

## TÊTE-À-TÊTE

### In Conversation with Dr. D. P. Abrol: A Life Dedicated to Entomology, Apiculture, and Pollination Biology

In this edition of *Tête-à-tête*, we feature **Dr. D. P. Abrol**, an eminent entomologist and academician whose contributions to pest management, apiculture, and pollination biology have significantly enriched agricultural science in India. Dr. Abrol served the **Sher-e-Kashmir University of Agricultural Sciences and Technology** for over three and a half decades, holding several key academic and administrative positions. During his distinguished career, he served as Head of the Division of Entomology (August 2008–February 2015), and also held important administrative responsibilities as Controller of Examinations and Director of Education in 2012. His long association with the university reflects a remarkable commitment to teaching, research, and academic leadership.



**Dr. D. P. Abrol**

Ex-Dean, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences

Dr. Abrol's research interests span pest management, honeybee management, and pollination biology—areas that are increasingly critical for sustainable agriculture and food security. Over the course of his career, he has authored **22 books, 12 manuals, and 60 book chapters**, and published **more than 300 research papers** in national and international journals. He has successfully led **over nine externally funded research projects** and participated in **international collaborative projects with institutions in Poland and Switzerland**, contributing significantly to global research partnerships.

An active participant in the international scientific community, Dr. Abrol has visited several countries—including Switzerland, Poland, South

Korea, Malaysia, Saudi Arabia, and Thailand—as a special invitee for academic engagements and scientific collaborations. His contributions to entomology and agricultural sciences have been widely recognized through numerous prestigious honours and awards.

Notably, Dr. Abrol became the **first scientist from Jammu & Kashmir** to be elected as a Fellow of the **National Academy of Agricultural Sciences, India**, and a Fellow of the **Royal Entomological Society, London**. Among his many accolades are the **Young Scientist Award (1992)** from the Jammu and Kashmir State Council for Science and Technology, the **Pran Vohra Award (1993)** from the **Indian Science Congress Association**, and the **Prof. T. N. Ananthkrishnan Award (1997–1998)** for outstanding contributions to

entomology. He also received the **Dr. Rajendra Prasad Puruskar (1999–2000)** from the **Indian Council of Agricultural Research** for his Hindi book on beekeeping titled *Madhmakhi Palan—Sidhant Evam Vidhian*.

Further recognition includes the **11th Apicultural Association Award (2010)** for outstanding contributions to apiculture, and a **Gold Medal from King Saud University** for his contributions to the development of apiculture in Asia. In recent years, Dr. Abrol has also been listed among the **top 2% of scientists worldwide (2022–2025)** in the ranking compiled by **Stanford University**.

Even after retirement from active university service, Dr. Abrol continues to contribute to the scientific community in multiple advisory and evaluative roles. He currently serves as a member of **Peer Review Teams for accreditation of universities**, a member of **QRT teams for evaluation of AICRP projects**, an expert member of the **Neonicotinoids Group for Asian countries**, and a **core member of SERB–DST, Government of India**. He is also associated with the Asian chapter of **Apimondia** and frequently serves as an expert on various academic and research selection committees.

Through his extensive research, academic leadership, and continued engagement with the scientific community, Dr. Abrol remains an inspiring figure in Indian entomology. In this conversation, he shares insights from his long and distinguished journey in science, research, and academic service.

The following interview was conducted by Dr. P. R. Shashank (PRS), Managing Editor, Indian Entomologist. In this engaging conversation, Prof. Abrol reflects on his long and distinguished career in entomology, shares insights from his

research on pest management, apiculture, and pollination biology, and discusses the evolving role of entomological research in ensuring sustainable agriculture and food security. The interview also highlights his experiences in academia, international collaborations, and his perspectives on the future directions of entomological sciences

**PRS: You were born in a rural village in Jammu & Kashmir and rose to become a leading authority in apiculture. What early experiences shaped your interest in Agriculture and Entomology?**

**Dr. D. P. Abrol (DPA):** I was born on 6th February 1959 in Kangri village of District Rajouri, Jammu & Kashmir, India, located about 90 km from Jammu. Growing up in a farming family with a rural background, I gained practical knowledge of agriculture through lived experience, even before receiving any formal education. The village school was nearly 4 km from our home, requiring daily travel on foot across hilly terrain. We lived in a mud house, and until 1980, electricity was unavailable; kerosene lamps were our sole source of light for studying. Grain was milled in traditional water mills, and drinking water had to be carried from village wells almost 1 km away. Life was simple and self-reliant—fire was carefully preserved to relight the hearth, as matchsticks were not in use at that time. I received my early education at Government High School, Baja Bain (District Rajouri, J&K) from 1965 to 1975. I completed my B.Sc. at Government Gandhi Memorial Science College, Jammu (1975–1979), followed by an M.Sc. from the University of Jammu (1979–1981), and earned my Ph.D. from Haryana Agricultural University, Hisar (1981–1986).

