

In Memoriam: Prof. (Dr.) P. Pushpangadan (1944–2025)

Scientist, Institution Builder and Pioneer of Ethnobiology

Vinodkumar T. G. Nair

Managing Editor, *Journal of Traditional and Folk Practices*

*vaidyavinodkumar@gmail.com

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The scientific community has lost one of its most distinguished scholars with the passing of Prof. (Dr.) P. Pushpangadan, an eminent botanist, ethnobiologist and visionary institution builder whose pioneering contributions transformed ethnobotany, medicinal plant research, biodiversity conservation and the scientific validation of traditional

knowledge in India on December 19, 2025. Widely regarded as the Father of Indian Ethnopharmacology, his death at the age of 81 marks the end of a remarkable career spanning more than five decades of research, innovation, institutional leadership and public service.

Born on 23 January 1944 in Prakkulam, Kollam district, Kerala, Prof. (Dr.) P. Pushpangadan received his academic training at the University of Kerala, Aligarh Muslim University and the Council of Scientific and Industrial Research (CSIR), Jammu. Over the course of his career, he established himself as one of India's leading authorities in plant sciences, with research interests encompassing cytogenetics, plant breeding, conservation biology, ethnobotany, ethnobiology, ethnopharmacology, pharmacognosy, medicinal plants, biotechnology and biodiversity management.

Prof. (Dr.) P. Pushpangadan combined scientific excellence with exceptional administrative leadership. He served as Director of the Tropical Botanic Garden and Research Institute (TBGRI, presently known as Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI)), Thiruvananthapuram, Kerala, India where he transformed the institute into a nationally recognized centre for research on tropical biodiversity, medicinal plants and traditional knowledge systems. He subsequently led several premier scientific institutions,

including the National Botanical Research Institute (NBRI), Lucknow, the Rajiv Gandhi Centre for Biotechnology (RGCB), Thiruvananthapuram and the Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow. In each of these roles, he strengthened multidisciplinary research, promoted innovation and fostered collaborations across scientific disciplines.

Among his many scientific achievements, Prof. (Dr.) P. Pushpangadan's work on *Arogyapacha* (*Trichopus zeylanicus* ssp. *travancoricus* Burkill. ex Narayanan) stands as a landmark in the history of ethnobiology. Recognizing the traditional knowledge of the Kani tribal community of Kerala, he and his colleagues scientifically investigated the plant's medicinal properties, leading to the development of JEEVANI, a scientifically validated herbal formulation having immuno-enhancing, anti-fatigue, anti-stress and hepatoprotective properties. Equally significant was the innovative benefit-sharing mechanism known as 'TBGRI Model of Benefit Sharing', established with the Kani tribal community in Kerala, ensuring that the custodians of the traditional knowledge received a share of the commercial benefits. This is considered as the first Benefit Sharing Model in the world. This unique benefit sharing model won the UNDP Equator Initiative Award during the Earth summit in 2002 held at Johannesburg, South Africa. This initiative became an internationally acclaimed model for ethical bioprospecting and informed subsequent discussions on access and benefit-sharing under the Convention on Biological Diversity and related international frameworks.

Prof. (Dr.) P. Pushpangadan's scientific output was extraordinary. He authored and co-authored hundreds of peer-reviewed research papers, edited numerous books and monographs and obtained several patents relating to medicinal plants, herbal formulations and biotechnological

innovations. His work significantly advanced the documentation, conservation and scientific validation of India's rich ethnomedical traditions while highlighting their relevance to modern healthcare, biodiversity conservation and sustainable development.

Beyond his research achievements, Prof. (Dr.) P. Pushpangadan played a pivotal role in promoting ethnobiology as a rigorous scientific discipline in India. He encouraged interdisciplinary approaches that integrated botany, anthropology, pharmacology, biotechnology and conservation science, thereby broadening the scope and societal relevance of biological research. His mentorship inspired generations of students and young scientists, many of whom have gone on to make important contributions in academia, research institutions and public policy.

His outstanding contributions were recognized through numerous national and international honours, including the Padma Shri, awarded by the Government of India in recognition of his distinguished service to science and engineering. He was also elected to several learned academies and served on numerous national and international scientific committees, where his expertise influenced research priorities and biodiversity policy.

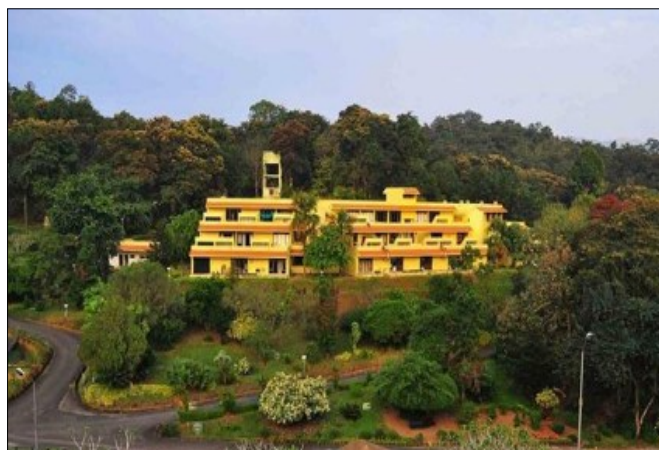
Prof. (Dr.) P. Pushpangadan firmly believed that science must be both socially relevant and ethically grounded. Throughout his career, he demonstrated that traditional knowledge systems and modern scientific inquiry are complementary and that sustainable innovation depends upon respecting the intellectual contributions of indigenous communities while conserving the biological resources upon which humanity depends.

