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BEEKEEPING ROLE IN ENHANCING FOOD SECURITY AND ENVIRONMENTAL PUBLIC HEALTH

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Abstract
This conceptual article delves into the intricate relationship between public health and environmental health, using the underutilisation of beekeeping in the United States as a case study. The concept of food security, established after the 1996 World Food Summit, encompasses pillars of availability, accessibility, utilization, and stability. This thorough framework creates the foundation for comprehending the crucial aspects of food security and prepares the reader for a careful examination of the implications presented by the US honeybee colonies' decline. The decline in honeybee colonies in the United States poses a significant threat to food production. Loss of honeybee colonies and the lack of attention to apiculture have far-reaching consequences for public and environmental health. This article explores the often-overlooked intersection of food security and beekeeping, recognizing the intricate dependencies between pollinators and crop sustainability. Honeybees, crucial pollinators for essential food crops, offer not only ecological benefits but also socio-economic opportunities. The article also highlights beekeeping's diverse contributions, such as enhanced pollination, increased crop yields, ecosystem health, and climate change resilience. Despite the evident benefits of beekeeping for food security and the nutritional richness of bee products, commercial beekeeping in the USA is monopolised by a mere 1.4% of beekeepers. The 1.4% commercial beekeepers control 89.7% of country colonies, an indication of the huge neglect of apiculture. This neglect led to an alarming 48.2% loss of honeybee colonies between April 2022 and April 2023. This unprecedented decline, often overlooked, highlights a deficiency in attention and strategic planning within agriculture, underscoring broader implications for public and environmental health in the United States. This article introduces a theoretical framework incorporating ecological systems, social ecology, system theory, resource-based views, livelihood diversification, and sustainability, emphasizing their role in understanding and improving food security through beekeeping.

Keywords: apiculture; ecological systems; food security; livelihood diversification; pollination; social ecological theory; sustainable agriculture.

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BACKGROUND

Following the World Food Summit in 1996, the term "food security" was used to describe a situation in which all individuals, regardless of time or place, have physical and financial access to sufficient, safe, and nourishing food; food that captures all their dietary as well as preferential needs for an energetic and healthy life (Duncan et al., 2021). Following this declaration of what constitutes food security, four main pillars stood out. The components are food availability, accessibility, utilisation, and stability (Bucatariu, 2020).

Food availability captures the “supply side” of food security, which is largely dependent on the level of production, stock, food aid and import capacity. Accessibility to food includes both physical and economic access. In some cases, national access does not guarantee household access to food and thus a lack of food security (Cuenca et al., 2023). Utilisation encompasses adequate intake of the necessary dietary proportions in the body. The sufficient energy and nutrients intake is determined by the methods of food preparation, food distribution, harvesting techniques, storage, processing and even transportation.

Lastly, stability as a pillar of food security refers to supply constancy and food accessibility bearing in mind the variations in weather conditions, price fluctuations and other economic and/or political factors (Cuenca et al., 2023). This complex issue, often overlooked, underscores a systemic neglect in US food systems, revealing potential implications for both public health and environmental health. The nutritional richness of bee products emphasises their importance in dietary patterns, linking beekeeping to public health outcomes.

Food security, a fundamental pillar of global well-being and development, remains a complex and pressing challenge in today’s world. As populations continue to grow and the climatic conditions keep on changing, the sustainable production of nutritious and accessible food becomes increasingly crucial (Giuseppe, 2015). Amidst this challenge, beekeeping emerges as a noteworthy contributor to food security (Adamte, 2023), offering a multifaceted and ecologically significant solution. The intricate relationship between pollinators, particularly honeybees, and agricultural production has been a subject of academic exploration and policy consideration for decades. This article embarks on an academic inquiry to elucidate the pivotal role played by beekeeping in enhancing food security. By delving into ecological, economic, and social dimensions of this age-old practice, we aim to provide a comprehensive understanding of how beekeeping fosters food security, both locally and globally.

