

A NEW BUZZ

Like many countries, India is in the middle of a pollinator crisis. In several states, farmers now rent honeybees to secure a decent harvest. In areas where agriculture is nearly impossible due to shortage of natural pollinators, people are manually carrying out nature's most critical operation. This artificial substitution of pollinators raises new concerns. A report by

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A BONE-CHILLING COLD has settled over the Himalayan district of Mandi, even as March is drawing to a close. But it does little to deter Gopal Singh, now nearing 70, from venturing outside. Accompanied by his grandson, Singh drives towards the biggest market in Janjehli valley in the stillness of the wee hours. Waiting for him at the bazaar is Bunty Chauhan with almost 50 boxes, each measuring half a metre on each side. Singh quickly inspects the boxes and asks Chauhan to place two of them in his car's boot space. "The supply is limited and I am running out of time," Singh tells *Down To Earth* (DTE), as he drives off to his apple orchard, located some five kilometres away in his village Shihal. "These boxes contain 10,000 to 20,000 honeybees, which are in demand by apple growers in Janjehli and other parts of Himachal Pradesh," says Chauhan, as he hands over the remaining boxes to those queued up at his shop that originally is a hardware store.

Perched at an altitude of 2,150 metres, Janjehli valley is known for its tranquil landscape and sprawling apple orchards. By the end of March, flower buds in most orchards in the valley have attained a delicate pink hue and are nearing blooming stage. "The mature ones will bloom within a week and will need to be pollinated over the next three to five days before the petals start dropping," says Singh, who has placed the hive boxes at strategic locations in his orchard. Just till four to five years ago, he recalls, wild bees and butterflies used to buzz around the orchards in the valley. But then suddenly their numbers declined. Now, it is difficult to spot even a single pollinating insect around the trees. "We will lose an entire year's harvest if we fail to ensure pollination during this crucial flowering stage," says Singh.

The situation is no different in other parts of Himachal Pradesh. While Bunty Chauhan claims to be supplying 300 boxes to apple growers in Janjehli alone, Ram Lal

Chauhan, an apple grower from Shimla district, says over 400,000 hive boxes are rented annually across the state. In fact, one of the objectives of the "development of beekeeping" scheme run by the state horticulture department is to help farmers with pollination to improve crop productivity. "The pollination crisis has deepened to such an extent that there is hardly any apple farmer in Himachal Pradesh who does not rent bees for pollination."

A SILENT CRISIS

Pollinators, in a way, are the guardians of our ecosystems. They sustain life by ensuring food security and maintain biodiversity. Flowering plants, which are a primary source of food for humans and animals, typically reproduce by delivering pollen to each other to fertilise seeds. While some, like corn, cast their pollen to the wind, most others depend on pollinators—20,000 species of wild bees and many species of butterflies, moths, wasps, beetles, birds and bats—to do the job. The UN's Food and Agriculture Organization (FAO) says about a third of global food crops rely on these pollinators for their yields. Bees alone, both wild and domesticated, pollinate 85 per cent of all cultivated crops and a significant portion of the wild flowering plants globally, estimates a study, "Worldwide occurrence records suggest a global decline in bee species richness", published in *One Earth* in 2021.

Many cereal crops such as wheat, rice and maize are primarily wind-pollinated or self-pollinated and can successfully reproduce without relying on pollinators (see 'Banking on pollination', p28). But these tiny insects and other pollinating animals are essential for the production of everything from fruits to vegetables to seeds, nuts and oils, that provide a disproportionate share of important vitamins and minerals. In fact, crops like coffee, cocoa and almonds that make up a big chunk of the gross domestic product in several developing countries, also depends on the pollination work of bees. In addition, pollinators contribute to crops that provide biofuel,



