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The Journey of America's Honeybees: Migratory Beekeeping, Almond Pollination and Colony Health

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Migratory beekeeping is an important component of modern agriculture, providing managed honeybee colonies for crop pollination and supporting agricultural productivity and food security. In the United States, nearly two million honeybee colonies are transported annually to California for almond pollination, demonstrating the enormous scale and economic importance of this practice. This article explores the development, management and challenges of commercial migratory beekeeping, with particular emphasis on the long-distance transportation of *Apis mellifera* colonies across different agricultural landscapes. Although migratory beekeeping generates income through honey production and pollination services, it exposes honeybee colonies to several stress factors, including transportation stress, overcrowding, pesticide exposure, nutritional deficiencies and the spread of pests and pathogens, particularly *Varroa destructor*. These factors can adversely affect colony strength, worker longevity and overall survival. The article also discusses possible approaches to improving colony health through better transportation management, diversified floral resources, effective disease monitoring, integrated mite management and improved coordination between beekeepers and farmers. Furthermore, the American experience is examined in the context of Indian migratory beekeeping, highlighting opportunities under the National Beekeeping and Honey Mission (NBHM). Adopting sustainable and bee-friendly management practices can strengthen pollination services, improve beekeeper livelihoods and contribute to agricultural sustainability and biodiversity conservation.

Keywords: migratory beekeeping, honeybee, *Apis mellifera*, almond pollination, *Varroa destructor*, colony losses, pollination services

Introduction

Every day, the food we eat depends partly on the unseen work of insect pollinators. From mustard oil and apples to tomatoes and coffee, many agricultural products rely on insects visiting flowers for pollination. According to Klein *et al*. (2007), approximately 75% of leading food crops benefit from animal pollination, while around 35% of global crop production by volume depends on it. Pollinators also play an essential role in maintaining nutritional security by supporting the production of fruits, vegetables, nuts and other foods rich in vitamins, minerals and healthy oils (IPBES, 2016). Among these pollinators, honeybees hold a particularly important position because their colonies can be managed, multiplied and transported according to crop requirements. This has led to the development of migratory beekeeping, a practice in which beekeepers transport honeybee colonies over long distances to follow successive flowering seasons and provide pollination services to agricultural crops. In the United States, this practice has developed on a large commercial scale, with thousands of colonies transported to California every year for almond pollination, one of the world's largest managed pollination events.

Although migratory beekeeping provides economic opportunities for beekeepers and improves crop pollination, it also creates several challenges for honeybee colonies. Long-distance transportation, overcrowding, pesticide exposure and dependence on large monoculture crops can affect bee health and colony survival. These challenges highlight the need for sustainable and bee-friendly migratory beekeeping practices. The experiences of American commercial beekeepers also offer valuable lessons for India, where migratory beekeeping is gaining importance under initiatives such as the National Beekeeping and Honey Mission (NBHM). Understanding the benefits, challenges and management of migratory honeybee colonies is therefore essential for strengthening sustainable agriculture, biodiversity conservation and food security.

The Convoy That Arrives at Midnight

Imagine a cold night in late January in California's Central Valley. A line of tractor-trailers waits beside an almond orchard, engines humming. Under the headlights, forklift drivers lift wooden hives, four to a pallet and set them down between rows of bare trees. Each box holds tens of thousands of sleeping bees. They have travelled for days from Idaho, the Dakotas, Texas or Florida and they have no idea where they are. By morning the sun will warm the orchard, the first pink-white blossoms will open and the bees will go to work. The scale is hard to picture. Within weeks, around two million colonies, carrying perhaps a hundred billion bees, will be spread across more than a million acres of almond trees. Truck drivers plan fuel stops around the weather. Beekeepers sleep in their cabs. Orchards that were silent yesterday are suddenly loud with wings. This is migratory beekeeping in action. Most of us never see it, but we eat the results every day.

If the Bees Can't Come to the Flowers…

A Bloom Too Big for Local Bees

Crops don't bloom to suit the bees nearby. Many flower for only two or three weeks, across thousands of hectares, in landscapes where wild pollinators have lost much of their habitat to roads, houses and endless fields of a single crop. A farmer cannot wait for nature to catch up. The beekeeper's answer is simple: if the bees can't come to the flowers, bring the bees to the flowers. The numbers behind this are striking. One healthy colony can hold 20,000 to 60,000 worker bees at the height of the season and during peak bloom the foragers of a single hive may visit millions of flowers in a day. Wild pollinators alone could rarely match that in numbers over such a large area.