This academic exploration is underpinned by a recognition of the intricate web of interdependencies between pollinators and crops that sustain human populations. Honeybees are renowned for their role as pollinators, facilitating the reproduction of numerous food crops essential for human nutrition. The article will delve into the ways in which beekeeping practices can support and enhance these pollination services, ultimately increasing crop yields and food availability (Decourtye et al., 2019). Furthermore, the article explores the socio-economic dimensions of beekeeping, emphasising how it offers livelihood opportunities to individuals and communities, especially in regions with limited economic resources. Beekeeping, as a form of sustainable agriculture, holds the potential to alleviate poverty and improve food security for many (Giuseppe, 2015). In a world marked by environmental challenges, the ecological benefits of beekeeping cannot be overlooked. The promotion of biodiversity and sustainable land use through the preservation of natural habitats is a critical aspect of this inquiry. Understanding how beekeeping practices can be aligned with ecological conservation efforts is essential for a holistic approach to food security.

In the pages that follow, we will engage in a rigorous examination of the scientific literature, empirical case studies, and policy perspectives, with the aim of offering a comprehensive understanding of how beekeeping, with its diverse implications, can serve as a vital pathway to enhancing food security. By doing so, this article contributes to the ongoing dialogue surrounding sustainable agriculture, ecological stewardship, and the quest for a food-secure future for all.

Problem statement

Unlike other agriculture enterprises, beekeeping as a practice is not common despite its numerous benefits in enhancing food security. Its products such as honey, wax, pollen, and propolis have rich nutritional contact required in dietary pattern of the human beings (Ibrahim et al., 2021). Available statistics indicate that honey beekeeping in the United States is controlled by 1.4% of beekeepers categorised into the commercial beekeeping group (Steinhauer, 2023). Commercial beekeepers control 89.7% of country colonies.

Beekeeping in the United States also suffers from loss of colonies. Between April 2022 and April 2023, beekeepers in the US lost approximately 48.2% of their managed honeybee colonies (Steinhauer, 2023). According to Steinhauer (2023), in the previous year, the total loss of colonies was 39.0%. While the loss of colonies by this margin should be worrying, it is treated casually, an indication that apiculture has not been

well embraced like other practices including dairy farming, beef farming, fruit production, and flower production.

Loss of colonies and the casual treatment of apiculture has a huge impact on food security. All stakeholders in the beekeeping industry must re-strategise in a bid to enhance beekeeping as a practice which greatly impacts food production and by extending public health and environmental health in the US.

Method and aim

The approach to this paper is conceptual. It focuses on the exploration and development of theoretical frameworks, models, or ideas through academic literature without necessarily presenting new empirical data (Jaakkola, 2020). Unlike empirical studies that rely on data collection and analysis, conceptual papers delve into the synthesis, analysis, and interpretation of existing knowledge to propose new theoretical perspectives, frameworks, or insights (Jaakkola, 2020).

Conceptual papers play a crucial role in academic fields and research by contributing to the theoretical foundation of a discipline (Jaakkola, 2020). They offer a deeper understanding of concepts, relationships, and phenomena, helping to shape and refine theoretical frameworks that guide empirical research (Jaakkola, 2020). These papers often bridge gaps in existing literature, offer alternative viewpoints, or propose innovative conceptualisations, providing a foundation for future empirical studies (Jaakkola, 2020).

Moreover, conceptual papers facilitate interdisciplinary dialogue by connecting ideas across different fields (Jaakkola, 2020). They can foster critical thinking, stimulate discussions, and inspire researchers to explore new avenues of inquiry. By challenging current assumptions and proposing novel concepts, conceptual papers contribute to the evolution and advancement of knowledge within a particular academic discipline. Overall, they are essential for the development and enrichment of theoretical perspectives, thereby enhancing the overall quality and depth, variety, and richness of academic research (Jaakkola, 2020).

Theoretical framework

Beekeeping is an agricultural practice that generates various products. It serves a wider range of functions that benefits plants, animals, humans, and ecological systems. The process is complex, requiring the application of several theories to locate the intricate nature of honeybees to humans, animals, and the ecosystem. The review will be informed by several theories to precisely locate the connection between beekeeping and improving food security. The ecological systems theory will inform the review since it focuses on the interconnected environmental systems influencing an individual's development (Darling, 2007). The framework has evolved over the years to integrate the dynamic interplay between biological, psychological, and ecological factors (Neal & Neal, 2013). The theory will offer an understanding of the dynamic interplay between beekeeping and ecological system balance.

