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7 August 1925 — 28 September 2023



*M. S. Swaminathan*



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Elected FRS 1973

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Professor Monkombu Sambasivan Swaminathan, celebrated as the father of the Indian Green Revolution, has significantly contributed to global food security. Born on 7 August 1925 in Kumbakonam, India, his early experiences during the Bengal famine of 1942–1943 profoundly influenced his career in genetics and plant breeding, leading to a PhD from the University of Cambridge in 1952. Upon returning to India in 1954, he dedicated himself to agricultural improvement. His pivotal role from 1960 to 1982, primarily through introducing Mexican dwarf wheat varieties and hybrid rice, dramatically increased agricultural productivity and reduced famine risks. Following the Green Revolution, Swaminathan focused on nutritional security, specifically addressing ‘hidden hunger’. As a renowned institution builder, he greatly enhanced India’s agricultural research infrastructure while serving as director general of the Indian Council of Agricultural Research. He initiated several vital

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programmes, such as the Agricultural Scientists Recruitment Board, the All-India Agricultural Research Services and the 'lab-to-land' programme, which connected scientific research with practical farming applications across India. Internationally, Swaminathan's contributions were profound; he served as the independent chairman of the UN FAO Council and director general of the International Rice Research Institute. His work earned him the inaugural World Food Prize 1987, often called the 'Nobel Prize for Food and Agriculture'. His other accolades include the UNEP Sasakawa Environment Prize and the Global Environmental Leadership Award. Swaminathan was elected Fellow of the Royal Society in 1973 and has been honoured with all Indian civilian awards, including the Padma Bhushan, Padma Vibhushan and the Bharat Ratna, India's highest civilian award, bestowed in 2024 by the president of India to acknowledge his profound impact on Indian agriculture and global food security. A short list of awards can be found at the end of this memoir, and a full list is included in an online supplement.

## INTRODUCTION

In the annals of agricultural history, one name emerges as a beacon of hope and unwavering dedication to humanity: Monkombu Sambasivan Swaminathan, often affectionately called 'Professor Swaminathan'. Celebrated as a visionary scientist and staunch advocate for a 'Zero Hunger' world, his profound influence has reshaped both India's agricultural landscape and global food security initiatives. His career was characterized by a blend of scientific expertise and astute administrative skills, which together spurred abundant harvests, eradicated famine and positioned India as a leader in global wheat and rice production (figure 1). Professor Swaminathan's pivotal contributions during India's transformative Green Revolution from 1960 to 1982 solidified his status as a luminary in agricultural science. As Swaminathan himself eloquently stated, 'the future belongs to nations armed with grain, not guns'. This memoir celebrates the life, work and enduring legacy of this extraordinary agricultural scientist.

## CHILDHOOD, EDUCATION AND EARLY CAREER CHOICES

Born on 7 August 1925 in Kumbakonam, Madras Presidency (now Tamil Nadu), M. S. Swaminathan was the second son of Dr M. K. Sambasivan and Parvati Thangammal Sambasivan. His father, a renowned social reformer and surgeon, established a large hospital in Kumbakonam. After his father's untimely death, from the age of 11, Swaminathan was raised by his uncle, M. K. Narayanaswami, a radiologist. Although expected to pursue a medical career and manage his father's hospital, Swaminathan's educational journey took a different trajectory. After transferring to the Catholic Little Flower High School in Kumbakonam, where he successfully passed the matriculation exam aged 15, his passion for genetics redirected his path during the tumultuous period of the Quit India Movement and the Bengal famine of 1942–1943. In 1947 he earned a BSc in agriculture from Coimbatore Agricultural College, Madras University (now Tamil Nadu Agricultural University). He



Figure 1. M. S. Swaminathan in a wheat field. Photograph courtesy of MSSRF, Chennai, India.

later completed postgraduate studies in genetics and plant breeding at the Indian Agricultural Research Institute (IARI) in New Delhi by 1949, followed by a United Nations Educational, Scientific and Cultural Organization (UNESCO)-Netherlands fellowship in potato genetics at the Agricultural University in Wageningen (now Wageningen University and Research), The Netherlands (see also Fresco 2015). In 1950 he joined the School of Agriculture at the University of Cambridge, where he earned his PhD in 1952 for his thesis on ‘Species differentiation and the nature of polyploidy in certain species of the genus *Solanum* – section *Tuberarium*’. Despite an offer to join the faculty at the University of Wisconsin, USA, Swaminathan returned to India in early 1954, determined to apply his expertise for the betterment of his homeland.

#### PIONEERING CAREER: LEGACY OF LEADERSHIP IN RESEARCH, EDUCATION AND POLICY

For over seven decades, Swaminathan forged an illustrious career that profoundly impacted agriculture science and food production globally. He began as a young scientist, venturing into farm fields and laboratories across three continents. As his expertise grew, he assumed critical roles within Indian government agencies and agricultural research institutions, as well as advisory capacities both domestically and internationally. His leadership in these roles has left a permanent mark on agricultural research and policy development.

