

Green Revolution: A war between
Hunger and self sustainability

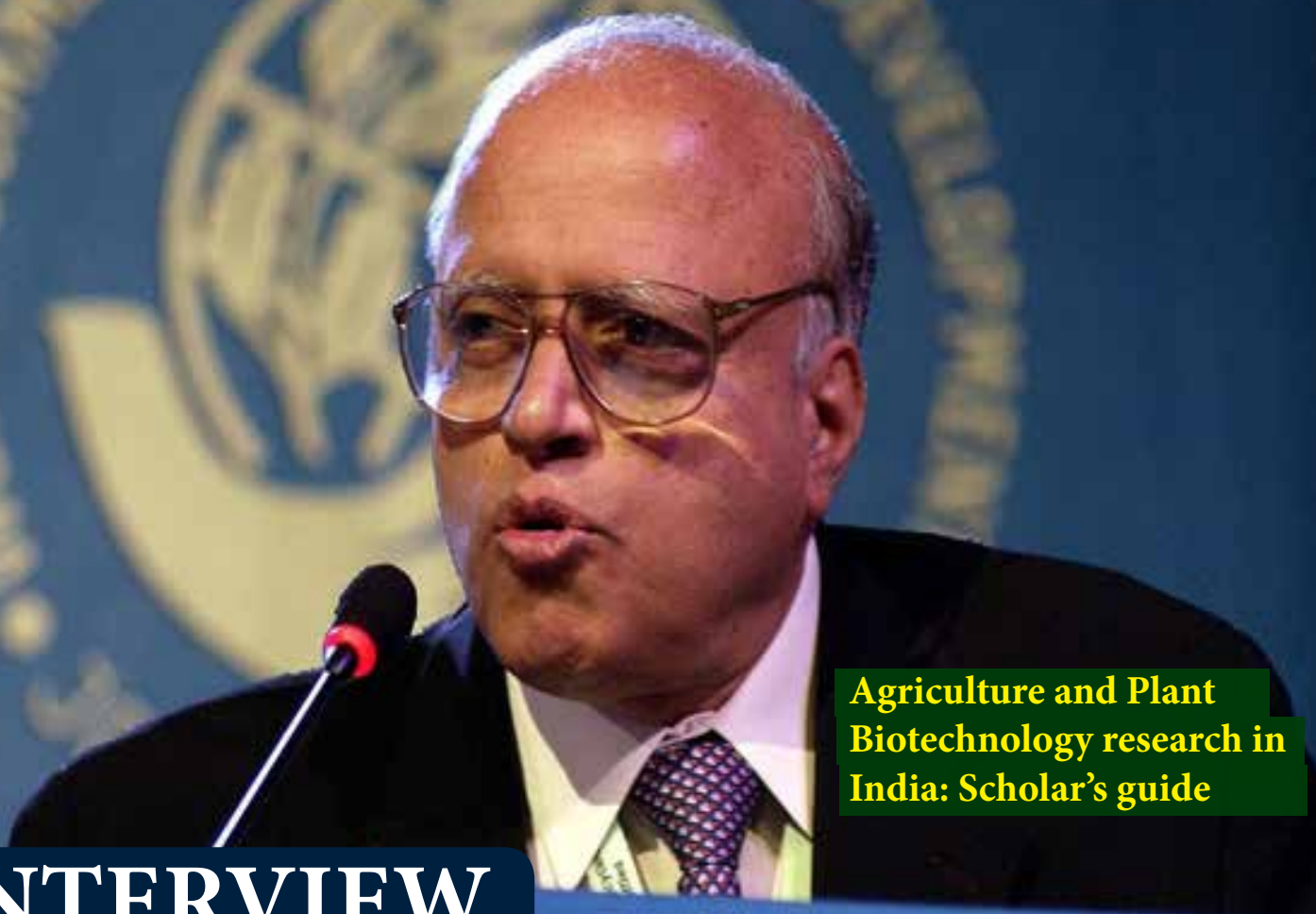
Are GMOs Silent Killers or
Silently Killed? : Pros and Cons !

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BIOTECH EXPRESS

Sir M S Swaminathan



Agriculture and Plant
Biotechnology research in
India: Scholar's guide

INTERVIEW

“Father of Indian Green Revolution”

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M S SWAMINATHAN

**FATHER of
GREEN REVOLUTION**

Most Prestigious Awards

**Padma Shri (1967), Padma Bhushan (1972), Padma Vibhushan (1989)
First World Food Prize**

Currently UNESCO - Cousteau Professor in Ecotechnology &
Chairman, M S Swaminathan Research Foundation (MSSRF)