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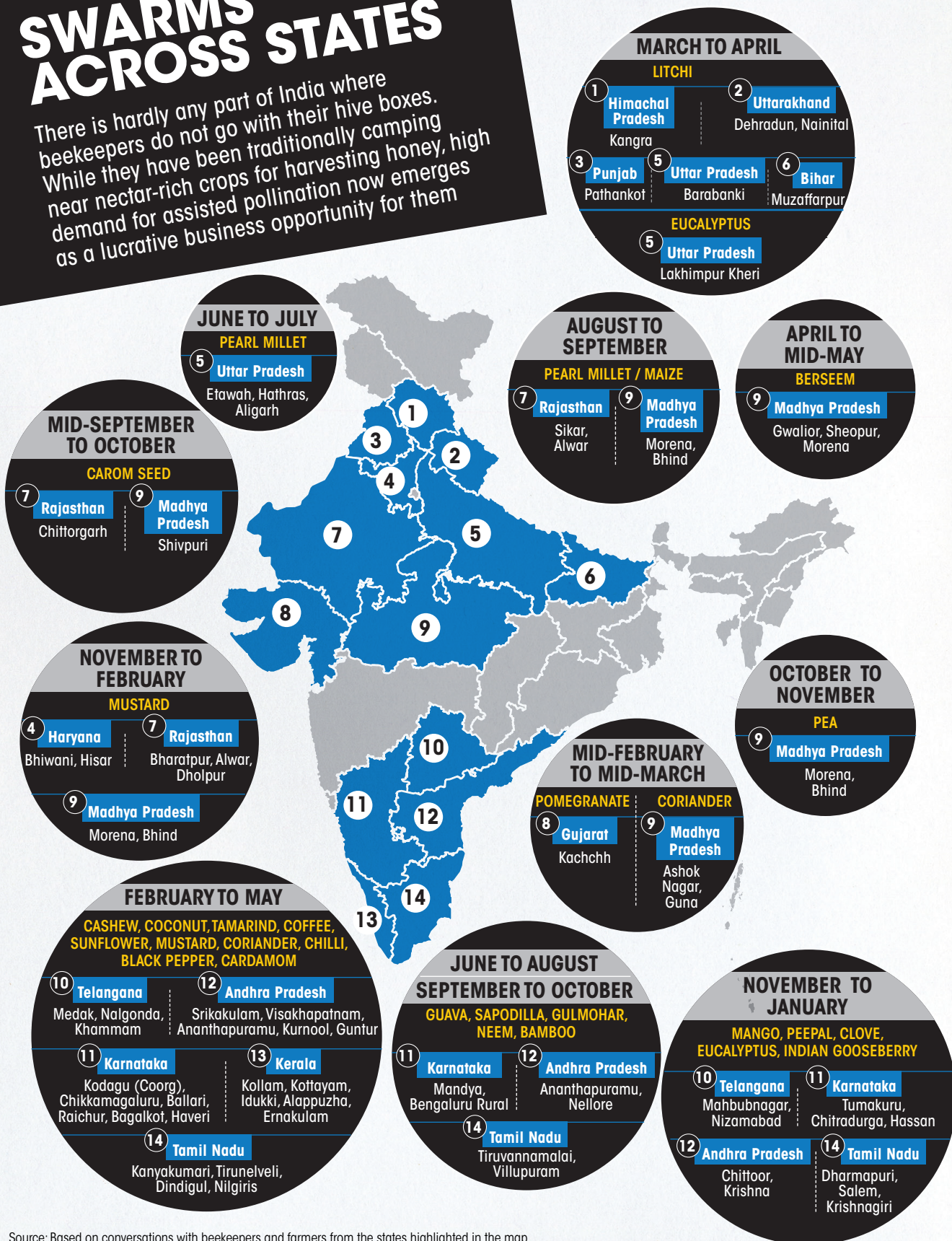
Gopal Singh, apple orchard owner, Janjehli valley, Himachal Pradesh



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SWARMS ACROSS STATES

There is hardly any part of India where beekeepers do not go with their hive boxes. While they have been traditionally camping near nectar-rich crops for harvesting honey, high demand for assisted pollination now emerges as a lucrative business opportunity for them



Source: Based on conversations with beekeepers and farmers from the states highlighted in the map



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A farmer carries rented beehive boxes for pollination in apple orchards in Janjehli valley, Mandi district, Himachal Pradesh

fibres, medicines, forage for livestock and construction materials, says FAO.

