

M. S. Swaminathan (1925–2023)

Writing personal news of Bharat Ratna Monkombu Sambasivan Swaminathan (MSS) is a rare privilege and pleasure. Many leading scientists, intellectuals and policy makers agree that MSS harnessed science and technology to provide food and nutrition security to humanity initially through what he referred to as ‘Exploitative Agriculture’ (Green Revolution) and subsequently through eco-friendly, socially-equitable ‘evergreen revolution’.

The historical fact is that before MSS appeared on the Indian agricultural scenario in mid-1950s, and until he brought about the ‘Wheat revolution’ during 1967–1968, India was always food-deficient. The two books, viz. *The Population Bomb*¹ and *Famine 1975! America’s Decision: Who will Survive?*² had concluded that hunger in India would persist to result in millions of deaths. They went on to say that America would be unable to provide food aid to India in a hopeless situation. These books added humiliation to hunger. Throughout the world, India’s image was of a ‘begging bowl’. By then, MSS was already focusing on dwarf wheats and dwarf rices to transform India’s image as a ‘food basket’. Following dramatic wheat yield increases during 1967–1968, the entire nation was jubilant. The Government of India released a commemoration stamp ‘Wheat Revolution’ in 1968. Yet, the same year, MSS cautioned the nation against deleterious ecological and social dimensions of what he referred to as ‘Exploitative Agriculture’. In this regard, his Presidential Address in the section Agricultural Sciences of the 55th Indian Science Congress, Part II, Varanasi 1968 is reproduced below:

‘Intensive cultivation of land without conservation of soil fertility and soil structure could lead ultimately to the springing up of deserts. Irrigation without arrangements for drainage would result in soils getting alkaline or saline. Indiscriminate use of pesticides, fungicides and herbicides could cause adverse changes in biological balance as well as lead to an increase in the incidence of cancer and other diseases, through the toxic residues present in the grains or other edible parts. Unscientific tapping of underground water would lead to the rapid exhaustion of this wonderful capital resource left to

us through ages of natural farming. The rapid replacement of numerous locally adapted varieties with one or two high-yielding strains in large contiguous areas would result in the spread of serious diseases capable of wiping out entire crops, as happened prior to the Irish potato famine of 1845 and the Bengal rice famine of 1943. Therefore, the initiation of exploitative agriculture without a proper understanding of the various consequences of every one of the changes introduced into traditional agriculture and without first building up a proper scientific and training base to sustain it may only lead us into an era of agricultural disaster in the long run, rather than to an era of agricultural prosperity.’



What MSS wrote in 1968 was repeated four decades later³ under the title ‘The End of Plenty’. He wrote that the Green Revolution that Borlaug started deals with short-term yield increases, and does not eliminate long-term perpetual food crisis. He wrote: ‘The miracle of Green Revolution is over in Punjab; yield growth has essentially flattened since the mid-1990s. Over-irrigation has led to steep drop in the water table, now tapped by 1.3 million tube wells, while thousands of productive land has been lost to salinization and water-logged soils. Forty years of intensive irrigation, fertilization and pesticides have not been kind to the loamy grey fields of Punjab nor in some cases to the people themselves.’ The last sentence refers to a steep increase in cancer incidence among farmers in contact with chemical pesticides. Both Borlaug and the USDA (United States Department of Agriculture) were not pleased with the term ‘Exploitative Agriculture’. Hence, William Gadd of the U.S. Agency for International Development rechristened the ‘exploitative agriculture’ as the ‘Green Revolution’. The political sarcasm was

that the ‘Green Revolution’ symbolized ‘peace and food security’ instead of a rather violent ‘Red Revolution’ that established the former Soviet regime. MSS wanted the long-term harmful environmental and social aspects of the Green Revolution eliminated; hence, he started working on the concept and approaches for transforming Exploitative Agriculture into an ‘Evergreen Revolution’. He defined it as ‘achieving productivity in perpetuity without accompanying ecological and social harm’. Realizing that food security involves not only ‘food availability’ but also ‘access to food’ (i.e. a function of livelihoods), he integrated eco-agriculture with rural livelihood. His lecture ‘Agriculture, Evolution, Productive Employment and Rural Prosperity’ (Princess Leelavati Memorial Lecture on 17 January 1972, University of Mysore, p. 35) was the blueprint of the M.S. Swaminathan Research Foundation (MSSRF) that he set up in 1988 in Chennai. Setting up the MSSRF in Chennai fulfilled the promise he had made to the Nobel Laureate Sir C. V. Raman, who had stayed for two days at MSS’s bungalow in the IARI, New Delhi in 1967. Most of the financial resources came from several national and international awards which carried a financial component. In particular, he received a handsome amount from the ‘World Food Prize’ in 1987. The prize is equivalent to the Nobel Prize in Agriculture. There were also several other such prizes: Tyler Prize for Environmental Achievement, Honda Prize for Developing Eco-Technologies, UNEP Sasakawa Environment Prize, Volvo Environment Prize, Blue Planet Prize and several others. MSS’s idea of an ‘evergreen revolution’ widely received support and global acclamation from several top scientists, intellectuals and policy makers. Jeffrey Sachs, the then Director of the ‘Earth Institute’ Columbia University, New York, wrote the following foreword to MSS’s book, *From Green to Evergreen Revolution*⁴: ‘The great agronomic successes since Malthus’ time, including Green Revolution itself, have come at huge and sometime irreversible environmental costs. Even with all our technological wizardry, we have not yet adopted a truly sustainable method of feeding the planet. Swaminathan brims with ideas, prescriptions, policy plans and experiments. He knows that we can meet the great sustainability challenges