Fellow FRS, NASc, INSA, IASc, AAAS, WIF

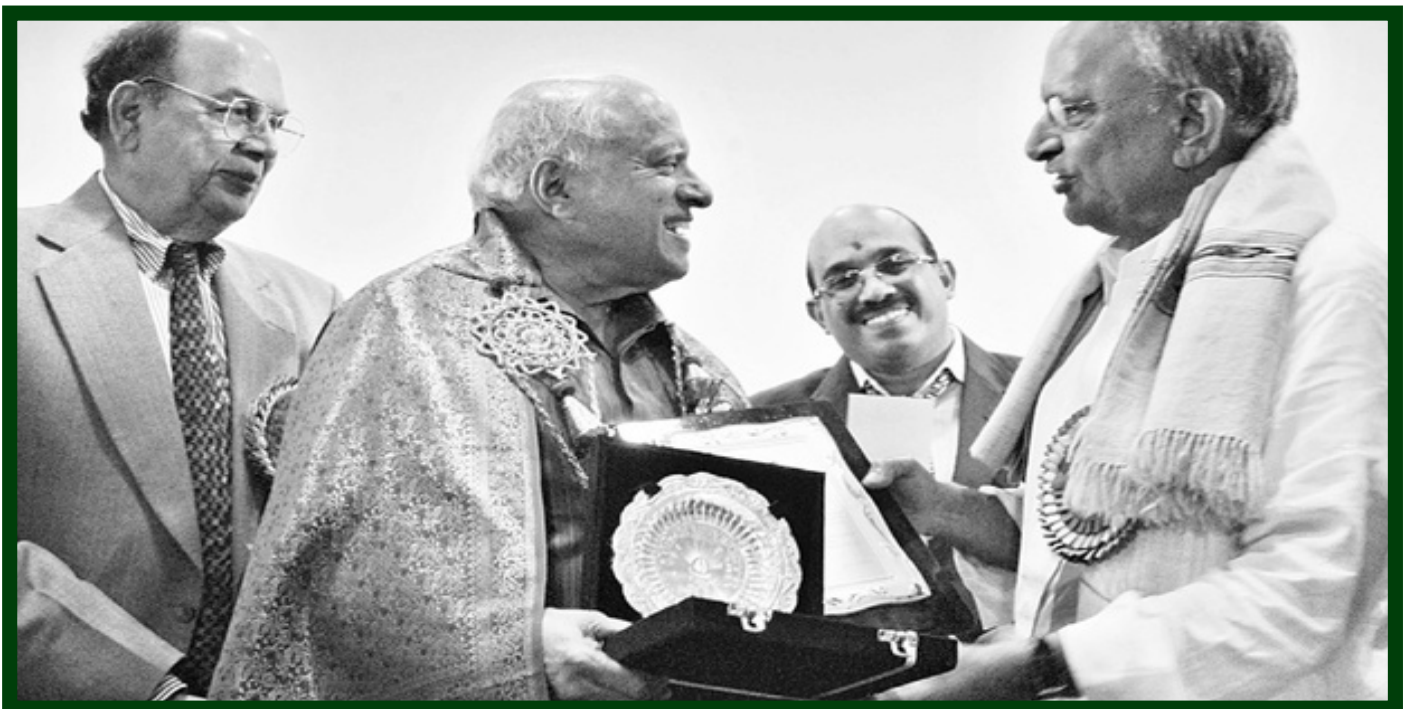


“We were honoured that the Swaminathan Sir gave this interview personally for Biotech Express magazine. We look forward to many more years of collaborative working to promote Indian Science and the importance of agricultural biodiversity to nourish people and sustain the planet.”

When the international edition of Time magazine named Indian agricultural scientist M. S. Swaminathan as one of the 100 most influential Asians of the twentieth century, many readers wondered who Swaminathan was. While less well known than the other Indians on Time 's list, such as poet Rabindranath Tagore and nonviolence advocate Mohandas K. Gandhi, Swaminathan may have touched the lives of impoverished Indians more directly than those other historical figures. As the originator of the so-called Green Revolution, Swaminathan set in motion fundamental changes in agricultural production in India that have put an end to India's age-old status as a nation on the brink of starvation.

In this magazine words can't express his efforts and his whole life cannot be described in few pages, but as academic magazine we are giving here excerpts from the talk we did. He did uncountable miracles in this long tenure and still at the age of 90+ he is successfully working in MSSRF.

Kamal Singh



M.S. Swaminathan is one of the world's leading agricultural scientists. He played a catalytic role in India's green revolution between 1960 and 1982. From April 1982 to January 1988 he served as Director General of the International Rice Research Institute (IRRI). He also served as the President of the Pugwash Conferences on Science and World Affairs (2002-07). President of the International Union for the Conservation of Nature and Natural Resources (IUCN) (1984-90).

For the decade prior to assuming his post with IRRI, Dr. Swaminathan was at the forefront of one of the most remarkable agricultural accomplishments in recent history moving India from having the largest food deficit in the world to producing enough grain to feed all of its people. From 1954 to 1972, he worked at the Indian Agricultural Research Institute, New Delhi, mainly in the field of wheat improvement. He served as Director General of the Indian Council of Agricultural Research; Secretary of the Department of Agricultural Research and Education (1972-1979); and Principal Secretary of the Ministry of Agriculture and Irrigation (1979-1980). He was member in-charge of agriculture and rural development in India's Planning Commission from 1980 to 1982.

