, requires considerable effort and time – the beekeeper must make an effort to pry the frame by the shoulders of the upper bar, first on one side of the hive, then on the other side. After that, it is possible to lift the frame from the hive body manually or using a special grip. The use of chisels increases the probability of deformation and breakage of the upper bar’s shoulders of the beehive frames. In addition, alternate attempts to pry the frame by the upper bar’s shoulders leads to the deformation of the entire frame, increases the risk of injury to bees.

2. Methods

There is beekeeping chisel [9] consisting of a plate with two working areas, and one working area (scraper) is curved-shaped, and the other is crescent-shaped.

There is beekeeper's chisel [10] consisting of a plate with two working areas, and one working area is made in the form of a trapezoid, and the other is crescent-shaped, the width of the most part of the trapezoid is equal to the sum of the width of a small part of the trapezoid with the height of the shoulders, the width of the small part of the trapezoid is equal to the width of a frame located in the hive, and the width of the most part of the trapezoid is equal to the sum of the width of the frame and the two gaps between the frames.

There is beekeeping chisel [11] containing a handle and a base made in the form of a cutting element on one end and curved element on the other end. The cutting element has two cutting edges made in mutually perpendicular directions, and the curved working element is formed as a scraper with a straight edge. In addition, the base is equipped with a corkscrew spin, a pricker, a screwdriver, metal working file, wood working file and a chisel, hinged on the base.

The use of these devices requires considerable effort and time – the beekeeper must make an effort to pry the frame by the shoulders of the upper bar, first on one side of the hive, then on the other side. After that, it is possible to lift the frame from the hive body manually or using a special gripper. The use of chisels increases the probability of deformation and breakage of the upper bar’s shoulders of beehive frames. In addition, alternate attempts to pry the frame by the upper bar’s shoulders leads to deformation of the entire frame, increases the risk of injury to bees.

There is a commercially available gripper for beehive frames consisting of four steel sidewalls, two spring elements and two flat knobs (figure 1 (a)). The gripper is designed to facilitate the removal of frames from the hive during the inspection of bee colonies. To remove the frame from the hive, the beekeeper should place the gripper so that the upper bar of the selected frame is located between the gripper's clamps. After that, the bar should be clamped, shifting the gripper’s knobs towards each other, and then the selected frame in the clamped position should be carefully removed from the hive body.

An independent use of this device requires the preliminary use of chisels, and, consequently, considerable effort and time.
Using this device independently or in combination with a chisel, the beekeeper should make effort to separate the frame from one side of the hive body and then from the opposite side. After that, it is possible to evenly lift the frame from the hive body. The use of this device with force increases the probability of deformation and breakage of the shoulders and the upper bar of beehive frames. In addition, the efforts made to the device in the process of its independent use can also lead to deformation of the entire frame, increases the risk of injury to bees.

There is also a commercially available gripper for beehive frames, one of the flat knobs of which has an elongation formed as a chisel (figure 1 b).

![Figure 1](image-url)  
**Figure 1.** Gripper (a) and gripper with a chisel (b) for beehive frames (images from open sources).

This device has disadvantages typical for chisels and grippers for beehive frames.

### 3. Results and discussion

The employee of the FSBEI of Higher Education “Pskov State University” has developed a beehive frame separator. The frame separator consists of an upper plate, sidewalls containing protrusions, a through hole for an axis of rotation or a lower plate.

The utility model “Beehive frame separator” relates to agriculture, in particular to beekeeping, and is designed for the mechanization of individual beekeeping operations [12].

The technical task solved by the claimed utility model “Beehive frame separator” is to reduce the user's movements to remove the beehive frame from the hive to a minimum, to reduce the probability of breaking the shoulders and the upper bar of beehive frames.

The technical task is achieved by the fact that the device is a lever, which contains short and long shoulders, as well as a support or an axis of rotation, including in the sleeve, which serves as a support point. The long shoulder is made in the form of an upper plate placed on top of the upper bar of the beehive frame, along the entire length of which there are two curved unidirectional sidewalls. The width of these sidewalls does not exceed the thickness of the upper bar of the beehive frame. The width of the non-curved part of the upper plate does not exceed the width of the upper bar of the beehive frame. The length of the upper plate does not exceed half of the length of the upper bar of the beehive frame, bounded by the sides of the side bars of the beehive frame facing the hive body.