#### *Research, education and extension contribution*

Swaminathan’s pioneering research career commenced in 1949, reflecting his visionary approach to scientific inquiry and his dedication to addressing global food security challenges. His formative years yielded groundbreaking discoveries in genetics and speciation within the *Solanum* genus, particularly the *Tuberarium* section (1–4). His

findings were published in esteemed journals such as *Genetics*, *Nature*, *Journal of Heredity*, *Genetica*, *Euphytica*, *Bibliographica Genetica*, *American Journal of Botany* and *American Potato Journal* (1–7). These publications illuminated the intricate mechanisms governing speciation in the *Solanum* genus, with a focus on the *Tuberarium* section. His seminal works include ‘Induced polyploids in the tuber-bearing *Solanum* species and their crossability with *Solanum tuberosum*’ (1) and a comprehensive collaboration with Dr H. W. Howard in 1953 titled ‘The cytology and genetics of the potato (*Solanum tuberosum* L.) and related species’ (3). These remain enduring classics in the field (1, 3, 4).

Swaminathan’s deep understanding of the genomic relationships between cultivated tetraploid potatoes ( $2n = 4x = 48$ ; *Solanum tuberosum*) and their wild diploid counterparts ( $2n = 2x = 24$ ) led to groundbreaking interspecific hybridization efforts. This monumental breakthrough facilitated the transfer of genes conferring resistance to both abiotic and biotic stresses in potatoes. His paper published in *Nature* on 5 November 1955 showcases his ingenious approach to resolving cross-incompatibility among certain diploid species of *Solanum* (5). This accomplishment was particularly significant in the context of crosses between *Solanum pinnatisectum* and *Solanum bulbocastanum*, as these were the only species known at that time to possess genes conferring resistance against late blight in potatoes. During his tenure as a young research scholar at the University of Wisconsin, USA, he achieved a milestone by developing a revolutionary potato hybrid. This innovative hybrid incorporated the frost-resistance gene sourced from the tetraploid wild relative *Solanum acaule* ( $2n = 48$ ). Subsequently, this hybrid material played a pivotal role in the creation of a renowned frost-resistant potato variety widely celebrated as ‘Alaska Frostless’. Swaminathan’s deep commitment to his homeland inspired his bold decision to return to India, where he subsequently forged a highly successful career.

#### *Architect of the Indian Green Revolution*

Swaminathan embarked on a quest to increase agricultural productivity, particularly of staple food grains like wheat and rice (8–10, 15). The seeds of the Green Revolution were first sown in the fields of the Central Rice Research Institute (CRRI) through the *indica-japonica* rice crosses. This programme laid the early foundations for the Green Revolution in India, leading to the development of fertilizer-responsive rice varieties suited for Indian rice-growing regions. His work in mutation breeding, genetic relationships among wheat species and the incorporation of dwarfing genes in wheat and rice marked significant turning points in global crop production. His tireless efforts from 1949 to 1989 significantly improved the yield, quality and stability of wheat, rice and potato crops, demonstrating his unwavering dedication to advancing agricultural productivity. His contributions to make India self-sufficient in foodgrains, by introducing and breeding dwarf wheat varieties, led to enhanced production from 50 million tons in 1950 to 330 million tons now. Hence, from being an importing country, India became a net exporting nation. His scientific innovations thus brought about a paradigm shift offering a lifeline to millions facing food insecurity and creating a profound impact.

Swaminathan’s distinguished research career is characterized by an extensive portfolio of scholarly works. From 1950 to 1980 he authored an impressive 46 single-author papers, making a significant contribution to the scientific literature (23). His complete bibliography

includes 254 papers, with 155 of them highlighting his role as either the sole or primary author. His research primarily focused on crop improvement, with 95 papers dedicated to this area, followed by substantial contributions to cytogenetics and genetics, comprising 87 papers, and phylogenetics, with 72 papers.

Throughout his illustrious career, Swaminathan leveraged various platforms to disseminate his pioneering research and insights. He was a frequent contributor to revered journals such as the *Indian Journal of Genetics*, with 46 papers, *Current Science*, with 36 papers, and internationally acclaimed publications including *Nature*, with 12 papers, *Science* and *Radiation Botany*, also with 12 papers (see also Dil 2004; Kesavan 2017). His academic influence extended beyond journal articles. Swaminathan authored several seminal books that echo the central themes of his life's work: biodiversity and sustainable agriculture as fundamental solutions to combat global hunger (). These publications, along with his numerous papers, dialogues and speeches, collectively underscore his unwavering commitment to advancing agricultural science and addressing the pressing challenges of global food security (14, 18, 19, 27).

#### A KEY ARCHITECT AND FATHER OF THE INDIAN GREEN REVOLUTION

Swaminathan embarked on a mission to markedly enhance agricultural productivity, with a particular focus on staple food grains such as wheat and rice. The genesis of the Green Revolution occurred in the fields of the CRRI through the pioneering *indica-japonica* rice crosses. This effort sought to tailor plant types to be functionally responsive to the external application of fertilizers. The objective was to engineer plants to have a reduced stature without compromising the length of their grain-bearing panicles. Driven by this innovative vision, he employed methods such as interspecific hybridization, induced radiation, chemical mutagenesis and the application of plant growth regulators. These scientific endeavours greatly enriched the understanding of biological processes and responses to physical and chemical stimuli, although achieving dwarf or semi-dwarf wheat plants with normal spikes proved challenging.