With his passing, India has lost an exceptional scientist, an inspiring institution builder and a compassionate mentor. Yet his scientific legacy continues through the institutions he strengthened, the researchers he mentored, the knowledge systems he helped preserve and the enduring influence of his work on ethnobiology, biodiversity conservation and equitable benefit-sharing. His life remains a testament to the transformative power of science rooted in ethics, inclusivity and respect for nature.

Prof. (Dr.) P. Pushpangadan also made significant contributions to scientific publishing and the dissemination of traditional knowledge research. From its inception in 2013, he served as a distinguished member of the Editorial Advisory Board of the *Journal of Traditional and Folk Practices*. His association with the journal reflected his unwavering commitment to advancing ethnobiology, ethnomedicine and traditional knowledge systems through rigorous scientific communication. He provided valuable intellectual guidance in shaping the journal's editorial vision, encouraging high standards of scholarship, interdisciplinary research and the scientific validation of indigenous knowledge. His continued support and wise counsel were instrumental in establishing the journal as a credible platform for research on traditional and folk practices.

A vision that became institutions - An ode to a scientist who will be remembered for decades: The enduring legacy of Prof. (Dr.) P. Pushpangadan:

Prof. (Dr.) P. Pushpangadan has made significant contributions to the advancement of plant sciences and biodiversity based research in India and has provided visionary leadership to several premier national scientific and research institutions. He served as Director of the NBRI from February 1999 to February 2006 and as Director of the JNTBGRI from November 1990 to February 1999. He also held the additional charge of Director of the RGCB from 18 April 1994 to 15 December 1994 and of the CIMAP from 31 December 2000 to 10 May 2001. Dr. Pushpangadan is distinguished by his extensive multidisciplinary expertise and more than 43 years of research experience spanning fundamental, applied and translational domains of plant science. His scholarly contributions comprise of more than 543 scientific publications, including 300 original research papers/review articles in peer reviewed national and international journals, 186 chapters in scholarly books, 31 books authored/edited and more than 26 popular articles. He has further enriched the scientific literature through the authorship and editing 58 scientific reports (Appendix I).



KSCSTE - Jawaharlal Nehru Tropical Botanic Garden & Research Institute



CSIR-National Botanical Research Institute (NBRI)

Early research in cytogenetics and plant breeding: Dr. Pushpangadan commenced his scientific career in 1969 at the CSIR Regional Research Laboratory, Jammu, under the guidance of the late Dr. Janaki Ammal. During this period, he acquired fundamental expertise in cytological techniques and chromosome counting.

By employing both conventional and modern plant-breeding approaches, he developed high-quality hybrids of *Ocimum* and *Cymbopogon* species, including the eugenol-rich *Ocimum* hybrid 'CLOCIMUM' and the geraniol-rich *Cymbopogon* hybrid 'JAMROSA', both of which have subsequently been brought under commercial cultivation. His fundamental investigations on the inheritance and biosynthesis of essential-oil constituents, employing radioisotope tracer techniques in combination with systematic breeding studies, provided evidence for the non-mevalonate pathway involved in the biosynthesis of certain monoterpene compounds and elucidated their patterns of inheritance in *Mentha* and *Ocimum* species. Dr. P. Pushpangadan developed a comprehensive understanding of the functional dynamics of medicinal and aromatic plants. Through experimental investigations, he demonstrated the evolution of new species/varieties in certain medicinal plants and investigated the inheritance and expression of therapeutically important principles in medicinal and aromatic plants. Based on these studies, he established that although the inheritance and expression of therapeutic principles, particularly secondary metabolites, are genetically regulated, their specific expression is modulated by a range of macro- and micro-environmental factors, including both biotic and abiotic factors, as well as by the developmental stage of the plant. These findings have considerable significance for the domestication and systematic cultivation of medicinal plants that predominantly occur in the wild.

In 1975, he and his research group transferred the technology for cultivation of colchicum over an area of approximately 30,000 hectares to Hindustan Unilever Ltd. *O. canum* Sims (linalool-rich), *O. americanum* L. (methyl chavicol-rich), *O. cv. citratus* (citril-rich), and the *Cymbopogon* hybrid 'JAMROSA' (geraniol-rich) were among the strains released for cultivation by external agencies.