The length of the unidirectional sidewalls exceeds the length of the non-curved part of the upper plate by an amount corresponding to the length of one shoulder of the beehive frame. The parts of the unidirectional sidewalls extending beyond the upper plate, which connects them, form a short shoulder, and can be connected from the opposite side by another (lower) proportional plate or the axis of rotation, including in the sleeve. These parts, which form a short shoulder, have a width not exceeding the thickness of the shoulders of the beehive frame (the part of the upper bar located outside the outer contour of the side bars of the beehive frame). The width and length of the lower plate does not exceed the width and length of the shoulder of the beehive frame. The lower plate or axis of rotation, including in the sleeve, is located in a place that allows these elements of the device to serve as a support point.
The shape of the long shoulder implies the presence of symmetrically arranged pairs of protrusions on the unidirectional sidewalls, which allow a user to apply force to the device with a commercially available gripper for beehive frames.

The shape of the unidirectional sidewalls allows a user to install the device on top of the upper bar of the beehive frame by passing the shoulder of the beehive frame through the space formed by the sidewalls and the lower plate interconnecting them or axis of rotation, including in the sleeve.

The technical task is achieved by the fact that the proposed device is made of metal or solid food-grade plastics (for example, polycarbonate, polystyrene, polypropylene, polyvinyl chloride, high-density polyethylene, polyethylene terephthalate, etc.).

Essentially, the design of the frame separator consists of the upper plate 1, sidewalls 6, including sidewalls forming a short shoulder 2, with a through hole 7 for the axis of rotation 3, including in the sleeve 4, or the lower plate 5, and also contains at least one pair of protrusions 8 (figure 2, figure 3).

The principle of operation of the proposed device – when installing the device on top of the upper bar of the beehive frame, the shoulder of the beehive frame is passed through the space formed by the sidewalls of the device and the lower plate, which interconnects them, or the axis of rotation, including in the sleeve, until the lower plate or the axis of rotation, including in the sleeve, comes up against the outer contour of the side bar of the beehive frame (figure 4).
Figure 4. Demonstration of the location of the mock-up samples of the frame separator made of metal on the beehive frame: before installation in the hive body (a), after installation in the hive body (b).

The beehive frame with the device installed on its upper bar is located in the hive body. To remove the beehive frame from the hive body, the beekeeper lifts the device by the long shoulders with a gripper (figure 5).

Figure 5. Demonstration of the removal of the beehive frame: lifting the long shoulder with the gripper (a) and forming the force on the short shoulder (b) of the frame separator.

By doing so, the clamps of the gripper come up against the protrusions located along the lower edge of the sidewalls of the long shoulder. A force formed on the long shoulder leads to the formation of a force on the short shoulder, sufficient to lift the beehive frame from the side on which the device is located. The lower plate or the axis of rotation, including in the sleeve, serves as a support point. In order for the device to return to its original position, the user places the beehive frame in the hive body.

The technical result of the claimed utility model “Beehive frame separator” is to reduce the user's movements to remove the beehive frame from the hive to a minimum, reduce the probability of breaking the shoulders and the upper bar of beehive frames.

4. Conclusions
Modern beekeeping includes several areas, each of which is affected by scientific and technological progress.
Mechanization and automation have been introduced in beekeeping, however a complete exclusion of manual labor in this industry is impossible.

The beekeepers prefer technical solutions that can facilitate their work, minimize time and physical costs.

The removal of the beekeeping frame is an extremely painstaking process that requires both a very attentive attitude and a high speed of execution.

The use of known devices does not ensure synchronous separation of the beehive frame from opposite sides of the hive body, does not ensure uniform lifting of the beehive frame from the hive body, requires considerable effort and time – the beekeeper must make an effort to pry the frame by the shoulders of the upper bar, first on one side of the hive, then on the other side. After that, it is possible to lift the frame from the hive body manually or using a special gripper. The use of chisels increases the probability of deformation and breakage of the upper bar’s shoulders of beehive frames. In addition, alternate attempts to pry the frame by the upper bar’s shoulders leads to the deformation of the entire frame, increases the risk of injury to bees.

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The result of the use of the beehive frame separator is the reduction of the beekeeper's movements to remove the beehive frame from the hive to a minimum, the reduction of the probability of breaking the shoulders and the upper bar of beehive frames.

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