Swaminathan's unwavering commitment to staying abreast of global innovations led him to discover the Norin-10 dwarfing genes in wheat from Japan and the Deejee-woo-jen dwarfing genes in rice from China. His initial interaction with Orville Vogel at Washington State University eventually facilitated his collaboration with Norman E. Borlaug, the director of the Wheat Research and Production Program at CIMMYT in Mexico. This enduring partnership between Swaminathan and Dr Borlaug catalysed the wheat revolution (22, 26).

Recognizing the potential of Borlaug's new dwarf wheat varieties to adapt to diverse climatic conditions, Swaminathan sought his assistance to address the looming famine threat in India. In March 1963 Borlaug responded enthusiastically, joining Swaminathan on a three-week expedition through North India's wheat belt (figure 2). Throughout this period, they meticulously assessed crop conditions and growing environments and engaged in extensive dialogues with local farmers. Borlaug's conviction in the feasibility of these high-yield varieties solidified as he gained insights from Swaminathan, observed the agricultural conditions first-hand and absorbed the experiences shared by the local

community. It became increasingly apparent that the high-yield dwarf wheat varieties, originally developed in Mexico, had the potential to significantly boost grain production in India (26).

*'Lab to land' initiatives: bridging theory and practice*

When Borlaug's 'miracle seeds' were introduced through national demonstration trials, as a crucial 'lab to land' initiative meticulously coordinated by Swaminathan, the results were extraordinary. These trials, crucial for translating laboratory research to practical, cultivable solutions, showcased the new wheat varieties' remarkable adaptability to the diverse soils and climates across India. Swaminathan strategically placed these demonstration plots in the fields of impoverished farmers, emphasizing the social impact of their increased production. This approach was intended to ensure that the success of these trials would be seen as a result of technological innovation rather than the advantages of affluent farming. Despite the success in yield, there remained a challenge concerning the palatability of the introduced varieties. The Indian consumers were less receptive to the red-coloured Mexican wheat varieties, like Lerma Rojo, which were not preferred for making the traditional unleavened chapati bread. Addressing this issue, Borlaug provided wheat seeds from his projects in Pakistan, which bore a more appealing amber colour that was better suited to local culinary preferences. Building on this, Swaminathan conducted extensive research on these varieties, leading to the development of 'Sonalika' and 'Kalyan Sona'—varieties that not only met the agronomic criteria but also possessed the qualities desirable for chapati-making of Indian taste (23). These varieties became instrumental in enhancing food security while adhering to the cultural and culinary practices of India, illustrating the nuanced approach required in the global spread of agricultural innovations.

In the pivotal years of 1964 and 1965, the combined efforts of Norman Borlaug and Swaminathan successfully persuaded the Indian government to approve the widespread cultivation of new, high-yielding wheat varieties. This critical decision, spurred by a synergy of scientific innovation, comprehensive farmer education and robust political leadership under figures such as Minister of Agriculture C. Subramaniam, Prime Minister Lal Bahadur Shastri and later Prime Minister Indira Gandhi, was instrumental in averting a potential famine. By the late 1960s, these efforts had set Indian agriculture firmly on a path towards self-sufficiency in cereal grains (26). This monumental achievement was celebrated by the government under Prime Minister Indira Gandhi through the issuance of a special postage stamp in 1968, fittingly named the 'Wheat Revolution' (figure 3). The results of these agricultural reforms were transformative: by 1999, India's annual wheat production had escalated dramatically to 70 million tons, a significant increase from the 11 million tons recorded in the early 1960s. By 2024, this figure had further risen to an impressive 113 million tons harvested across approximately 32 million hectares. Swaminathan's vision extended beyond the laboratory (11, 21, 26).

The Green Revolution in Asia represents an exceptional period of enhanced food production and significant reduction in hunger, achieved through the effective amalgamation of scientific breakthroughs, their practical implementation and astute policy-making. Swaminathan described the Green Revolution as a 'symphony of ingredients', where science served as the primary catalyst for change, supported by a comprehensive array of public



Figure 2. The incredible partnership of M. S. Swaminathan (left) with Norman E. Borlaug (right), who later received the Nobel Peace Prize in 1970. Photograph courtesy of MSSRF, Chennai, India.

