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Prof. M.S. Swaminathan: Father of Green Revolution in India

A memoir presented on the occasion of celebrating
conferment of Bharat Ratna

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Summary

Prof. M.S. Swaminathan, popularly known as the Father of India's Green Revolution, is credited with saving millions of people from starvation through his landmark work on enhancing productivity and production of wheat and rice crops during the 1960s-70s. He also provided a concept of transforming the "Green Revolution" into an "Evergreen Revolution," which might allow agriculture to withstand the consequences of climate change and sustainably feed the world's population. Prof. Swaminathan always advocated the cause for smallholder farmers and sustainable farming practices. He strongly believed in the power of science to benefit the marginalized and was a vocal proponent of empowering farmers with knowledge and resources. With a vision of a holistic approach to agriculture emphasizing the importance of conserving biodiversity and natural resources, and promoting environmentally friendly farming techniques, he founded the MS Swaminathan Research Foundation in 1988. He worked there till his last breath to develop and promote strategies for economic growth that directly targeted increased employment of poor farmers, especially women in rural areas. The gratitude of the people, scientists, farmers and society, towards him is profoundly and emotionally engrained. Prof. Swaminathan, named as one of the three most influential Indians (Mahatma Gandhi and Rabindranath Tagore, being the other two), by TIME magazine in 1999, was indeed an agent of transformation who brought dignity and admiration for Indians and India. His legacy continues to inspire researchers, policymakers, and advocates worldwide to address the pressing challenges of our time, from climate change to sustainable agriculture.

1. Introduction

In the annals of India's agricultural history, one name stands out brilliantly – Professor Monkombu Sambasivan Swaminathan (August 7, 1925 - September 28, 2023), popularly known as Prof. M.S. Swaminathan, "MSS", "MS", "Swami" or "Professor". His dedication, wisdom, and

"If agriculture fails, everything else will fail"

M.S. Swaminathan

humility were unparalleled. His visionary leadership has always been an inspiration to all agricultural scientists not only in India, but globally. His legacy in championing sustainable agriculture and promoting global food security will undoubtedly live on. Prof. Swaminathan was a globally acclaimed agricultural scientist known for his elegant contributions to food security and rural, social, and gender equity in India and several developing countries. Leveraging his expertise in plant genetics, the forward-thinking scientist strategically combined scientific research, global collaboration with food and agriculture organizations, and networking with policy makers to spearhead a remarkable transformation in India's

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agricultural landscape, propelling the nation from a food-importing country to a food-sufficient one. While he championed the cause of the Green Revolution in the 1960s with the Nobel Laureate, Dr. Norman Borlaug, he subsequently advocated for an Evergreen Revolution for sustainable growth, incorporating all the domains of agriculture.

2. A Seed is Sown: The Foundation of a Legacy

Prof. Swaminathan was born on August 7, 1925, in Kumbakonam, Tamil Nadu, India. He was born into a Tamil Brahmin family with a strong background in agriculture and academics. His father, Dr. M.K. Sambasivan, was a surgeon, and his mother, Smt. Parvati Thangammal Sambasivan, came from a family deeply rooted in farming. Growing up, Swaminathan's family values and background greatly influenced his interest in agriculture and science. His family had a deep connection to the land, and he was exposed to the challenges faced by farmers from a young age. This upbringing instilled in him a sense of responsibility to contribute to improving the lives of farmers in India.

Prof. Swaminathan's academic journey was marked by dedication and a commitment to improving agriculture and food security. Swaminathan attended local schools in Kumbakonam and excelled in his studies. Seeing the impacts of the Bengal famine of 1943 and issues of food shortage during the Second World War, he decided to study agriculture. He completed his Bachelor of Science in Agriculture from the Agricultural College and Research Institute in Coimbatore, Tamil Nadu, in 1944. He pursued postgraduate studies at the Indian Agricultural Research Institute (IARI) in New Delhi, where he obtained a Master's degree in Genetics and Plant Breeding in 1949, and was a UNESCO Fellow at Wageningen Agricultural University, Netherlands. His interest in genetics and breeding laid the foundation for his later work in crop improvement. Swaminathan completed his Ph.D. in Genetics from the University of Cambridge, United Kingdom in 1952 and undertook post-doctoral studies at the University of Wisconsin, USA (1952-1953). His doctoral research focused on the genetics of barley and wheat. After completing his Research Associateship, in a defining decision, he declined a faculty position in the USA, choosing to return to India in 1954 to drive impactful change in his homeland.

