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Effect Of Maintaining Bee Colonies In Hives Of Various Designs On Honey Productivity Under The Conditions Of The Samarkand Region

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Abstract: *The article presents scientific data on the life of bee colonies during the overwintering period when kept in beehives of various designs used in beekeeping under the conditions of the Samarkand Region, on their loss-free emergence from winter, and on the effect of different hive types on colony productivity.*
Keywords: *multi-tier hive, two-tier hive, horizontal beehive, design, technology, bottom board, modernization, wax foundation, larva, egg, super, pocket, clamp.*

Relevance of the topic: Uzbekistan's natural climatic conditions have favorable opportunities in increasing the productivity of agricultural crops, in keeping bee colonies in beehives of various designs on the basis of modern advanced technologies [1.3.], and in increasing the production of beekeeping products**.** In particular, under the variable climatic conditions of the Samarkand Region, the importance of beehives during the bees' overwintering period is very great. [2.4.5.] At present, there are more than 1850000 bee colonies in our republic, and all the opportunities exist to develop beekeeping and increase production.

The task of organizing beekeeping operations in the Republic's rapidly developing farm enterprises, modernizing the technology for keeping bee colonies, and thereby seeking ways to increase colony productivity, consists in implementing-even from early spring-the minutest technological processes within the bee colony on the basis of a modernized, new technology. In beekeeping, mainly three types of hives are used, namely: horizontal hives, two-tier hives, and multi-tier hives. Under Uzbekistan's hot climatic conditions, studying which type of hive to use and its effect on colony productivity is one of today's pressing issues.

The Resolution of the President of the Republic of Uzbekistan dated 16 October 2017, No. PR-3327, "On measures to further develop the beekeeping sector in our Republic", was adopted.

Based on this resolution, under the conditions of our republic it is necessary to introduce modern advanced technologies such as: increasing the volumes of production and processing of beekeeping products; introducing modern advanced methods of production, in particular, organizing on a centralized basis the manufacture of artificial feeds for bees and, through the wide application of this practice, strengthening the feed base of beekeeping.

In Uzbekistan, economic reforms are being further deepened, and long-term, specific programs of measures are being adopted for the development of every sector in the republic. On the basis of the President of the Republic of Uzbekistan's Resolution No. PR-120 of 8 February 2022, the Program "On approving the measures to be implemented for the development of the beekeeping sector in 2022–2026" was approved, which became a major factor in fundamentally restructuring the sector and sets out measures such as increasing honey production to 50 thousand tons by 2026.

Aim of the research: to study in which types of hives to keep bee colonies under Uzbekistan's conditions and the effect on colony productivity, and to identify beehives that are suitable for hot climatic conditions. Based on the above, the following tasks were studied under the research program:

1- To study the technologies for keeping and maintaining bee colonies in various types of hives (multi-tier, two-tier, and horizontal hives).

2- to study the feeding technologies for bee colonies in different types of hives,

3- to study the technology of expanding the internal volume for bee colonies in beehives of different types,
4- to study the effect of keeping bee colonies in different types of beehives on colony productivity,
5- to study the effect of different types of hives on the overwintering of bee colonies,
6- to determine the economic efficiency of the research activities, as envisaged.

Multi-tier hives: They consist of four tiers, and each tier can accommodate 10 frames measuring 435 × 230 mm. The thickness of the wooden walls on all four sides of the multi-tier hive is 35 mm. On the two outer side walls of the hive, there are special recesses that serve as handles; they are used when moving bee colonies.

In apiaries, when bees are kept in multi-tier hives, the tasks performed during the season-such as inspecting bee colonies, expanding the colony volume, supplying frames with wax foundation, harvesting honey, and stockpiling feed for wintering-are carried out by swapping the hive tiers, and higher income is achieved.

In the 10 frames of a multi-tier hive there are about 64,000 honeycomb cells, 1/3 of these is sufficient to store 10 kg of feed honey, while another 1/3 provides the capacity to rear larvae in the frame cells over a period of two weeks. After that, the bee colony can be left undisturbed for 20 days. In addition, during the summer there should be hive supers in the apiary filled with stored frames so that other work can be carried out.