Social ecological theory and system theory will inform the review. According to Høgh-Jensen (1998), the hypothesis brings tighter cohesive groups of interconnected, interrelated components: both natural and manmade. It further brings together concepts from various disciplines like political science, economics, agriculture, biology, geography, and engineering. (Hartvigsen et al., 1998) In this review, the framework is vital in understanding the interconnected components and processes within the beekeeping system to effectively provide honeybee health, productivity, and sustainability. The framework consists in ecological, social, and management factors to create an effective and sustainable system. The social ecological theory considers the multifaceted interplay between persons, relationships, and community. The theory will be deployed to have an in-depth understanding of the social and ecological systems involved in beekeeping. Therefore, applying this framework will locate the structural interconnectivity within the beekeeping industry and how they improve food security.

Resource-based views and livelihood diversification theories will inform the inquiry. Peng et al. (2022) define the livelihood diversification framework as the process by which households build a portfolio of social support and activities in order to survive and improve their standard of living. The framework is also viewed as a diversification theory as it seeks to lower risk and improve resilience. The resource-based view theory focuses on the resources that industries and organizations can leverage to have a sustained competitive edge (Barney, 1991: Hitt et al., 2015). In this review, the concept will be applied in reviewing the factors that impact beekeeping and locating how they can be made sustainable to improve food security.

In the wake of climate change and global warming, the sustainability concept has been broadly discussed (Khalili, 2011; Antal & Van Den Bergh, 2014: Urry, 2015). The sustainability theory attempts to prioritise and incorporate social responses to ecological and cultural problems. Meadowcroft (2015) indicates that the

hypothesis entails the development of lasting economies and societies that can be lived on a global scale, while also resolving intergenerational ethics and the need for justice between generations and global justice. The concept of sustainability has gained impetus in the modern ecological movement, which focuses on living in a manner that does not affect the future generation (Fawzy et al., 2020). In this review, the theory will locate how beekeeping promotes sustainable practices to improve food security.

LITERATURE REVIEW

Many studies have focused on the role of beekeeping in enhancing food security. Bee improves food security through pollination. It increases crop yields and promotes diversity. Also, it enhances ecosystem health, diversification of agricultural practices, climate change resilience, sustainable food development. Finally, it raises nutrient diversity (Etxegarai-Legarreta & Sanchez-Famoso, 2022; Patel et al., 2020; John et al., 2017). For instance, Klein et al. (2006) affirm that honeybees are considered the most important pollinating agents globally due to their efficiency and ability to navigate across the globe. Besides, they play a critical role in pollinating for food production. Apiculture utilities can be classified into three broad categories: ecological, social cultural, and social economic. Each of the tenets has been broadly studied and the outcomes are forthcoming.

The concept of beekeeping

Regarding the current review, it is difficult to find a definition of the term "beekeeping". Masuku (2013, p.237) notes beekeeping is "an agricultural activity defined as the art, science, and/or business of managing bees for the purpose of producing honey, wax, and other bee products for personal consumption and industrial use".

Etxegarai-Legarreta and Sanchez-Famoso (2022) define beekeeping as the process of rearing bees for commercial purpose and primarily obtaining products such as wax, pollen, propolis, and honey. Arguably, most communities keep bees for the purpose of honey, but in the process, other repercussions such as pollination, ecological benefits, and diversification of agricultural practice are attained.

Among livestock activities, apiculture involves distinctive features. Casanelles-Abella & Moretti (2022), attributes these features to the fact that bees move freely and require fewer resources compared to animals such as cattle, pigs, and sheep. Besides, bees are not perceived as exploring flora resources. Instead, they complement it.

Popescu and Popescu (2019) assert that apicultures allow farmers to generate additional income while using the least resources. The concept of bees can be instrumental in agricultural practices. That plays a vital role in mitigating climate repercussions.

The beekeeping position within the agricultural sector is shown on Figure 1. Here, we represent our own interpretation of the beekeeping place in the agriculture hierarchy.

