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BUSINESS MODEL OF A SPECIALIZED BEE-COLONY TRANSPORT SERVICE (USA)

Summary. *This article is dedicated to the economic analysis of mobile bee-colony transport services in the United States. The relevance of the topic is determined by intensive agriculture's heavy dependence on entomophilous pollination and rising hive-rental rates. The study's novelty lies in synthesizing heterogeneous statistical sources from 2006–2024 and constructing an integrated model of the industry's revenues, costs, and risks. The paper describes market volumes, the logistical routes for moving two million colonies, and price dynamics, and also examines demand factors, including the concentration of pollination fees in the almond sector. Special attention is paid to sustainability threats – above all, mass colony losses and the reduction of nut-orchard acreage. The aim of this analysis is to assess the economic efficiency of the business model under consideration and to develop directions for enhancing its resilience. To achieve these goals, the study employs comparative methods, econometric modeling, content analysis of regulatory and media materials, and graphical trend visualization. Government reports from USDA, industry reviews in Bee Culture, IBIS World, Choices Magazine, publications by KCRW, EarthDate, SARE, and practical beekeeping guides were examined. The conclusion proposes measures to reduce biological and market risks. This article will be useful to beekeepers, agronomists, agricultural economists, logistics specialists, policymakers, and practitioners.*

Key words: *pollination, mobile beekeeping, almonds, business model, transport rates, hive logistics, honey bees, economic efficiency, risks, sustainability.*

Introduction. The U.S. agro-industrial sector depends heavily on honey-bee pollination, especially for the commercial cultivation of fruit, berry, and nut crops. The relevance of studying the business model of such specialized logistics companies is determined by the growing demand for pollination services amid expanding entomophilous crop acreage (primarily almonds in California) and simultaneous challenges in beekeeping — from colony collapse to rising apiary maintenance costs.

The aim of the present study is a comprehensive analysis of the business model of a specialized bee-colony transport service in the USA.

The research tasks include:

1. quantitative assessment of the industry's economic indicators over recent years;
2. identification of trends in demand for pollination services and transport rates;
3. analysis of the typical logistical scheme for moving bee colonies;
4. examination of the risks and constraints faced by this business sector.

Methods and Materials. T.M. Adjero [1] presented an apiary business plan, the data of which made it possible to assess the cost structure. D.J. Bond [2] collected USDA statistics on pollination payments, which were used to construct revenue dynamics. Source [3] provided a description of the economic relationships between beekeepers and farmers; that information served in formulating the logistical schemes. B.K. Goodrich [4] published a study of field contracts that underpinned the tariff analysis. B. Goodrich, M. Fenton, and D. Penn [5] presented the 2022 forecast, used to evaluate the current state of the almond sector. E. Maeder, M. Spivak, and E. Evans [6] described the cost–benefit ratio of pollination, data applied when calculating profitability. H. Posada [7] prepared an industry report that became the source of long-term market trends. E. Shatkin and A. Domanik [8] collected interviews with market participants; those insights were included in the risks section. A comparative analysis, econometric-statistical modeling, graphical trend visualization, and content analysis of regulatory documents were applied.

Results. Pollination using migratory apiaries has grown into a substantial agricultural service industry in the United States. The total market for pollination services is estimated at hundreds of millions of dollars per year. According to USDA data, U.S. growers paid approximately $320 million for commercial pollination in 2017 [2]. By comparison, the gross value of honey produced in the same period was about $330 million

annually [2]. Thus, pollination now rivals — and even surpasses — traditional beekeeping (honey production) in its share of beekeepers' income [4]. The principal driver of the pollination market is California's almond industry, which is entirely dependent on bee pollinators and each year requires the mobilization of vast numbers of colonies (Figure 1).