Family background and early education of Dr M S Swaminathan

Commonly called M S or Swaminathan, Mankombu Sambasivan Swaminathan is an Indian geneticist and international administrator, renowned for his leading role in



National Awards

Shanti Swarup Bhatnagar Award (1961); Birbal Sahni Medal, Indian Botanical Society (1966); Silver Jubilee Commemoration Medal, Indian National Science Academy (1971); Barclay Medal, Asiatic Society (1978); Moudgil Prize (1978); Borlaug Award (1979); Meghnad Saha Medal, Indian National Science Academy (1981); Rabindranath Tagore Prize, Visva Bharati University (1981); R.D. Misra Medal, Indian Environmental Society (1981); 'Krishi Ratna' Award, Bharat Krishak Samaj/World Agriculture Fair Memorial Trust Society (1986); Dr J.C. Bose Medal, Bose Institute (1989); Lal Bahadur Shastri Deshgaurav Samman (1992); Jawaharlal Nehru Birth Centenary Award, Indian Science Congress Association (1992); Charles Darwin International Science and Environment Medal (1993); Dr B.P. Pal Medal, National Academy of Agricultural Sciences, India (1997); V. Gangadharan Award, National Development (1997); B.P. Pal Memorial Award, Indian Science Congress Association (1998); Shatabdi Puraskar, Indian Science Congress Association (1999); Prof. P.N. Mehra Memorial Award (1999); Legend in his Lifetime Award, World Wilderness Trust (1999); Asutosh Mookerjee Memorial Award for 1999-2000, Indian Science Congress Association; Indira Gandhi Prize for Peace, Disarmament and Development (2000); Millennium Alumnus Award, Tamil Nadu Agricultural University (2000); Millennium Scientist Award, Indian Science Congress Association (2001); Lokmanya Tilak Award, Tilak Smarak Trust, Pune (2001); Indira Gandhi Gold Plaque (2002); Raja Rammohan Roy Puraskar (2005); All India Management Association's Life Time Achievement Award (2007); Distinguished Global Thinker Award, Institute for Integrated Learning in Management, New Delhi (2007); Lal Bahadur Shastri National Award for Excellence in Public Administration, Academics Management (2007); Fifth Panampilly Prathibha Puraskar (2012); GITAM Foundation Annual Award, Visakhapatnam (2012); Indira Gandhi Award for National Integration (2013).

BEM would also like to thanks Dr Kambadur Muralidhar for arranging talk with Dr Swaminathan and helping us in framing questions w.r.t agriculture Biotechnology and administrative experiences.

International Awards

Mendel Memorial Medal, Czechoslovak Academy of Sciences (1965); Ramon Magsaysay Award for Community Leadership (1971); Bennett Commonwealth Prize of the Royal Society of Arts (1984); Bicentenary Medal, University of Georgia, USA (1985); Albert Einstein World Science Award, World Cultural Council (1986); Award for Serving the Cause of Women in Development (1985); First recipient of the Award instituted by the Association for Women in Development, Washington, DC, United States; First World Food Prize Smithsonian Institution in Washington, DC, USA (1987); The Golden Heart Presidential Award of Philippines, 1987.

In recognition of Swaminathan's contributions to the research, training and technology transfer programmes of IRRI, the Board of Trustees named the Training and Technology Transfer Building of the Institute as 'M.S. Swaminathan Hall'. The IRRI Trustees also established a special fund for providing scholarships in his name for candidates who wish to do research by women in rice farming systems. This is in recognition of his services to the cause of women in agriculture.

Commandeur of the Order of the Golden Ark of the Netherlands (1990); The Tyler Prize for Environmental Achievement (1991); Honda Prize, Honda Foundation, Tokyo, Japan (1991); Asian Regional Award by the Asian Productivity Organisation (1994); UNEP– Sasakawa Environment Prize, 1994; World Academy of Art and Science, Special Award (1994); Global Environmental Leadership Award, Climate Institute, Washington, DC, USA (1995); Highest award for International Cooperation on Environment and Development, China (1997); Ordre du Merite Agricole, France (1997); Henry Shaw Medal, Missouri Botanical Garden, USA (1998); The VOLVO Environment Prize, Sweden/ USA (1999); UNESCO Gandhi Gold Medal, France (1999); Franklin D. Roosevelt Four Freedoms Award, Franklin and Eleanor Roosevelt Institute (2000); Planet and Humanity Medal of the International Geographical Union (2000); The Economic Times Awards for Corporate Excellence–Lifetime Achievement (2002); Toda Award for Peace Achievement, Japan; Outstanding Technology Leadership, included among the 50 world leaders by Scientific American (2004); Soka Gakkai Hiroshima Peace Award (2005); The Crop Science Society of America Presidential Award (2005); Ordre Du Merite Agricole (Commander of the Agricol Merit) (2006), France; Sahametrei Medal of the Royal Government of Cambodia (in the grade of Chevalier) (2006); Medalla Rectoral Universidad de Chile, Chile (2009); Willa S. Cather Medal, Lincoln, University of Nebraska (2011); Living Legend of International Union of Nutrition Sciences, Granada, Spain (2013).