ahead, but only through tremendous will, scientific knowledge, ethical commitment and openness to partnerships and cooperation. It is a tall order but Swaminathan has proved time and again that it can be done’.

Wilson⁵, a Harvard University biologist of rare distinction cites MSS’s ‘Evergreen Revolution’ as the best available option to feed the burgeoning human population and save the rest of life as well.

From what has been aforementioned, it should be evident that Bharat Ratna M.S. Swaminathan is ‘Father of Evergreen Revolution’ and not ‘Father of Green Revolution’ (i.e. exploitative agriculture).

In this Personal News, his early life, education, visit of Mahatma Gandhiji to his house, the role of his father (a surgeon) in eradicating mosquitoes in Kumbakonam, etc. are left out to reduce the number of words. Further, 15 of his biographers (Indian and Foreign scientists and journalists) have done a magnificent job on these aspects.

MSS has the following distinctions

- 46 National Awards.
- 35 International Awards including the World Food Prize, Smithsonian Institution, Washington 1987 – considered equivalent of Nobel Prize in Agriculture.
- 62 Honorary Doctorates from Indian and 23 from Foreign Universities.
- 10 Fellowships of the various Scientific Academies and Societies.
- 28 Fellowships of International Scientific Academies and Societies including the Royal Society of London (FRS) and Foreign Associate of the National Academy of Sciences USA, Founding Fellow, Third World Academy of Sciences, Italy.
- 22 Honorary position as Chairman, Vice-Chairman, President of International Committees.
- 22 Honorary positions in National and International Organizations including as President of International Union for the Conservation of Nature and Natural Resources (IUCN), Chairman, National Commission on Farmers (2004–2014), President of Pugwash Conferences on ‘Science and World Affairs’ (2002–2007), etc. Usually, only the physicists are elected as the Presidents. It was, therefore, a great honour to all the biologists, especially the Indian biologists, that MSS, a biologist, was elected as President. While the founder members

Bertrand Russell and Albert Einstein considered human security only from a nuclear weapons point of view, MSS enlarged the concept of human security by adding hunger and pandemics like HIV/AIDS as threats. Of course, COVID did not occur then.

- He had served as a Member/Chairman in about fifty National Committees.

It is significant that, as Chairman of the National Biotechnology Board (1981–82), he had recommended genetic engineering of crop plants only as a last resort. He had cautioned against the development of pesticide (e.g. Bt) and herbicide (e.g. Ht) tolerant crops not only because of human and farm animals’ health concern, but also because ‘selection pressure’ would result in the emergence of resistant crops. He observed that commercial interests should not outweigh health and environmental concerns. That Bt-cotton has developed resistance against chemical pesticides is now well-known.

Unique honours to MSS

MSS had received a few unique honours. One of these is that the *TIME* magazine of the USA, the Asian edition of August 1999, has cited MSS as one of the three most influential Indians (Mahatma Gandhi and Rabindranath Tagore being the other two) among a galaxy of 20 most distinguished Asians of the 20th century.

Considering that food is the most basic among a hierarchy of human needs, MSS’s focus on achieving food and nutrition security at the global level accorded him unparalleled admiration and respect. Those closely following his tireless endeavours and successes towards elimination of hunger from the planet Earth were rather unhappy that he was not awarded the Nobel Prize. Critical analysis reveals that MSS’s role in India’s quantum jump in cereals production was far more significant than Borlaug’s. It is unfortunate that MSS was not given Bharat Ratna in the late 1960s itself. This author believes that the most appropriate time for honouring MSS with Bharat Ratna was 1968 when the Government of India released the Wheat Revolution Commemoration stamp.

When MSS passed away on 28 September 2023, without Bharat Ratna, Prime Minister Narendra Modi wrote about his contributions to India’s food security in all the leading newspapers. He wrote, ‘I want

you all to think about the challenging circumstances in which he (MSS) stood as a colossus guiding our nation towards the path of self-sufficiency and self-confidence.’ He also pointed out, ‘Academically brilliant he could have chosen any career but he was so impacted by the Bengal famine of 1943 that he was clear that if there is one thing he would do, it would be to study agriculture.’