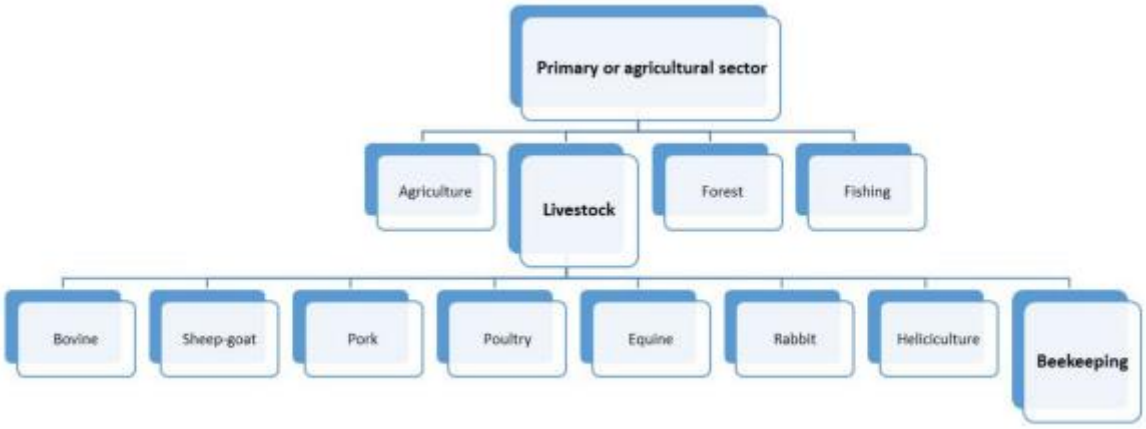

Figure 1: Beekeeping in the agriculture hierarchy

Source: Own interpretation by the author

Pollination of crops

Klein et al. (2006) notes honeybees are the most significant pollination agents in the world because of their

effectiveness and global navigation. Besides, they play a critical role of pollinating in food production.

Aryal et al. (2020) valued the role of pollination performed by wild animals including bees. The outcome indicated that they play a vital role in ensuring the ecosystem balance, primarily by increasing the pollination rate. The process is essential because it improves flora biodiversity, increases the variety of seeds and plants, which provides food to wild animals and lessens repercussions of soil degradation (Toni & Djossa, 2015). Ideally, pollination services led to greater ecological balance and biological diversity enhancing food security. However, regular ecological functioning can be interfered with, particularly if important species like honeybee colonies are significantly alarmed.

Available studies assert that there are several parameters that can affect the essence of honeybees (Toni & Djossa, 2015). Firstly, misuse of plant protection products such as herbicides can lower the population of bees and limit their movement (Pimentel & Burgess, 2013). Secondly, ecological pollution such as water and air can affect the movement of bees and limit their pollination potential. Also, challenges in accessing food resources attributed to monoculture can lower the honeybee population (Pimentel & Burgess, 2013). Lastly, the advancement of innovation in food and animal production has lowered the population of bees in most areas. For instance, greenhouses are closed limiting the honeybee's movement and impacting their population. St. Clair et al. (2022) suggest that proper measures must be developed to increase the bee population and ensure they continue to pollinate crops and maintain the ecosystem health.

Bio indicators of global health and climate change

Most people think that pollination is the only service that bees provide. However, according to Etxegarai-Legarreta and Sanchez-Famoso (2022), superorganisms like beehives are thought to be important sources of agrochemicals for the environment. Hence, they are considered as the most accurate parameters for detecting climate change trends, particularly the disturbance in the ecosystem.

Gordo and Sanz (2006) indicate that bees have unique features. They are universal, whereby they can be positioned in any geographical area and can pollinate both rural and urban areas. They are ideal for collecting water, air, and soil samples attributed to morphological, demeanour, and biological features. Besides, they are highly sensitive to chemical products, and costs are relatively low.

Etxegarai-Legarreta and Sanchez-Famoso (2022) further indicate that products such as wax, honey, and pollen offer valuable information. In this regard, beehives provide an accurate forecast of climate change patterns, forming a basis on which mitigation measures are adopted. Climate change is undeniably one of the primary causes of food insecurity globally. Having proper measures based on accurate information can be pivotal in mitigating climate change and enhancing both food and animal production.

Socioeconomic profitability

Beekeeping is a viable economic activity attributed to several factors. Firstly, it requires fewer initial costs, making it attractive to the younger populace (Allen-Wardell, 1982). Secondly, it involves low maintenance costs and the assumed risk is relatively low. Besides, it requires less space and takes a shorter time before income starts flowing (Altunel & Olmez, 2019). Lastly, it improves the financial security of beekeepers by generating several products including honey and wax.