Biographies on Dr Swaminathan

1. Ramanujam, S., Siddiq, E. A., Chopra, V. L. and Sinha, S. K., Science and Agriculture: M.S. Swaminathan and the Movement for Self-Reliance, IARI, New Delhi, 1980, pp. 400.
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3. Iyer, R. D., Scientist and Humanist. M.S. Swaminathan, Bharatiya Vidya Bhavan, 2002, pp. 245.
4. Dil, A., Life and Work of M.S. Swaminathan. Toward a Hunger-free World, East West Books (Madras) Pvt Ltd, Chennai, 2004, pp. 636.
5. Gopalakrishnan, G., M.S. Swaminathan. One Man's Quest for a Hunger-free World, Education Development Centre, Chennai, 2002, pp. 130.
6. Parasuraman, N. (Tamil), M.S. Swaminathan – Architect of Sustainable Agriculture, Mathi Nilayam, Chennai, 2014, pp. 239.
7. Deolgavkar, A., Swaminathan – Bhukmukticha Dhyas (Liberator from hunger). Akshar Prakashan, Mumbai, 2000, pp. 162.
8. Deolgivekar, A., Swaminathan – Bhukmukticha Dhyas, Supriya Sharad Marathe, Mumbai, 2008, pp. 183.

India's Green Revolution. He was born on 7 August 1925 in Kumbakonam of Tamil Nadu. Influenced by services of his father during swadeshi movement and India Independence movement, he inherited the sense of Service and martyrdom in him early in his life. Swaminathan got married on 11 April 1955 to Mina Boothalingam, whom he had met in 1951 at Cambridge University (UK) from where she obtained M A degree in Economics. Mina is an eminent authority in the field of education with particular reference to pre-school education. She played a key role in the development of Integrated Child Development Services (ICDS) as well as Mobile Creches catering to the needs of migrant labour children. She is currently Distinguished Chair on Gender and Development at MSSRF.

The Swaminathans are blessed with three highly talented daughters: Soumya the eldest trained as a paediatrician and currently the DG, ICMR and Secretary, Department of Medical Research, Govt of India; Madhura the second, is a Rhodes scholar, obtained D Phil degree from Oxford University (UK), is also currently the Chairperson of M.S. Swaminathan Research Foundation, and Nitya is Professor of Gender and Development at the University of East Anglia, Norwich, UK.

Research Career

From late 1940s until mid-1950s. In a span of 6 to 7 years, he obtained the Ph D degree of Cambridge University and published significant original research papers in journals such as Genetics, Nature, Journal of Heredity, Genetica, Euphytica, Bibliographica Genetica, American Journal of Botany, American Potato Journal, etc., wherein he elucidated the mechanisms of speciation in the genus Solanum, section Tuberarium. Understanding the genomic affinity of the cultivated tetraploid potato $2n = 4x = 48$ (*Solanum tuberosum*), with wild diploid ($2n = 2x = 24$) enabled inter-specific hybridization and transfer of genes to confer resistance against abiotic and biotic stresses to potato. When he was a young research scholar in the Wisconsin University (USA), he developed a potato hybrid carrying the frost-resistance gene from a tetraploid wild relative *S. acaule* ($2n = 48$). Later, this hybrid potato material was used to develop a frost-resistant potato variety called 'Alaska Frostless'.

Although he was offered an attractive research-cum-teaching position in Wisconsin, MS chose to return to his motherland where he had no job then.

Impressed with his brilliance and highly noteworthy contributions to the cytogenetics and breeding of po-

tato, MS was appointed in the Central Rice Research Institute (CRRI; Cuttack) and assigned to work in the indica-japónica rice hybridization programme.

After six months of his stay at CRRI, MS was selected by the Union Public Service Commission and joined as Assistant Cytogeneticist in the then Botany Division of the Indian Agricultural Research Institute (IARI), New Delhi in October 1954.

Nearly a decade later, when MS became the Head of the Botany Division, he appropriately changed its name as Genetics Division. It is here that his most outstanding basic research ranging

Research papers on the above-said topics were published in Nature, Current Science, Science, Genetics, Radiation Research, Radiation Botany, Environmental and Experimental Botany, Experientia, Die Naturwissenschaften, Experimental Cell Research, etc.

Although MS had been focusing on radiation and chemical mutagenesis, cytogenetics and crop improvement, he was also keeping himself abreast of developments in a wide range of genetics and plant breeding researches. He was also quick to grasp major developments in other disciplines like biotechnology, biochemistry, biophysics, atmospheric

Question: Sir what Motivated you to pursue research career

Answer: My motivation came from the desire to achieve Gandhiji's goal of a hunger-free India, since as a University student I was deeply moved by the sight of starving children, women and men in Bengal. I then felt that Bengal famines should become problems of the past and should not recur in Independent India.

from the elucidation of the structure of the chromatid, mitosis in yeast, mechanisms of ionizing radiation and chemical mutagenesis, radio-sensitivity as a function of ploidy level, actions of low and high LET ionizing radiations on diploid and polyploid wheats, overcoming 'diploic selection' in vegetatively propagated material exposed to ionizing radiation using the strategy of chronic irradiation to Drosophila genetics and human cytogenetics by culturing human peripheral blood leucocytes for chromosome karyotyping of congenital abnormalities in syndromes gained unparalleled momentum.

sciences, remote-sensing, etc. He also wanted his students to get interested in various domains of science and integrate the principles, tools and techniques of physics and chemistry in their own studies in biology.