**PRS: From your schooling in Rajouri to earning a Ph.D. from Haryana Agricultural**

## **University, what key experiences shaped your decision to specialize in honeybee research?**

**DPA:** From my undergraduate and postgraduate days, I developed a keen interest in the collection and identification of plants and in observing visiting insects. The buzzing and melodious sounds of insects always fascinated me. Honey, the miraculous gift of honeybees to humankind, particularly captured my imagination, and I became deeply curious about the life, behaviour, and organization of honeybees, as well as their vital role in sustaining global food security and maintaining ecological balance. After completing my M.Sc., I had the opportunity to join the Department of Zoology, Haryana Agricultural University, Hisar, as a Ph.D. student. My long-cherished dream of working on insects—especially honeybees and other pollinators—became a reality under the guidance of the eminent scientist Prof. Dr. R. P. Kapil. Prof. Kapil was an outstanding scientist, a dedicated teacher, and an innovative researcher. Along with his team, he developed pioneering technologies for the domestication and conservation of non-*Apis* bee pollinators. Working under his mentorship was truly a dream come true. Students trained by Prof. Kapil went on to occupy prestigious positions in science, with each making significant contributions and earning national and international recognition. Notably, one of my seniors, Prof. R. C. Sihag, was recently awarded the Padma Shri for his outstanding contributions to beekeeping.

## **PRS: As a young scientist, what challenges did you face in shifting focus from general entomology to pollination biology and honeybee management in the 1980s?**

**DPA:** Most entomologists prefer to work on diverse entomological disciplines and often avoid honeybee

research due to the fear of stings and the challenges associated with handling live colonies. During my undergraduate years, I was fascinated by observing insects moving from one flower to another, and their gentle, melodious sounds deeply attracted me. The sweetness of honey—traditionally used in earlier times alongside Ayurvedic medicines, including remedies for eye ailments—left a lasting impression on my mind and sparked my curiosity to understand its production and the biology behind it. Working with honeybees, their remarkable social organization, tireless labour, and fascinating behavioural patterns has continually inspired me to explore their life processes in greater depth.

## **PRS: As former Dean of the Faculty of Agriculture at Sher-e-Kashmir University and Head of the Division of Entomology, what were the most significant reforms you implemented to advance agricultural education and research in Jammu & Kashmir?**

**DPA:** Under my leadership as Head (2008-2015), the Division of Entomology not only attained national prominence but also achieved international recognition as a centre of excellence in research and development. This is reflected in the establishment of international research collaborations with the Department of Behavioural Ecology, Institute of Environmental Sciences, Jagiellonian University,



Kraków, Poland, and the ETH Laboratory, Zurich, Switzerland. Scientists from both Jagiellonian University and ETH Zurich have visited the Division of Entomology, strengthening academic exchange and collaborative research.

In addition, a new international collaboration focusing on the global decline of pollinator biodiversity was initiated, with the Division serving as an Indian co-partner in collaboration with the British Natural History Society, UK, under the international coordination of Dr. P. H. Williams.

As Dean, Faculty of Agriculture (2016-2021), I introduced several innovative academic and administrative reforms aimed at enhancing the quality of education and governance.

**Attendance System:** Upon assuming office as Dean, Faculty of Agriculture, low student attendance was identified as a major concern. To address this, undertakings were obtained from students at the time of admission, duly endorsed by their parents, committing to regular attendance and acknowledging that they would not be eligible for examinations without fulfilling the mandatory 75% attendance requirement. Faculty members were instructed to submit monthly attendance records by the 5th of each month, duly signed by the Head of Department, with copies forwarded to the Dean and Director of Education. This initiative effectively resolved the issue, resulting in a marked improvement in student attendance and classroom discipline.