Bees develop well when the positions of the supers are swapped. If a bee colony is managed without swapping the supers:

Firstly; the queen bee keeps laying eggs in the upper super, and as a result there is no space left for storing honey;

Secondly; after the larvae turn into bees and emerge from their cells, the worker bees fill those cells with pollen, because the bees are restricted from storing honey in the lower super;

Thirdly; the queen bee does not descend from the upper super to lay eggs, because warm air is always maintained in the upper super. In addition, bees dislike empty space or widened gaps between frames, and to narrow this space they move up into the newly added middle super and quickly draw comb; in other words, the idle bees are kept busy, and as a result both the issuing of a swarm and the preparation for swarming are prevented;

Fourthly; when it is time to add a super, the beekeeper lifts the third super to the top and, in its place, puts a new fourth super or places the bottommost super there. The purpose of raising the third super to the top is that the lowest super accumulates a lot of nectar. Therefore, during honey harvesting, to make the work easier, the honey-filled super is moved to the top.

If there is a heavy nectar flow 8-10 kg per day-from plants such as linden and juka, the bees pour nectar into the empty upper frames and fill them. As a result, the queen bee's egg laying is naturally restricted.

Two-tier hives: They consist of two tiers, each accommodating 12 frames measuring 435×300 mm. After each main tier, a honey super is fitted that holds 10 frames measuring 435×145 mm. The thickness of the wooden walls on the front and back of both the main tier and the super is 40 mm, and 30 mm on the sides. The lower entrance openings are 15 mm above the hive floor; the upper entrance is circular, 25 mm in diameter.

The advantage of managing bees in such a hive is that once the first tier is filled with bees, a second hive tier is added on top before the bees reach a swarming state. To prevent the colony's internal temperature from dropping suddenly, 5-6 frames are placed in the second hive tier, the remaining empty part of the hive is blocked off with a cushion, and as the bee colony develops, frames are gradually added, expanding it. Because the volume of such a two-tier hive is large, good conditions are created for the queen bee to lay many eggs, numerous larvae are reared, and the number of bees reaches up to 5-6 kg. When the bees are numerous and the hive's internal volume is cramped during honey gathering, during the main nectar-gathering period, a third tier or a smaller-volume super with frames (435×145 mm in size) can be installed on top of it.

Without knowing the development of the bee colony and the ability of nectar-secreting plants to secrete nectar, it is impossible to keep bees in a two-tier hive. Otherwise, the productivity of the bee colony will decrease. The main reason for this is that the beekeeper delays placing the second tier for a certain period. The time of placing the second tier is mainly determined according to the development of the bee colony and the flowering of the main nectar-secreting plants. The second tier must be

completely filled by the bees. Therefore, the second tier is placed on the hive one month before the flowering of the main nectar-producing plants. If the second tier is added later, then the bee colony will not be able to have great strength (there may be a period of accumulated numerous larvae), the bees emerge from the cells after the period of plants secreting nectar has ended. Such a situation negatively affects the collection of nectar coming from nature.

Horizontal hives. In these horizontal beehives, the thickness of the wooden walls on the front and back is 40 mm, and on the two sides it is 30 mm. The lower base part of the hive is made of wood and is completely closed. The lower flight openings are installed at a height of 12 mm from the hive floor. The upper flight hole is placed at a height of 20-30 mm, depending on the hive's placement. The upper side of the roof part is covered with sheet metal, an air inlet opening is placed on both sides, and along the air inlet opening the inner side of the hive's roof part is covered with a 3-mm mesh.

In Uzbekistan, bees are mainly kept in horizontal hives with 20-24 frames. The reason is considered to be the presence in horizontal hives of an under-roof structure adapted to hot climatic conditions and the availability of reserve fresh air there.

The queen bee's egg laying and the colony's development are not limited in horizontal hives. Good conditions are created there, and it is possible to rear numerous larvae. Strong bee colonies raised in horizontal hives collect a lot of honey, and their productivity is not less than that of other types of hives.

In horizontal hives, developing the bee colony is simple, and the inside of the hive is arranged as follows. If the brood comb frames with bees are placed opposite the hive's ventilation openings, the honey and pollen frames are placed on the two outer sides of the part where the colony is located. Gradually, the number of larvae increases, and the queen bee can lay as many eggs as there are frames. When the bees are numerous and the hive's internal volume is cramped during honey collection, it is possible to install a super with frames measuring 435×145 mm on top of it.