However, these pollinators are disappearing at an alarming rate in many parts of the world, largely due to intensive farming practices, monocropping, excessive use of agricultural chemicals like pesticides and higher temperatures associated with climate change. The numbers are stark. According to a 2007 report by the UN Environment Programme, 71 per cent of pollinator species have seen population declines, with 3.4 per cent driven to extinction in just the past two decades. The IUCN Red List paints a similarly sobering picture: 16.5 per cent of vertebrate pollinators are now at risk, a figure that jumps to 30 per cent for species confined to islands. Nowhere is the crisis more dramatic than in the case of honeybees, which have suffered up to 90 per cent hive losses in some parts of the US due to colony collapse disorder, an abnormal phenomenon. And the loss of this crucial ecosystem service is already being felt on the farming sector.

A study published in *Current Biology* in 2008, shows yields of pollinator-dependent crops have stagnated or declined, while crops not reliant on pollinators remain

unaffected. This crisis, termed “pollinator limitation”, highlights the dwindling availability of pollinators and its direct threat to food security. “Across continents and ecosystems, the decline of pollinators has emerged as one of the most pressing and underappreciated crises of our time,” write Devaraju Shishira, a beekeeping consultant in Goa, along with R Uthappa and S B Chavan, scientists with the Indian Council of Agricultural Research (ICAR), in a DTE article published in May 2025.

Though India is among the countries with the highest diversity of honeybee species, little is known about how the pollinators fare in India (see ‘Know thy pollinators’, p30). DTE’s interactions with farmers and some estimates by researchers show that the scale of pollinator population decline in the country could be alarming.

In 2014, researchers from the Centre for Pollination Studies of Calcutta University, Kolkata, and University of East Anglia, UK, conducted a study in parts of Odisha, where farmers reported a significant decrease in their crop yields in the last 10 to 25 years. Most of the 41 crops being grown by the farmers were reliant on pollinators, particularly honeybee species. Analysis

BANKING ON POLLINATION

More than 87% of flowering plant species rely on pollinators for reproduction and yield

No reliance

Crop yield not affected by absence of pollinators



Cereals:

Wheat, maize, rice, rye, barley, sorghum, millet, oat



Tubers, roots:

Cassava, potato, sweet potato, carrot



Pulses:

Lentils, pea, chickpea



Fruits, vegetables:

Banana, pineapple, grape, lettuce, bell pepper



Sugar crops:

Sugarcane, sugar beet

Others: Betel, asparagus, cabbage, castor, cauliflower, chicory, date, garlic, hazelnut, jojoba, spring onion, onion, olive, pistachio, quinoa, spinach, taro, trifoliate, walnut, yam

Slight reliance

Crop yield dips up to 10% in absence of pollinators



Fruits, vegetables:

Orange, tomato, lemons, papaya



Oil crops:

Palm, poppy seed, linseed, saffron seed



Pulses:

Black eyed pea, pigeon pea, beans



Groundnut

Others: Bambara beans, chilli, grapefruit, persimmon, string beans

Medium reliance

Crop yield declines 10-40% in absence of pollinators



Oil crops:

Sunflower, rapeseed, sesame, mustard



Soybean



Fruits:

Strawberry, currant, fig, gooseberry, eggplant



Coconut, okra



Coffee beans

Others: Broad beans, karite nuts, cottonseed

High reliance

Crop yield declines 40-90% in absence of pollinators



Fruits: Apple, apricot, blueberry, cherry, mango, peach, plum, pear, raspberry



Nuts: Almond, cashew, kola nut



Avocado

Others: Cucumber, buckwheat, nutmeg, fennel, coriander

Essential reliance

Crop yield declines over 90% in absence of pollinators



Fruits: Kiwi, cantaloupe, pumpkin, watermelon



Cocoa beans



Brazil nut

Others: Vanilla, quince

showed that four of the five different bee species, which included *Apis cerana*, *Apis dorsata*, *Apis florea*, *Amegilla* spp and *Xylocopa* spp, experienced a decline of 70-90 per cent, with the exception of *Apis dorsata*, which was reported to have increased in the extensively farmed areas. The study was published in *Biological Conservation* in July 2017.