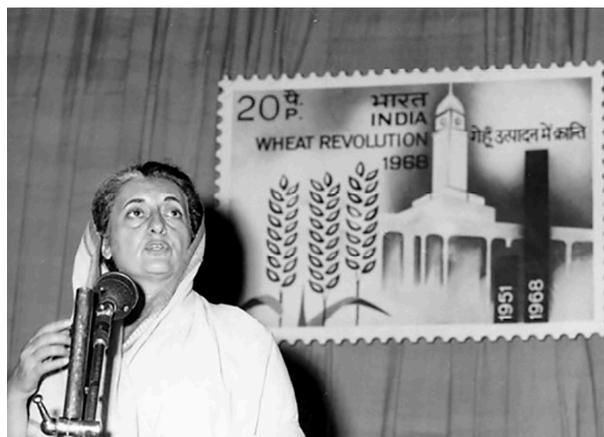


Figure 3. Commemoration of the Wheat Revolution by then-Prime Minister Indira Gandhi releasing the 'Wheat Revolution' stamp in 1968, a gesture honouring the milestones of the Green Revolution in Indian agriculture marked by a significant increase in wheat production, which had surged by 5 million tons (from 11 million to 16 million tons). Photograph courtesy of MSSRF, Chennai, India.

policies and essential services such as seed production, electricity and fertilizers. Importantly, the relentless dedication and hard work of the farmers were pivotal to this success. In a 2014 interview, Swaminathan reflected on the Green Revolution as a mass movement initiated by the farmers themselves, with scientists like himself playing a crucial role in guiding and facilitating its execution. This era not only marked a significant turn in India's agricultural history but also set a global precedent for how scientific advancements can be harnessed to improve food security and sustainable farming practices.

The impact of Swaminathan's work was poignantly underscored in a heartfelt letter from Norman Borlaug in 1970, following Borlaug's own Nobel Peace Prize recognition. This correspondence, resonating deeply within the agricultural community, acknowledged the pivotal role that Professor Swaminathan played in what came to be known as India's Green Revolution. Throughout the 1960s and 1970s, Swaminathan spearheaded initiatives that fundamentally transformed India from a nation grappling with food insufficiency to one achieving complete self-sufficiency in food production. His pioneering efforts helped dispel the perennial fears of famine that had long plagued the region. The term 'Green Revolution' has become synonymous with Swaminathan's enduring contributions, marking a period of significant transformation in India's agricultural history. Through the introduction of innovative crop varieties and the promotion of modern farming techniques, he empowered farmers across the nation to dramatically increase their crop yields (15, 16, 20). This revolution not only provided essential sustenance for India's growing population but also played a crucial role in alleviating poverty and fostering economic growth across the nation. Swaminathan's monumental efforts during this era earned him the well deserved moniker 'Father of India's Green Revolution', a title that reflects his profound influence on the country's agricultural and economic landscapes.

#### VISIONARY INSTITUTION BUILDER, POLICY MAKER AND GLOBAL ADVOCATE OF ZERO HUNGER

Swaminathan's legacy transcends his groundbreaking research and scientific achievements; he was a true institution builder whose impact on the global scientific landscape is indelible (see also Pathak 2023). His unyielding commitment to advancing agricultural science and addressing hunger-related challenges facilitated the establishment and growth of several pivotal organizations. The Indian Council of Agricultural Research (ICAR), an autonomous body under the Department of Agricultural Research and Education of the Ministry of Agriculture, and Farmers Welfare, Government of India, was established on 16 July 1929. Within this framework, the National Agricultural Research, Education and Extension System (NAREES) has been at the forefront of the agricultural revolution in India, with Professor M. S. Swaminathan playing a pivotal role in its development. As a central figure in the Green Revolution, Swaminathan was more than just a leading voice; he was the embodiment of the transformative changes that swept through global agriculture. His approach was holistic, always seeking new technologies and institutional systems to address the pressing problems of food and ecological security. His leadership helped to foster a farmer-centric mindset within NAREES and promoted a culture of scientific research that is responsive to the needs of sustainable farming.

One of Swaminathan's key contributions was the creation of the All-India Agricultural Research Service (ARS), which enhanced collaborative research across India, fostering innovative agricultural solutions and unity among researchers. He was instrumental in establishing the Agricultural Scientists Recruitment Board (ASRB) on 1 November 1973, following the recommendations of the Gajendragadkar Committee. The ASRB conducts competitive exams for ARS scientists and the National Eligibility Test for recruiting lecturers and assistant professors in agricultural universities. During his tenure as head of the Genetics Division and later as director of the IARI, Swaminathan organized and implemented the first All India Coordinated Crop Improvement Projects (AICRPs) for major food crops. These projects became the epicentre of the Green Revolution, promoting an inter-institutional and interdisciplinary research culture that allowed multi-location trials, facilitating rapid advancements in agricultural science and technology (12, 13). Under his guidance as the director general of ICAR, the AICRP concept was expanded to cover all areas of agricultural research, influencing research policies and enhancing the quality and relevance of agricultural research in India and globally. His establishment of various project directorates and interdisciplinary research schools marked another significant milestone in his legendary career. Within the IARI, Swaminathan founded the Nuclear Research Laboratory, underscoring his dedication to innovative research methods.