It is estimated that up to 2.1 million bee colonies are transported into California from across the country during the almond bloom in February [5]. In 2017 alone, California almond growers accounted for approximately 80 percent of all pollination service payments in the United States [2]. In effect, the almond industry has become the nucleus of the mobile pollination market [8]. The cost of bee pollination services in the U.S. has shown a sustained upward trend over the past two decades, particularly in the almond sector (Figure 2).

For many commercial beekeepers, rental income from hive leases for pollination now exceeds revenue from honey sales. In California, there has been a complete reversal in apiary revenue structures: whereas pollination once accounted for only one‑third of income (with the balance coming from honey), today as much as two‑thirds of profits derive from leasing colonies to farmers. This shift in business model is driven both by high pollination fees and by stagnation in the honey market [8]. According to IBISWorld, the U.S. beekeeping market (including pollination services) is projected to reach approximately USD720 million by 2024, yet industry growth rates remain low [7]. This underscores that the expansion of the pollination segment occurs against a backdrop of broader economic challenges in apiculture.

The organization of specialized live-colony transport services is a highly complex logistical operation, akin to managing a movable "livestock" resource. Commercial apiarists who lease hives practise migratory beekeeping along a strictly timed route that follows the bloom of major nectar crops [3]. For example, by February a large proportion of the nation's hives are concentrated in Central California for almond pollination; in spring they move northwest to apple and cherry orchards; in June to Maine's blueberry fields and Florida's citrus groves; and in summer they "rest" during clover and sunflower flows in the Dakotas [3]. Transporting millions of live bees requires extreme specialization: hives are loaded onto truck platforms at night, when the bees are least active, and moved only during the cooler hours to prevent overheating. Extended stops are virtually eliminated, since sealed trailers without ventilation can cause bees to suffocate [8]. A standard freight trailer holds about 400 hives [6], each secured and covered with mesh. Thus, a large‑scale beekeeper managing several thousand colonies must mobilize an entire fleet for each relocation. Some apiary owners invest in their own trucks and trailers, while others contract specialized carriers experienced in live-bee transport. Recently, pollination brokers have appeared to facilitate contracts between growers and beekeepers and to coordinate hive placement. Surveys of almond growers indicate that over half prefer to diversify their hive sources by engaging multiple apiarists and working through brokers simultaneously [4]. Pollination service agreements have become quite formalized, specifying delivery dates, minimum colony strength (number of fully staffed frames per hive), liability for pesticide losses, hive theft, and force-majeure contingencies.

The economic efficiency of the mobile pollination model remains a subject of debate, as high revenues are offset by significant costs. Direct operating expenses for commercial apiaries include hive transport (fuel,