3. Landmark Contribution - Green Revolution

Returning to India in 1954, Prof. Swaminathan worked at the Central Rice Research Institute, Cuttack, Odisha and further the IARI, New Delhi. Prof. Swaminathan was concerned about India's food security with a 'ship to mouth' existence and India's image as a 'begging bowl'. He was interested in increasing agricultural productivity and production, especially of our staple food grains (wheat and rice). For this, he envisioned that the plant type should be tailored to be functionally responsive to the external application of fertilizers. The height of plants should be reduced without reducing the length of the grain-bearing panicle. This is what he strived to achieve by pursuing interspecific hybridization, induced radiation and chemical mutagenesis, and the use of plant growth regulators. While all these substantially added to our fundamental knowledge of biological processes/responses induced by physical and chemical agents, the goal of obtaining dwarf / semi-dwarf wheat plants with normal spikes was, however, not realized.

Fortunately, his ability to keep himself abreast of major innovations and development anywhere in the world helped him trace the 'Norin-10' dwarfing genes from Japan in wheat and 'Dee-Geo-woo-Gen'

"Poverty has many dimensions beyond income: education, health, environment, water, sanitation, livelihood security, and peace"

M.S. Swaminathan

dwarfing genes from China in rice. His initial contact with Prof. Orville Vogel of the Washington State University (Pullman, USA) led him to Prof. Norman E. Borlaug, Director of International Maize and Wheat Improvement Center (CIMMYT), Mexico. As a result, Prof. Swaminathan and Prof. Borlaug collaborated, with Borlaug touring India and sending supplies for a range of Mexican dwarf varieties of wheat ('Lerma Rojo' and 'Sonora-64') from Mexico. which were to be bred with Japanese varieties. Initial testing in an experimental plot showed promising results. The crop was high-yielding, good quality, and disease-free. The hesitation by farmers to adopt the new variety with high yields, was unnerving. In 1964, following repeated requests by Prof. Swaminathan to demonstrate the new variety, he was given funding to plant small demonstration plots. A total of 150 demonstration plots on one hectare were planted. The results were promising, and the anxieties of the farmers were reduced. More modifications were made to the grain in the laboratory to suit Indian conditions better. The new wheat varieties were sown, and in 1968, production went to 17 million tonnes, 5 million tonnes more than the last harvest. With unwavering determination, Prof. Swaminathan and his team orchestrated a dramatic transformation in wheat production. Subsequently, the Government of India declared India self-sufficient in food production in 1971.

This impressive growth marked a turning point for India's agricultural landscape. The predictions of widespread famine in Indian subcontinent by the doomsayers, the Paddock brothers, were proven wrong due to the dedicated efforts of scientists like Prof. M.S. Swaminathan and the resilience of Indian farmers. Hailed as the Father of India's Green Revolution for this monumental contribution, Prof. Swaminathan strived his entire life for ending food insecurity and ensuring a more equitable and sustainable future for all.

4. Shaping the Future through Key Positions

Among several coveted positions that Prof. Swaminathan occupied in India, each with elegance, innovation and creativity, are the Director, IARI (1961-72); Director General, ICAR and the Secretary of the newly formed DARE (1972-79); Agriculture Secretary, Govt. of India (1979); Acting Deputy Chairman and Member, Planning Commission (1980-82). Further, he was the first Indian to become Director General of the International Rice Research Institute, Philippines (1982-88), and his leadership was recognized with the first World Food Prize in 1987. One of his most pivotal roles came in 2004, when he was appointed Chair of the National Commission on Farmers. This commission was established in response to rising farmer distress and alarming rates of suicides among farmers. The Commission's report, submitted in 2006, made several recommendations. A prominent suggestion was that the Minimum Selling Price (MSP) should be at least 50% above the weighted average cost of production. He was nominated as a Member of the Rajya Sabha for his expertise and contributions to agriculture for one term (2007-13).

