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The Importance Of Economic-Geographical Factors In The Development Of Beekeeping In The Central Region Of Uzbekistan

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Abstract: This article explores the ecological and economic importance of beekeeping in the central region of Uzbekistan, while identifying the major environmental and biological stressors affecting honeybee colonies. The study highlights the negative impact of industrial emissions, chemical pesticides, heavy metals, and fungal or viral infections on bee health and colony survival. In the central agro-industrial zones, the intensified environmental burden has led to increased prevalence of diseases such as ascosphaerosis, aspergillosis, and varroatosis among honeybee populations.

Furthermore, the paper emphasizes the critical ecological role of bees as pollinators in sustaining biodiversity and stabilizing agro-ecosystems. Based on data presented in diagrams and tables, the influence of external environmental factors such as temperature fluctuations, humidity levels, pollution, and the reduction of nectar sources on bee productivity and colony strength is statistically demonstrated.

The article proposes a set of integrated preventive and management strategies aimed at preserving beekeeping in the central regions of Uzbekistan. From both an ecological and economic perspective, the research underscores the strategic significance of developing sustainable beekeeping practices to ensure long-term environmental health and agricultural productivity in the region.

Keywords: Honeybee health, Central Uzbekistan, beekeeping development, environmental pollution, fungal diseases, ascosphaerosis, aspergillosis, varroatosis, agro-ecosystems, pollination, climate change, entomophilous plants, heavy metals, ecological stressors, sustainable apiculture.

Introduction. In recent years, the depletion of natural resources and the intensification of ecological issuessuch as widespread deforestation, land degradation, oil contamination, pollution of water bodies and atmospheric air have become major contributors to climate change and the destruction of natural ecosystems in our region. This ongoing environmental deterioration poses a serious risk to the socio-economic structures of both nations and specific localities. The escalating anthropogenic pressure on the environment has had a direct impact on bee populations. The shrinking of forage areas and habitats significantly weakens bee colonies, decreasing their resilience and increasing their vulnerability to various diseases. These adverse conditions create an ideal environment for the rapid spread of infections.

Environmental and Fungal Stressors Threatening Apiculture in the Central Region of Uzbekistan. O.F. Grobova and A.M. Smirnova (1987) identified Aspergillus niger Tieghem, Aspergillus flavus Link, and Aspergillus fumigatus Fresenius as pathogenic fungi responsible for bee mortality. These fungi are particularly aggressive under conditions prevalent in the central region of Uzbekistan, where fluctuations in temperature and humidity provide favorable environments for fungal proliferation.

According to V.I. Bilay and E.Z. Koval (1988), colonies of A. niger grown on Czapek agar exhibit compact mycelium with white to light-yellow pigmentation. The colony typically spans only 2.5-3.0 cm in diameter and is characterized by heavy black or dark brown conidial heads, often forming radial patterns.

Within a single hive, fungal spores can be spread by nurse bees and cleaning workers. Pathogens can also be transmitted from colony to colony via drones, robber bees, parasitic insects, contaminated equipment, honey, and pollen. During acute outbreaks, up to 50% of brood may become infected. In severe cases, fungal infections can lead to the complete collapse of a bee colony (Klochko R.T., Luganskiy S.N., 2006; Ogurtsov A.F., 2008). Infected larvae exhibit hardened, greyish, limestone-like features. Affected brood becomes covered in a white mold, dies, and dries out, eventually transforming into elongated, chalky, brittle structures aligned within the comb cell (Roussy L., 1962; Najafov N.I., 2010).

Najafov N.I. (2010) notes that in the early stages of infection, fungal spores enter the larval gut along with food. As stated by Mirzoev M.D., Negmatov A.A., and Khasanov F.D. (2012), the mycelium then penetrates through the midgut and spreads throughout the larval tissue, gradually enveloping the entire body

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in a white fungal coating. Fungal Diseases and Their Impact on Beekeeping in the Central Region of Uzbekistan. Within the sealed brood cells, the fungal mycelium continues to grow through the wax cap, leading to the mummification of dead larvae. According to L.A. Khit (1985), N. Kokorev, and B. Chernov (2008), as well as K.V. Bogomolov and V.V. Yarankin (2011), chalkbrood disease most commonly appears during the spring and summer, with peak activity recorded between June and August.

