



MANKOMBU SAMBASIVAN SWAMINATHAN: A LEGENDARY AGRONOMIST

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ABSTRACT

Swaminathan was a renowned figure in agronomy and agricultural science, known for his significant contributions to the Green Revolution and sustainable agriculture. His legacy is a testament not only to his scientific acumen but also to his humanitarian vision. This study not only celebrates his achievements but also offers valuable lessons for future advancements in agriculture and development.

KEYWORDS: Swaminathan, Green Revolution, Sustainable Agriculture, Legacy, Scientific Acumen and Humanitarian Vision.

INTRODUCTION

Mankombu Sambasivan Swaminathan (7 August 1925 – 28 September 2023) was a towering figure in agronomy and agricultural science, whose pioneering work left an indelible mark on global food security and sustainable agriculture. Often hailed as a principal architect of India's Green Revolution, Swaminathan's leadership in developing and promoting high-yielding varieties of wheat and rice significantly transformed agricultural practices and productivity in India and beyond. His collaboration with Norman Borlaug, particularly during the critical periods of the 1960s, orchestrated a robust response to the looming famine threats in India and Pakistan, showcasing the power of scientific innovation coupled with effective policy and farmer engagement.

Swaminathan's influence extended internationally through his role as Director General of the International Rice Research Institute (IRRI) in the Philippines, where his contributions earned him the inaugural World Food Prize in 1987, underscoring his global impact on agriculture. His recognition as "the Father of Economic Ecology" by the United Nations Environment Programme further highlights his dedication to integrating economic and ecological principles in agricultural practices.

Posthumously honored with the Bharat Ratna in 2024, Swaminathan's legacy is a testament not only to his scientific acumen but also to his humanitarian vision. His extensive research on crops such as potatoes, wheat, and rice, particularly in the areas of cytogenetics, ionizing radiation, and radio sensitivity, has been foundational to advancements in crop science. As a leader in various esteemed organizations, including the Pugwash Conferences and the International Union for Conservation of Nature, he influenced policies and practices that fostered environmental conservation and sustainable development.

Swaminathan's impact on agricultural policy in India is profound, exemplified by his chairmanship of the National Commission on Farmers in 2004, where he advocated for comprehensive reforms to enhance the agricultural sector. His founding of the M.S. Swaminathan Research Foundation and the introduction of the concept of the "Evergreen Revolution" in 1990 emphasized the need for sustainable agricultural practices, ensuring food security without compromising environmental health.

Throughout his tenure as a member of the Indian Parliament from 2007 to 2013, Swaminathan continued to champion agricultural and social causes, including the recognition of women farmers. His extensive accolades, including the Shanti Swarup Bhatnagar Award, the Ramon Magsaysay Award, and the Albert Einstein World Science Award, reflect a lifetime of dedication to science, agriculture, and humanity, making him one of the most influential Asians of the 20th century, as recognized by Time magazine. This paper delves into the multifaceted contributions of M.S. Swaminathan, exploring his scientific achievements, policy innovations, and enduring legacy in the realm of sustainable agriculture.



IMPORTANCE OF THE STUDY

This study of M.S. Swaminathan's contributions is crucial for understanding the transformative impact of his work on agriculture and science. Swaminathan was instrumental in the Green Revolution, which revolutionized Indian agriculture by developing high-yielding crop varieties and modern farming practices, addressing critical food shortages and ensuring national food security.

His extensive research in crop improvement, genetics, and sustainable agricultural practices has advanced our understanding of plant biology and promoted environmentally friendly farming methods. Swaminathan's efforts extended beyond scientific research to influential policy-making and global advocacy, demonstrating the powerful intersection of science and policy in achieving sustainable development goals.

Examining his legacy also provides insights into the challenges and controversies in scientific research, emphasizing the need for rigorous scrutiny and transparency. His numerous awards and honors highlight the global recognition of his contributions, underscoring the broad impact of his work on agriculture, science, and international cooperation. This study not only celebrates Swaminathan's achievements but also offers valuable lessons for future advancements in agriculture and development.