The Almond Rush

Almonds are the most extreme case. California produces roughly 80% of the world's almonds and the industry estimates that the bloom needs about two million honeybee colonies (Almond Board of California, n.d.). That is more than half of all managed colonies in the country (USDA NASS, 2023). Each February, hives from almost every state converge on one valley. For beekeepers, the almond bloom is the biggest event of the year, part harvest, part reunion, part survival test. For many, the income from these few weeks decides whether the whole year is profitable.

A Year on Wheels

A migratory beekeeper's calendar reads like a travel itinerary:

Season	Where the Bees Go	What They Do There
Winter	Florida, Texas, or indoor storage	Rest and rebuild strength
Feb–Mar	California Central Valley	Almond pollination
Apr–May	Pacific Northwest	Apples, cherries, pears
Late spring	Maine, Michigan, New Jersey	Blueberries, cranberries
Summer	North and South Dakota, Minnesota	Clover and canola honey flows
Autumn	Back south	Build up for winter

Each stop has its own rhythm, price and risks. A late frost in the orchards, a drought on the prairies, or a highway accident can turn a good year into a bad one overnight.

An Ancient Habit with a Modern Engine

Bees have been moved for thousands of years. Eva Crane (1999), the great historian of beekeeping, describes how ancient Egyptians loaded hives onto boats and floated them down the Nile, following the flowering season as the river rose and fell. Egyptian temple reliefs more than 4,000 years old show beekeepers at work, which suggests that the partnership between humans and honeybees is older than most written records. In America the story begins with a surprise: honeybees are not native there. European settlers brought them in the early 1600s and they spread so widely that many people assume they have always been part of the landscape. Migratory beekeeping grew with the railways and then boomed with 20th-century trucking. What was once a slow, seasonal drift becoming a precise logistics business. Modern operations use GPS, weather forecasts and pollination contracts signed months in advance. A single semi-trailer can carry several hundred hives, each one a small, humming city on wheels.

Loading Night: The Art of Moving a Million Stingers

Moving bees is easy to explain and hard to do well.

1. **Wait for dark.** By night almost all foragers are back inside, so nobody is left behind. Load at midday and many workers are still out in the field and they return to find their home gone.
2. **Close the doors.** Hive entrances are sealed with screens or nets so that air keeps flowing but bees stay in.
3. **Keep the bees cool.** A crowded colony makes its own heat and a parked truck can turn into an oven within hours. Drivers keep moving whenever possible and some mist the load with water in hot weather.
4. **Stack, strap and drive.** Forklifts load the pallets and netting is stretched over the whole load. A single trailer may carry several hundred colonies and weigh well over 10 tonnes.
5. **Pass the check.** California inspects arriving hives for pests such as the red imported fire ant (California Department of Food and Agriculture, n.d.).

Then comes the part no checklist covers: long hours, short sleep, roadside meals and a living cargo that can sting.

Meet the People Who Live by the Bees

In *The Beekeeper's Lament*, journalist Hannah Nordhaus (2011) follows North Dakota beekeeper John Miller, who comes from a family of migratory beekeepers. She shows a life arranged entirely around the bees: long drives, constant worry about winter losses and a stubborn devotion to the work. Money is part of the story too. Almond pollination fees have ranged from roughly $150 to more than $200 per colony, depending on the year and for many commercial beekeepers this income matters more than honey sales. Honey prices swing with imports and market competition, while pollination contracts can be planned around. A box of bees is valuable enough that hive thefts during almond season have made national news.

It is a hard, unglamorous life and for those who love it, the only life they want.

When the Road Takes Its Toll

The bees pay for this travelling life and researchers have started to measure the cost.

Tired Travellers

In a study published in *Scientific Reports*, migratory management and environmental conditions affected the lifespan and oxidative stress of honeybee workers (Finstrom *et al.*, 2016). In plain words, constant moving wears bees out. Shorter-lived workers mean the colony must raise replacements faster, using energy it would otherwise spend on foraging.

A Crowded Waiting Room for Diseases

When hundreds of thousands of colonies gather in one place, mites and germs mix easily. Bees drift between hives, rob weak colonies and share flowers. Alger *et al.* (2019) found that migratory beekeeping influenced pest and pathogen loads and colony size. The *Varroa* mite, a tiny reddish-brown parasite that feeds on bees and spreads deadly viruses, remains the greatest

problem for beekeepers everywhere (Traynor *et al*., 2020). Left untreated, an infested colony usually dies within a few years.

A Chemical Cocktail

Orchards may be treated with insecticides and fungicides. Pettis *et al.* (2013) found that pollen collected from pollinated crops carried several agrochemicals and that exposure made bees more vulnerable to the gut parasite *Nosema ceranae*. Another study found a wide range of pesticide residues inside migratory hives (Traynor *et al*., 2016). No single chemical may be lethal on its own, but combinations can quietly weaken a colony over weeks.