Depending on the characteristics of nectar-secreting plants, if the queen bee's egg laying has been restricted, the brood frames in the middle together with the queen bee are swapped with the honey frames to the two sides, or instead of the honey frames a special restricting grid that the queen bee cannot pass (that worker bees can pass) is placed. When this is done, the queen bee's egg laying is restricted, and honey accumulation in the colony increases. If a lot of nectar is coming from nature, the worker bees naturally restrict the queen bee's egg laying by filling one third of each cell with nectar, blocking it. After the main nectar-gathering period ends, conditions are created for the queen bee to lay many eggs. In this way, a basis is created for the bee colony to be strong and to enter wintering with numerous young worker bees.

When bee colonies with full strength are kept in horizontal hives, in order for the colony's bees not to prepare to swarm, the internal volume of the colony is expanded once, that is, at the end of spring or at the beginning of summer, in order to ensure the good development of the colony, conditions are created just as at the time when a swarm is caught and transferred into the hive, and empty frames and frames with artificial wax foundation are placed opposite the hive's flight entrances. Bees assimilate the inserted frames and the new frames with wax foundation, draw comb, collect abundant nectar from the flowers of plants that bloom in early summer, and, being busy with several tasks, are prevented from swarming.

In Uzbekistan today, bee colonies are mainly kept in horizontal hives with 20-24 frames. The reason is that horizontal hives consist of a single tier, are adapted to hot climatic conditions, and, most importantly, stand out for their larger volume than other types of beehives, for the presence of the main part of the horizontal hive, the super, the under-roof structure and the roof part, and for the ease of placing them during relocation. The presence of these features is convenient for the beekeeper's work and provides the opportunity to obtain a high yield from bee colonies.

In horizontal hives, it is possible to place from 20 to 26 frames measuring 435×300 mm. In the super, depending on the hive's volume, it is possible to place from 18 to 34 frames measuring 435×145 mm.

The thickness of the wooden wall on the front and back of the hive is 40 mm, and on the two sides it is 30 mm. The lower part of the horizontal hive is made of wood and is completely closed. From the bottom board of the horizontal hive, the lower flight openings are opened at a height of 12 mm. The upper flight openings are placed at a height of 20-30 mm, depending on the placement of the horizontal hive. The upper side of the

roof part is covered with sheet metal, an air inlet opening is installed on both sides, and along the air inlet opening the inside of the hive's roof part is covered with a 3-mm mesh.

Horizontal hives have many convenient aspects for maintaining bee colonies. In horizontal hives, expanding the internal volume of the colonies is carried out by moving the frames to the right or left depending on the colony's growth and development; in two and multi-tier hives, we can use only the tiers. In two and multi-tier beehives, when expanding the colony size, many mistakes may be made and it requires a lot of labor. In horizontal hives, when expanding the colony size, the bees pass through the partition board, make wax cells for themselves, and there is an opportunity for growth and development.

In horizontal hives, during the winter season, in order to keep queen bees in reserve, by forming a pocket at its edge and placing full partitions, it is also possible to form small 3-4-frame colonies.

When keeping bee colonies with full strength in horizontal hives, in order for the colony bees not to prepare to swarm, the internal volume of the colony is expanded once, that is, at the end of the spring season or at the beginning of the summer season, for the purpose of ensuring the good development of the colony, empty frames and frames with artificial wax foundation affixed are placed opposite the hive's flight openings.

When bee colonies are kept in horizontal hives, in order to prevent swarming, dividing the bee colonies into two equal parts gives good results. In this case, the accumulated numerous worker bees rear not the eggs of one queen bee, but also the eggs laid by the queen bee of the second colony formed as a result of dividing the colony. In the queen bee's egg laying and the colony's development, there is a great possibility to use horizontal hives without restriction. There, if the nectar in plants decreases, it is possible to rear numerous larvae.

If we compare beehives and the frames used for them, we can observe that the indicators of horizontal hives show good results; information about this is given in the table below.

Table 1 Main dimensions of hives and frames used in beekeeping, mm.

Types of hives	**Internal width**	**Internal length**	**Height**	**Thickness of the bottom board**	**Thickness of the wooden wall**	**Dimensions of frames used**	**Number of frames per tier**
Multi-tier hives	450	375	250	35	35	435x230	10
Two-tier hives	450	450	320	35	40	435x300	12
Horizontal hives	450	810	330-400	35	40 (front and back) 30 (two sides)	435x300	20

From the data of Table 1 it is seen that, because horizontal hives consist of a single tier, are very convenient to move, are adapted to hot climatic conditions, have a larger volume than other types of hives, have a simple structure, allow air to accumulate as a reserve in the under-roof structure, and have a large number of frames, under the conditions of Uzbekistan it is advisable to maintain bee colonies in horizontal hives. To avoid hindering the bees' work, it is advisable to collect the honey in the second half of the day.