Research conducted by O.F. Grobova, L.N. Guzeva, Z.E. Rodionova, T.V. Konovalova, and Yu.M. Batueva (1992) identifies the misuse of antibiotics and acaricides as one of the primary causes for the emergence of chalkbrood. These substances weaken bees' natural immunity, trigger dysbiosis, and metabolic disorders. As a result, worker bees, drones, and queens may act as vectors for disease transmission in hives throughout the central region of Uzbekistan.

Another significant fungal infection affecting bees in the central region is aspergillosis, also known as stonebrood. As noted by Klochko R.T., Malinovskaya L.S., Ignatieva G.I., and Sokhlikova A.B. (1996), this disease often leads to the death of both adult bees and brood. The causative agent belongs to the Aspergillus genus, classified under the class Deuteromycetes, order Hyphomycetes. Recent studies (Raper & Fennell, 1965; Fassatiova, 1979) emphasize that certain Aspergillus strains exhibit structural variations that influence their virulence and growth patterns. These features complicate control efforts, particularly in areas where hives are exposed to environmental stressors. In 2024, extensive field data collected from beekeepers in the central region of Uzbekistan revealed the complex intersection of biological, ecological, and economic pressures on apiculture. The average annual honey yield was 13 kg per hive, priced at 54,000 UZS per kilogram. Monthly maintenance costs per hive comprising feed, sanitation, and labor total approximately 155,000 UZS, including labor expenditures of about 72,000 UZS. Economic projections for hive investment assumed a 10-year productive lifespan and a 10% discount rate. Notably, depreciation and income tax were excluded from net cash flow estimates, as apiculture is still classified as a tax-exempt activity during its initial 10 years of operation in the central Uzbek regions. Beyond fungal pathogens, bees in the central region of Uzbekistan face acute stress from industrial pollutants, especially in areas surrounding petrochemical complexes. Elevated concentrations of heavy metals such as arsenic, lead, and copper are associated with chronic declines in local bee populations. Environmental bioassays have shown that honey produced near such industrial zones exhibits significantly lower immunological activity. Carbon monoxide and nitrogen oxide emissions contribute further to physiological stress in bees, disrupting their internal homeostasis.

The honeybee (Apis mellifera) is a sensitive bioindicator that responds swiftly to even minute changes in environmental conditions. Anthropogenic disturbances such as deforestation, monoculture practices, pesticide drift, and urban sprawl have destabilized colony structure and productivity across the central belt of Uzbekistan. Bees in these areas display reduced foraging activity, impaired navigation, and weakened resistance to secondary infections. These disruptions are especially pronounced when dietary diversity is low or when protein resources within the hive are depleted.

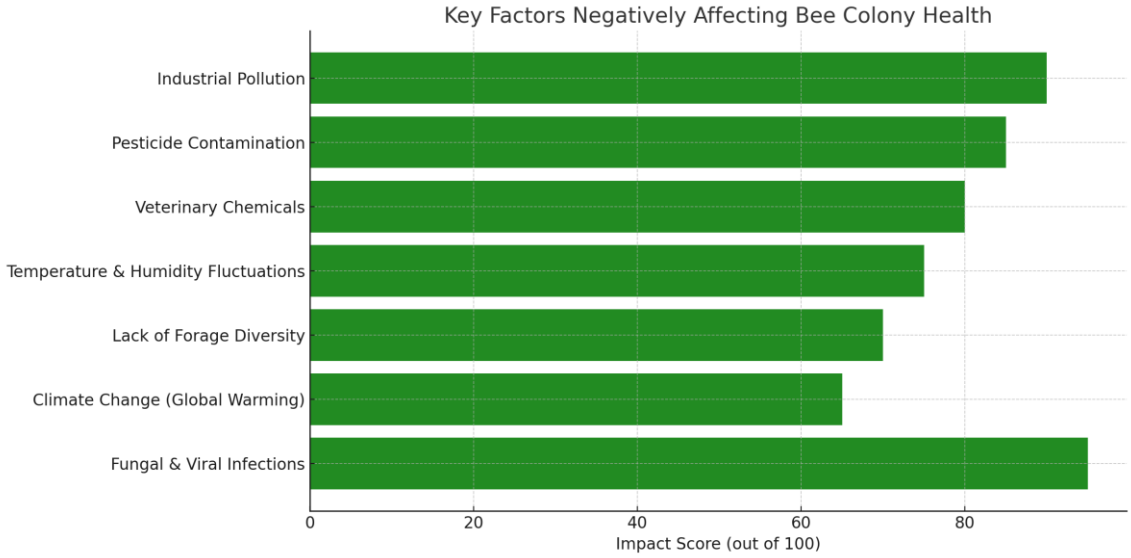

Figure 1. Key Environmental and Biological Factors Affecting Bee Colony Health.