Professor Swaminathan recognized that empowering farmers with the knowledge and tools to maximize their yields was as crucial as developing new varieties. Perhaps his most impactful role came in 2004 when, as chairman of the National Commission on Farmers, he led the formulation of crucial recommendations for resolving the growing crisis of farmer distress and suicides and addressed the issues plaguing Indian agriculture through formulating appropriate policies to uplift the farming community. His tireless advocacy played a pivotal role in bringing the struggles of farmers to the forefront of national consciousness. Notably, he advocated for a minimum support price that was 50% higher than cost of cultivation (C2), policy advice he gave to influence policy makers. He also pleaded for a national policy for farmers' welfare to be enacted by Parliament while serving as a member of the Upper House (*Rajya Sabha*).

Beyond the confines of India, Swaminathan's vision was boundless (24). His influence extended internationally through key roles in founding critical institutions such as the International Crop Research Institute for the Semi-Arid Tropics in India, the International Board for Plant Genetic Resources (now known as Bioversity International) in Italy and the International Council for Research in Agro-Forestry in Kenya. He collaborated actively with international entities like the International Rice Research Institute (IRRI), the Consultative Group on International Agricultural Research, the Food and Agriculture Organization (FAO) and the United Nations Educational, Scientific and Cultural Organization (UNESCO), leveraging his expertise to tackle global food security challenges. His efforts in establishing agricultural institutions worldwide have left a lasting imprint on global agricultural practices and policy. Swaminathan's research not only safeguarded food for countless individuals but also sparked a global agricultural movement, inspiring substantial change and progress internationally. His advisory roles extended to countries including China, Vietnam, Myanmar, Thailand, Sri Lanka, Pakistan, Iran and Cambodia. In his later years, he remained a driving force in the global fight against hunger, co-chairing the United Nations Millennium Project on hunger from 2002 to 2005, which underscored the critical

nature of this global issue (Denning 2015). He also led the Pugwash Conference on Science and World Affairs from 2002 to 2007, further demonstrating his commitment to fostering international dialogue and cooperation.

Swaminathan's role in the public domain and in public policy was consistently oriented toward harmony and mutual respect, guided by a clear and focused aim. He exemplifies the vital role that leading scientists can play in society and in shaping public policy. Known for being outspoken yet always respectful, he was deeply respected and widely accepted. His leadership has been influential on a global scale through organizations such as the IRRI, International Union for Conservation of Nature (IUCN), Pugwash, FAO, High-Level Panel of Experts (HLPE) on Food Security and Nutrition and Committee on World Food Security (CFS), demonstrating his comprehensive global perspective (see Rabbinge 2015). However, he never overlooked his critical contributions in India, where he played a pivotal role in agricultural sciences, institution building, and policy-making, and as a society leader in helping farmers.

Throughout his career, Swaminathan's resolve to eradicate hunger in India was unrelenting (see Sundaram 2014). He envisioned a hunger-free India by 2007, a reflection of his firm belief in the transformative power of science and sustainable agricultural practices (21) (see Kesavan 2017). Moreover, his influence was not confined to research and policy; he actively participated in the political arena, notably chairing the National Commission on Farmers, addressing vital issues facing agricultural communities. In 2007 he was nominated to the *Rajya Sabha* (the Upper House) of Parliament by then-President A. P. J. Abdul Kalam, where he introduced the Women Farmers' Entitlements Bill 2011, aimed at empowering women in agriculture. Swaminathan worked closely with almost every prime minister of India since independence, contributing significantly to the nation's food security and sustainable agricultural practices. His concept of the 'Evergreen Revolution' aimed to ensure sustained and environmentally friendly agricultural productivity, mirroring the success of the Green Revolution but with an emphasis on sustainability, termed 'productivity with perpetuity' (20). In his later years, Swaminathan continued to advocate for digital inclusion and the dissemination of research insights to policymakers in the fields of hunger and nutrition (17,25). His enduring energy, idealism and commitment to improving human welfare earned him the admiration and gratitude of millions globally. Swaminathan's remarkable life and contributions continue to inspire future generations in their pursuit of agricultural excellence and the alleviation of global hunger (27).

#### A FELLOW OF GLOBAL DISTINCTION: AWARDS AND ACCOLADES

Swaminathan, a luminary in agricultural science, stands as a beacon of inspiration and achievement. Throughout his distinguished career, he received numerous prestigious awards and honours, demonstrating his profound influence both nationally and internationally. His career as a global fellow in agriculture and genetics was distinguished by myriad fellowships and memberships, highlighting his significant impact in scientific circles. Swaminathan's journey to recognition began in 1957 when he was named a Fellow of the Indian Academy of Sciences (FASc), followed by his election as a Fellow of the Indian National Science Academy (FNA) in 1962. These early accolades set the stage for a series of honours,

including his election as a Fellow of the Royal Society (FRS) in 1973 (figure 4) and as a Foreign Associate of the National Academy of Sciences of the United States in 1977. His tireless dedication to advancing agricultural research and technology garnered accolades not only from India but also from the broader international community. Swaminathan's global impact is further evidenced by accolades such as the esteemed Ramon Magsaysay Award and the World Food Prize (figure 5). These accolades, spanning several countries and institutions, celebrate his exceptional contributions to ensuring food security, promoting sustainable agriculture and enhancing the well-being of humanity.