His major involvement during the last three decades in promoting sustainable agriculture and rural development using innovative paradigms such as ecotechnology-based biovillages and modern information and communication-based Village Knowledge Centres (VKCs) have obscured his absolutely outstanding contributions to life sciences in gen-

EDUCATION

- a) B.Sc. from Travancore University in 1944
- b) B.Sc. Agriculture from Coimbatore Agricultural College, Madras University, 1947
- c) Associateship of the Indian Agricultural Research Institute, New Delhi, in Genetics, 1949
- d) UNESCO Fellow in Genetics at the Agricultural University at Wageningen, The Netherlands, during 1949-50
- e) Ph.D. from the School of Agriculture, University of Cambridge, U.K. in 1952
- f) Research Associate in Genetics at the University of Wisconsin USA during 1952-1953

Honorary Positions in International Committees/ Organisations

- a) Vice Chairman, Technical Advisory Committee to the Consultative Group on International Agricultural Research (CGIAR) (1971-77)
- b) Vice Chairman, Protein-Calorie Advisory group of United Nations, (1972-77)
- c) Chairman, Committee of the Whole, UN Conference on Desertification, Nairobi (1977)
- d) Chairman, U.N. Advisory Committee on Science and Technology for Development (1980-83)
- e) President, International Federation of Agricultural Research Systems for Development (IFARD) (1976-1983)
- f) President, International Bee Research Association (IBRA) (1978-1990)
- g) Independent Chairman, FAO Council (1981-1985)
- h) Member, Scientific and Technical Advisory Committee, Tropical Diseases Research, World Health Organisation (1983-1985)
- i) Chairman, Governing Board, CAB International (1991-94)
- j) Andrew D. White Professor-at-Large of the Cornell University, United States of America (1989-95)
- k) Trustee of the Ford Foundation (1989-97)
- l) Chairman of the Global Hunger Project (1994-2000)
- m) Founder Chairman of the Trustees of the Iwokrama International Centre for the Sustainable Management of Rainforests, Guyana (1992-99)
- n) Member, China International Council for Sustainable Development (1992-2002)
- o) Chairman, Genetic Resources Policy Committee of the Consultative Group on International Agricultural Research (1994-2002)
- p) Founder-Trustee, Biobliotheca Alexandrina, Egypt

Positions Held

- a) Teacher, Researcher and research administrator at the Central Rice Research Institute, Cuttack and at the Indian Agricultural Research Institute, New Delhi (1954-72)
- b) Director General, Indian Council of Agricultural Research and Secretary to the Government of India, Department of Agricultural Research and Education (1972-79)
- c) Principal Secretary to the Government of India, Ministry of Agriculture and Irrigation (1979-80)
- d) Acting Deputy Chairman, Planning Commission, Government of India. (April- June, 1980)
- e) Member (Agriculture, Rural Development, Science and Education) Planning Commission, Government of India (June 1980-April 1982)
- f) Director General, International Rice Research Institute (IRRI) Los Banos, Philippines, (April 1982-January 1988)
- g) Chairman, M S Swaminathan Research Foundation (1989 onwards)
- h) UNESCO Chair in Ecotechnology (1994 onwards)
- i) Chairman, National Commission on Farmers, Government of India (2004-06)
- j) President, Pugwash Conferences on Science and World Affairs (2002-2007)
- k) President, National Academy of Agricultural Sciences (2005-07)
- l) Member, National Advisory Council, Government of India (2010-

Question: What do you enjoy most about being a scientist?

Answer: My message to young scientists is that they should enjoy science and work for the progress of our understanding of natural phenomena. The scientific approach is the one which will take them to the desired goal speedily and surely. The greatest joy comes from having a goal and working towards it. In early 1960s my goal was to break the barrier to high yields in wheat and rice and I did this with the help of science. I share the view of Jawaharlal Nehru, when he said, “the future belongs to science and those who make friendship with it”.