Development of ethnobiology as a multidisciplinary research field & establishment of ethnopharmacology research in India: In 1983, he was appointed as Chief Coordinator of the All India Coordinated Research Project on Ethnobiology (AICRPE), launched by the Ministry of Environment and Forests, Government of India. AICRPE was a multi-institutional and multidisciplinary research programme that represented a logical outcome of the vision articulated by Prof. M. S. Swaminathan in 1976. The programme was aimed at documenting the multidimensional aspects of the life, cultural traditions and knowledge systems associated with the utilization of biological resources by the tribal communities of India. It comprised 25 centres located in

various universities and national laboratories and involved more than 600 scientists representing diverse disciplines, including botany, zoology, anthropology, chemistry, pharmacology and social sciences. As Chief Coordinator, Dr. Pushpangadan guided, supervised and coordinated the research activities undertaken at these centres. Based on the data generated through AICRPE, he initiated the development of a digitized National Database on Ethnobiology.



Dr. P. Pushpangadan receiving the Norman Borlaug Award from Prof. M. S. Swaminathan in 1988 for his pioneering research contributions in biodiversity conservation, ethnobiology and bioprospecting

It was at CSIR - Indian Institute of Integrative Medicine (IIIM), Jammu, that Dr. Pushpangadan initiated research in cytogenetics under the guidance of Dr. Janaki Ammal and subsequently established the first ethnopharmacology research division in India in 1985 to undertake systematic scientific investigations of traditional remedies. The ethnopharmacological research framework developed by Dr. Pushpangadan integrated the theoretical foundations, practices and knowledge systems of Ayurveda with contemporary scientific knowledge, methodologies, tools and technologies of modern medicine. The approach also incorporated the expertise of Sanskrit scholars for the interpretation and documentation of traditional medical knowledge. Subsequently, full-fledged Ethnomedicine and Ethnopharmacology Divisions were established under his leadership at JNTBGRI in 1992, where he had joined as Director in 1990, and at NBRI, Lucknow, in 1999.

In 1989, the Government of India appointed Dr. Pushpangadan as the National Consultant for Medicinal Plants and recommended his candidature to the World Health Organization (WHO). WHO subsequently engaged him to investigate the causes underlying the decline of traditional systems of medicine. In his report to WHO, Dr. Pushpangadan identified the declining availability of medicinal plants required for treatment within local health traditions as a major contributing factor and consequently recommended the systematic conservation and cultivation of medicinal plants, particularly those collected from wild populations. WHO accepted these recommendations and

requested the concerned funding agencies to initiate appropriate measures. The Danish International Development Agency (DANIDA) subsequently supported the conservation initiative and constituted a five-member committee, including Dr. Pushpangadan, to examine the issue and formulate recommendations. Dr. Pushpangadan served as the WHO nominee on this committee. After three months, the committee submitted its report recommending the establishment of *in-situ* gene banks and *ex-situ* conservation systems. DANIDA supported the programme with approximately Rs. 12 crores. At this stage, Mr. Darshan Shankar, who had been associated with the programme from its inception, proposed that the funds should be channelled through a non-governmental organization. Accordingly, the funds were provided to a newly established NGO formed by the Ministry of Environment and Forests, namely the Foundation for Revitalisation of Local Health Traditions, of which Dr. Pushpangadan was a Founder Member.

Transformation of JNTBGRI into a multidisciplinary research institution: Soon after assuming charge, Dr. Pushpangadan reorganized and streamlined the activities of JNTBGRI and initiated several new action-oriented research programmes in both the garden and laboratory. Systematic, action-oriented research at JNTBGRI was substantially strengthened following his appointment. Prior to 1990, the Institute had no significant externally funded research programmes. Dr. Pushpangadan independently prepared several major research proposals and submitted them to national and international funding agencies. Within approximately one year, JNTBGRI began receiving several externally funded projects, resulting in the initiation and expansion of active research and developmental programmes in both the garden and laboratory. Within three to four years, Dr. Pushpangadan transformed JNTBGRI into a leading biodiversity research centre of international recognition.

Dr. Pushpangadan organized extensive and systematic plant exploration, inventory, collection and characterization of rare, endangered and endemic tropical plant species of India at morphological, cytological, chemical and molecular levels. These initiatives contributed to the establishment of one of the finest and largest conservatory gardens and field gene banks in Asia. During this period, he also initiated research in several emerging areas, including molecular taxonomy, bioprospecting through chemical screening and DNA fingerprinting, drug prospecting, molecular genetics and bioinformatics at JNTBGRI.

Dr. Pushpangadan established the first fully fledged Ethnomedicine and Ethnopharmacology Division in the country at JNTBGRI. The interdisciplinary Ethnomedicine and Ethnopharmacology Division, headed by Dr. S. Rajasekharan, functioned under his direct supervision, developed and patented more than 15 scientifically validated and standardized herbal drugs.

TBGRI Model or Pushpangadan Model of Benefit Sharing: The development and commercialization of the herbal drug 'JEEVANI' resulted in the establishment of a globally acclaimed model of equitable benefit sharing, representing a landmark contribution to the recognition of traditional knowledge and the fair sharing of benefits arising from its scientific and commercial utilization. Jeevani was developed based on knowledge obtained from Kani tribal community. The model relates to the development of the scientifically validated herbal drug, "JEEVANI", based on a tribal lead obtained from a plant species known as "*Arogyapacha*". This is considered as the first Benefit Sharing model in the world.