In our republic, spring arrives earlier than in other countries, and by this time the number of young bees in the colony increases, and the need arises to provide them with work. Accordingly, we analyzed the

effect on the total honey collection of bee accumulation in multi-tier, two-tier, and horizontal hives, their productivity, relocation periods, and the quality of the queen bee.

By comparing the accumulation of bees in the colony and their productivity, we also studied the queen bee's live weight and its dependence on fecundity and on the number of drones in the colony.

In the conditions of the Samarkand region, during the wintering period, we tested in the research how bees overwinter in three types of beehives. In each group, 10 bee colonies were taken. Multi-tier beehives constituted the control, and two-tier and horizontal hives constituted the experimental groups.

In spring, in March, the results of bee wintering were recorded. Information about this is given in Table 2.

Table 2 Characteristics of bee wintering in beehives of various designs

Indicators	**n**	**Multi-tier hives (X±Sx)**	**Cv %**	**Two-tier hives (X±Sx)**	**Cv %**	**Horizontal hives (X±Sx)**	**Cv %**
Colony strength in aisle terms	10	6,4±0,03	2,8	6,3±0,04	2,2	6,3±0,02	1,3
Bee mortality (kg)	10	0,51±0,02	13,1	0,48±0,02	10,1	0,20±0,04	4,5
Feed consumption during wintering (kg)	10	10,9±0,18	4,9	10,0±0,14	4,7	9,9±0,14	4,3
Feed consumption per aisle (kg)	10	1,7±0,04	5,7	1,5±0,02	5,6	1,3±0,02	5,5
Bee colony strength	10	2,4±0,05	2,1	5,8±0,04	2,3	6,0±0,07	3,8
Bees reared in spring (in square terms)	10	68,4±1,20	5,8	71,2±1,19	5,6	77,8±0,9	3,9
Daily egg laying of the queen bee (pcs)	10	578,3±13,3	5,8	593,3±10,23	5,5	648,3±8,20	3,9

From the data of Table 2, it is seen that during the wintering period, in horizontal beehives all indicators were much higher. In particular, because during the wintering period two colonies were placed in horizontal beehives, as a result of them warming each other from both sides, their feed consumption was 9,9 kg, while this indicator was 10,9 kg in multi-tier hives and 10,0 kg in two-tier hives. Similarly, in each bee aisle in horizontal beehives 1,3 kg of honey was consumed, while in multi-tier hives 1,8 kg and in two-tier hives 1,6 kg of feed consumption was observed.

The most important indicator is considered to be the indicator of bee mortality during the wintering period. During the wintering period, it was 0,20 kg in horizontal beehives, while this indicator was determined to be 0,51 kg in multi-tier beehives and 0,48 kg in two-tier beehives.

In particular, in early spring, in horizontal beehives the amount of brood rearing amounted to 77,8 squares, while this indicator was greater by 113,7 % compared to multi-tier beehives and by 109,2 % compared to two-tier beehives. Similarly, the queen bee's daily egg laying in horizontal beehives was 648,3 eggs, and it was found that this indicator was 112,1 % higher compared to multi-tier beehives and 109,2 % higher compared to two-tier beehives.

Also, we can see such a picture, the information on the wintering of bees in beehives of various types, from the diagram in Figure 1 below.