Swaminathan was honoured with India's highest civilian awards for his exemplary contributions to agriculture. These prestigious awards include the Padma Shri in 1967, the Padma Bhushan in 1972 and the Padma Vibhushan in 1989, affirming his status as one of the nation's most revered recipients of these honours. Moreover, the conferral of the Bharat Ratna on Swaminathan, honouring him as the father of the Green Revolution in India, has been universally acclaimed by the agricultural scientific community. Swaminathan is a distinguished figure who received all of India's prestigious civilian awards, culminating in the Bharat Ratna (in 2024), which highlights his profound influence on Indian agriculture and his dedication to the nation's farmers. Above all the awards and accolades, Swaminathan was fondly regarded as the 'Farmer's Scientist' owing to his lifelong dedication to the welfare of the farming community.

In addition to these accolades, Swaminathan received 84 honorary doctorates from universities worldwide, was elected a fellow of various scientific academies, held the UNESCO Chair in Ecotechnology, served as a member of the Parliament of India (*Rajya Sabha*), chaired the HLPE for the CFS (2010–2013) and led the task force overseeing projects in Afghanistan and Myanmar in the field of agriculture. These prestigious recognitions not only highlight his remarkable journey through the world of academia and scientific leadership but also reflect his unwavering commitment to advancing agricultural research and sustainable practices on a global scale.

#### FAMILY AND FOUNDATION: A LEGACY OF LOVE, ACCOMPLISHMENT AND IMPACT

Swaminathan and Mrs Mina Swaminathan celebrated their union on 11 April 1955, after meeting at the University of Cambridge in the UK, where Mrs Swaminathan earned her MA in economics. Her subsequent dedication to early childhood education and gender development studies marked significant contributions to these fields. The couple resided in Chennai, Tamil Nadu, until the passing of Mrs Swaminathan on 14 March 2022, at the age of 88. They are survived by three accomplished daughters (figure 6). Dr Soumya Swaminathan, the eldest, is a distinguished paediatrician and researcher who has served as The World Health Organization's chief scientist and deputy director-general for programmes. At present, she is a Chairperson of the MSSRF. Dr Madhura Swaminathan, the second daughter, is a Rhodes scholar with a DPhil from the University of Oxford, now serving as a professor of economics at the Economic Analysis Unit of the Indian Statistical Institute in Bangalore. The youngest, Dr Nitya Rao, is a professor of gender and development at the School of Global Development, University of East Anglia, in Norwich, UK.



Figure 4. Swaminathan on his admission to the Royal Society in 1973, pictured with Sir Bernard Katz FRS. Photograph courtesy of the Royal Society.



Figure 5. Swaminathan receiving the World Food Prize in 1987. Photograph courtesy of MSSRF, Chennai, India.

The M. S. Swaminathan Research Foundation (MSSRF, [figure 7](#)), established with the proceeds from his First World Food Prize in 1987, continues Swaminathan's work. This not-for-profit trust, founded in 1988, employs modern science and technology to enhance agricultural and rural development, enriching the lives and livelihoods of communities



Figure 6. M. S. Swaminathan with his wife, Mina Swaminathan, positioned directly behind his chair, and their three daughters: Dr Soumya Swaminathan, Dr Nitya Rao and Dr Madhura Swaminathan (from left to right). Photograph courtesy of Dr Soumya Swaminathan.

with a pro-poor, pro-women and pro-nature approach. The foundation tackles practical challenges in agriculture, food and nutrition, partnering with knowledge-based institutions, public and private sector organizations and local communities. MSSRF has become a hub for sustainable development initiatives, supporting research and actions in areas such as the conservation of endangered species, protection of coastal ecosystems, precision farming, ecotechnology, community education, technical training and rural Internet access programmes. Swaminathan's extensive collection of research notes, annotated drafts, correspondence and photographs is housed at the National Centre for Biological Sciences in Bengaluru, providing a valuable resource for researchers and students.

Significant parallels have been drawn between two influential research institutions (Bruce 2005): Cold Spring Harbor Laboratory in Long Island, New York, established by James Watson (ForMemRS 1981), and the MSSRF in Chennai, founded by Swaminathan. Conceived by visionary scientists renowned for their contributions to biology and agriculture, respectively, both serve as hubs of innovation and research. Cold Spring Harbor Laboratory has played a pivotal role in the field of genetics research, and is especially noted for its development of molecular genetics. In contrast, MSSRF has been instrumental in advancing agricultural research and farming practices in India, focusing on promoting sustainable agricultural techniques and enhancing food security. These centres not only foster scientific inquiry and innovation but also embody the personal commitment of their founders to harness science for the greater public good. They address global challenges in health and food security, acting as beacons of progress and positive impact.