Based on the technology transfer of JEEVANI to the Arya Vaidya Pharmacy (Coimbatore) Limited, JNTBGRI decided to part with 50% of the license fee (Rupees 10 lakhs) and royalty (2%) received from the company to the Kani tribal community who provided the lead of *Arogyapacha*. Through this Benefit Sharing, JNTBGRI implemented Article 8(j) of the Convention on Biological Diversity (CBD) and recognized the IPR of Kani tribe. To implement the Benefit Sharing mechanism, Kani tribe registered a Trust called Kerala Kani Samudaya Kshema Trust with the guidance and support of JNTBGRI. The benefits received from the technology transfer as license fee and royalty were remitted to the Trust account.

Pre-benefit sharing mechanism implemented through the appointment of two informants, Mallan Kani and Kuttimathan Kani of Chonampara tribal settlement, Kottoor, Thiruvananthapuram district, Kerala as consultants in the Division of Ethnomedicine and Ethnopharmacology at TBGRI for a period of 7 years from 1993 to 1999. They were benefited with the remuneration paid for Rs. 504000/- (@ 3000/ month for 2 persons). This is one of the novelties of ABS Kani model of benefit sharing. This benefit-sharing mechanism subsequently became widely recognized as the TBGRI Model or Pushpangadan Model of Benefit Sharing. At the invitation of UNDP Equator initiative Summit, Dr. Pushpangadan presented this model at the UNDP Centre in Geneva. He was subsequently awarded the prestigious UNDP Equator Initiative Award in 2002 for this contribution during the World Summit on Sustainable Development held in Johannesburg in 26 August – 4 September 2002.

Biodiversity based rural development: Dr. Pushpangadan conceived and successfully implemented a grassroots-level, action-oriented rural development programme under the titles "Herb for All and Health for All" and "Plants for All and Job for All" in four selected villages in Thiruvananthapuram district, Kerala. The programme was essentially a self-help initiative aimed at empowering rural communities, particularly women and homemakers, to address household requirements related to food, nutrition and primary healthcare through optimal utilization of local biodiversity. The programme also



Prof. (Dr.) P. Pushpangadan, former Director of JNTBGRI, handing over a cheque of Rs. 5.19 lakhs to the Kerala Kani Samudaya Kshema Trust

focused on providing training in the productive utilization of local biological and natural resources through the application of science and technology, thereby facilitating the conversion of local biodiversity and other natural resources into economic value. He established an ideal home-garden model at JNTBGRI in 1994, which was subsequently replicated in the villages. Following the successful implementation of the programme, several neighbouring villages expressed interest in its extension. The Kerala State Planning Board subsequently incorporated the programme into the decentralized People's Plan Programme in 40 villages in 1998. The World Bank and WHO subsequently jointly deputed a team to document the programme through a video film entitled 'Nature's Pharmacy', which was subsequently disseminated internationally.

Conservation biology and gene bank: He introduced the concept of establishing field gene banks in botanical gardens with support from the Department of Biotechnology (DBT). In 1993, he established the first Field Gene Bank of medicinal and aromatic plants at the JNTBGRI. He collected approximately 210 rare, endangered and threatened plant and tree species from the Andaman and Nicobar Islands and introduced them at JNTBGRI. This conservation initiative subsequently contributed to the preservation of these plant resources during the Tsunami calamity that affected the region on December 25, 2005. Dr. Pushpangadan also established a dedicated Conservation Biology and Gene Bank Programme for medicinal and aromatic plants at JNTBGRI.

During the period 1991–1999, he, together with a team of scientists, developed one of the finest and largest conservatory gardens in Asia at JNTBGRI, comprising more than 56,000 plant accessions representing over 7,000 tropical plant species. The Field Gene Bank for medicinal and aromatic plants established at JNTBGRI with financial assistance from the Department of

Biotechnology, Government of India, represented a distinctive conservation initiative and was visited and highly appreciated by internationally renowned scientists, including Peter Raven of the USA, Prof. V. Heywood and Sir G. T. Prance. He also initiated systematic and rapid bioprospecting programmes involving chemical screening and DNA fingerprinting, as well as drug-prospecting programmes employing contemporary techniques in chemistry, biotechnology and molecular biology. In addition, *in-vitro* tissue repositories, pollen banks, seed banks and cryopreservation facilities were initiated at JNTBGRI during 1997–1999.



Dr. P. Pushpangadan with Sir G. T. Prance at the Conservatory Garden of JNTBGRI

Leadership at the National Botanical Research Institute (1999 to Jan 2006): In February 1999, Dr. Pushpangadan assumed charge as Director of the National Botanical Research Institute (NBRI), Lucknow, one of the major plant research institutes of international repute under the Council of Scientific and Industrial Research (CSIR). As Director of NBRI, approximately 510 scientific, technical and administrative personnel worked under his leadership. The major R&D activities of NBRI undertaken under the guidance of Dr. Pushpangadan as Director are summarized below.

