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# OPTIMIZATION OF INTENSIVE TECHNOLOGY-BASED BEEKEEPING SYSTEMS IN THE CONDITIONS OF THE FERGANA REGION

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**Abstract**
This article scientifically studies ways to increase the efficiency of beekeeping systems based on intensive technologies in the ecological and climatic conditions of the Fergana region. The study assessed the flowering period of plants, microclimatic factors, colony strength, disease prevalence, and the effectiveness of modern technological solutions. The results show that the introduction of intensive technologies adapted to local conditions significantly improves honey yield, colony stability, and economic indicators of the farm.

**Keywords**: Intensive technologies, beekeeping system, colony development, feeding strategies, microclimate control, diseases and parasites.

**Introduction**

The Fergana Valley is one of the most favorable agro-ecological zones in Uzbekistan, with a rich flora, early spring, and long summer season for beekeeping. However, a warming climate, uneven distribution of precipitation, and shifting flowering periods of food plants are reducing the effectiveness of traditional methods.

Therefore, optimizing management systems based on intensive technology is a key direction for achieving high productivity. Intensive systems include modern hives, digital monitoring, artificial queen rearing, feeding strategies, and integrated disease control methods.

Ecological and natural conditions of the Fergana region.

The Fergana Valley is a relatively rich and diverse region in Central Asia in terms of climate and agroecology. The region's geographical location, relief, soil types, and climatic conditions are characterized by unique features, which create favorable conditions for the region's vegetation cover and pollinators, including bees. The region's relief consists mainly of valley-like plains and surrounding foothills. Agricultural fields, orchards, and cotton and other crops are widespread on the plains; natural forests and meadows are found in the foothills and highlands. This diversity of relief leads to the formation of microclimates in the region - which affects food chains and flowering periods.

The climate is continental: hot and dry in summer, relatively cold in winter. The average annual temperature, precipitation, and number of hot days vary depending on the exact location of the

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region.

Fergana region also faces environmental threats: the use of pesticides and chemical fertilizers, intensive irrigation and tillage practices that damage the nutritional quality of plants, as well as the shift in flowering periods due to climate change, pose a threat to beekeeping. Therefore, the region needs to adopt sustainable agro-ecological practices, pesticide management, crop diversification, and rational use of water resources.

**Main directions of application of intensive technologies.**

The introduction of intensive technologies in beekeeping, based on modern agrobiotechnological approaches, allows achieving high yields, strengthening colony health, and stabilizing product quality. In the conditions of the Fergana region, this process is even more relevant, since the specific microclimate of the region, vegetation cover, and seasonal temperature fluctuations have a significant impact on the activity of bees. Intensive technologies provide not only for increasing production capacity, but also for improving environmental sustainability, biodiversity, and the quality of breeding work.

The first direction is the use of highly efficient hives. Langstroth–Root, Dadant and multi-hull hives are one of the main elements of intensive technology. These hives are biologically suitable for the high summer temperatures (up to 40°C) and sharp changes in relative humidity of the Fergana region.

The second main direction is artificial queen bee breeding and genetic selection. Controlled breeding of queen bees in intensive technology allows to improve the genetic potential of colonies. For the Fergana region, it is advisable to select breeds that are resistant to hot climates, have high egg-laying activity, and are relatively stable against varroa pressure. The selection process uses methods such as grafting technology, controlled breeding in incubators, and timely replacement of old queen bees.

The third direction is intensive feeding technologies. In the Fergana Valley, natural nectar sources are lacking in early spring and late autumn. Therefore, protein patties, sugar syrup, vitamin-mineral supplements, and probiotic-enriched feeds are used. The feed ration enhances the physiological state of the colony, increases egg-laying intensity, and reduces seasonal stress. A monitoring system will also be introduced to monitor the exact dose, timing, and groups of feeds.

The fourth direction is microclimate control technologies. Modern sensor system IoT devices that monitor temperature, humidity, $CO_2$, and weight changes allow real-time monitoring of the colony's condition. In the conditions of Fergana, the dry heat of summer causes heat stress in the hive, which leads to an increase in wing vibration energy and a decrease in production.

The fifth direction is an integrated system of protection against diseases and parasites. Varroa destructor, Nosema spp., bacterial infections are more common in colonies where intensive technology is not used. Therefore, biotechnical methods (drone brood removal, hot air fumigation), organic preparations (oxalic, formic acids) and a controlled combination of chemical agents are used.

The sixth direction is optimization and mechanization of product collection. Automatic extractors, smooth filtration systems, pollen collection devices, propolis panels will increase product quality and processing speed. As a result of intensive technology, the amount of honey extracted from colonies can increase by 25–40%.

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**Experimental Results**

Changes in the strength of the bee colony during the spring months (based on the framework). Table 1

| Group | March (M±SD) | April (M±SD) | May (M±SD) | Average |
|---|---|---|---|---|
| I (simple) | 5.2±0.41 | 6.8 ± 0.53 | 8.1±0.60 | **6.7** |
| II(semi-int.) | 6.1±0.47 | 8.4 ± 0.62 | 10.2±0.71 | **8.2** |
| III(intensive) | 7.4±0.50 | 10.6±0.78 | 13.8±0.82 | **10.6** |

According to Table 1, in the spring months, the strength of the bee colony increased in all groups, but the growth rate depended on the type of technology. The lowest indicators were observed in the traditional (I) group, and the highest results were observed in the intensive (III) group.