It is worth noting that bees produce an array of products that fetch a lot of money in the open market. According to Aryal et al, (2020), products include honey, wax, propolis, pollen, royal jelly, and apitoxin. Each of the products performs a core function with the hive. For instance, royal jelly provides a reproduction site, and propolis and apitoxin provide protection. These products offer an array of economic importance due to their nutritional and therapeutic properties.

Khan et al. (2007) indicate that bee products serve as antioxidant, antimicrobial, anaesthetic, healing, stimulant, bactericidal, antiseptic, antitumor and aphrodisiac agents. Recent studies propose that honeybee products have potential benefits in treating obesity, concern, and diabetes (Silveira et al., 2021). However, more clinical trials are required to locate the connection between human consumption and honeybee product benefits. So, honeybees are associated with numerous benefits, providing a source of income to beekeepers.

Honeybee products are used in the medical field to resolve many illnesses and complications. Andrieu et al. (2021) indicate that apitoxin is used in treating severe allergies, particularly those related to stings. During the global pandemic, the essence of honey was emphasised due to its ability to boost immunity, which has antimicrobial and anti-inflammatory abilities, fighting off the COVID-19 repercussions (Yang et al., 2020). Its usage in veterinary medicine is well documented.

The growing demand for raw honey natural products has led to the emergence of key sectors such as the food, cosmetic, and pharmaceutical industries (Wang, 2021). However, it is important to note that honey products such as medicine are contaminated with anthropogenic chemicals from the surroundings. Yang et al. (2020) mention the massive usage of pesticides and poor beehive management are the contamination sources.

Fortunately, nations have developed policies that emphasise organic beekeeping to keep up with the surge in demand for honey products. Arguably, the demand for honey has increased considerably in recent years, meaning that the commodity price has risen (Pippinato et al., 2020). The feat means beekeepers can increase their revenues and attain economic security.

Food production

The study of Etxegarai-Legarreta and Sanchez-Famoso (2022) reviewed bees as products and outlined their importance. Bees can be sold as living material to create new colonies and increase their population. Recently, according to Madras-Majewska et al. (2016), they are leased to enhance pollination services provided by wildlife in flower and fruit farms. As a result, they increase productivity, fruit and flower quality and ultimately increase farm income.

Available studies indicate that honeybees are known to visit 90% of 107 most important crops. In Europe, approximately 84% of crops depend on insect pollination (Madras-Majewska et al., 2016; Chauzat et al., 2013). In other nations such as Spain, the fruits and flower sectors largely depended on insects for pollination. Ideally, most horticulture crops depend on honeybees for pollination increasing food production.

Other studies assert that honeybees (both in the adult and larvae stage) are projected to future food sources. According to Ghosh et al. (2016), in Africa, tropical Africa and Australia, insects are considered as a source of food. The concept is not embraced in Europe and the Western world. However, the economic advantage related to insects including lower consumption and less production of greenhouse gases are changing the trend. For instance, in Europe, insects are currently considered novel insects (Etxegarai-Legarreta & Sanchez-Famoso, 2022). Even though insect as food is facing a barrier in the West, the notion is gradually changing. Honeybees in this context are the third domesticated animals and they are reared on both large and small scales (Gutiérrez Urcola, 2023). Defoliart (1995) indicates that honey can be compared to dairy animal production where cattles are kept for milk and meat. Therefore, honeybees can be used as future food. It is low cost and provides an ideal source of food.

Human nutrition

One of the key pillars of food security is utilisation, which emphasises safety and nutritional content of food. Beekeeping provides humans with food that contains a large portion of nutrients the human body requires (Waykar & Alqadhi, 2016). Therefore, apiculture can assist communities to attain one of the key pillars of good security.

Honey is one of the byproducts, containing high levels of calories, vitamins A, B and C, mineral salts, and sugars. According to Waykar and Alqadhi (2016), one kg of honey contains more than 3350 calories. The presence of three vitamins and mineral salts provides humans with key fundamental nutritional requirements.

The other by-product is pollen. One hive is believed to produce 60 gm per day (Waykar & Alqadhi, 2016). The chemical properties of pollen vary depending on the kind of flowers. Waykar and Alqadhi (2016) indicate that pollen contains carbohydrates, proteins, magnesium fats, minerals, amino acids, potassium, calcium, phosphorous, iron, enzymes, and vitamins. Pollen contains vital amino acids required for human growth.