Reorganization of R & D programmes: Immediately after assuming charge in 1999, Dr. Pushpangadan reassessed the mandate of NBRI to align its activities with emerging scientific and technological advances and to strengthen the core competencies of its R&D groups in cutting-edge areas, while also developing efficient self-financing mechanisms to support the productive growth of the Institute. In accordance with the vision and strategic directions articulated in the CSIR-2001 vision and strategy document and with the expert guidance of the Research Advisory Committee (RAC), Dr. Pushpangadan reorganized the R&D structure of NBRI and clearly defined its vision and mission, with emphasis on both basic and applied research. Activities related to inventory, collection, documentation, database development and sustainable utilization of wild plant genetic resources of the country were strengthened. Classical taxonomy was integrated with advanced approaches, including gene

prospecting, molecular taxonomy and chemical prospecting, to enable comprehensive characterization and preparation of passport data for rare, endangered and endemic plant species of India. A field gene bank for rare, endangered and endemic plants of the Indo-Gangetic plains was initiated, while the *in-vitro* gene bank was further strengthened. Plant biotechnology, including molecular biology and genetic engineering, was also strengthened to facilitate both fundamental and applied research.

Creation of new R&D initiatives: The reforms in R&D management at NBRI gained further momentum through the introduction of transdisciplinary research programmes encompassing both basic and applied research. New action-oriented interdisciplinary R&D divisions were established through the reorganization and restructuring of existing divisions and the creation of new divisions and infrastructure facilities. Some of the major initiatives are described below:

Pharmacognosy & ethnopharmacology division: The existing Pharmacognosy Division was strengthened through the provision of additional facilities and human resources, including recruitment of personnel with expertise in Ayurveda, phytochemistry, pharmacognosy, pharmacology and pharmacy. The primary objective was to undertake bioprospecting for biodynamic molecules and develop scientifically validated and standardized herbal drugs, with particular emphasis on primary healthcare products, pharmaceuticals, herbal health drinks, nutraceuticals, functional and designer foods, cosmeceuticals, safe natural dyes and biopesticides. During the seven-year period from 2000 to 2006, several products were developed and more than 232 patents were filed in India and abroad, including 95 original patents. Nine herbal products, namely 'Herbal Gulal' (safe natural colours for Holi), 'Nutra-diab' (a designer food for diabetics), 'Nutri Jam' (a nutrient-rich jam), 'Nabira' (a herbal health drink), 'Luvstick' (an herbal functional lipstick) and 'Anticig' (a herbal formulation intended to support cessation of smoking and other tobacco-related habits), were transferred to private companies for commercial production against payment of license fees and royalties. 'Anticig' subsequently received clearance from the US FDA for marketing in the USA. According to the source material, this represented one of the earliest instances of an Indian herbal product receiving such clearance.

He also provided leadership in ethnopharmacological research aimed at developing scientific methodologies and strategies for the standardization of medicinal plants, crude drugs, finished herbal drugs and other plant-based products. The objective was to establish reproducible conditions for the production of herbal products and drugs conforming to defined standards of quality, purity, stability, safety and shelf-life. These standardization approaches were subsequently strengthened and recognized by relevant governmental and scientific agencies.

Government of India recognized NBRI in 2002 as the nation's referral centre for medicinal plants/crude drugs and herbal drug standardization:

Nutraceutical research: One of the significant contributions of Dr. Pushpangadan was the development of a new direction in bioprospecting at NBRI focused on the development of nutraceuticals through integrated research on indigenous plant resources and the traditional knowledge associated with them. Over the subsequent years, the NBRI nutraceutical research group developed a range of customized nutritional supplements and functional foods for pregnant and lactating women, infants, growing children, diabetic patients and elderly populations, with specific nutritional and functional objectives related to growth, brain development and physiological well-being. 'Nutra-diab', a designer food developed for diabetic patients following appropriate clinical evaluation, was transferred to a company and subsequently made commercially available. Other nutraceutical products progressed through different stages of development, standardization and technology transfer.

Field gene bank for rare-endemic and threatened plants: Building upon the field gene bank model established by him at JNTBGRI, Dr. Pushpangadan subsequently focused on establishing a similar simulated '*in-situ*' field gene bank for rare, endemic and threatened plant species of the Indo-Gangetic plains. This represents an innovative approach to rare-plant conservation in which threat-prone species are introduced and protected at a new natural site in which ecological conditions comparable to their original habitats are recreated. Such an approach facilitates the maintenance of natural vigor and supports the establishment, regeneration and persistence of viable populations.

Bioinformatics: A full-fledged bioinformatics division was established with state-of-the-art infrastructure, computing facilities and intra- and internet connectivity to support the research activities of scientists. The Bioinformatics Division developed several digital resources, including CD-ROM-based resources and databases on the plants of India, the Plants of India Database available on the web, the Regional Database on Legumes of South Asia, and a digitized database on Ethnobiology, incorporating value-added information. The Division also established a dedicated website for NBRI.