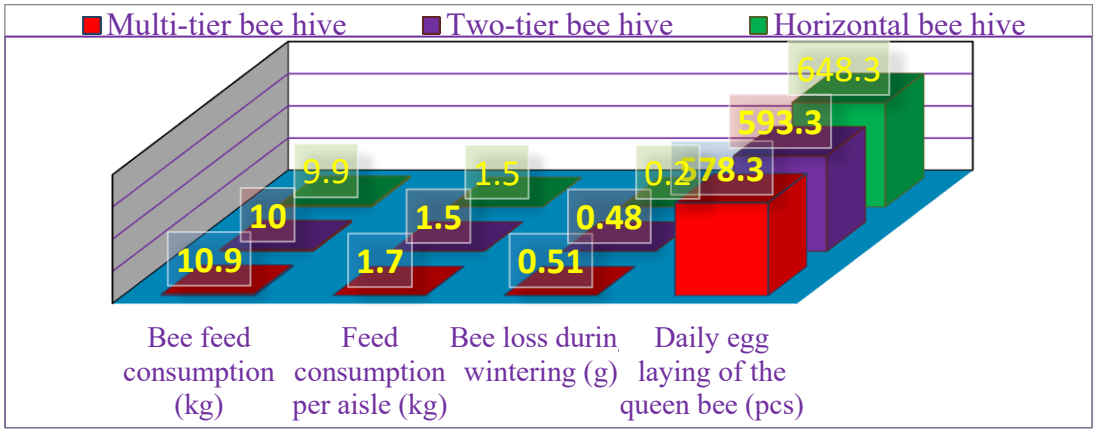

Figure 1. Diagram of the change of their indicators during the wintering period in beehives of various types.

From the data of Figure 1, it can be seen that the indicators of bee wintering in beehives of various designs were also different. In particular, we can see that such indicators in horizontal beehives were considerably better compared to other types of hives. Especially, in early spring after wintering, we can see such indicators in horizontal beehives: the amount of brood in the colony is large and the queen bee's daily egg laying increases day by day.

Also, the effect of beehives of various designs on colony wintering: in horizontal beehives, compared to other types of beehives, the bees overwintered well, consumed less feed, and came out of the wintering period without losses. In early spring, it was determined that a lot of brood was reared.

Similarly, we also studied the effect of beehives of various designs on honey productivity under the conditions of migratory beekeeping in the Samarkand region. Under the conditions of migratory beekeeping, multi-tier and two-tier beehives have some inconveniences when transporting, because each of their tiers is removable, and during the relocation of the hives they shift from their place.

To prevent the tiers in them from moving, the tiers must be tightly fastened with clamps that secure them. In horizontal beehives during relocation, such clamps are not needed. Therefore, moving them is much easier. For this purpose, we also studied the effect of various types of beehives on the productivity of bee colonies. Information about this is given in the following Table 3.

Table 3 The effect of maintaining bee colonies in hives of various designs on colony productivity.

Indicators	n	Multi-tier hives (X±Sx)	Cv %	Two-tier hives (X±Sx)	Cv %	Horizontal hives (X±Sx)	Cv %
Bee frames (pcs)	10	15,0±0,01	3,9	12,0±1,4	3,10	15,0±1,21	3,20
Bee aisle (pcs)	10	11,1±0,05	3,5	8,0±1,6	3,5	13,4±1,14	3,11
Amount of bees in the hive (kg)	10	2,7±0,21	2,9	2,8±1,17	3,0	3,1±1,24	3,4
Queen bee's daily eggs (pcs)	10	1550,1±0,18	5,4	1625,8±0,18	5,7	1925,0±1,19	5,9
Amount of brood in the hive (square)	10	186,1±0,19	5,5	191,1±1,18	5,4	231±1,8	5,8
Gross honey amount (kg)	10	35,1±1,01	1,4	38,0±0,25	1,5	44,1±0,30	1,9
Marketable honey amount (kg)	10	20,1±1,00	1,5	23,0±0,31	1,01	29,1±0,33	1,14
New frames drawn (pcs)	10	5,21±0,01	1,5	4,5±0,01	1,02	6,1±0,02	1,14

From the data of Table 3 it is seen that during the period of keeping bee colonies in beehives of various designs, their productivity indicators were also different; in July 2023 the number of bee aisles in multi-tier

beehives was 11.1, while this indicator was 8.0 in two-tier beehives and 13.4 aisles in horizontal beehives. Or this indicator was determined to be 120.7 % higher compared to multi-tier beehives and 167.5 % higher compared to two-tier beehives.

Similarly, it was observed that the queen bee's daily egg laying was also greater in horizontal beehives. The queen bee's daily egg laying in horizontal beehives amounted to 1925,0 eggs, while this indicator was found to be 1550,1 eggs in multi-tier beehives and 1625,8 eggs in two-tier beehives. Or these were greater by 124,1 % and 118,4 %.

Similarly, honey collection in beehives of various types was also different. The marketable honey yield in horizontal beehives was 29,1 kg, while in multi-tier beehives it was 20,1 kg, and in two-tier beehives this indicator amounted to 23,0 kg. Or it was determined that these indicators in horizontal beehives were 144,7 % higher compared to multi-tier beehives and 126,5 % higher compared to two-tier beehives.