Available studies indicate that pollen has several benefits when ingested in the human body. According to Munstedt and Franke (2005), in developed nations, pollen is converted to grains, powder, and capsules and used as protein supplements. Elist (2006), states that when ingested in the human body, it increases the effectiveness of chemotherapy for patients suffering from various types of cancers. Besides, it has proved to be effective in the treatment of anaemia. It eliminates constipation and associated problems. The work of Waykar and Alqadhi (2016) asserts that pollen plays a crucial role in rebalancing the body system since it serves as a detoxifier. Ideally, apart from providing a source of food, pollen has several benefits for the human body, improving the overall health (Abdelnour et al., 2019).

Royal jelly and propolis are the others that honeybees produce. According to Waykar and Alqadhi (2016), they constitute 18% of proteins and amino acids (including 8 essential ones); 10-17% of vitamins E, B1, B2, B3, B6, B7, PP; sugar; 5.5% of fat; 2-3% of minerals. Also, they contain hormones such as testosterone and antibiotics. They are rich in nucleic acids such as DNA and RNA.

When ingested in human beings, bee products perform useful functions: anti-inflammatory, cell growth, bone metabolism, hormonal balancing. Propolis contains more than 300 compounds such as ketones, vitamins,

flavonoids, phenolic acids, and inorganic substances. Hartwich et al. (2000) argue ingesting propolis assists in healing wounds and treating respiration illnesses.

Therefore, beekeeping provides several products that have high nutrition content, improving human beings' dietary patterns.

DISCUSSION

The ecological systems theory illuminates interconnected environmental systems influencing an individual's development (Darling, 2007). To be precise, it provides a framework for gaining an in-depth understanding of the beekeeping industry and its repercussions on the environment and society at large.

Patel et al. (2020) assert that beekeeping plays a pivotal role in improving food security as well as sustainable development primarily through its contribution to pollination services and biodiversity. Aryal et al. (2020) valued the role of pollination performed by wild animals (including bees). The findings indicated that they play a critical role in ensuring the ecosystem balance, primarily by increasing the pollination rate.

The pollination process contributes to ecological balance and diversity. It necessitates the formation of better plant varieties and seeds. Besides, according to Toni and Djossa (2015), it improves flora biodiversity and increases the variety of seeds and plants. That eventually provides food to wild animals and lessens soil degradation.

Bee-keeping intersects with ecosystem results in the formation of public goods (Vrabcová & Hájek, 2020). One of public goods features is their non-excludable character. That means if the product is offered to one individual, it is offered to others. For instance, pollination created a landscape full of diversity, which is a good available to everyone and the consumption by one individual does not exclude others from using it.

The ecological system theory further indicates that normal ecosystem functioning can be disturbed, especially when the populations of main species like honeybees are alerted. Toni and Djossa (2015) state that several parameters can affect the essence of honeybees.

Firstly, the misuse of plant protection products such as herbicides can plummet the population of bees and limit their movement (Pimentel & Burgess, 2013). Secondly, ecological pollution of water and air can affect the movement of bees and limit their pollination potential (Pocol et al., 2021). Also, challenges in accessing food resources attributed to monoculture can lower honeybee populations (Pimentel & Burgess, 2013). The ecological systems theory offers a model for understanding the intricate relationship with the honeybee sector and its repercussions on food security (Patel, 2020). Honey beekeeping enhances food security by increasing pollination rate, eventually improving food production. Also, it increased biodiversity by improving the quality of plants and seeds.

The interconnection between beekeeping and public health is evident in the potential consequences of diminishing honeybee populations. Bees play a pivotal role in pollination, directly impacting agricultural productivity and food security. The decline in beekeeping not only threatens the nutritional diversity derived from bee products but also poses risks to the availability and affordability of a crop variety. The nutritional richness of bee products emphasises their importance in dietary patterns, linking beekeeping to public health outcomes.

Moreover, the environmental health implications of this crisis are substantial. Beekeeping practices often involve the use of pesticides, contributing to environmental degradation and potentially affecting ecosystems beyond the immediate apiary. The loss of honeybee colonies further disrupts the delicate balance of ecosystems, impacting biodiversity, soil health and public health.

RECOMMENDATIONS

To address the underutilisation of beekeeping and the alarming loss of honeybee colonies outlined in this conceptual article, several recommendations and solutions are proposed.