Touch and smell garden for physically challenged and visually impaired: The "Touch and Smell Garden" is a specialized facility developed at NBRI for visually impaired and physically challenged persons. Established over an area of approximately 0.1 hectare, the garden contains diverse plant species characterized by fragrant flowers and/or aromatic foliage. Plant labels containing relevant botanical and other information are provided in the Braille system. The Touch and Smell Garden at NBRI represents an innovative facility for inclusive botanical education and public engagement.



Dr. P. Pushpangadan with Former President of India, Dr. A.P.J. Abdul Kalam at Touch and Smell Garden, National Botanical Research Institute (NBRI)

Eco education & rural empowerment: The botanical garden at NBRI attracts visitors representing diverse sections of Indian society. Recognizing the importance of botanical gardens as platforms for public education and dissemination of scientific knowledge, Dr. Pushpangadan established the Eco-Education Centre in 2001. The centre was specifically designed to engage young students and create awareness regarding biodiversity conservation and sustainable utilization of biological resources. It provides students and members of the public with opportunities to examine models, equipment, experiments, exhibits and scientific literature, thereby facilitating understanding of fundamental concepts in ecology and environmental biology and appreciation of the importance of nature conservation. The centre also implemented outreach programmes aimed at enhancing the knowledge base and capacities of rural communities.

Dr. Pushpangadan was instrumental in designing and developing various theme gardens and outreach programmes at NBRI aimed at generating awareness among diverse target groups, including women and children, regarding the importance and potential of plant resources in ensuring food, nutritional, health and ecological security for both rural and urban populations of Uttar Pradesh. To address nutritional security and prenatal and postnatal healthcare requirements of women, as well as the appropriate growth and development of infants and young children, particularly during critical stages of brain development, a model kitchen garden for rural and urban households was developed at NBRI. This model theme garden provided a practical demonstration of the potential of locally available plant resources to support household nutrition and health. An outreach programme focusing on food and nutrition also gained acceptance among rural women by assisting them in designing home gardens using locally available plant resources and providing an environmentally sustainable opportunity for supplementary income generation.

The objective of the outreach programme implemented by NBRI under the leadership of Dr. Pushpangadan was to empower rural communities, particularly rural women, to utilize local biological resources in a sustainable and productive manner. Dr. Pushpangadan and his team developed a structured and user-friendly database on the biological resources of Uttar Pradesh. This resource supported the identification of location-specific production technologies capable of converting locally available biological resources into economic value and thereby contributing to rural employment generation. Under the outreach programme, Dr. Pushpangadan and his team selected several villages for the development of home and community gardens aimed at enhancing household food, nutritional and primary healthcare security. The selected villages included Chatarpur and Bhairanau of Block Bakshi Ka Talab (BKT) and Kalli Paschim of Block Sarojini Nagar, Lucknow District. As an initial step, the research team undertook a detailed assessment of the socioeconomic, technological and economic conditions and quality of life of the communities and documented locally available biological resources and other facilities. The assessment indicated that these villages were socioeconomically disadvantaged and affected by malnutrition, illiteracy and limited livelihood opportunities. The team subsequently selected Kalli Paschim as a model village for focused intervention. The programme was primarily directed towards women and homemakers, and a knowledge-empowerment initiative was implemented to enhance the skills and capacities of households to achieve greater self-reliance in food, nutrition and primary healthcare. Women were encouraged to establish home and community gardens containing nutritionally rich vegetables, fruits and medicinal plants required for primary healthcare. Quality planting materials, including pulses, vegetables such as protein-rich winged bean, and medicinal plants, were supplied to the participating households. After three years, the programme demonstrated substantial improvement, with most households maintaining productive home gardens that contributed to their nutritional requirements. Women were also trained in the preparation of safe and simple herbal remedies for common self-limiting ailments and encouraged to market surplus garden produce as a means of generating supplementary income and enhancing their economic independence.

Under the women empowerment programme, the Horticulture Division of NBRI provided hands-on training in cultivation and value addition, including flower drying and preparation of various value-added products. During the four-year period, approximately 800 women received training in floriculture and flower-drying techniques. A substantial number of farmers, rural women and homemakers subsequently utilized these skills for self-employment and income generation.