Another survey of 127 agricultural plots around Bengaluru suggest that agricultural intensification and use of chemical fertilisers has significantly reduced the abundance and richness of wild bees in the study areas. The study was published in *Landscape Ecology* in August 2022.

A study of giant honeybees in India also affirmed they are endangered in India. Experts tell DTE that in the Himalayan region, a decline in wild bees, butterflies and moths has impacted apple harvests.

NEW-AGE POLLINATORS

This silent crisis in pollination has given rise to a new business of assisted pollination. Beekeepers, who once relied on honey production and used to camp near high nectar-yielding crops such as mustard and lychee, now earn more by renting out their colonies for pollination services as well.

In Janjehli valley, Bunt Chauhan says, "Apple orchard owners usually place their requests for hive boxes in advance and pay a rent of ₹1,200 per box for the entire flowering season that lasts for 15 to 20 days. I keep ₹100-200 per box, and transfer the remaining to the supplier who runs an apiary in Una town, some 300 km away." The supplier Arun Chaudhary's apiary, essentially an open-air farm, is located in a forested area about 20 km from Una town and houses more than 250 hive boxes. On a regular day, these colonies of domesticated bees forage nectar from wildflowers and return to their hives by dusk. Workers at the farm later harvest the honey and store it for selling. On days when the bees need to be transported to orchards for assisted pollination, workers at the farm begin carefully sealing the beehive boxes as soon as

'KNOW THY POLLINATORS'

Our understanding of Himalayan pollinators is incomplete. This is concerning given accelerating environmental changes, global warming, habitat fragmentation and shifting land-use patterns

V P UNIYAL

THE WESTERN Himalayan region is one of the most ecologically significant and biologically diverse mountain ecosystems globally, and provides critical habitat for numerous pollinator species. In fact, as a transitional zone between the Palearctic and Oriental biogeographic realms, the western Himalayas host unique assemblages of pollinator species adapted to various altitudinal gradients, from subtropical foothills to alpine meadows exceeding 4,000 metres in elevation. Their economic importance cannot be overstated. The region supports extensive pollinator-dependent agriculture, including fruit crops like apples, apricots and cherries, oilseeds, pulses, vegetables and numerous medicinal and aromatic plants. Research indicates that over 70 per cent of major crops in the Himalayan states benefit from animal pollination, with some showing complete dependence on specific pollinators. For instance, apple production in Himachal Pradesh relies heavily on native *Apis cerana* and *Bombus* species, with cross-pollination increasing fruit set by 40-60 per cent compared to wind or self-pollination. Their services also support forest product yields, including those of medicinal plants and timber, create ecotourism potential through butterfly tours and nature experiences, and provide invaluable ecosystem services that underpin regional economies. Yet, our understanding of Himalayan pollinator communities remains incomplete. This knowledge deficit becomes particularly concerning given accelerating environmental changes, global warming, habitat fragmentation and shifting land-use patterns.

For instance, high-altitude solitary bees demonstrate unique adaptations to alpine conditions but lack comprehensive population assessments. Specialised butterfly species inhabiting elevations above 3,500 metres show particular vulnerability to climate shifts. Nocturnal pollination systems involving moth species remain virtually undocumented in mountain ecosystems. Hoverfly populations, known to provide valuable pollination services at lower elevations, have not been systematically studied in high mountain environments. Alpine meadows and scree slopes likely harbour specialised plant-pollinator relationships that could provide critical insights into ecosystem resilience.