"Empowering women in agriculture is not only a matter of gender equity but also a strategy for enhancing food security and rural development"

M.S. Swaminathan

5. Building National Agricultural Research, Education and Extension System (NAREES)

Established on 16 July 1929, the ICAR, an autonomous organisation under the DARE, Ministry of Agriculture and Farmers Welfare, Government of India today has 113 research institutes, 76 agricultural universities, and 731 Krishi Vigyan Kendras (KVKs) supervised by 11 Agriculture Technology Application and Research Institutes (ATARIs) spread across the country. India has one of the largest agricultural

research human resource capital in the world with the approximately 30,000 scientists (6,500 in ICAR and 23,500 in the agricultural universities) and more than 100,000 technical and supporting personnel. ICAR is addressing proactively food security and enhancing social-ecological resilience of India. At present, India is leading with one of the largest agricultural research and education network in the world.

The structure of the present NAREES system has evolved from the institutionalization processes of the Green Revolution research in the mid-1960s for rapid science and technology-driven agricultural transformation of India from begging

“Agriculture is not just about farming; it involves science, economics, sociology, and many other disciplines”

M.S. Swaminathan

bowl of the world to a country of food self-sufficiency. The remarkable emergence of the NAREES system within a brief 3-4 year period (1967-1971), built entirely within the public sector, stands as a testament to several factors: foresighted leadership, visionary strategy, unwavering national policy, and the dedicated efforts of exceptional individuals like Prof. Swaminathan.

Prof. Swaminathan was instrumental in the creation of the All-India Agricultural Research Service(ARS), which facilitated collaborative research efforts among scientists from all corners of the nation. This networking of scientific minds laid the foundation for innovative solutions of problems in agriculture, fostering a sense of unity among researchers dedicated in improving national agricultural landscape. The ASRB was established on November 1, 1973 as an independent recruitment agency in pursuance of the recommendations of the Gajendragadkar Committee. The major objective of ASRB is to recruit ARS scientists and research management personnel for ICAR. ASRB conducts all India competitive examinations for ARS to recruit the scientists at the entry level. It also conducts National Eligibility Test (NET), a prerequisite for the fresh recruitment of Lecturer/ Assistant Professor in the Central and State Agricultural Universities.

DARE was established in December 1973 in the Ministry of Agriculture and Farmers' Welfare. It has the four autonomous bodies under its administrative control. In India, DARE is the nodal Department for the International Cooperation in agricultural research and education. The Department mediates bilateral and multilateral cooperation with foreign governments, multilateral agencies and international bodies or organisation through ICAR. The DARE also facilitates international student's admissions in the various Agriculture Universities/ICAR Institutes.

During his tenure as Head of the Genetics Division and later as Director of IARI, Prof. Swaminathan organized and implemented the first All India Coordinated Research Project (AICRP), in major food crops which became the epicenter of the green revolution. The AICRPs fostered an inter-institutional, inter-state, international, and interdisciplinary research culture that enabled multiple location trials across different environments to facilitate a rapid co-evolution of new science and technology generation and transfer. Despite agriculture being a State subject, the AICRPs became a powerful model of institutional governance and center-state coordination. As the DG, ICAR, Prof. Swaminathan extended the AICRP concept to all domains of agricultural research including crops, natural resources management, animal science and fisheries. His subsequent advocacy for research reforms, research priorities, and farmer-centric approaches have continued to influence the formulation of research policies for enhancing the

quality and relevance of agricultural research in India and elsewhere.