**Modified Synopsis Presentation System:** The existing system of conducting M.Sc. and Ph.D. synopsis seminars within individual divisions was restructured. Pre-synopsis discussions were first held at the divisional level, followed by presentations before the entire faculty, including advisory committee members and Heads of Departments, in the presence of the Dean (Faculty

of Agriculture) as Chairperson and the Director of Research and Director of Education as members. This comprehensive review process significantly strengthened research quality by incorporating multidisciplinary feedback. Faculty-wide seminars were institutionalized during the third week of every month.

**Viva Voce Under CCTV Surveillance:** To ensure transparency and maintain the highest standards of examination, Ph.D., M.Sc., and comprehensive viva voce examinations were introduced under CCTV surveillance. Students were also required to undergo a pre-viva voce examination before their advisory committees prior to the final viva.

**Wi-Fi System:** A campus-wide Wi-Fi facility was introduced for the benefit of students, faculty, and staff, significantly improving access to academic and research resources.

**Green Graduation Programme:** A Green Graduation initiative was launched, under which each student was encouraged to nurture and maintain a plant throughout their four-year stay at the university, promoting environmental responsibility and sustainability.

**Swachhta Abhiyan:** A cleanliness drive (Swachhta Abhiyan) was initiated to instil a sense of hygiene and civic responsibility among students and to maintain a clean and healthy campus environment.

**Photography and Media Cell:** A Photography and Media Cell was established to document university activities and showcase the institution's technological and academic achievements.

**Technology Cell:** A dedicated Technology Cell was created to facilitate the regular dissemination of new technologies among students, teachers, and farmers, strengthening extension and outreach activities.

**Agri-Fest:** An Agri-Fest was organized to provide

students with a platform to demonstrate their technical knowledge, creativity, and practical skills.

**Seminars and Debates:** Regular seminars and debates were organized to foster academic discourse, critical thinking, and communication skills among students.

**PRS: You've received prestigious awards like the Young Scientist Award (1992), Pran Vohra Award (1993), and Dr. Rajendra Prasad Puruskar (1999–2000). Which achievement are you most proud of, and how did it impact your work in Apiculture?**

**DPA:** In recognition of outstanding host plant relationship of bees, understanding environmental factors influencing flight and pollination activities of bees, pollination efficiency, diseases and management of honeybees which have great bearing in enhancing agricultural, horticultural productivity and beekeeping industry. Besides, research, I am very proud of Dr. Rajendra Prasad Puruskar (1999–2000) was conferred for Hindi book on beekeeping which has revolutionized beekeeping industry all over the country for the beekeepers to learn and practice beekeeping.

**PRS: How has pollination research in India evolved over the last three decades, and what role did your work play in this progress?**

**DPA:** During last three decades much strides has been made in the pollination research in India. Government of India has given due thrust to pollination research and recognised beekeeping as input in agriculture. AICRP on honeybee and pollinators training has been reframed as honeybee and pollinators to give more thrust on pollination. AICRP centres on honeybee and pollinators has increased and almost every state of the country has got AICRP centres to boast pollination studies. At

present there are 18 regular centres and 6 voluntary centres working on honeybees and pollinators. Multilocational Network project on biosystematics of insects under the esteemed patronage of Prof V Ramamurthy has played a key role in exploring the non-*Apis* bee pollinators. In our centre, we Identified seven species of bumblebees and sixteen distinct species of Megachilids belonging to three tribes within the Megachilinae subfamily: Megachilini, Anthidini and Osmiini from various landscapes of this Jammu and Kashmir. Given the significant role of wild populations of bee pollinators in crop pollination, conservation with mitigating the stress factors are imperative. Prioritizing their conservation efforts would greatly contribute to ecosystem sustainability and enhance food security. Pioneer in developing management techniques of wild bee pollinators which play tremendous role in pollination of field and fruit crops for enhancing crop productivity. Most efficient pollinators of wide variety of crop plants in natural and agricultural systems have been identified. Evaluated the optimum number of colonies for different crops which shall increase yield manifold ranging from 20-100%. Recommendations popularized and adopted by farmers in pollination of crops in an area of at least 3.97 lakh ha. of Jammu region. Pioneer in developing low-cost management technology for honeybee diseases, mites and other bee enemies. It has become popular as an economically viable and popular technology for resource poor farmers. Books on bees and beekeeping, non - *Apis* pollinators and pollination biology are recognized as a standard reference in pollination biology, particularly in relation to pollinator diversity and ecology, crop pollination and agricultural productivity, pollinator–plant interactions and conservation of pollinators in agro-ecosystems. In universities and research institutions, they are

being commonly used as supplementary or core reading for postgraduate courses in entomology, apiculture, ecology, and agricultural sciences.