OBJECTIVES OF THE STUDY

1. To explore M.S. Swaminathan's early life, education, key influences, and roles as an administrator and educator, focusing on his impact.
2. To analyze the institutions influenced by Swaminathan, their legacies, his personal life, and the impact of his death on his legacy.
3. To document Swaminathan's scientific contributions, career evolution, and pioneering work in radiation botany and its agricultural applications.
4. To highlight M.S. Swaminathan's role in India's Green Revolution and its impact on food security.
5. To examine public recognition, accolades, honorary doctorates, and fellowships received by Swaminathan.
6. To catalog Swaminathan's publications, analyze their impact on agriculture and development, and explore controversies surrounding his work and public positions.

METHODOLOGY

The required data has been collected from secondary sources, including books, journals, dissertations, theses, seminar and conference papers, magazines, daily newspapers, and online resources.

ANALYSIS AND DISCUSSION

The study highlights M.S. Swaminathan's early life, career, and major contributions to agriculture. It emphasizes his pivotal role in the Green Revolution, his extensive research in plant genetics and breeding, and his global recognition and awards.

Early Life and Education

Mankombu Sambasivan Swaminathan was born on 7 August 1925 in Kumbakonam, Madras Presidency. His father, M.K. Sambasivan, a general surgeon, passed away when Swaminathan was 11 years old, after which he was cared for by his paternal uncle. Swaminathan attended local schools and later the Catholic Little Flower High School in Kumbakonam, where he completed his matriculation at the age of 15. Growing up in an agricultural environment, he witnessed firsthand the challenges faced by farming communities, including the impact of crop price fluctuations, weather conditions, and pest infestations on their livelihoods.

Initially inclined towards studying medicine as per his parents' wishes, Swaminathan switched his focus to agriculture after witnessing the Bengal famine of 1943 and the subsequent rice shortages across the subcontinent during World War II. Despite societal pressures favoring medicine or engineering careers, he pursued agricultural studies. He earned his undergraduate degree in zoology from Maharaja's College, Thiruvananthapuram (now University College, Thiruvananthapuram, University of Kerala), and then studied Agricultural Science at the University of Madras (Madras Agricultural College, now Tamil Nadu Agricultural University), graduating in 1944. During this time, he was influenced by Professor C. Ramaswami's teachings in agronomy.



In 1947, Swaminathan moved to the Indian Agricultural Research Institute (IARI) in New Delhi to focus on genetics and plant breeding, earning a postgraduate degree with distinction in cytogenetics in 1949. His research concentrated on the genus *Solanum*, particularly potatoes. Despite being selected for the Indian Police Service through civil service examinations, Swaminathan opted to pursue genetics with a UNESCO fellowship in the Netherlands, studying at Wageningen Agricultural University's Institute of Genetics. His research there addressed challenges such as potato resilience against pests and cold weather, influenced by wartime agricultural practices in Europe.

In 1950, Swaminathan continued his studies at the Plant Breeding Institute of the University of Cambridge School of Agriculture, where he earned a Doctor of Philosophy degree in 1952 for his thesis on species differentiation and polyploidy in *Solanum* species. Subsequently, he spent 15 months as a post-doctoral research associate at the University of Wisconsin's Laboratory of Genetics, focusing on setting up a USDA potato research station. Despite offers to remain abroad, Swaminathan returned to India in early 1954.

Back in India, he initially worked as an assistant botanist at the Central Rice Research Institute in Cuttack, participating in a hybridization program under Krishnaswami Ramiah that influenced his future work with wheat. Later that year, Swaminathan joined the Indian Agricultural Research Institute (IARI) in New Delhi as an assistant cytogeneticist. His advocacy for agricultural self-sufficiency in India led to collaborations with Norman Borlaug, culminating in the successful introduction of high-yielding wheat varieties, marking the beginning of India's Green Revolution. This effort significantly boosted wheat production and contributed to India achieving food self-sufficiency by 1971.