6. Building Food Security for All: The International Impact of Prof. Swaminathan's Work

Prof. Swaminathan's contributions to agriculture and food security have received global recognition and acclaim. His work has had a profound impact not only in India but also in many other countries facing similar agricultural challenges. He actively collaborated with international organizations, including Consultative Group on International Agricultural Research (CGIAR), United Nations Food and Agriculture Organization (FAO), and United Nations Educational, Scientific and Cultural Organization (UNESCO), leveraging his vast knowledge and expertise to tackle global food security challenges. Notably, he played a key role in the establishment of the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) in Hyderabad, the International Board for Plant Genetic Resources (now known as Alliance Bioversity International - CIAT) in Italy and the International Council for Research in Agro-Forestry (ICRAF) in Kenya. As Chairman of the UN Advisory Committee for Science and Technology, Prof. Swaminathan played an important role in setting up the International Centre for Genetic Engineering and Biotechnology (ICGEB) in New Delhi. He also played a key role in promoting a Global Institute for Co-operation in Water Management in Valencia (Spain), when he served as Chairman of the International Committee on Water Management (1996-98). His guidance was instrumental in shaping numerous institutions in China, Vietnam, Myanmar, Thailand, Sri Lanka, Pakistan, Iran, and Cambodia. Prof. Swaminathan co-chaired the United Nations Millennium Project on hunger from 2002 to 2005 and was head of the Pugwash Conferences on Science and World Affairs between 2002 and 2007.

"Poverty has many dimensions beyond income: education, health, environment, water, sanitation, livelihood security, and peace"

M.S. Swaminathan

His association with various international organizations, including the FAO, provided valuable insights and expertise to the world on issues related to agriculture and food security. Prof. Swaminathan was invited to serve on numerous global committees, expert groups, and consultations on agriculture, biotechnology, and sustainable development. Universities and academic institutions around the world have conferred upon him numerous honorary degrees in recognition of his exceptional contributions to agriculture and science. His books, articles, and lectures on agriculture, food security, and sustainable development have been widely disseminated and appreciated globally. His ideas and principles, including the importance of sustainable and equitable agricultural practices, have influenced agricultural policies and practices in many countries, particularly those seeking to enhance food security and rural development.

7. Foundation of National Academy of Agricultural Sciences (NAAS)

Leveraging his deep understanding of agriculture and extensive engagement with policymakers, Prof. Swaminathan championed the creation of an independent "think tank" dedicated to providing unbiased, knowledge-based, and holistic guidance on agricultural policy. The NAAS was established in 1990 as a stand-alone organization to give agricultural scientists from various fields a forum. This forum allows for the discussion of important domestic and global topics, the presentation of group opinions, and the recommendation of action plans to decision-makers, planners, business associates, farmer associations, and other interested parties. Consequently, since its establishment, NAAS has been actively involved in discussing significant issues and producing more than 150 Policy Papers, Policy Briefs, and Strategy Papers. Beyond policy influence, the Academy plays a vital role in recognizing and celebrating excellence

in agricultural research, raising the profile of the field, and fostering its integration with other scientific disciplines.

8. Key Recognitions and Awards

Prof. Swaminathan is a Distinguished Fellow of over 30 Academies globally, including the prestigious Fellowship of the Royal Society and a Founder Fellow of the Third World Academy of Sciences. He is the recipient of 85 honorary Doctoral degrees, D.Sc. (*Honoris causa*) from across the globe. He was honoured with the Mendel Memorial Medal from the Czechoslovak Academy of Sciences (1965); Ramon Magsaysay Award (1971); Albert Einstein World Science Award (1986); the first World Food Prize (1987); Tyler Prize for Environmental Achievement (1991); Four Freedoms Award (2000); and the Planet and Humanity Medal of the International Geographical Union (2000). He was conferred with the Order of Golden Heart of the Philippines; Order of Agricultural Merit of France; Order of the Golden Ark of the Netherlands; and Order of Cambodia. The United Nations Environment Programme has called him the 'Father of Economic Ecology' and in 1999, he was on the TIME's list of most influential Asian people of the 20th century, along with Mahatma Gandhi and Rabindranath Tagore. Prof. Swaminathan's exceptional contributions to India earned him esteemed accolades, alongside the Shanti Swarup Bhatnagar Award (1961), Padma Shri (1967), Padma Bhushan (1972), Padma Vibhushan (1987), Lal Bahadur Shastri National Award (1999), Indira Gandhi Prize (2001) and now the coveted Bharat Ratna (2024), India's highest civilian award.