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Proteins are critical to the development of royal jelly, synthesized by the pharyngeal glands of nurse bees. Inadequate protein intake results in reduced gland activity and lower brood output, ultimately leading to colony decline. Moreover, the bioaccumulation of eco-toxicants such as lead and cadmium accelerates the physiological aging of bees, manifesting in disrupted weight ratios of body segments and altered developmental timing. This biochemical aging compromises colony longevity and reproductive success, posing a long-term threat to apiculture sustainability in Uzbekistan's central region.

The gut microbiota of bees, a key determinant of their immunity, is also sensitive to environmental pH shifts induced by chemical residues and poor forage quality. Disruption in the acid-base balance of the intestines leads to increased susceptibility to fungal, bacterial, and viral co-infections. This highlights the urgent need for targeted mitigation strategies including habitat restoration, sustainable forage planting, and regulated chemical use to protect pollinators in this ecologically vital zone.

Table 1.

Environmental and Biological Stressors Impacting Honeybee Colonies in Central Uzbekistan.

Factor	Impact Description	Severity (1–10)
Heavy metal pollution	Bioaccumulation in nectar and pollen impairs immunity	9
Pesticide exposure	Disrupts gut microbiome, lowers detoxification capacity	8.5
Acaricide overuse	Reduces colony resistance, facilitates fungal infections	8
Temperature and humidity fluctuations	Destabilizes hive microclimate, encourages pathogen growth	7.5
Loss of flowering wild plants	Reduces nutritional availability and foraging diversity	7
Cloudy weather due to global warming	Lowers flight activity and nectar/pollen collection	6.5
Fungal and viral diseases	Direct mortality, colony collapse syndromes	9.5

Key Environmental and Pathogenic Threats to Honeybee Colony Sustainability in the Central Plains of Uzbekistan. The sustainability and productivity of honeybee colonies in the central plains of Uzbekistan are significantly undermined by a range of anthropogenic and environmental stressors. Chief among these are industrial pollutants such as heavy metals (lead, arsenic, cadmium) and synthetic compounds that contaminate both air and soil. These toxins, often emitted by industrial enterprises, can accumulate in nectar and pollen, weakening bee physiology and suppressing immune responses, especially under fungal infections.

Additionally, widespread pesticide contamination in entomophilous (insect-pollinated) flora presents another layer of threat. Pesticides such as neonicotinoids and acaricides interfere with the digestive microbiome of bees, reducing protein assimilation efficiency and consequently lowering immunity.

Veterinary and sanitizing chemicals used within beekeeping operations further compound these issues. When applied without proper regulation, these substances increase colony vulnerability to fungal diseases such as Ascosphaerosis and Aspergillosis. These infections thrive particularly in environments where temperature and humidity fluctuate abruptly a common occurrence in continental climates like that of Uzbekistan's steppe regions.

The sanitation of hives specifically the speed and thoroughness of removing diseased or dead bees has been shown to influence the spread and persistence of infections. Colonies with insufficient hygienic behavior are more likely to succumb to diseases such as Melanosis and Candidiasis.

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Impact of Forage Diversity and Climate Change. One of the often overlooked yet critical factors is the reduction of wild and ruderal flowering plant areas. These plants, unlike monoculture crops, provide continuous and diverse pollen sources throughout the season. Their decline directly correlates with decreased colony strength and diminished honey yields.

Climate change has exacerbated these challenges. Increased cloud cover and a higher number of overcast days documented across Uzbekistan have significantly suppressed bee flight activity. This reduction in foraging effort reduces pollen intake and subsequently colony robustness.

Conclusion. A positive correlation exists between environmental stress loads and the pathogenic infection rates in bee colonies. Degradation of bee habitats, combined with excessive chemical exposure and climate volatility, contributes to declining resilience among colonies. In the central plains of Uzbekistan, targeted ecological, agricultural, and sanitary interventions are urgently needed to ensure long-term sustainability of apiculture. This includes stricter pesticide regulation, habitat conservation for wild flora, improved hive management practices, and early detection systems for fungal diseases.

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