Five key areas demand immediate scientific attention. Comprehensive taxonomic surveys are needed across understudied high-altitude habitats, including glacial margins and alpine deserts. Detailed phenological studies must track how climate change is altering the synchronisation between pollinator activity and plant flowering periods. Research should focus on specialised pollination systems that may be vulnerable to environmental changes. Scientists need to investigate vertical migration patterns as species potentially shift their ranges in response to warming temperatures. Attention should be paid to pollinators associated with rapidly changing cryosphere environments, as these may represent some of the most threatened species. Emerging reports indicate that many pollinator species are establishing populations at higher elevations than previously recorded, underscoring the dynamic nature of these communities and the need for updated research.

Priorities should include expanding taxonomic and ecological research on high-altitude species, DNA barcoding, developing climate-resilient conservation strategies, strengthening policies protecting pollinators and their habitats, implementing landscape-scale habitat restoration, and building regional capacity for pollinator monitoring and conservation. Research should also focus on determining thermal tolerance limits of key pollinators, understanding phenological tracking capabilities, assessing adaptive potential to rapid changes, examining interactions between climate and other stressors, and developing predictive models of future distributions. The government should develop national pollinator protection strategies, create state-level implementation plans, foster cross-border collaboration for migratory species, allocating dedicated research funding and establishing monitoring frameworks. The policy measures should be evidence-based, drawing on scientific research and traditional ecological knowledge, and designed for long-term sustainability.

(V P Uniyal is former scientist-G at Wildlife Institute of India. He serves as director of the Centre for Sustainable Ecology and Biodiversity Research at Graphic Era University, Dehradun, Uttarakhand)

the dusk falls. To ensure that the bees have food supplies during transit, the workers place jaggery or sugar syrup inside each hive. Chaudhary personally oversees the packing process. The boxes are then loaded onto a canter truck with precision.

Chaudhary explains that across the Janjehli valley, there is consistent demand for bee colonies during pollination seasons. Each colony fetches him between ₹1,000 and ₹1,500 per flowering season. In other words, his 250 bee colonies fetch him ₹2.5 lakh to ₹3 lakh just within 20 to 30 days. After deducting costs for transport, loading and unloading, feeding the bees and paying the intermediary Bunt Chauhan, Chaudhary says he is left with a net profit of over ₹1.5 lakh in a month. By comparison, 250 colonies yield about 7,500 kg of honey a year, which, at the current average market price of ₹100 per kg, earns him ₹7.5 lakh in a year. Running the apiary costs close to ₹6 lakh a year. So the net profit from honey production stands at ₹1.5 lakh a year. “Renting out bees for pollination has become a profitable venture for beekeepers,” Chaudhary says.

While in Himachal Pradesh, the deployment of domesticated honeybees to offer pollination services has emerged as a win-win solution for both farmers and beekeepers, in several other regions pollinator decline is so severe that even the captivating aroma and nectar-rich flowers of crops like coffee fail to attract them. Farmers in these regions are opting for painstaking methods such as manual pollination.

HAND OVER HIVES

Between February and March, the air in Kodagu, located in the Western Ghats of Karnataka, is filled with a pleasant fragrance as coffee plantations are adorned with white blossoms, resembling jasmine flowers. “These flowers once attracted a frenzy of bees during the flowering season. Now, that hum has dulled,” says Nanjappa Codava, a second-generation coffee grower in Kodagu. To pollinate the flowers on his 2-hectare (ha) coffee plantation, Codava

employs around 25 people, who are adept at hand pollination. Every day during the one-month-long flowering season, the team of hand pollinators arrive at Codava’s plantation with cotton buds and gently brush the inside of each flower to transfer pollen to pistil. “Though bristled brushes are available for manual pollination, we prefer cotton buds as they are more absorbent and gentle on the flowers. This is a skilled operation, and no common labourer can do it without proper training. Besides, the process is laborious as coffee flowers bloom in millions,” Codava tells DTE. “The pollination is also time-specific and is done only in the morning and evening. Labourers charge between ₹800 and ₹850 per day,” says Codava. Though capable of self-pollination, Arabica varieties of coffee that dominate the cool climes of the Western Ghats and Nilgiri Hills benefit from cross-pollination. “Yet, hand pollination offers only a modest yield when compared with natural pollination by bees,” says Codava.