9. Legacy and Continuing Works

Prof. Swaminathan left behind a substantial and enduring legacy in the subject of agriculture, as well as influence on upcoming scientific generations and ongoing efforts and projects. He is widely recognized as the key figure who transformed the country's agriculture. His pioneering work in developing high-yielding crop varieties, improved farming practices, and policy advocacy played a pivotal role in this achievement. His work in India inspired similar agricultural transformations in other countries facing food security challenges. Swaminathan's ideas and principles have had a global impact on agricultural research and development.

In recent years, Swaminathan shifted his focus towards advocating for sustainable and environmentally-friendly agricultural practices. He emphasized the importance of conserving agrobiodiversity and natural resources, and adopting climate-resilient farming techniques. Sustainable and all-encompassing farming methods are given

"Biodiversity is the foundation of agriculture; we must conserve it to ensure food security for future generations. Farmers are the custodians of biodiversity; their knowledge and practices are invaluable for sustainable agriculture"

M.S. Swaminathan

priority in agroecological farming methods, which were strongly supported by Prof. Swaminathan. He promoted the application of indigenous wisdom and customs in agriculture. Understanding how climate change is affecting agriculture, Prof. Swaminathan underlined the significance of crop types and farming practices that are climate robust. He kept bringing attention to the difficulties facing agriculture as a result of climate change.

Prof. Swaminathan's work has inspired countless young scientists and researchers to pursue careers in agriculture and related fields. He has been an influential mentor to many, nurturing a new generation of agricultural scientists and policymakers. Swaminathan's commitment to ethical and sustainable

agricultural practices has set an example for future scientists and policymakers. His emphasis on social equity and environmental sustainability continued to shape the thinking of those working in agriculture and related disciplines.

The M.S. Swaminathan Research Foundation (MSSRF) has made numerous important contributions to agriculture, rural development, and food security in India and beyond. It has played its role in advancing the principles of the Green Revolution in India, particularly in the development and dissemination of high-yielding crop varieties and modern farming practices. The foundation has been a pioneer in promoting sustainable and eco-friendly agricultural practices, focusing on conserving biodiversity, minimizing chemical inputs, and enhancing soil and water management. MSSRF's research has led to the development of biofortified crops, addressing malnutrition by improving the nutritional content of staple foods, such as iron-fortified pearl millet. It has championed the empowerment of women in agriculture, providing them with training, resources, and opportunities for leadership roles in farming and rural development. The foundation has developed and promoted climate-resilient crop varieties and farming systems to help small-scale farmers adapt to changing climate conditions.

Despite his advanced age, Swaminathan remained active in research and advocacy. He persisted in adding to the conversation about rural development, food security, and sustainable agriculture through his writing, public speaking engagements, and attendance at several forums and conferences. Prof. Swaminathan played a key role in the establishment and upkeep of institutions and associations devoted to agricultural development, research, and policy advocacy. His vision and values are still upheld by these institutions.

10. Epilogue

Prof. Swaminathan devoted his entire life to the field of agriculture. He demonstrated that research can and should be directed toward addressing concrete difficulties, so serving as an example of how science can act as a catalyst for positive change. We were all inspired by his ceaseless efforts and steadfast dedication to the cause of agriculture. In addition to influencing the lives of millions of Indians and others worldwide, Prof. Swaminathan was a mentor to scientists, a teacher to students, a guide to farmers, and a counsellor to administrators. He also played a significant role in the establishment of agricultural institutions with international recognition. He ensured that farmers were at the center of all agri-R&D initiatives, created previously unheard-of possibilities for thousands of agri-researchers, and raised the bar for agri-science across the nation so that future generations would profit from, remember, celebrate, and be appreciative of it all.