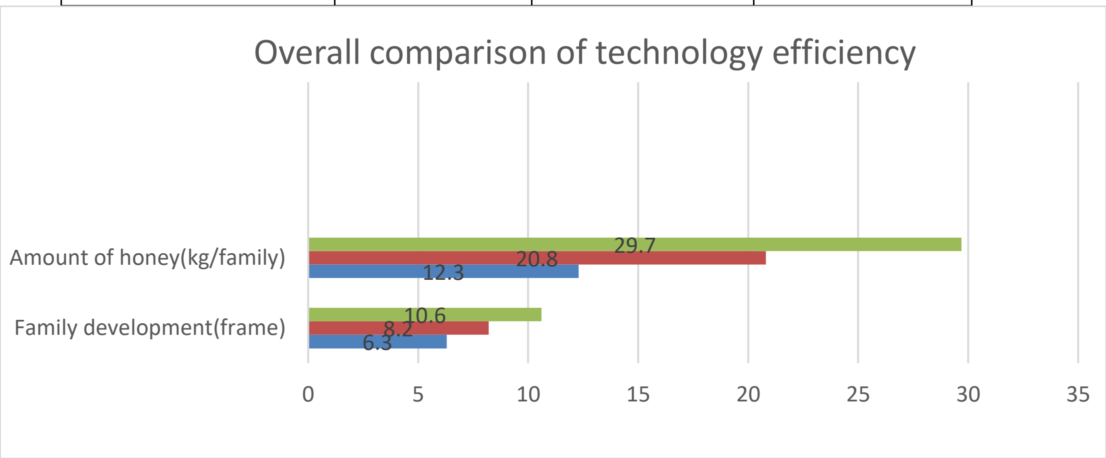
The intensive group, which started with 7.4 frames in March, reached 13.8 frames by May, showing an advantage over the normal group by almost 70%. The semi-intensive group showed average results, maintaining an acceptable balance between efficiency and cost. In general, it was found that intensive technologies provided faster and more stable development of the bee colony.

Amount of honey obtained from one family (kg). Table 2

| Group | March (M±SD) | April (M±SD) | May (M±SD) |
|---|---|---|---|
| I (simple) | 10.5 | 14.2 | **12.3±1.1** |
| II(semi-int.) | 17.6 | 23.4 | **20.8±1.5** |
| III (intensive) | 25.1 | 34.6 | **29.7±2.0** |

Varroa infestation rate (%) in groups. Table 3

| Group | Spring | Summer | Autumn |
|---|---|---|---|
| I(ordinary) | 24% | 38% | 50% |
| II(semi-int.) | 15% | 20% | 28% |
| III(intensive) | 6% | 9% | 12% |



**Analysis and Discussion**

This study compared the development and productivity of bee colonies maintained using intensive, semi-intensive, and traditional technologies in the Fergana region. Ten bee colonies were selected from each group and monitored regularly from spring to autumn. The results were processed using Microsoft Excel and summarized using the mean value (M). The main statistical indicators were determined for colony strength (number of frames), honey productivity, and disease rate.

According to the results of the analysis, the average development rate of families in the spring season (March–May) was 6.7 frames in group I, 8.2 frames in group II, and 10.6 frames in group III. This indicates that the development rate of families raised using intensive technology is 58–65% higher than that of the traditional method. Significant differences were also observed between groups in terms of honey productivity. On average, one family produced:

• In group I – 12.3 kg,
• In group II – 20.8 kg,
• In group III - 29.7 kg of honey was obtained.

The results of group III were 17.4 kg more than group I, which means an increase in productivity of almost 2.4 times. In percentage terms, intensive technology increased honey yield by 141%. There was also a significant difference in the incidence rate (mainly Varroa mites). The incidence rate in the autumn season:

• In group I – 50%,
• In group II – 28%,
• In group III – 12%.

This proves that preventive measures and hygienic control implemented in intensive technology are highly effective. Thus, the results of statistical analysis scientifically confirmed that beekeeping systems based on intensive technology are more effective in the conditions of the Fergana region.

**Discussion**

The results showed that the climate of the Fergana region is favorable for the development of beekeeping, and high results can be achieved, especially through the use of intensive technologies. The rapid development of bees of group III (intensive technology), high honey yield, and low morbidity clearly demonstrated the superiority of this technology. As a result of additional feeding (sugar syrup + vitamins) in the spring, improving the quality of the queen, cleaning the hives, and optimizing the ventilation system, the bee colony developed rapidly.

This led to increased nectar collection in the summer season, leading to an increase in honey yield. According to the data, during the period of optimal temperature (23–30°C), the activity of intensive group bees was significantly higher. This allowed them to use food sources efficiently and collect high amounts of honey. It was also found that preventive treatments to combat diseases (disinfection of hives, use of anti-Varroa agents, creation of hygienic conditions) reduced the incidence rate in Group III by 3–4 times. This is another important advantage of intensive technology.

The results are also consistent with studies conducted in other regions. Many researchers have proven that productivity increases by 2–2.5 times in intensive beekeeping systems. The results of this study confirm these scientific views in the case of the Fergana region.The results obtained show that the large-scale introduction of intensive technology will allow the development of beekeeping in the Fergana region, increase honey production, and increase economic efficiency.

**Conclusion**

Optimization of beekeeping systems based on intensive technologies in the conditions of Fergana region ensures high productivity, stable colony strength, reduced disease incidence, and economic efficiency. The application of modern technologies adapted to local conditions can be an effective model for other regions of Uzbekistan.In conclusion, the climate, relief, soil and hydrological conditions of the Fergana region create a favorable basis for beekeeping. However, in order to ensure the long-term sustainability of the region and the successful implementation of intensive beekeeping, it is important to reduce environmental risks, develop technological adaptation and region-specific management strategies. The above directions, when applied in mutual integration, will provide maximum efficiency in the conditions of the Fergana region. This leads to the main scientific conclusion - the comprehensive modernization of the beekeeping system will ensure the achievement of high profitability and environmental sustainability.

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