Dr. P. Pushpangadan with Dr. Ulf Nyman, distinguished Swedish seed specialist and ethnopharmacologist, who served as a Professor at the University of Copenhagen and Dr. V. George, renowned Phytochemist and Former Scientist F, JNTBGRI

Collaborative ventures with Govt. of Uttar Pradesh:

Dr. Pushpangadan, together with Dr. C. S. Nautiyal and Dr. H. B. Singh, initiated a collaborative programme between NBRI and the Department of Agriculture, Government of Uttar Pradesh, to facilitate the transfer of laboratory-developed technologies to agricultural fields. Products such as plant growth enhancers and biopesticides developed by NBRI for seed, soil and foliar applications were successfully transferred/licensed to the Department of Agriculture. More than 200 officers of the Department of Agriculture and over 2,000 farmers were trained by NBRI in the production and application of biopesticides developed through the Institute's research programmes. Commercial production based on the transferred technologies commenced in 2004. According to the source material, approximately 90,000 acres had been brought under legume cultivation using these technologies. On 20 September 2005, NBRI organized a training programme for agricultural officers, and cultures of *Rhizobium* and *Azotobacter* developed by NBRI were distributed for application over approximately 51,500 and 10,500 acres of pulse and wheat crops, respectively. Similarly, field trials were conducted on Department of Agriculture farms using phosphate-solubilizing bacteria (PSB) developed by NBRI. The PSB technology was projected to cover approximately 20,475 acres across Uttar Pradesh by 2006. These technologies provided multiple benefits, including enhanced agricultural productivity and reduced dependence on synthetic chemical fertilizers and potentially harmful pesticides, thereby contributing to environmental protection and sustainable agricultural production.

Major awards and recognitions: Prof. Pushpangadan has received numerous national and international medals and awards, including the prestigious Norman Borlaug Award in 1998, the UNDP Equator Initiative Award in 2002 at the World Summit in Johannesburg, South Africa, the Ayurved Gaurav Award in 2009, the Padma Shri

Award in 2010, and the Dr. A. P. J. Abdul Kalam Memorial NABS Lifetime Achievement Award in 2020 from the National Academy of Biological Sciences, Chennai. He is a Fellow of the National Academy of Sciences (FNASc), a Fellow of the National Academy of Agricultural Sciences (FNAASc), and a Fellow of five other scientific bodies in India. He has served as President of the National Society of Ethnopharmacology and as President of the International Society of Ethnopharmacology (1998–2001) and the International Society of Environmental Botanists (April 1999–January 2006). He has also served as Vice-President, Chairman, Vice-Chairman and Member of several national and international scientific bodies and committees. He has visited more than 78 countries in various capacities, including as leader of scientific delegations, scientific expert, participant in international seminars and symposia, and chair of international expert panels for the review of research programmes.



Dr. P. Pushpangadan receiving the Padma Shri Award from the Former President of India, Smt. Pratibha Patil, in 2010

Ode repetition to an institutional builder and visionary that will be remembered for decades: Prof. (Dr.) P. Pushpangadan's distinguished scientific career represents a significant chapter in the evolution of modern Indian plant science and biodiversity-based research. His scholarly contributions exemplify how foundational investigations in cytogenetics, plant breeding and secondary-metabolite biosynthesis can evolve into comprehensive multidisciplinary programmes encompassing ethnobiology, ethnopharmacology, conservation biology, bioprospecting, natural-product development and rural technology transfer. His scientific journey is characterized by the seamless integration of fundamental research with applied and translational approaches, thereby establishing meaningful connections between biological discovery, technological innovation and societal benefit.

His visionary institutional leadership at JNTBGRI transformed the Institute into a multidisciplinary centre of excellence in biodiversity research, supported by extensive programmes in plant exploration and characterization, field gene-bank establishment, advanced

conservation repositories, and molecular and chemical bioprospecting. At NBRI, he further expanded this scientific vision through integrated programmes encompassing herbal drug standardization, nutraceutical research, bioinformatics, plant biotechnology, agricultural technology and environmental education. These initiatives collectively strengthened the interface between plant genetic resources, scientific innovation, sustainable utilization and societal development.

Among his most enduring scientific and societal contributions is the TBGRI/Pushpangadan Model of Benefit Sharing, associated with the development and commercialization of the herbal drug *Jeevani*. The model demonstrated, in a pioneering manner, how traditional knowledge could be integrated with scientific validation, intellectual-property protection and commercialization while ensuring direct and equitable economic benefits to knowledge-holding communities. This innovative framework represents a landmark in the evolution of contemporary approaches to traditional knowledge, bioprospecting and equitable benefit sharing, and continues to hold profound relevance in addressing the interconnected challenges of biodiversity loss, sustainable bioresource utilization, protection of traditional knowledge, natural-product discovery, rural livelihood development and the emergence of a knowledge-driven bioeconomy.

The legacy of Prof. Pushpangadan therefore extends far beyond individual scientific discoveries, publications or institutional achievements. Its enduring significance lies in the conceptual and institutional framework he developed, linking plant diversity, traditional knowledge, scientific inquiry, biodiversity conservation, technological innovation, intellectual property, technology transfer and community empowerment into an integrated continuum of knowledge and action. This holistic paradigm represents a significant foundation for contemporary research, innovation and policy in ethnobiology, ethnopharmacology, biodiversity conservation and the sustainable utilization of biological resources, while providing a compelling model for translating the richness of biological and traditional knowledge into scientifically validated, socially responsible and economically sustainable outcomes.

The memory of Prof. (Dr.) P. Pushpangadan will continue to inspire botanists, ethnobiologists, pharmacologists, conservationists and all those committed to advancing scientific knowledge while safeguarding humanity's rich biological and cultural heritage.