**PRS: Your Hindi book Madhumakhi Palan-Sidhant Evam Vidhian earned a national award, what motivated you to write it, and how has it influenced beekeeping practices among Hindi-speaking farmers in India?**

**DPA:** No doubt several books on beekeeping both Indian and foreign were available but no book was available in accordance with the local conditions and in their own language. Beekeepers and farmers wanted to learn beekeeping in their own language. This prompted me to make efforts to present beekeeping in simple form in their own language. This book in Hindi has revolutionized beekeeping industry all over the country for the beekeepers to learn and practice beekeeping. This book serves as practical guide for farmers, beekeepers, students, hobbyists and all those interested in bees and beekeeping. The second edition of Madhmakhi Palan ki Nai Dashain published in 2021 has helped beekeepers in rearing and raising the European honeybee colonies to a highly respectable 3.5 million colonies at present producing more than 100 thousand metric tons of honey, 10 thousand metric tons of beeswax, and tons of pollen. Beside this, this venture has helped generating self-employment for more than 100 thousand rural and urban unemployed youths, and providing pollination service to over 2.5 million acres of cross-pollinated plants. Fortunately, this book is available on shelf of each university and in the hands of all those interested in beekeeping. More than trained 5000 farmers, beekeepers, students, unemployed youth, hobbyists and empowered women in beekeeping entrepreneurship through different national Bee Board, university, department of agriculture and non-governmental social organizations. With my

assistance, many beekeepers have established their own entrepreneurship enterprises, some have been appreciated by Hon'ble Prime Minister of India. My text books in beekeeping is being used for teaching purposes not only in India but throughout the world. My research findings have been appreciated all over the world with many awards and appreciation.

**PRS: Can you share insights from your collaborative projects with ETH Zurich and Jagiellonian University on honeybees and bumblebees? What key findings emerged, and how are they being applied in Indian apiculture?**

**DPA:** The populations of honeybees and bumblebees have been decreasing around the world in the recent decades. A variety of pathogens and parasites, including bacteria, fungi, protozoa, nematodes, mites and insects play significant role in honeybee and bumblebee colonies loss. Parasites of the genus *Nosema* (Microsporidia: Nosematidae) and the genera *Crithidia* and *Lotmaria* (Kinetoplastida: Trypanosomatidae) have a significant negative impact on honeybee and bumblebee colonies. Recent studies of nuclear DNA markers of these parasites allowed to describe new species and genetic variants. Collaborative project on Assessing large scale environmental risks for biodiversity with tested methods (Contract number: GOCE-CT-2003-506675 ALARM) was conducted with European Union with Prof Michal Woyciechowski of Department of Behavioural Ecology Jagiellonian University, Krakow Poland. The studies revealed the prevalence of parasites in honeybee and bumblebee populations of the two Indian states (Jammu and Kashmir, Karnataka) identified using PCR with primers specific for the ribosomal RNA genes cluster of *Nosema*, *Crithidia* and *Lotmaria* species. Co-

infection by microsporidian and trypanosomatid parasites was detected in several honeybee and bumblebee specimens from Jammu and Kashmir state. Comparative analysis of ribosomal RNA genes sequences showed that honeybee samples from India studied were infected by *N. bombi*, *N. ceranae* and *L. passim*. Bumblebee populations were infected by *Nosema D*, *Crithidia bombi* and *Crithidia expoeki*. No honeybee's specimen with trypanosomatid infection was found in Karnataka state. For the first time *N. bombi* infection was detected in the honeybee population.