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Before End



Recognition by Scientific Academies

- a) Fellow of the Indian Academy of Sciences (F.A.Sc.) (1957)
- b) Fellow of the Indian National Science Academy (FNA) (1962)
- c) Honorary Fellow of the National Academy of Sciences, India (1976)
- d) General President, Indian Science Congress, Waltair (1976)
- e) Honorary Fellow of the Swedish Seed Association, Sweden (1971)
- f) Fellow of the Royal Society of London (FRS) (1973)
- g) Foreign Associate, National Academy of Sciences of the United States (1977)
- h) Foreign Member, All-Union Academy of Agricultural Science, USSR (1978); Russian Academy of Agricultural Sciences (1992)
- i) Founding Fellow, Third World Academy of Sciences (1983)
- j) President, XV International Congress of Genetics, New Delhi (1983)
- k) Foreign Member, Royal Swedish Academy of Agriculture and Forestry (1983)
- l) Foreign Honorary Member, National Academy of Arts and Sciences, Massachusetts (1984)
- m) Foreign Fellow, National Academy of Sciences of Italy (Accademia Nazionale delle Scienze della Dei XL - 1985)
- n) Fellow of the Royal Society of Arts, London (1985)
- o) Honorary Research Professor of the Chinese Academy of Agricultural Sciences (1987)
- p) Honorary Research Professor in Genetics of the Chinese Academy of Sciences (1987)
- q) Fellow, European Academy of Arts, Sciences and Humanities (1988)
- r) Fellow, Bangladesh Academy of Sciences (1992)
- s) International Member of the American Association for the Advancement of Science (1992)
- t) President, National Academy of Sciences, India (1988-90)
- u) President, National Academy of Agricultural Sciences, India (1991 - 1996)
- v) Corresponding Member, Accademia dei Georgofili, Italy (1994)
- w) Fellow of the Linnean Society of London (1994)
- x) Fellow of the American Association for the Advancement of Science (1994)
- y) Honorary Fellow of the Crop Science Society of America & the American Society of Agronomy (1996)
- z) Vice-President, XVIII International Congress of Genetics, Beijing (1998)
- aa) Honorary Fellow of Association of Aquaculture (1998)
- bb) Fellow, Madras Science Foundation (1999)
- cc) Fellow, Indian Society for Plantation Crops (2000)
- dd) Honorary Member of the World Innovation Foundation (2002)

Question: How do you think scientific research, which contains a lot of technical language and data, can be more accessible to the general public of India?

Answer: Scientists should also become communicators of their research results in the local language so that people can understand. There is a big gap between science and society which we should bridge.



M. S. Swaminathan at the World Food Prize Convocation.
Source: <http://www.msswaminathan.com/>

Question: What aspects of your work do you think could be described as Indian science? What do you think are the challenges of using traditional ways of knowing with Indian science?

Answer: Traditional Indian science is based on observation and experience. Science is a continuum. There is nothing like traditional and modern – one leads to another. We should therefore neither discard traditional wisdom and knowledge, nor condemn modern science we should blend the two.

Box: Excerpts from what the most eminent citizens of the world have said about Swaminathan.

Norman E. Borlaug, Nobel Laureate of International Maize and Wheat Improvement Centre, Mexico, 10 November 1970:

'The Green Revolution has been a team effort and much of the credit for its spectacular development must go to Indian officials, organizations, scientists and farmers. However, to you, Dr Swaminathan, a great deal of the credit must go for first recognizing the potential value of the Mexican dwarfs. Had this not occurred it is quite possible that there would not have a Green Revolution in Asia...'

Ronald Reagan, President, USA, 11 September 1987:

'It is with great pleasure that I congratulate you on being chosen as the First World Prize Laureate. This award recognizes what many in the global food and agricultural community have known for a long time that your efforts have made a dramatic and lasting impact on improving world food supply.'

Joshua Lederberg, 1958 Nobel Laureate in Medicine and Physiology, 25 September 1987:

'I was so pleased to hear the news of your award. There could not have been a more appropriate choice. I can think of no one who has combined the insights of the cutting edges of biological science with attention to the most urgent needs with the competence, devotion and energy that you have given. The world is and will be a better place on account of your contributions to its welfare...'

Javier Perez de Cueller, Secretary General, United Nations, October 1987:

'Dr. Swaminathan is a living legend. His contributions to agricultural science have made an indelible mark on food production in India and elsewhere in the developing world. By any standards, he will go into the annals of history as a world scientist of rare distinction...'

R. Venkataraman, former President of India on the occasion of Swaminathan's 70th birthday, National Academy of Agricultural Sciences, New Delhi, August 1995:

'Pleasant, soft spoken, dignified but unassuming, Dr. Swaminathan has a demeanor which conceals his brilliant intellect, unparalleled achievements in science and research, and countless awards, prizes, fellowships and honours showered on him by national and international institutions. The Green Revolution which transformed our chronic food-deficit country with three hundred sixty million people into a food self-sufficient one with nine hundred million has earned for him an indelible place in our national history...'

Ismail Serageldin, Chairman, CGIAR, 27 January 2000:

Dr. Swaminathan is a great humanitarian, an International scientist, and a bold and imaginative visionary. The results of his efforts have had a multiplier effect, helping small farmers to produce more food, increase incomes and protect the environment. This has resulted in the elimination of major sources of discord and conflict. Dr. Swaminathan's contribution to the development of sustainable agriculture is unassailable, and is universally acknowledged....

He has broadened the concept of agricultural sustainability to include not only consideration of ecology and economics but also of ethics, social and gender equity and employment generation...'

eral, and cytogenetics and radiation and chemical mutagenesis in particular.