Administrator and Educator

In 1972, Swaminathan was appointed as the director-general of the Indian Council of Agricultural Research (ICAR) and a secretary to the Government of India. In 1979, he took on the role of principal secretary, a significant position in the Government of India. The following year, he transitioned to the Planning Commission. As the director-general of ICAR, Swaminathan advocated for technical literacy by establishing numerous centers across India. During periods of drought, he organized groups to monitor weather and crop patterns, aiming to protect the poor from malnutrition. His tenure at the Planning Commission introduced considerations for women and the environment into India's five-year development plans for the first time.

In 1982, Swaminathan became the first Asian director-general of the International Rice Research Institute (IRRI) in the Philippines, a position he held until 1988. During his time at IRRI, he organized an international conference on "Women in Rice Farming Systems," earning recognition from the Association for Women in Development for integrating women into development efforts. Swaminathan raised awareness among rice-growing families about maximizing the value of each part of the rice crop. His leadership at IRRI contributed to his receipt of the first World Food Prize in 1987. Additionally, he served as the president of the International Union for Conservation of Nature and vice-president of the World Wildlife Fund.

The prize money from the World Food Prize was used to establish the M.S. Swaminathan Research Foundation. In his acceptance speech, Swaminathan highlighted the paradox of growing hunger despite increased food production and discussed the reluctance to share power and resources. Commendation letters from notable figures such as Javier Pérez de Cuéllar, Frank Press, and President Ronald Reagan acknowledged his efforts.

Later, Swaminathan chaired the World Food Prize Selection Committee following Norman Borlaug. At ICAR, beginning in the late 1950s, he taught subjects like cytogenetics, radiation genetics, and mutation breeding, mentoring many Borlaug-Ruan interns as part of the Borlaug-Ruan International Internship program.

Institution Builder

M.S. Swaminathan was instrumental in establishing the Nuclear Research Laboratory at the Indian Agricultural Research Institute (IARI). He played a crucial role in founding the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) in India, the International Board for Plant Genetic Resources (now Bioversity International) in Italy, and the International Council for Research in Agro-Forestry in Kenya. Swaminathan also contributed to the development of research institutions and provided support in countries such as China, Vietnam, Myanmar, Thailand, Sri Lanka, Pakistan, Iran, and Cambodia.



Later Years

From 2002 to 2005, Swaminathan co-chaired the United Nations Millennium Project on hunger. He also served as the head of the Pugwash Conferences on Science and World Affairs from 2002 to 2007. Bruce Alberts, then-President of the U.S. National Academy of Sciences, praised Swaminathan in 2005, stating, "At 80, M.S. Swaminathan retains all the energy and idealism of his youth, and he continues to inspire good behavior and more idealism from millions of his fellow human beings on this Earth. For that, we can all be thankful." Swaminathan's vision was a hunger-free India by 2007.

In 2004, he was appointed chair of the National Commission on Farmers, and in 2007, President A.P.J. Abdul Kalam nominated him to the Rajya Sabha. During his tenure, he introduced The Women Farmers' Entitlements Bill 2011, aimed at recognizing women farmers, though it lapsed.

Swaminathan coined the term "Evergreen Revolution" to describe his vision of sustainable productivity, which he defined as "productivity with perpetuity." In his later years, he was involved in initiatives focused on bridging the digital divide and bringing research on hunger and nutrition to decision-makers.

Personal Life and Death

M.S. Swaminathan was married to Mina Swaminathan, whom he met in 1951 while they were both studying at Cambridge. The couple lived in Chennai, Tamil Nadu, and had three daughters: Soumya Swaminathan, a pediatrician; Madhura Swaminathan, an economist; and Nitya Swaminathan, who specializes in gender and rural development.