A One-Dish Dinner

A blooming orchard is a feast, but it is also a monoculture. For a few weeks the bees eat almost nothing but almond nectar and pollen. Once the bloom ends, the landscape may offer little to eat for hundreds of kilometres, so beekeepers feed sugar syrup and protein patties to keep colonies going. Bees, like people, do better on variety and pollen from many different flowers gives them a wider range of nutrients.

Trouble for the Neighbours

Mallinger *et al*. (2017) found that managed honeybees can sometimes compete with wild bees for food or pass diseases to them, although the effects vary by region and species. Trucked-in honeybees cannot replace healthy wild pollinator habitat. Bumblebees, mason bees, leafcutter bees and hundreds of other native species do important work and they need flowers and nesting places all season long, not just during a two-week bloom.

A Race Against Loss

In 2006–07, beekeepers in the U.S. reported colonies disappearing in alarming numbers. Hives were found full of honey and young bees but empty of adults, as though the workers had simply vanished. The mystery was named Colony Collapse Disorder (vanEngelsdorp *et al*., 2009) and it made headlines around the world. Scientists tested many theories before concluding that there was no single cause. A combination of varroa mites, viruses, pesticides, poor nutrition and the stress of constant management had pushed colonies over the edge together. The acute CCD crisis faded after a few years, but heavy losses did not go away. Surveys by the Bee Informed Partnership have often shown yearly losses near or above 40% and industry reports for 2024–25 described especially severe losses among commercial beekeepers. Losses of around 15–20% are generally considered economically sustainable. Beekeepers cope by splitting healthy colonies and raising new queens every year. It works, but it is expensive and exhausting, like rebuilding a house every spring.

Can the Journey Be Made Kinder?

There is reason for hope and change is already happening:

- **Self-fertile almond varieties**, such as 'Independence', need far fewer bees per acre. If more orchards plant them, the demand for travelling hives will ease.
- **Climate-controlled winter storage**, in cool warehouses in Idaho and the Pacific Northwest, lets colonies rest through winter instead of being trucked south. Bees stored this way are often stronger in spring.
- **Flowering cover crops and field margins**, such as mustard, clover and wildflowers planted between orchard rows, can feed bees before and after the main bloom.
- **Better research on mite control, nutrition and bee breeding** steadily improves colony health, and some varroa-resistant lines show promise.
- **Better communication between beekeepers and farmers** about spray timing and drift can sharply reduce pesticide exposure.

What This Means for India: Our Own Travelling Hives

Indian beekeepers also follow the flowers and the tradition is older than many realise. Colonies of *Apis mellifera* (the European honeybee, introduced to India in the 1960s) and *Apis cerana* (the native Asiatic hive bee) are moved between states to catch mustard bloom in Rajasthan, Punjab and Haryana, sunflower in Karnataka, eucalyptus in the south and litchi in Bihar and

Uttarakhand. The economics mirror the American story. Pollination by bees is known to raise the yield and quality of crops such as mustard, sunflower, apple, and litchi, and beekeepers who move hives can earn from both honey and pollination services. The National Beekeeping and Honey Mission (NBHM), launched in 2020 as part of the "Sweet Revolution," supports this growing sector with training, infrastructure and market linkages (National Bee Board, n.d.). The American experience offers practical lessons for India:

- **Plan the route** so bees always have something to forage on, and avoid long stretches of bare monoculture.
- **Treat mites and diseases before moving**, not after. *Varroa* and *Tropilaelaps* mites are real threats in Indian apiaries too.
- **Talk to farmers** about spray schedules so pesticides are not applied during bloom. A single careless spray can wipe out visiting colonies.
- **Value pollination as a service**, not just honey as a product. Farmers are learning that paying for pollination is money well spent.
- **Protect native and wild bees** alongside managed colonies. India's native *Apis* species and many non-*Apis* pollinators do essential work in crops and wild plants.
- **Guard against pests that travel with hives.** Moving colonies can spread mites and diseases quickly, so inspection and quarantine matter.

The Next Time You Crack an Almond

Behind a single almond are weeks of preparation, thousands of kilometres of driving and a beekeeper who has probably not slept much. The bees simply do what they have always done: visit flowers. Migratory beekeeping is a partnership between people and insects and one of the quiet reasons our food system works. It is also fragile. It depends on healthy bees, fair prices, and landscapes with enough flowers to go around. When any one of those weakens, the whole journey is at risk. Perhaps that is the real lesson of the travelling hives: our food is never as simple as it looks on the shelf. It is carried there, petal by petal and kilometre by kilometre, by insects that ask for nothing except flowers and by people who ask for nothing except a fair chance to keep working with them.

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