The PM was so right as most of his associates knew that MSS did not join the Indian Administrative Service, and did not take up the faculty position offered to him by the University of Wisconsin, USA. Instead, he returned to India and accepted a temporary position as Assistant Botanist in 1954 at the Central Rice Research Institute, Cuttack, in the FAO-sponsored scheme on the *Indica-japonica* rice hybridization programme. Six months later, in October 1954, he became an Assistant Cytogeneticist at the Botany Division of IARI, New Delhi. His rise to higher positions since then was meteoric. He became cytogeneticist in 1956. He rose in 1961 to become the Head of the Division of Botany. In 1966, he became the Director of the IARI. In 1972, he was appointed the Director-General of the Indian Council of Agricultural Research (ICAR) and Secretary, Department of Agricultural Research and Education (DARE) under the Union Ministry of Agriculture. In March 1980, the then Prime Minister Indira Gandhi asked him to join the Planning Commission since she wanted ‘doers’ and not merely ‘thinkers’ to design India’s future planning. Hence he served the Commission as Acting Deputy Chairman and Member-in-Charge of Agriculture, Rural Development, Science and Technology, Health, Education and Employment. Three unprecedented chapters in the Sixth Five Year Plan (1980–1987) introduced by MSS were: (a) Women and development, (b) Environment and development, (c) A New Deal for the self-employed.

In December 1987, Clarence Gray, the then Chairman, Board of Trustees of the International Rice Research Institute (IRRI), Los Banos in the Philippines, came to New Delhi and conveyed to MSS in person, the decision of the Trustees to invite him as Director-General of IRRI. He decided to accept the offer as it would give him an opportunity to work on rice, a crop of fundamental importance to India’s food security as well as that of Asia. So, he went to Indira Gandhi and expressed his desire to return to research. She said to him that he

was indispensable. He responded, 'Madame after hearing what you said, I feel it is time to go'. She wondered and said, 'Why? Have I hurt you in any way? I sincerely feel you are indispensable'. MSS replied, 'I sincerely feel that one must leave when one is most wanted, and this is why I feel that this is the right time to help our country in a different capacity.' Gandhi paused for a while and said, 'Yes indeed, you must leave when you are wanted and not when people want you to leave.' She blessed him as he left.

MSS returned from the Philippines early in 1988 and initiated steps to establish his own research centre (MSSRF) at Madras. MSSRF, in its goal of achieving sustainable food productivity and rural livelihood development, harnesses eco-friendly technologies. One of these is using satellites and computers in the villages to link farmers with scientists, farmers with farmers, and scientists with farmers. It is referred to as lab-to-lab, land-to-lab, lab-to-land and land-to-land linkages. Land refers to farmers. At the MSSRF, MSS developed methods of blending frontier science and technologies (e.g. remote sensing, nuclear, information and communication and biotechnologies) with traditional knowledge and ecological prudence of the rural and tribal communities to provide a 'pro-nature, pro-poor, pro-women and pro-livelihood' orientation to technology development and dissemination in rural areas. For a substantial period of post-independence, high-level science and technology had been limited/confined to a few major Indian cities and neighbouring towns. But India's roots are in the well-spread-out 638,000 villages comprising over 70% of India's population and bulk of them are illiterate and unskilled. Abject poverty is their way of life. It is now changing not only because MSS has shown the way, but also because the current political governance largely follows the path set by MSS. There is a view, however, that the current 'farmers' agitation' would not have happened, had the Governments in the past and present, implemented the recommendations of the Farmers' Commission Report submitted in 2007 by MSS.

What has been mentioned above might give the impression that MSS was mostly an applied researcher and had made no/negligible contribution to basic biosciences. This is just not true. His basic research during the 1950s and early 1960s was outstanding, which won him the Shanti Swarup Bhatnagar Award in 1961 and Fellowship of the Royal Society, London

(FRS) in 1973. The details of his basic research are outlined elsewhere⁶. The details of his basic research in cytogenetics, radiation biology, radiation and chemical mutagenesis, cell biology, etc. are elaborated in the biography '*M. S. Swaminathan: Legend in Science and Beyond*'⁷. Due to limitation of space, only his most outstanding contributions are outlined below:

- (i) Elucidation of speciation and transfer of genes/chromosomes from wild diploid ($2n = 24$) *Solanum* species to cultivated tetraploid potato ($2n = 48$) *Solanum tuberosum* during his research career in Wageningen, the Netherlands, Cambridge University, UK and Wisconsin University, USA.
- (ii) Setting up of 'Cobalt - 60 gamma garden' at the IARI, New Delhi for chronic irradiation of crops, particularly vegetatively propagated ones in order to eliminate the problem of 'diplontic selection' (that is the elimination of a few slowly dividing mutated cells by an overwhelming number of normal, non-mutated cells).
- (iii) Initiation of research on 'Indirect biological effects of ionizing radiation' on cells and organisms.
- (iv) Elucidation of mitotic division in yeast contrary to the prevalent view his research revealed that normal mitosis occurs, but the cell membrane does not disintegrate.
- (v) Assessment of DNA content and organization of eukaryotic chromosomes.
- (vi) 'Diploidization' of polyploids in *Triticum*.
- (vii) Elucidation of 'oxygen effect' in radiobiology.