Swaminathan was influenced by the teachings of Gandhi and Ramana Maharshi. His family donated one-third of their 2000-acre property to support Vinoba Bhave's cause. In a 2011 interview, Swaminathan mentioned that he was inspired by Swami Vivekananda during his youth.

M.S. Swaminathan passed away at his home in Chennai on 28 September 2023, at the age of 98.

Scientific Career

Potato

In the 1950s, M.S. Swaminathan made significant contributions to understanding the origin and evolutionary processes of the potato. He identified its origin as an autotetraploid and studied its cell division behavior, providing important insights into polyploidy. His 1952 thesis focused on "species differentiation and the nature of polyploidy in certain species of the genus *Solanum*, section *Tuberosum*," facilitating the transfer of genes from wild species to cultivated potatoes. His research had practical applications, such as the development of frost-resistant potato varieties during his post-doctoral work at the University of Wisconsin. His genetic analyses were crucial in improving potato yield and growth, integrating multiple genetic aspects in a multidisciplinary approach.

Wheat

During the 1950s and 1960s, Swaminathan conducted essential research on the cytogenetics of hexaploid wheat. The wheat and rice varieties developed by Swaminathan and Norman Borlaug were central to the Green Revolution.

Rice

At the International Rice Research Institute (IRRI), Swaminathan initiated efforts to develop rice with C4 carbon fixation capabilities, enhancing photosynthesis and water usage efficiency. He also contributed to the development of the world's first high-yielding basmati rice.

Radiation Botany

Under M.S. Swaminathan's leadership, the Genetics Division of the Indian Agricultural Research Institute (IARI) gained international recognition for its research on mutagens. He established a 'Cobalt-60 Gamma Garden' to study radiation-induced mutations. Collaborating with prominent Indian nuclear scientists such as Homi J. Bhabha, Vikram Sarabhai, Raja Ramana, and M.R. Srinivasan, Swaminathan facilitated access to the Atomic Energy Establishment, Trombay (later the Bhabha Atomic Research Centre), for agricultural scientists. His first PhD student, A.T. Natarajan, conducted significant research in this area.

The research aimed to enhance plant responsiveness to fertilizers and demonstrate practical applications of crop mutations. Swaminathan's foundational studies on the effects of radiation on cells and organisms contributed to the development of redox biology. His 1966 paper on neutron radiation in agriculture, presented at an International Atomic



Energy Agency conference in the United States, was deemed "epoch-making" by Rudy Rabbinge. The work of Swaminathan and his colleagues also had implications for food irradiation.

Contribution to the Green Revolution:

The Green Revolution, a period of rapid agricultural growth in India, owes much of its success to M.S. Swaminathan's visionary efforts. In the 1960s, India faced severe food shortages. Swaminathan, along with other scientists, developed high-yielding varieties (HYV) of wheat and rice. These new varieties, combined with modern agricultural techniques, led to significant increases in crop yields, ensuring food security for the nation.

Swaminathan's work earned him international acclaim, making him a symbol of agricultural innovation. When the Green Revolution began in the Western world, Swaminathan brought it to India, teaching farmers to boost their output using HYV seeds, fertilizers, and modern practices. In collaboration with Norman Borlaug, he produced HYV wheat seeds and encouraged their use across India. In 1965, he organized exhibitions to demonstrate the benefits of genetically engineered grains, which tripled crop yields in the first year.

Swaminathan's efforts led to an increase in average agricultural production from 12 million tonnes to 23 million tonnes in just four crop seasons. He also worked with Prime Minister Indira Gandhi to develop agricultural programs and policies for long-term self-sufficiency. Swaminathan served in various key positions, including Principal Secretary of the Ministry of Agriculture (1979-1980), Director-General of the Indian Council of Agricultural Research (1972-1979), and a member of the Planning Commission (1980-1982). His policy recommendations focused on improving the livelihoods of small and marginalized farmers, ensuring food security, and promoting inclusive agricultural growth and rural development.