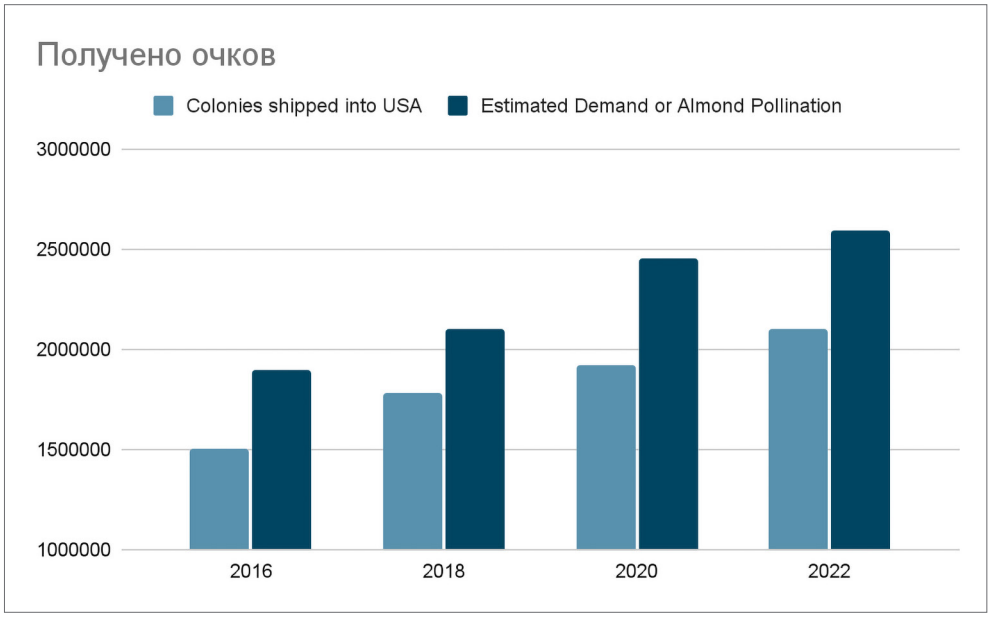

Fig. 1. Estimated demand for colonies and colony shipments to California, 2015–2022
Source: compiled by the author based on [5]

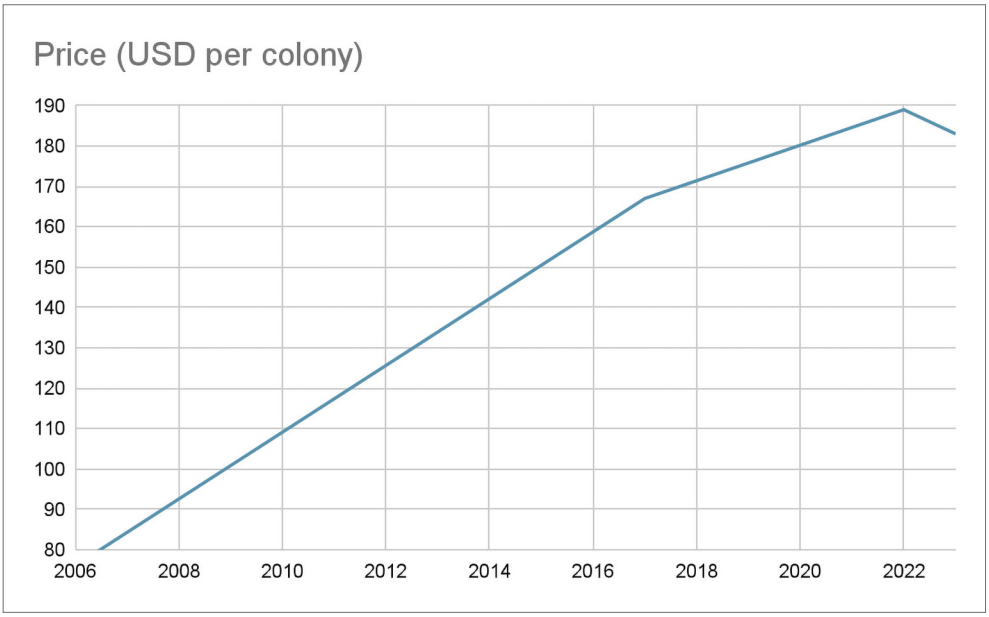

Fig. 2. Exponential increase in service cost over the last two decades
Source: compiled by the author based on [2; 5; 7]

equipment depreciation, driver wages), labour for loading and unloading, purchase of sugar and syrup for feeding bees during dearth periods, and expenses for maintaining colony health (Varroa mite prevention, disease treatment). Experts estimate that hive transport and the accompanying logistics are among the most labour-intensive and costly aspects of modern beekeeping [3]. For example, many commercial apiarists face declining honey production, rising feeding costs, and poor bee nutrition — all of which undermine colony population and vigor, critical factors for almond pollination (see Table 1).

Thus, the specialized business of transporting honey-bee colonies is characterized by high operating costs and risks that partly offset the gains from rising pollination fees.