Another collaborative project was conducted with ETH Laboratory in Switzerland on parasites of honeybees and bumblebees with Dr Schmid Paul Hempel, ETH Zurich Switzerland. The animal gut is a habitat for diverse communities of microorganisms (microbiota). Honeybees and bumblebees have recently been shown to harbour a distinct and species poor microbiota, which may confer protection against parasites. Here, we investigate diversity, host specificity and transmission mode of two of the most common, yet poorly known, gut bacteria of honeybees and bumblebees: *Snodgrassella alvi* (Betaproteobacteria) and *Gilliamella apicola* (Gammaproteobacteria). We analysed 16S rRNA gene sequences of these bacteria from diverse bee host species across most of the honeybee and bumblebee phylogenetic diversity from North America, Europe and Asia. These focal bacteria were present in 92% of bumblebee species and all honeybee species but were found to be absent in the two related corbiculate bee tribes, the stingless bees (Meliponini) and orchid bees (Euglossini). Both *Snodgrassella alvi* and *Gilliamella apicola* phylogenies show significant topological congruence with the phylogeny of their bee hosts, albeit with a considerable degree of putative host

switches. Furthermore, we found that phylogenetic distances between *Gilliamella apicola* samples correlated with the geographical distance between sampling locations. This tentatively suggests that the environmental transmission rate, as set by geographical distance, affects the distribution of *G. apicola* infections. We show experimentally that both bacterial taxa can be vertically transmitted from the mother colony to daughter queens and social contact with nest mates after emergence from the pupa greatly facilitates this transmission. Therefore, sociality may play an important role in vertical transmission and opens up the potential for co-evolution or at least a close association of gut bacteria with their hosts. These studies helped to understand and diagnose the bacterial, viral and protozoan diseases of honeybees, bumblebees and other pollinators.

**PRS: As a visiting professor at institutions in Poland, Switzerland, Malaysia, South Korea, Saudi Arabia, and Thailand, what cross-cultural lessons have you brought back to strengthen pollination research in India?**

**DPA:** Beekeeping practices in India are largely traditional and differ markedly from those followed in many other countries. In India, beekeeping is primarily oriented toward honey production, with limited emphasis on the crucial role of honeybees in pollination within natural ecosystems and agroecosystems for biodiversity conservation and enhanced agricultural productivity. Most beekeepers maintain colonies using only brood chambers, and the use of supers is uncommon. Moreover, greater emphasis is placed on frequent colony division and the extraction of maximum honey from the brood chamber. Such practices weaken colonies, reducing their ability to survive winter conditions or periods of floral scarcity.



Dr. Abrol Chairing a scientific Sessions in 44th Apimondia international conference held at Daejeon South Korea, September, 2015

In contrast, in European and several other Asian countries, honey is not extracted from the brood chamber; instead, extraction is confined to supers, with colonies commonly maintained with two to six supers. Strong colonies not only yield higher honey production but also function as efficient pollinators and exhibit greater resistance to pests, diseases, and natural enemies. Additionally, little attention has been given in India to the diversification of hive products. In some countries, as many as 72 value-added by-products have been developed from hive resources. Furthermore, the practice of hiring honeybee colonies for pollination services has yet to gain popularity in India, whereas in most European countries, renting colonies for pollination—particularly for fruit crops such as almond—is widely practiced.

**PRS: Your research spans pollination biology, honeybee management, and IPM.**

### **How has climate change affected honeybee populations in India, and what adaptive strategies do you recommend?**

**DPA:** Among the various drivers, climate change is one of the most serious factors, directly and indirectly influencing the abundance, geographical distribution, vigour, phenology, and behaviour of both plants and their pollinators. Climate change has been shown to severely disrupt plant-pollinator interactions, leading to increased incidence of pests and diseases in honeybee colonies. In addition, populations of natural pollinators such as bumblebees and wild solitary bees have declined markedly in recent years. As climatic conditions shift, habitats suitable for supporting pollinators may be lost in some regions while emerging in others. When suitable habitats disappear or when pollinators are unable to track these changes through dispersal, local extinctions



Dr. Abrol Participating International Conference: Apimondia

may occur. Climate change may also disturb the temporal synchrony between plant flowering periods and the seasonal activity of pollinators. A diverse assemblage of pollinators, with different traits and responses to ambient conditions, is one of the best ways of minimizing risks due to climatic change. The “insurance” provided by a diversity of pollinators ensures that there are effective pollinators not just for current conditions, but for future conditions as well.