Educational campaigns

Develop and implement educational campaigns targeting beekeepers, farmers, and the public. Create awareness regarding the crucial role of bees in food production and the potential consequences of neglecting apiculture. Emphasise the nutritional and economic benefits of bee products.

Training programs

Establish comprehensive training programs for beekeepers, focusing on sustainable practices, disease management, and colony preservation. Encourage the adoption of modern beekeeping techniques to improve productivity while minimising environmental impact.

Research and innovation

Invest in research to identify the causes of colony losses and develop innovative solutions. Support research initiatives that explore new technologies, breeding practices, and hive management strategies to enhance the resilience of honeybee colonies.

Policy support

Advocate for policies that incentivise sustainable beekeeping practices. This may include financial support, tax incentives, or regulatory measures that promote the well-being of bee colonies and the expansion of beekeeping operations.

Collaborative initiatives

Foster collaboration among beekeepers, researchers, policymakers, and agricultural stakeholders. Establish platforms for knowledge exchange, dialogue, and sharing of the best practices to create a cohesive and supportive beekeeping community.

Community engagement

Engage local communities in beekeeping initiatives by highlighting the economic and environmental benefits. Encourage community participation in hive management, bee-friendly gardening, and the creation of pollinator-friendly spaces.

Integration with agricultural practices

Integrate beekeeping into broader agricultural systems, promoting its symbiotic relationship with crop production. Demonstrate the positive impact of bees on crop yields and the overall health of ecosystems.

Monitoring and reporting

Implement a robust system for monitoring and reporting colony health. Develop standardised protocols for beekeepers to track colony conditions, share data, and contribute to a nationwide database that can inform research and policy decisions.

By implementing these recommendations, stakeholders can collectively contribute to the revitalisation of beekeeping practices, ensuring the sustainability of honeybee colonies and, consequently, enhancing global food security. This conceptual article serves as a catalyst for action, urging a re-evaluation of current strategies and a commitment to fostering a thriving apicultural industry.

RECOMMENDATIONS FOR FUTURE RESEARCH

Below, there are some potential study approaches that can build on the recommendations and ideas developed in this paper.

Grounded theory

Utilise grounded theory to establish the insights and capabilities of beekeepers, farmers, and the public as to beekeeping. Conduct in-depth interviews and observations to generate concepts and theories that emerge from the data, allowing for a comprehensive understanding of the factors that influence beekeeping practices and colony losses.

Action research

Implement action research to collaboratively address the underutilisation of beekeeping. Engage beekeepers, farmers, and the community in the design and implementation of educational campaigns, training programs, and policy advocacy. Use the iterative process of action research to assess the effectiveness of interventions and refine strategies based on real-time feedback.

Narrative inquiry

Apply narrative inquiry to collect and analyse personal stories related to beekeeping. Gather narratives from beekeepers, researchers, and community members to understand the cultural, social, and economic dimensions of beekeeping. Analyse the stories to identify common themes, challenges, and opportunities, contributing to a rich narrative understanding of the beekeeping landscape.

Ethnography

Conduct ethnographic research to immerse researchers in the beekeeping community. Observe beekeeping practices, rituals, and interactions within the community. Document the social dynamics, knowledge-sharing mechanisms, and cultural influences on beekeeping. This approach provides an in-depth understanding of the context in which beekeeping operates.

Interpretative phenomenological analysis (IPA)

Use IPA to evaluate the subjective experiences and perspectives of individuals involved in apiculture. Conduct in-depth interviews with beekeepers, farmers, and stakeholders to uncover their lived experiences. Analyse the data to identify shared themes and patterns, providing insights into the psychological and

emotional aspects of beekeeping practices.

Mixed-method approaches

Combine qualitative and quantitative methods to triangulate research results, offering a comprehensive understanding of the multifaceted issues in beekeeping.

Longitudinal studies

Conduct longitudinal studies to track the impact of educational campaigns, training programs, and policy changes over time, allowing for a nuanced understanding of their effectiveness.

Comparative analysis

Compare beekeeping practices and outcomes across different regions or communities to identify contextual factors influencing success and challenges.

By employing these research approaches, scholars can contribute nuanced insights into the complex dynamics of beekeeping, informing the design and implementation of effective interventions. This research can play a critical role in guiding evidence-based practices, policy formulation, and community engagement efforts to revitalise beekeeping practices and enhance global food security.

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