Hand pollination was once exclusive to crops like vanilla orchids as they grow in areas outside their natural range in Mexico where native pollinators like *Melipona* bees are absent. But it is now becoming the norm for a range of crops—from coffee to spices to fruits, vegetables and flowers. In fact, across the Western Ghats, a biodiversity-rich region, hand pollination appears to be gaining ground for crops such as Coorg oranges and spices like cardamom, clove and nutmeg. In the plains of Karnataka, one can see chilli and capsicum being grown on large swathes of farmland across districts of Bagalkot, Koppal, Dharwad, Belagavi, Hubballi, Dharwad and Bagalkot. The state is in fact among the top producers of chilli in the country. “Natural pollinators have long stopped visiting these fields, and more than 60 per cent of the farmers now depend on hand pollination,” says Gopal Naika, a chilli farmer in Bagalkot.

In the peri-urban areas of cities like Bengaluru, Mysuru, Hassan, Chikmagalur, Chitradurga and Shivamogga, where farmers primarily cater to the city



“Renting out bees for pollination has become a profitable venture for beekeepers”

Arun Chaudhary,
Beekeeper, Una town,
Himachal Pradesh

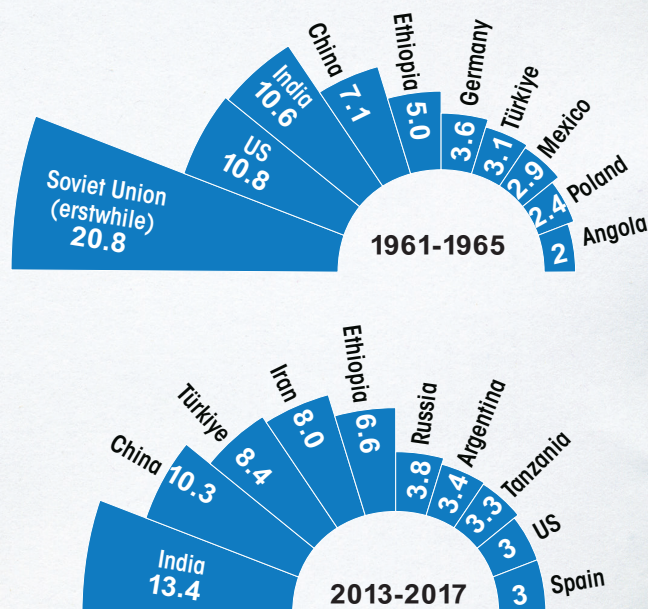


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MAJOR HUB

India now has the highest number of domesticated bee colonies in the world

(Figures in millions)



Source: "Uptrend in global managed honey bee colonies and production based on a six-decade viewpoint, 1961–2017", *Scientific Reports*, December 2022

populations, hand pollination is an assured method of ensuring vegetables such as tomato, brinjal, cucumber and gourds. In the coastal areas of Dakshina Kannada, Udupi and Uttara Kannada, growers of fruits like cashew, water apple, berries, mattu gulla brinjal, endemic varieties of musk melons, ash gourds, sambar cucumber and coconut also resort to manual pollination. In Mundgod town of Uttara Kannada district, grower Ramesh Naik says that a few years ago, farmers of high-value mango varieties like Devgad and Ratnagiri Hapus (Alphonso) suffered huge yield losses due to a decline in pollinator numbers in the district. Following manual pollination, their production has gone up. The fruit quality has also improved both in terms of pulp and aroma, Naik says.