**PRS: As a member of NITI Aayog’s Sub-Committee for Beekeeping Development and QRT teams for AICRP on Honeybees & Pollinators, what policy recommendations are you advocating to boost India’s honey**

## **production?**

**DPA: Key Recommendations include**

1. Institutionalize the National Bee Board and rename it as the Honey and Pollinators. Board of India under the Ministry of Agriculture and Farmers’ Welfare as it will help in advancing beekeeping through multiple mechanisms such as:
2. Setting up of new integrated bee development centers and strengthening the existing ones.
3. Establishment of a well-equipped, sophisticated National Research Centre on Apiculture (NRCA) with its head quarters in a suitable location

4. This facility will efficiently combine research and teaching space to improve bee health and biodiversity, train new undergraduate and graduate students, mentor new beekeepers and assist commercial and small beekeepers.
5. Creating a honey price stabilization fund. Collection of data on important aspects of apiculture.
6. Simplifying procedures and specify clear standards for ease of exporting honey and other bee products.
7. Beekeeping should not be restricted to honey and wax only instead marketing of bee products such as pollen, propolis, royal jelly, and bee venom can contribute to the income of Indian farmers.
8. Recognize honeybees as inputs to agriculture and consider landless beekeepers as farmers.
9. Training and development of beekeepers should be provided by state governments. National and regional infrastructure should be developed for storage, processing, and marketing of honey and other bee products.
10. Plantation of bee-friendly flora at appropriate places and engaging women self-help groups in managing such plantations.
11. Recognition of apiculture as a subject for advanced research under the aegis.

**PRS: What were the major milestones during your tenure as Dean at SKUAST-Jammu, which ones you cherish the most?**

**DPA:** Marked improvement in research and academics. Faculty lectures and seminars helped the student to update their knowledge with the current advances in science.



**PRS: Over the years, you have mentored students, researchers, and extension workers. What qualities do you believe are essential for young scientists entering entomology?**

**DPA:** Students need to be independent researchers and motivated to undertake problems confronting farmers. Research problems should be identified based on direct feedback from farmers and should integrate applied research with fundamental studies. Field visits and on-site stay programs in farmers' fields are the most effective ways for researchers and extension workers to gain a deeper understanding of these issues. Additionally, students should develop an interest in insects through entomological clubs and regular interactive activities.

**PRS: Looking ahead, what emerging technologies or research areas do you believe will transform apiculture in India over the next decade?**

**DPA:** Despite their pivotal role, honey bees face a myriad of threats including deforestation, habitat loss, climate change, pesticides, and competition from introduced species. These factors have contributed to declines in local populations, necessitating urgent attention and coordinated efforts to safeguard their biodiversity and

ecological contributions. Honey bees not only contribute significantly to agricultural productivity through pollination but also play integral roles in traditional medicine and local economies, reflecting their dual importance in health and cultural practices. There is a need for enhancing employment generation and rural development, through beekeeping. Ensuring nutritional security to resource-crunch Indian public, through hive products. Augmenting agricultural productivity, through planned pollination with honey bees. Augmenting biodiversity and environmental sustainability, through honey bees.

Some of the critical areas needing attention:

1. Hive health & pests (Varroa control, queen management)
2. Forage planning & floral diversity
3. Training & beekeeping organizations
4. Quality standards & certification
5. Marketing, branding & product diversification
6. Infrastructure, finance & policy support
7. Sustainable, pollinator-friendly practices

To achieve these areas there is a need to focus on:

- Impact of climate change on beekeeping and pollination is one of the most issue which needs to be considered seriously.
- Asia is very rich in biodiversity of bees. There is serious decline in honeybee colonies both domesticated as well as wild. There is a need to make an in-depth exploration of biodiversity native honey bee species
- Assess the overall biodiversity of bee pollinators, monitor their decline, its causes and its impact on pollination services
- Undertake taxonomic studies, and evaluate the impact of pollinators on economic yields.
- Promote the conservation and the restoration and sustainable use of pollinator diversity

in agriculture and related ecosystems

- More research is required in crop pollination along with better coordination of the research efforts at the community level in different producing areas to help sustain production of the diverse crops that nourish humanity.
- The improvement in the current policy to provide pollinators with abundant well-connected habitat, plentiful food and freedom from toxic chemicals and disease is the need of the hour.
- Utilizing all the Honey bee colonies for planned Pollination of various crops to boost up crop production and to increase farmers' income without any additional expenditure on this Input. Migration of bee colonies wherever bee flora is available has triple benefits i) Honey production, ii) Colony multiplication and Bee pollination.
- Use of pesticides should be judicious with due advanced intimation to Beekeepers. Linkage between Farmers and Beekeepers should be established.
- Risk assessment of specific pesticide ingredients and regulation based on the identified risks are important responses, and the environmental hazard from pesticides used in agriculture can be decreased at the national level.
- Managing urban and recreational green spaces to increase the local abundance of nectar-providing and pollen-providing flowering plants increases pollinator diversity and abundance.
- Land restoration and reclamation through beekeeping, both in rainforests and arid lands. That many areas in Asia are facing problems due to water shortage and

climatic changes, covering such a topic, taking in consideration, planting nectar and pollen forage shall be most important. Preparing pollen atlas of different plants for Identification of bee flora.