Innovations in Agriculture

M.S. Swaminathan's contributions extend beyond the Green Revolution. He championed sustainable and eco-friendly agricultural practices. Swaminathan emphasized the importance of integrated pest management, soil health, and water conservation. His advocacy for agroecology and biodiversity conservation has been pivotal in promoting a holistic and balanced approach to farming. Swaminathan's emphasis on sustainable agriculture has gained significance in the face of climate change challenges and the need for resilient farming systems.

Public Recognition

Awards and Honours

M.S. Swaminathan received numerous prestigious awards throughout his career. In 1965, he was awarded the Mendel Memorial Medal by the Czechoslovak Academy of Sciences. His many international accolades include the Ramon Magsaysay Award (1971), the Albert Einstein World Science Award (1986), the first World Food Prize (1987), the Tyler Prize for Environmental Achievement (1991), the Four Freedoms Award (2000), and the Planet and Humanity Medal from the International Geographical Union (2000). During his acceptance of the Ramon Magsaysay Award, he quoted Seneca: "A hungry person listens neither to reason, nor to religion, nor is bent by any prayer."

Swaminathan was also honored with the Order of the Golden Heart of the Philippines, the Order of Agricultural Merit of France, the Order of the Golden Ark of the Netherlands, and the Royal Order of Sahametrei of Cambodia. China recognized his contributions with the "Award for International Cooperation on Environment and Development." An artwork featuring Swaminathan, made up of 250,000 pieces of glass, is displayed in the Dr. Norman E. Borlaug Hall of Laureates in Des Moines, Iowa. The International Rice Research Institute (IRRI) has named a building and a scholarship fund in his honor.

Nationally, Swaminathan received the Shanti Swarup Bhatnagar Award in 1961. He was also awarded the Padma Shri, Padma Bhushan, and Padma Vibhushan, as well as the H.K. Firodia award, the Lal Bahadur Shastri National Award, and the Indira Gandhi Prize. By 2016, he had accumulated 33 national and 32 international awards. On 9 February 2024, he was conferred the Bharat Ratna, India's highest civilian award. In 2004, an agricultural think tank in India established the 'Dr. M.S. Swaminathan Award for Leadership in Agriculture' in his honor.

Honorary Doctorates and Fellowships

M.S. Swaminathan received 84 honorary doctorates and mentored numerous Ph.D. scholars. Sardar Patel University awarded him an honorary degree in 1970, followed by institutions like Delhi University and Banaras Hindu University. Internationally, he was honored by the Technical University of Berlin in 1981, the Asian Institute of Technology in



1985, and the University of Wisconsin in 1983. The University of Massachusetts, Boston, awarded him a science doctorate, praising the "magnificent inclusiveness of [Swaminathan's] concerns, by nation, socioeconomic group, gender, inter-generational, and including both human and natural environments." In 2014, Fitzwilliam College, Cambridge, where he earned his PhD in botany, made him an honorary fellow.

Swaminathan was elected a fellow of numerous science academies in India and internationally. He was recognized as a fellow by 30 academies of science and societies worldwide, including those in the United States, United Kingdom, Russia, Sweden, Italy, China, and Bangladesh, as well as the European Academy of Arts, Science and Humanities. He was a founding fellow of The World Academy of Sciences and was conferred an honorary professorship by the National Agrarian University in Peru.

Publications

M.S. Swaminathan published extensively throughout his career. He authored 46 single-author papers between 1950 and 1980 and contributed to a total of 254 papers, with 155 of them listing him as the single or first author. His research spanned crop improvement, cytogenetics and genetics, and phylogenetics. Some of his key publications include:

- Swaminathan, M.S. (1951). "Notes on induced polyploids in the tuber-bearing *Solanum* species and their crossability with *Solanum tuberosum*." *American Potato Journal*, 28: 472–489. doi:10.1007/BF02854980. S2CID 38717901.
- Howard, H. W.; Swaminathan, M. S. (1953). "The cytology of haploid plants of *Solanum demissum*." *Genetica*, 26 (1): 381–391. doi:10.1007/BF01690622. ISSN 0016-6707. PMID 13142313. S2CID 39650946.
- Swaminathan, M. S.; Hougas, R. W. (1954). "Cytogenetic Studies in *Solanum verrucosum* Variety *Spectabilis*." *American Journal of Botany*, 41 (8): 645–651. doi:10.2307/2438291. ISSN 0002-9122. JSTOR 2438291.
- Swaminathan, M. S. (1954). "Nature of Polyploidy in Some 48-Chromosome Species of the Genus *Solanum*, Section *Tuberarium*." *Genetics*, 39 (1): 59–76. doi:10.1093/genetics/39.1.59. ISSN 0016-6731. PMC 1209637. PMID 17247468.
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Additionally, Swaminathan authored and edited several books on biodiversity and sustainable agriculture:

- ❖ Swaminathan, M. S.; Kochhar, S. L. (2019). *Major Flowering Trees of Tropical Gardens*. Cambridge University Press. ISBN 978-1-108-48195-3.
- ❖ Swaminathan, M. S. (2017). *50 Years of Green Revolution: An Anthology of Research Papers*. World Scientific. ISBN 978-981-320-007-4.
- ❖ Swaminathan, M. S. (2014). "EDITORIAL: Zero hunger." *Science*, 345 (6196): 491. Bibcode:2014Sci...345..491S. doi:10.1126/science.1258820. JSTOR 24745192. PMID 25082671. S2CID 206560890.
- ❖ Swaminathan, M. S. (2011). *In Search Of Biohappiness: Biodiversity And Food, Health And Livelihood Security*. World Scientific. ISBN 978-981-4462-56-3.
- ❖ Swaminathan, M. S. (2010). *Science and Sustainable Food Security: Selected Papers of M S Swaminathan*. World Scientific. ISBN 978-981-4282-11-6.
- ❖ Swaminathan, M. S. (2006). "An Evergreen Revolution." *Crop Science*, 46 (5): 2293–2303. doi:10.2135/cropsci2006.9999.
- ❖ Swaminathan, M. S.; Ikeda, Daisaku (2005). *Revolutions to Green the Environment, to Grow the Human Heart: A Dialogue Between M.S. Swaminathan, Leader of the Ever-green Revolution and Daisaku Ikeda, Proponent of the Human Revolution*. East West Books (Madras). ISBN 978-81-88661-34-3.
- ❖ *Halving Hunger: It Can Be Done*. United Nations Millennium Project Hunger Task Force. 2005.
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Controversies

During the 1970s, M.S. Swaminathan and his team were involved in a significant controversy regarding a scientific paper that reported the creation of a mutant wheat breed, Sharbati Sonora, by gamma irradiation of the Mexican variety Sonora 64. The claim that this new breed had a very high lysine content was later disputed. The controversy was exacerbated by the suicide of an agricultural scientist, highlighting broader systemic issues within Indian agricultural research.

In another incident, a paper titled "Modern Technologies for Sustainable Food and Nutrition Security," published in the November 25, 2018 edition of *Current Science*, listed Swaminathan as a co-author. The article faced criticism from several scientific experts, including K. VijayRaghavan, the principal scientific adviser to the Government of India, who described it as "deeply flawed and full of errors." Swaminathan stated that his involvement in the paper was minimal and that he should not have been listed as a co-author.

CONCLUSION

In conclusion, M.S. Swaminathan was a renowned figure in agronomy and agricultural science, known for his significant contributions to the Green Revolution and sustainable agriculture. His work in developing high-yielding crop varieties and promoting eco-friendly farming practices revolutionized Indian agriculture, ensuring food security and prosperity. Throughout his career, Swaminathan received numerous awards and honors for his impactful research and policy advocacy. His legacy continues to inspire future generations in the field of agriculture and development, leaving a lasting impact on global food security and environmental conservation.

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