“In 1987, Javier Perez de Cuellar, the then secretary-general of the United Nations wrote, “Dr. Swaminathan is a living legend. “

Swaminathan Sir - As an administrator

As Director General of the Indian Council of Agricultural Research, M.S. Swaminathan reorganized India's agricultural programme, yet helping his home country was just the beginning. His dream is to rid the world of hunger and poverty, and he has devoted his life to this cause.

Through the last several decades, Mr. Swaminathan has served as the Director General of the International Rice Research Institute, where he continued his efforts in genetic conservation and improvement, founded and chaired the M.S. Swaminathan Research Foundation (MSSRF), taught young scientists as a professor at various institutions, been elected a Fellow of Royal Society of London, the U.S. National Academy of Sciences, the Chinese Academy of Sciences, and the Italian Academy of Sciences, and has authored over 200 scientific papers and numerous books (most recently *In Search of Biohappiness*, published in 2011).

Among his many contributions as Director General of Indian Council of Agricultural Research (ICAR) during 1972-79, particular mention may be made of his designing and initiating on Agricultural Research Services (ARS) to provide opportunities for scientists for life long specialisation. ARS helped to attract and retain brilliant young scientists in the ICAR system.

Question: Any comment on GMOs?

Answer: The only GMO under cultivation is Bt cotton. Here again new problems like white fly have affected the crop. Therefore what is needed now is a blend of mendelian and molecular breeding. Marker assisted selection will be more effective than genetic modification. Meanwhile Government should set up regulatory mechanism which inspires public, political and professional and media confidence.

Milestones of his Career

Mr. Swaminathan has been honoured with numerous awards over the past 60 years, including the First World Food Prize in 1987, UNESCO Mahatma Gandhi Gold Medal in 1999, the Honda Award, the Tyler Environment Award, and the Ramon Magsaysay Award.

On the occasion of First World Food Prize, the Secretary General of the United Nations extolled, “Dr. Swaminathan is a living legend. His contributions to agricultural science have made an indelible mark on food production in India and elsewhere in the developing world. By any standards, he will go into the annals of history as a world scientist of rare distinction.”

Norman Borlaug won the Nobel Prize for Peace, and he subsequently acknowledged in a letter that ‘to you Dr Swaminathan, a great deal of the credit must go for first recognizing the potential value of the Mexican wheat dwarfs. Had this not occurred, it is quite possible that there would not have been a Green Revolution in Asia.’ There is no doubt that the quantum jump in wheat yields changed India's image from a ‘begging bowl’ to a ‘bread basket’.

A grateful India further honoured her pioneering son, conferring in series, the Padma Shri (1967), the Padma Bhushan (1972), and the Padma Vibhushan (1989), which are higher civilian awards in India. (Padma Vibhushan is just next to the highest Indian civil award known as Bharat Ratna.)

One of his greatest successes in recent years, was achieved during his tenure as a member of the Indian Parliament (2007-2013) where he worked to include nutritious and resilient minor millets in India's Food Security Bill, which targets more than 800 million people with publicly financed food distribution. This amendment, which took place in 2013, stimulates the production of highly nutritious and resilient crops, providing an invaluable contribution to climate adaptation and food security, especially in the more marginal areas of India where these crops are integral to local cultural identity as well as food security.

He has published several hundred papers in international journals and several books, including “Building a National Food Security System” (Indian Environmental Society, 1981) and “Science and Integrated Rural Development” (Concept Publishing Company, New Delhi, 1982).

Along with Prof. S.K. Sinha, he edited a book on “Global Aspects of Food Production” (Tycooly, 1987). He has chaired several national and international committees of exports, including the Indian Expert Group on Programmes for the Alleviation of Poverty, Eradication of Leprosy and Blindness, the eco-development of Goa, Himalayas and Western Ghats and the preparation of a draft National Population Policy and a draft Biodiversity Act.

Contributions to Education and Extension

In the early nineteen sixties, he designed and implemented the National Demonstration Programme in wheat, rice and other crops. The National Demonstration Programme resulted in a small government programme becoming a mass farmers’ movement for increasing productivity. 76 students have done their Ph.D thesis work under the guidance of Dr. Swaminathan. In 1972, he introduced the “Techniracy” concept of imparting training in the latest technical skills entirely through work experience, in order to bypass the problems created by illiteracy and fostered the establishment of a chain of Krishi Vigyan Kendras (Farm Science Centres) for this purpose by the Indian Council of Agricultural Research. He also initiated the Lab to Land Programme and the whole village operational Research Projects, when he was the Director General of

ICAR. Designed the organisation of Farm Schools in the fields of Farmer-achievers to promote farmer to farmer learning.