- Multipurpose tree species, with staggered flowering and useful to honey bees during their flowering, to be selected in Social Forestry and Afforestation Programmes.
- All the stakeholder viz. farmers, beekeepers, land managers, urban communities, indigenous people and local communities etc. should be encouraged to adopt pollinator-friendly practices through print and electronic media and social media.
- Cropping pattern and Inter-cropping to be suitably adjusted to provide food to Honey Bees for major part of the year and for additional income to the farmers also (This will support large number of Honey Bee colonies and increase their number)
- The honey bee culture and rural development for enhanced agriculture production and conserving biodiversity
- Making aware the stakeholders of existing global and regional policy initiatives and providing with advice on how national legislation can integrate effectively into existing global and regional policy frameworks for the conservation of pollinators.
- Promoting education and awareness in the public and private sectors of the multiple values of pollinators and their habitats, in improving the tools for decision-making, and in providing practical actions to reduce and prevent pollinator decline in different landscapes. Syllabus of Schools may be

revised to include practical aspects of beekeeping. Syllabus of Colleges, Forest Guards Colleges etc. may be revised to create technicians, research workers and scientists.

- Work out contribution of pollination crop wise in the country
- Linking bee keeping with job opportunities
- Improvement in existing management practices
- Encouraging bee products as food and medicine.
- Diversification and value addition of bee products
- Marketing of bee products
- Assess constraints in beekeeping
- Problem of diseases, pests, predators and natural enemies.
- Exploration, identification and domiciliation of non-Apis bee pollinators for enhanced productivity of crops,
- Urban beekeeping utilizing roof tops, hidden gardens. Parks private or public spaces.
- Census of beekeepers, bee colonies, etc. should be done
- Technical skills of beekeepers should be upgraded
- Bee colonies should be well maintained for higher honey production
- Rapid multiplication of bee colonies should be done
- Productivity of Bee colonies should be increased
- Bee-hives, Comb Foundation Sheets etc. should be readily made available to beekeepers on subsidized rates.
- Diversification of Bee-products should be done to make the beekeeping industry self-reliant.

- Quality control of bee-products to safeguard interests of both, producer & consumer
- If the existing beekeepers are encouraged, motivated and assisted to become semi-commercial beekeepers. The number of bee colonies can be doubled within a short period and with minimum cost.
- To promote agri- entrepreneurs & agri-startup for their involvement in beekeeping/ Honey production
- Empowerment of Women through Beekeeping
- Developing beekeeping infrastructural facilities. Easily available beehives and other beekeeping materials
- Packaging processing and storing
- Technologies need to be developed for effective identification of adulterated honey products

**PRS: Finally, if you were to describe your journey in one sentence, what would it be?**

**DPA:** It is essential to recognize that pollination is not a free service, and that investment and stewardship are required to protect and sustain it. Economic assessments of agricultural productivity should account for the “cost” of sustaining wild and managed pollinator populations. There is a need for well-documented cases of specific pollinator declines notwithstanding, rapid extrapolation from our current knowledge to imply worldwide

pollinator and crop production crises regarding pollinator-pollination declines. As Pavan Sukhdev notes in *The Economics of Ecosystems and Biodiversity* UN report, “Not even a single bee has ever sent you an invoice—and that is part of the problem. Because most of what we receive from nature is not priced, traded, or invoiced, it is often overlooked.”

The foregoing interview was conducted by Dr. P.R. Shashank, Managing Editor of Indian Entomologist. He serves as Senior Scientist and Incharge of the National Pusa Collection (NPC) at the Division of Entomology, ICAR–Indian Agricultural Research Institute, New Delhi. His areas of specialization include insect taxonomy, invasive insect pests, molecular diagnostics, and the application of artificial intelligence in pest detection. In his combined roles as a researcher and editor, Dr. Shashank has made substantial contributions to the advancement of taxonomic research and the dissemination of scientific knowledge in Entomology.

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