Prof. (Dr.) P. Pushpangadan is survived by his wife, Dr. P. Sreedevi, a retired Civil Surgeon and Gynaecologist, and his son, Dr. Vipin Mohan Dan, Senior Scientist at the JNTBGRI, Palode, Thiruvananthapuram. He was preceded in death by his elder son, Mr. Ajay Mohan Dan, who passed away in 2022.

Personal Reminiscences of Prof. (Dr.) P. Pushpangadan

• Dr. P. G. Latha

Former Director, Jawaharlal Nehru Tropical Botanic Garden and Research Institute (JNTBGRI), Thiruvananthapuram, India

Former Executive Editor, Journal of Traditional and Folk Practices

My association with Dr. Pushpangadan began in August 1990, soon after he joined JNTBGRI as its third Director. As a young scientist, I first met him with considerable apprehension, but within minutes his warmth, humility and encouraging nature put me completely at ease. He listened patiently to my work, offered thoughtful suggestions and from that day onward I never hesitated to seek his guidance on matters concerning the Institute.

Dr. Pushpangadan was not only an outstanding administrator but also one of the finest scientists I have known. A voracious reader with an exceptional command of English, he made pioneering contributions to botany, biotechnology, ethnomedicine, ethnopharmacology and related disciplines. His intellectual curiosity, scientific rigor and unwavering commitment to excellence made him a role model for generations of researchers.

Beyond his scientific accomplishments, he was a true gentleman kind, humble and generous with his time. During my tenure as Director, I frequently sought his advice on both professional and personal matters. I fondly remember visiting him and Madam Sreedevi at their home, where we spent many enjoyable hours in conversation. Despite living with diabetes, he had a special fondness for sweets, and I always carried some for him during my visits.

Few people knew that he was also a gifted performer of Kathakali and Mohiniyattam, delighting audiences during the Institute's Annual Day celebrations. His deep knowledge of indigenous food plants and traditional medicine reflected his lifelong commitment to documenting India's tribal and folk medicinal heritage and integrating it with modern scientific research for the benefit of society.

Dr. Pushpangadan's life and work continue to inspire all who had the privilege of knowing him. His scientific vision, exemplary leadership and enduring humanity will remain an inspiration to future generations. I offer my humble pranams to his cherished memory.

• Dr. K. N. Nair

Former Chief Scientist, Plant Diversity, Systematics & Herbarium, CSIR-NBRI, Lucknow

Former Member, Editorial Board, Journal of Traditional and Folk Practices

Following his distinguished tenure at JNTBGRI, Dr. Pushpangadan was appointed Director of the CSIR–National Botanical Research Institute (CSIR-NBRI), Lucknow, in February 1999. During his tenure from 1999 to 2006, he transformed NBRI into a leading international centre for plant science through visionary leadership and major institutional reforms.

During the initial phase of his stewardship at NBRI, Dr. Pushpangadan restructured and reoriented the institute's research and development programmes, with a strong focus on harnessing the potential of indigenous plant and microbial resources to develop innovative and affordable technologies, products and services for human welfare and sustainable development. New disciplines, such as Molecular Taxonomy, Ethnopharmacology and Eco-education, were introduced to strengthen the institute's ongoing R&D in systematics, bioprospecting and outreach activities. A full-fledged Information and Communication Technology (ICT) facility was also established to enhance the institute's overall science and technology management. His visionary approach to transdisciplinary research in bioprospecting led to the development of a broad spectrum of herbal and microbial products and technologies, including herbal drugs, pharmaceuticals, nutraceuticals, cosmeceuticals and biopesticides. Several of these IPR-protected products and processes were subsequently transferred to industry for commercial production and marketing.

Dr. Pushpangadan also forged strong partnerships with government agencies and industry, promoting "lab-to-land" initiatives in biofertilizers, biopesticides and sustainable agriculture. Under his leadership, NBRI established field gene banks for threatened plant species, developed thematic public gardens and created the internationally acclaimed Herbal and Tactile Gardens at Rashtrapati Bhavan. Several thematic gardens, namely the Kitchen Garden, Community Garden and Garden for the Blind and Hearing Impaired, were also developed at NBRI to promote education, public awareness and the empowerment of youth and women. The Herbal Garden and Tactile Garden at Rashtrapati Bhavan in New Delhi, developed at the behest of the then President of India,

Dr. A.P.J. Abdul Kalam, with the support of the National Medicinal Plants Board (NMPB), received international acclaim. His pioneering work in medicinal plants, traditional knowledge, biodiversity conservation and equitable benefit sharing earned NBRI national and international recognition, leaving a lasting legacy in Indian plant science and conservation.

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Appendix I

Publications of Prof. (Dr.) P. Pushpangadan

Research Papers/Review Articles Published in Peer Reviewed Journals

- Ambily, D.V., N.P. Rajith, V. George and P. Pushpangadan. 2011. Utilization of medicinal plants by the Paniyan tribe of Kozhikode district, Kerala. *Ethnobotany*. 22: 14–24.
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