MSS and conservation of biodiversity

MSS was a crusader for biodiversity conservation and its sustainable use. In his epoch-making Presidential Address, 'Genetic conservation: microbes to man' at the XV International Congress of Genetics held in New Delhi in December 1983, he pleaded for international efforts involving *ex-situ* preservation of germplasm (seeds, propagules, etc.) by cryogenic gene banks maintained at between -10°C and -20°C . This, of course, involves huge energy requirements and prohibitively expensive costs. Therefore, he suggested that the regions of Earth with sub-zero temperature throughout the year (permafrost conditions) could be used. MSS's idea was the

driving force for the Norwegian Government to create a Noah's ark in the form of the 'Svalbard Global Seed Vault' in the Norwegian Village of Longyearbyen on Svalbard Island; a 120-meter tunnel was chiseled out in the middle of an ice mountain to create three giant vaults, capable of storing 4.5 million distinct varieties of crops. MSS was invited to a seminar 'Frozen seeds in a Frozen Mountain: feeding a warming world' in Svalbard. He delivered an invited lecture titled, 'Freezing seeds: a humanitarian issue'.

His various other roles

He played a pivotal role in developing the 'Protection of Plant Varieties and Farmers' Rights Act 2001 (PPVFR 2001)' that was passed by Parliament of India. The Act is unique in that it recognizes the important role played by farmers not just as cultivators but also the role of tribal and rural farming women and men as conservers and enhancers of agro-biodiversity.

He also rose to the occasion following major disasters such as the Bhuj (Gujarat) earthquake on 26 January 2001 and the tsunami on 26 December 2004 that devastated the Southern coastal regions of Tamil Nadu. His article 'Beyond tsunami: an agenda for action'⁸ is even now widely referred to for its crisp recommendations to minimize the loss of lives and livelihoods in case of any such disaster occurring in future. The Royal Society of London invited him to make a presentation. He could not go, so he deputed this author. Our presentation resulted in a publication⁹.

His work ethics were deeply rooted in the principles of Gandhiji, viz. 'Antyodaya' (i.e. starting with the weakest and the poorest in the society) and 'sarvodaya' (advances of all at all levels). In administration, he always saw a 'human face' amongst the rules and regulations. On one occasion, when he was the Head of the Botany Division, IARI, one of his senior scientists who had been deputed for an International scientific symposium had overstayed for one more day. A senior bureaucrat in the IARI asked MSS about his proposed action against the scientist. MSS explained how the scientist made use of the extra day by visiting a famous institute. Not satisfied with this reply, the senior bureaucrat put a note on the file whether the overstay by the scientist concerned was 'inevitable'. Tersely but politely MSS wrote back, 'Nothing but death is inevitable'. The file was closed.

In conclusion, as his student, this author must comment on his role as a teacher. MSS taught cytogenetics and radiation genetics at the Post-Graduate School of IARI from the 1950s through the 1960s. Whether rainy, scorching heat or biting cold in Delhi, he would ride on his bicycle to the Botany Division from his Bungalow No. 12 via crop fields. His punctuality was such that students could reset their watches at 8.0 a.m. He organized his teaching material from original research papers and made them easily understandable to the students especially the weakest from rural India. He would offer references to articles published in the international journals that the IARI library had been subscribing to. This library was rechristened in 2016 as 'Professor M.S. Swaminathan Library'.

Once in a conversation, he told this author, 'Globalisation will confer benefits if it leads to common goals such as eradicating poverty, malnutrition and environmental degradation. It should not be based only on trade competition and making money.' It meant that no human ingenuity and technologies would help eliminate hunger

if the natural resources were degraded and exhausted. He also told this author, 'We are entering the age of Anthropocene where human action will determine whether we are going to lead the human family to a happy future or environmental disasters. We should try to make Anthropocene the beginning of a global partnership for Gross National Happiness (GNH) rather than GDP as a measure of the impact of human activities on the environment.' He also defined the agricultural research needed in an era of climate change¹⁰.

In conclusion, his demise is no doubt a great loss to his immediate family members and close friends, but far more so to those engaged in ensuring food security for the burgeoning population in an era of climate change.

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