Discussion. The analysis demonstrates that the mobile pollination business model in the United States emerged in direct response to the needs of intensive agriculture and stands out as a prime example of successfully commercializing an ecosystem service. On one hand, specialist firms and beekeeping operations that transport hives reap substantial revenue — pollination has overtaken honey production as their principal income source. On the other hand, this model reveals significant vulnerabilities and dependencies on external factors. Critically, the industry leans heavily on a single crop — almonds in California — so much so that roughly one third of all U.S. beekeepers' earnings derive from that one-month bloom period.

Such concentration introduces elevated risk. Early signs of market saturation are already visible: acreage devoted to almonds has begun to decline after years of expansion, driven by water restrictions and depressed nut prices. Should this contraction continue, demand for pollination services may fall, jeopardizing many beekeepers' livelihoods. An even more severe threat is the degradation of the resource base itself — the honey bees. Recent years have seen catastrophic colony losses, with over half of all hives succumbing annually to disease, pests, and other stressors, calling into question the long-term sustainability of the model. Beekeepers now must devote a large share of their revenues each year to raising replacement queens and nucleus colonies. According to industry experts, winter losses in 2023 were so extreme that some almond orchards entered spring 2024 unable to secure the full complement of hives they had contracted.

If the negative trends — bee health declines, pesticide impacts, climate shifts — persist, the mobile polli-

Table 1

Comparison of percentage of drought-prone acreage in the Northern Plains Climate Center, by week in July 2012 and 2021 [5]

Week	No Drought	Abnormally Dry or Worse	Moderate Drought or Worse	Severe Drought or Worse	Extreme Drought or Worse	Exceptional Drought
July 27, 2021	15%	85%	76%	59%	32%	6%
July 31, 2012	9%	91%	72%	59%	30%	1%

nation sector could face a shortage of healthy colonies. That in turn would drive up operating costs and service fees further or even force contract defaults. Nevertheless, the industry is taking steps to build resilience. Contractual arrangements with fixed terms have become widespread, guaranteeing beekeepers a defined income and partial risk coverage. Large agribusinesses now routinely engage multiple hive suppliers to diversify their exposure. Meanwhile, the rise of brokers and online pollination marketplaces is adding transparency and simplifying the matching of growers and beekeepers.

Government agencies and the scientific community are also backing the industry. The U.S. Department of Agriculture funds research programs on bee health and colony monitoring, while breeding efforts aim to develop pest-resistant stock and mitigate pesticide harm. In California, breeders have introduced self-fertile almond varieties (such as 'Independence') that, in theory, require fewer hives per acre. Field trials, however, show that even these self-pollinating cultivars deliver higher yields when serviced by honey bees. Farmers who forgo hive rentals effectively "borrow" pollinators from neighboring orchards, leading to suboptimal pollination overall.

Accordingly, demand for bee-pollination services is likely to remain strong even as self-fertile crops gain traction. From both a scientific and practical standpoint, this business model offers a rare case of a market mechanism executing an ecosystem function — plant pollination — by integrating it seamlessly into agricultural supply chains. Such specialized hive-transport services bolster food security and enhance the sector's economic efficiency. At the same time, they highlight the critical need for careful stewardship of the pollinators themselves and coordinated efforts among farmers, beekeepers, and public authorities to preserve honey-bee populations.

Conclusion. Specialized hive transporters have turned beekeeping into a highly lucrative sector: in 2017 growers paid roughly $320 million for pollination services, surpassing the revenues from honey sales. That income now comes largely from the California almond industry, which accounts for payments to beekeepers and represents about one-third of their total earnings. A well-developed network of interregional routes, standardized service contracts, and a dedicated fleet of trucks enables the rapid relocation of some 2 million colonies between farms across the country.

Yet the model's economic resilience is undermined by its narrow crop focus and ongoing biological losses. Adaptation measures — breeding disease-resistant bee strains, ramping up veterinary oversight, minimising transport stress, expanding insurance coverage, and tightening pesticide controls — are essential to sustain pollination efficiency and secure the agricultural sector's return on this critical ecosystem service.

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