Swaminathan's legacy extends far beyond his scientific achievements; it is his character and approachability that have endeared him to individuals from all walks of life. Known for



Figure 7. The M. S. Swaminathan Research Foundation, an institution dedicated to advancing sustainable agricultural practices and research (image copyright unknown).

his soft-spoken manner and impeccable etiquette, Swaminathan consistently demonstrated a persistence directed towards noble causes (see [Quinn 2015](#)). His down-to-earth personality rendered him easily approachable and widely cherished, gaining respect from a diverse group, spanning peers, politicians, young students and thousands of agricultural graduates, including the authors of this memoir (Rajendra S. Paroda, Rajeev K. Varshney and Malleshaiah SharathKumar), across different generations. Further, Swaminathan's humanitarian efforts have been significant. He played a crucial role in facilitating Dr Norman Borlaug's visit to India in 1963, which had a transformative effect on India's agriculture. Over the years, MSSRF has profoundly affected over 600 000 farm families, benefiting 100 000 farmers and fisherfolk daily across 18 countries. Swaminathan's multifaceted contributions have left an indelible mark on science, agriculture and humanity, establishing him not just as a pre-eminent figure in agricultural science but also as a beloved hero and maestro celebrated worldwide.

#### CONCLUDING REMARKS

The void left by Swaminathan's passing will be profoundly difficult to fill. He was a visionary, an adept planner and a great human being, deeply cherished by the farming community for his enduring dedication to peasants and Indian agriculture. His legacy remains an eternal wellspring of inspiration, serving as a potent reminder that science, commitment and compassion can collectively forge a brighter future for agriculture and humanity. His brilliance in scientific inquiry, steadfast advocacy for sustainable agricultural practices, and profound humanitarianism have touched the lives of thousands, leaving an indelible mark on the world. Though we bade him a physical farewell on 30 September

2023, Swaminathan's vision for a better, hunger-free world continues to resonate in the hearts of his family and the myriad admirers within the global agricultural community and the scientific fraternity. Some praise from distinguished global personalities, as well as some of Professor Swaminathan's inspirational quotes, can be found in the online supplement.

In this moment of reflection, we offer our heartfelt respects to this visionary scientist, symbolically surrounded by wreaths and flowers that represent the everlasting bloom of his innovative ideas and lofty ideals. Through his groundbreaking work and compassionate actions, Swaminathan charted a path that future generations are inspired to follow, ensuring that his influence will continue to foster growth and development in agriculture and beyond for years to come. We humbly join hands to submit our respect by chanting '*Om Shanti*' (Rest in Peace).

### KEY AWARDS AND FELLOWSHIPS

An extended list is provided as an online supplement at <https://doi.org/10.6084/m9.fig-share.c.7589683>.

#### *National awards*

1961	Shanti Swarup Bhatnagar Award for contributions to biological sciences
1967	Padma Shri Award by the President of India
1972	Padma Bhushan Award by the President of India
1979	Norman E. Borlaug Award
1981	Meghnad Saha Medal of the Indian National Science Academy Rabindranath Tagore Prize of Visva Bharati University, India
1989	Padma Vibhushan by the President of India
1992	Lal Bahadur Shastri Deshgaurav Samman, India Jawaharlal Nehru Birth Centenary Award of the Indian Science Congress Association
1997	Dr B. P. Pal Medal for unique contributions to agricultural research and development of the National Academy of Agricultural Sciences, India
1998	B. P. Pal Memorial Award of the Indian Science Congress Association
2000	Indira Gandhi Prize for Peace, Disarmament and Development for his outstanding contribution to plant genetics and ensuring food security
2005	Raja Ram Mohan Roy Award
2007	Lal Bahadur Shastri National Award for Excellence in Public Administration, Academics Management
2017	Bharath Shanthi Dootha Award
2018	First World Agriculture Prize

#### *International awards*

1965	Mendel Memorial Medal (for contributions to Plant Genetics), Czechoslovak Academy of Sciences, Prague
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- 1971 Ramon Magsaysay Award (for Community Leadership), Ramon Magsaysay Foundation, The Philippines
- 1984 Bennett Commonwealth Prize (for contributions to household nutrition security), Royal Society of Arts, United Kingdom
- 1987 First World Food Prize, World Food Prize Foundation, USA
- The Golden Heart Presidential Award, Republic of the Philippines (conferred by President Corazon C. Aquino), The Philippines
- 1990 Commandeur of the Order of the Golden Ark of The Netherlands
- 1994 Asian Regional Award (for contributions to the improvement of agricultural productivity in Asia), Asian Productivity Organization, Tokyo, Japan
- 1997 Highest award for International Cooperation on Environment and Development, Government of China, Beijing, China
- Ordre du Mérite Agricole (for rendered services of the highest quality to the cause of agriculture and its development), Ministry of Agriculture, France
- The Volvo Environment Prize (for outstanding research and devoted work in turning Indian food production from a deficit to a much-increased supply, combining modern science in plant breeding with appropriate government policy), Royal Swedish Academy of Sciences, Stockholm, Sweden
- 1999 UNESCO Gandhi Gold Medal (for outstanding work in extending the benefits of biotechnology for sustainable agricultural and rural development), UNESCO, Paris, France
- Franklin D. Roosevelt Four Freedoms Award (for contribution to solving famine in large parts of the world), Franklin and Eleanor Roosevelt Institute, Middelburg, The Netherlands
- 2000 Soka Gakkai Hiroshima Peace Award (for contributions to world peace, culture and education), Japan
- 2005 Ordre du Mérite agricole (Commander of the Order of Agricultural Merit), Ministry of Agriculture, France