"The future of nations will depend on how they deal with the challenge of producing more food "with less water"

M.S. Swaminathan

"The future belongs to nations with grains and not guns"

M.S. Swaminathan

Researchers, decision-makers, and activists all across the world are still motivated by his legacy to take on today's most important issues, such as sustainable agriculture and climate change.



Dr. Himanshu Pathak

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Dr. Himanshu Pathak was born in Purulia, West Bengal, India on 2 February 1965. He obtained his BSc (Ag) from Banaras Hindu University, Varanasi in 1986; and his MSc and PhD in Soil Science and Agricultural Chemistry from Indian Agricultural Research Institute (IARI), New Delhi in 1988 and 1992, respectively. He is a scientist of global repute working in the area of climate change and abiotic stress management.

Dr. Pathak joined as Secretary (DARE) & Director General (ICAR), New Delhi on August 1, 2022. Earlier, he was serving as the Director, ICAR-National Institute of Abiotic Stress Management, Baramati, Maharashtra (2020-2022). Prior to this, he was the Director of ICAR-National Rice Research Institute (NRRI), Cuttack, Odisha (2016-2020). Principal Scientist, Indian Agricultural Research Institute (IARI), New Delhi (2009-16); Professor, Discipline of Environmental Sciences, IARI (2013-16); Co-Facilitator, Rice-Wheat Consortium, International Rice Research Institute (IRRI)-India, New Delhi (2006-09); Humboldt Fellow, Institute of Meteorology and Climate Research, Germany (2004-06); Senior Scientist, IARI (2001-04), Scientist (Sr. Scale), IARI (1999-2001); Scientist, IARI (1997-99); Visiting Scientist, University of Essex, UK (1996-97) and Scientist, IARI (1992-97). He worked as a visiting scientist in University of Essex, United Kingdom; IRRI, Philippines; CSIRO Land and Water, Australia and Institute of Meteorology and Climate Research, Germany. He was engaged in teaching and guiding MSc and PhD students since 1993 at IARI, New Delhi.

Dr. Pathak is a Fellow of Indian National Science Academy; National Academy of Sciences, India; National Academy of Agricultural Sciences; West Bengal Academy of Science and Technology, and Indian Climate Congress, Bhubaneswar, Odisha. He is also the President of National Academy of Agricultural Sciences, New Delhi. He is the recipient of the Alexander von Humboldt Fellowship of Germany; Rafi Ahmed Kidwai Award of Indian Council of Agricultural Research; Dr. NS Randhawa Memorial Award, NAAS; Dr. RV Tamhane Memorial Lecture Award of by the Indian Society of Soil Science, Silver Jubilee Commemoration Medal of INSA; Golden Jubilee Commemoration Young Scientist Award of the Indian Society of Soil Science; BOYSCAST Fellowship of Department of Science and Technology (DST); Young Scientist Award; Dr. BC Deb Memorial Award; Prof. SK Mukherjee Commemoration Award and Platinum Jubilee Award Lecture by Indian Science Congress Association (ISCA) and Recognition Award of NAAS. He served as the President of Agriculture and Forestry Sciences Section of ISCA.

He was the Lead Author of the Inter-Governmental Panel on Climate Change (IPCC) 5th Assessment Report. He is also the Lead Author of IPCC for updating GHG inventory. Dr. Pathak was the Coordinator for United Nations Framework Convention on Climate Change (UNFCCC), Dept. of Research and Education (DARE), Ministry of Agriculture and Farmers Welfare, Govt. of India and received IRRI, Philippines Outstanding Administrative Support Award.

Dr. Pathak has published more than 200 research papers and 12 books. He has h-index 78, i10-index 249 with more than 24,100 citations in international literature.