Major Scientific Contributions

Has worked in collaboration with colleagues and students on a wide range of problems in basic and applied plant genetics, agricultural research and development and the conservation and enhancement of natural resources over a period of 60 years. Among the more important contributions are:

- elucidation of the origin and differentiation of potato species (1952);
- Improving the yield potential of indica rice through crosses between indica and joponica varieties (1954);
- standardisation of techniques for the induction of polyploidy (i.e., doubling the number of chromosomes) in several economic plants, including tuber-bearing solanum species (1950);
- accomplishment of difficult crosses in potato species, resulting in alien gene transfer for frost resistance (1953);
- elucidation of the factors influencing the induction and recovery of mutations in wheat and rice and elaboration of the relationships between the secondary effects of food irradiation and the assessment of the wholesomeness of irradiated food (1958);
- understanding of genetic relationships among wheat species (1960);

- identification of the barriers to high yields in wheat and the initiation of the wheat breeding programme involving the “Norin” dwarfing genes obtained from Mexico(1963);
- initiation of a rice breeding programme designed to transfer the non-lodging plant type to basmati strains (this led ultimately to the release of Pusa Basmati) (1965);
- development of the concept of “crop cafeterias”, “mid-season corrections in cropscheduling”, risk distribution agronomy and alternative cropping strategies for different weather conditions(1966);
- purposeful manipulation of genes in improving the yield, quality and stability of performance of wheat, rice and potato(1949 – 1989);
- development of whole village or watershed operational research projects based on principles of ecology and economics and promotion of the concepts of ecological economics and economic or developmental ecology(1972);
- development of disaster management strategies based on relief and rehabilitation measures in the most seriously affected (MSA) areas, and improved crop productivity in the most favourable (MFA) areas, and elaboration of the concepts of “drought code” and “good weather code”(1975);
- management of the disastrous drought of 1979 as Secretary to the Government of India in the Ministry of Agriculture and Development of a scientific Monsoon Management Strategy(1979);
- collection and conservation of plant genetic resources, particularly of potato, rice, wheat and mangrove species (1949 onwards);

Question: Any message to Life sciences community of India.

Answer: Indian science requires above all dedicated scientists who have the courage of the conviction. They should express their views based on scientific facts freely and fearlessly.

- o) development of the National Demonstration, Lab to Land programmes and while village, watershed operational research projects for the effective field testing and dissemination of research results among small farmer households(1964);
- p) organisation of coastal systems research and biovillages(1990);
- q) organisation of Genetic Resources Centres for Sustainable agriculture and for adaptation to sea level rise(1991);
- r) promotion of a job-led economic growth strategy based on a pro-nature, pro-poor and pro-women orientation to technology development and dissemination(1992);
- s) Organisation of Resource Centres for Farmers' Rights and Ecotechnology(1993);
- t) Organisation of Biovillages and Community Centred natural resources management strategies (1993);
- u) Establishment of computer-aided and internet connected Rural Knowledge Centres (1997); organisation of the Jamsetji Tata National Virtual Academy for Rural Prosperity and a National Alliance for Mission 2007 : Every Village a Knowledge Centre.
- v) Organising a Community Gene, Seed and Grain management strategy, involving concurrent attention to conservation, cultivation, consumption and commerce (1998)

The results of the above research studies and extension efforts have been published in scientific papers in national and international journals as well as in several books.

“Mr Andras Erdelyi, the Hungarian biographer of Prof. MS S waminathan gave the title to his book. “The Man Who Harvests Sunshine. The Modern Gandhi: M S Swaminathan”

Kamal Singh
Managing Editor and Publisher
Biotech Express Magazine

Top Cited Publications of M S Swaminathan

[CITATION] Cutting world hunger in half
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Road Map for Agricultural Biotechnology

communicated by M S Swaminathan on 27th December 2015

The following seven steps will help to foster agricultural biotechnology

1. Develop scientific guidelines for the choice of the problem to be taken up for genetic modification. Is there an alternative to recombinant DNA technology like marker assisted selection, genome editing etc.
2. Develop procedures for field testing of the GM material in the breeders' assembly line based on the principles contained in the Cartagena protocol on biosafety. The field testing should be done in full consultation with State Governments and in the fields of public good institutions such as Agricultural Universities.
3. Develop science based methods of assessing risks and benefits. Such procedures coupled with the results of field trails can help to decide whether the GMO pathway is the best way for achieving the desired end result.
4. Promote biotechnology literacy and establish resource centres for the mass media. Such media resource centres should help to promote public information and education and not become propaganda agencies.
5. At the national level, develop a National Biotechnology Board consisting of the Secretaries of DARE, Ministry of Agriculture, Ministry of Environment and Forest and Climate Change, ICMR, DST, CSIR, UGC, Atomic Energy and Niti Ayog for dealing with risk minimising methods of promoting GMOs. A suitable insurance policy should be provided to small farmers, so as to insulate them from risks beyond their control, such as drought.
6. State Governments and State Agricultural Universities should be involved at all stages, both in field testing and approval for cultivation.

In the short term, the existing system should be strengthened from the scientific angle and used to assess the GM varieties in the assembly line, so that no further time is lost in coming to a decision. Meanwhile a suitable Act for establishing a National Biosafety Regulatory Authority may be placed before Parliament for early approval.

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