In Udupi taluka of Karnataka, Shankarapura jasmine, also known as Udupi Mallige, has earned the Geographical Indication (GI) tag. The flower, characterised by an intense fragrance and the size of its

buds, is exported to various countries in West Asia. "Due to declining visits by natural pollinators, the crop yield had almost halved in the last 10 years. Researchers who visited our jasmine gardens attributed the absence of natural pollinators to the suspended particles in the air, mainly due to dust from the local thermal power plant," Mary Machado, a grower of Shankarapura jasmine, tells DTE. "We have now resorted to hand pollination, which has helped standardised the quality and output. But it is highly time consuming and laborious."

Manual pollination is neither simple nor cheap. It requires skilled labour, meticulous timing and repeated attention during the flowering phase. For example, vanilla must be pollinated within 12 hours of blooming—a window that, if missed, results in flower drop and yield loss. Coffee flowers are also delicate and wither fast. What was once a temporary fix is being institutionalised as a long-term strategy, with both government and private bodies offering training in manual pollination.

WARNING SIGNS

This artificial substitution of natural pollinators is not without concerns. In a 2021 study, published in *Basic and Applied Ecology*, scientists warn that the main constraints of hand pollination are high labour inputs, high material costs, and skills. Major risks of hand pollination include management ignoring pollinator conservation, high food prices, over-pollination, labour accidents and unfair labour. Studies involving supplemental hand-pollination of flowers have shown that seed production of plants is often limited by the quantity and quality of pollen received naturally, highlights a draft for consultation at the 14th meeting of the Conference of the Parties to the UN Convention on Biological Diversity.

There is no replacement for a bee's instinct, say scientists with the University of Agricultural Sciences (UAS), Bengaluru. To revive natural pollinator populations, scientists at UAS, Gandhi Krishi Vigyan Kendra and the Indian Institute of Horti-



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Beekeepers extract honey at a forest in Una district, Himachal Pradesh. They travel to different parts of the country throughout the year to pollinate various crops

cultural Research (IHR) are studying the “bee community transfer” system which worked wonders for the growers of California Almonds in the US. They say deforestation and habitat loss as major factors behind the decline of pollinators and encourage beekeeping in the problem areas. One of the success stories of infused bee population was implemented in the border districts of Kerala and Karnataka (in Sullia, Belthangady and Puttur). Aerial spray of endosulfan for controlling tea mosquitoes in the early years of the 2000s, had wiped out the entire bee population, prompting governments to promote beekeeping in the cashew orchards. It worked well, and today the cashews grown in these areas are of premium quality due to the natural pollinators that are residents of thousands of acres under cashew cultivation. The Karnataka Forest Development Corporation and the Karnataka Cashew Development Corporation along with their counterparts in Kerala even gave subsidies for beekeeping. Cashew orchard honey is a premium product in the market, claim Honey Producers Cooperative members in Puttur in Dakshina Kannada.

Some farmers in Karnataka are experimenting with companion planting, pollinator gardens, reduced pesticide regimes and beekeeping as long-term solutions. In Melukote, a group of organic vegetable growers

has successfully increased pollinator activity by integrating native flowering plants along their field borders.

At Dr Yashwant Singh Parmar University of Horticulture and Forestry in Himachal Pradesh, scientists are exploring ways to domesticate and rear bumblebees. The larger and hairy bodies of bumblebees allow them to easily collect and transfer pollen from one flower to another. A study published in *Asian Research Journal of Agriculture* says bumblebees are 400 times more efficient than honeybees in any pollination task and can visit 30 to 50 flowers per minute. They are less aggressive and unlike honeybees, bumblebees are capable of pollinating through vibrations, which allows them to navigate effectively and work in tunnels and closed structures. In greenhouse and glasshouse environments, bumblebees thus prove to be better pollinators than honeybees and can be used in the cultivation of crops like tomato, eggplant, cucumber, watermelon, strawberries, pumpkins, cherries and sweet peppers.

Such efforts matter. As American biologist E O Wilson writes in his book *The Diversity of Life*: “Insects and other terrestrial arthropods—such as bees, butterflies, beetles, and the like—are so essential to ecosystems that if they were to vanish entirely, humanity might not survive for more than a few months.” **DTE** @down2earthindia