Similarly, in building new frames with wax foundation it was also greater in horizontal beehives, and each bee colony built on average 6.1 new frames. This indicator was 5,2 pieces in multi-tier hives, and it was determined to be 4,5 pieces in two-tier beehives. Information on colony productivity in beehives of various types can also be seen in the diagram in Figure 2.

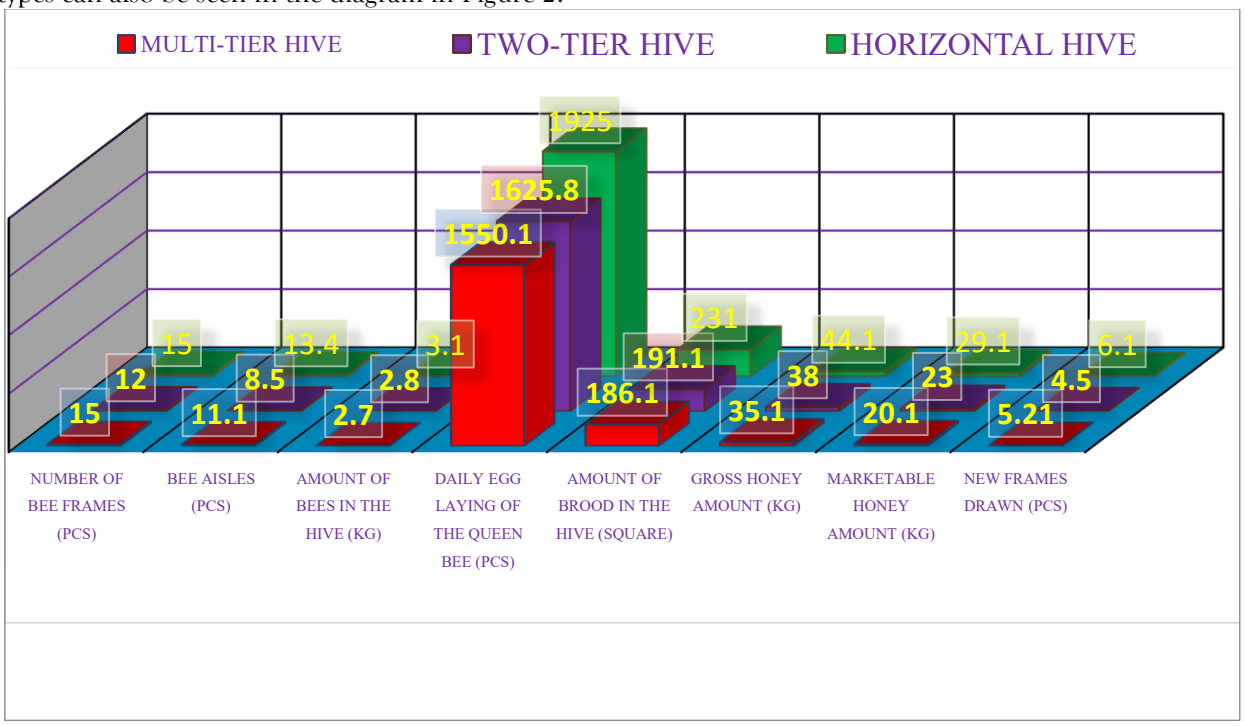

Figure 2. Diagram of the effect of keeping bee colonies in various types of beehives on colony productivity.

From the data of Figure 2 it can be seen that the effect of various types of beehives on colony productivity has been different. In particular, we can see that the queen bee's daily egg laying in bee colonies kept in horizontal beehives was 124,1 % and 118,4 % higher compared to those kept. Also, we can see that the indicators for gross honey collection and for building new bee frames have always been higher in horizontal beehives.

1- In conclusion, during the wintering of bee colonies in horizontal hives where two colonies were housed together (retaining warmth), such colonies passed the winter without losses; where losses occurred, bee mortality amounted to 8.0 %. In early spring, it was determined that 109.2 % and 113.7 % more brood was reared.

2- When keeping bee colonies in different types of hives, it was found that in horizontal hives the productivity indicators were 144.7 % higher than in other hives, and the indicator for drawing new comb on frames for honey production was 125.0–135.5 % higher.

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