*Fellowships*

- 1957 Fellow of the Indian Academy of Sciences
- 1971 Honorary Fellow of the Swedish Seed Association, Sweden
- 1973 Fellow of the Royal Society
- Foreign Associate, National Academy of Sciences of the United States of America
- 1977 Foreign Member, All-Union Academy of Agricultural Science, USSR
- 1983 Foreign Member, Royal Swedish Academy of Agriculture and Forestry
- 1984 Foreign Honorary Member, American Academy of Arts and Sciences
- 1985 Fellow, European Academy of Arts, Sciences and Humanities
- Fellow of the Royal Society of Arts, London
- Honorary Research Professor of the Chinese Academy of Agricultural Sciences
- 1987

1994

Fellow of the Linnean Society of London

Fellow of the American Association for the Advancement of Science

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The frontispiece portrait photograph is courtesy of the MSSRF, Chennai, India.

## AUTHOR PROFILES

*Malleshaiah SharathKumar*

Dr Malleshaiah SharathKumar is a distinguished researcher in horticulture science at Wageningen University & Research (WUR) in The Netherlands. He earned a BSc in horticulture sciences from the University of Horticultural Sciences, Bagalkot, India, followed by a master's degree in horticulture sciences from Tamil Nadu Agricultural University and a PhD from WUR. Dr SharathKumar's research career began at the Center for Urban Greenery and Ecology in Singapore and includes significant tenures at the National Orchid Garden and the Singapore Botanic Garden. He has also worked with prestigious institutions, including WUR and the Max Planck Institute of Molecular Plant Physiology in Germany, while fostering active international

collaborations. His substantial contributions to horticulture science are reflected in numerous publications and international recognition. Dr SharathKumar has made notable advancements in physiology, genetics, and breeding across various fields of horticultural science, including turfgrasses and ornamentals such as chrysanthemums and orchids. His exceptional work led to the naming of two orchid species in his honor, officially registered with the Royal Horticultural Society at Kew. In recognition of his contributions and innovative research, he was awarded the Young Researcher Award by the International Horticulture Science in Belgium. Currently, Dr SharathKumar's research focuses on molecular physiology and genomics, with the goal of enhancing the yield and productivity of horticultural crops. His seminal projects include advancing vertical farming technology, unraveling flowering mechanisms in short-day plants, and investigating the molecular responses of horticultural crops to heat stress. Additionally, he explores the photobiology of horticultural crops, aiming to optimize plant productivity and quality through advanced LED growth systems by studying the role of light spectra in enhancing crop quality and yield. Dr

SharathKumar's multifaceted research continues to make a profound impact on the field of horticulture science.

*Rajendra S. Paroda*



Dr Raj Paroda, a renowned agricultural scientist and visionary, has dedicated his life to advancing global agriculture. As director general of the Indian Council of Agricultural Research and secretary of the Department of Agricultural Research and Education, he transformed India's National Agricultural Research, Education and Extension System, creating over 30 institutions. His efforts in genetic resource management led to the establishment of India's National Genebank and specialized bureaux for diverse genetic resources. He also established genebanks in eight countries in Central Asia and the Caucuses, earning the nickname 'Genebank Guru'. Dr Paroda's foresight led to the construction of the National Agricultural Science Centre in India. He founded the Indian Society of Plant Genetic Resources, contributing significantly to its growth. His numerous accolades include the Padma Bhushan and the Norman E. Borlaug Award. Currently, he serves as founder chairman of the Trust for Advancement of Agricultural Sciences (TAAS), advocating for agricultural policy and food security.

*Rajeev K. Varshney*



Professor Rajeev K. Varshney is an agricultural scientist specializing in genomics, genetics, molecular breeding and capacity building in developing countries. As director of the Centre for Crop & Food Innovation, director of the WA State Agricultural Biotechnology Centre, and international chair of agriculture and food security at the Food Futures Institute at Murdoch University, Australia, he leads pioneering research to tackle global food production challenges. Over his 20-year career, Professor Varshney has improved food security, especially in Asia and Africa, by developing genomic resources for major tropical crops and leading international programmes to create superior crop varieties. His work connects Australian wheat, legume and horticulture industries with international agriculture through large-scale genomic resources and pre-breeding approaches. He has popularized genomics in crop breeding programmes worldwide, working with various stakeholders to deliver impactful research outcomes in Australia, India, China and many countries in Africa. Professor Varshney has authored 25 books and over 600 publications and has been a highly cited researcher for 11 consecutive years. His honours include Fellowship of the Royal Society and over 20 prestigious awards globally.

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- (2) 1953 (With R. Prakken) Cytological behaviour of some inter-specific hybrids in the genus *Solanum*, sect. *Tuberarium*. *Genetica* **26**, 77–101. (doi:10.1007/BF01690616)
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