TRIBUTE

Biodiversity Conservation

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M. S. Swaminathan was a towering figure in science. He made seminal contributions to national food security and to the well-being of the people of India.

Swaminathan had a deep interest in and knowledge of the science of genetics and plant breeding. He used these to touch millions of lives and to contribute to the eradication of hunger by increasing food production and availability, and by helping to facilitate the access to food for hundreds of millions of people. His contributions to science and development were summarised in the address by Javier Perez de Cuellar, Secretary General of the United Nations, on the occasion of the award of the first World Food Prize in 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.[1]

Swaminathan was instrumental not only in shaping food security but also the political sovereignty of India

Swaminathan's deep knowledge in the science of genetics and plant breeding and his zeal for increasing food production resulted in a long-lasting collaboration with Norman Borlaug. Borlaug won the Nobel Prize for Peace in 1970. On receiving the Prize, Borlaug wrote:

> The Green Revolution has been a team effort and much of the credit for its spectacular development must go to the Indian officials, organizations, scientists, and farmers.

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[1] In 1999, TIME magazine listed Swaminathan among the 20 most influential Asians of the 20th century (the other two Indians on the list were Mahatma Gandhi and Rabindranath Tagore).

> However, 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.

Of the change that came about because of the quantum leap in national food production in India, Swaminathan himself wrote:

> it gives me great satisfaction to see that India's destiny has changed from the begging bowl to a bread basket and that the government can now engage in international negotiations with greater dignity.

Transition from green to evergreen revolution in agriculture

The negative environmental features associated with the often excessive use of mineral fertilizers and chemical pesticides needed for realising the higher yields of green revolution wheat varieties, and unsustainable exploitation of groundwater led Swaminathan to develop the concept of an "evergreen" pathway to sustainable food production. He thus shifted his focus from green to "evergreen" revolution.

> To achieve an ever-green revolution, we need technologies that can help farmers to improve productivity in perpetuity without associated ecological harm. By mainstreaming ecological principles in technology development and dissemination, we can achieve sustained and sustainable advances in productivity.

To achieve this objective, Swaminathan advocated the use of the latest science and technological advances and agrobiodiversity. He established the M. S. Swaminathan Research Foundation (MSSRF) in 1988, with a clear roadmap towards sustainable agriculture for reducing dependence on chemical fertilizers and energy use in the smallholder famers' fields. Knowledge and rural technology-based skill empowerment of rural women and men towards sustainable management of natural resources, and for the creation of on-farm and non-farm livelihoods were major components of the evergreen revolution.

Swaminathan recognised the global importance of collection, conservation and sustainable use of agrobiodiversity

In the period from 1955 to 1970 Swaminathan built up the germplasm collections of wheat and rice and contributed particularly to the collection of over 7000 rice strains from the North Eastern region of India as a valuable source of rare genes and alleles. In the 1970s, as the Vice-Chairperson of the Technical Advisory Committee of the CGIAR, he was instrumental in establishing an International Board for Plant Genetic Resources (IBPGR), now Alliance Bioversity International-CIAT. As Director General of the Indian Council of Agricultural Research (ICAR), Swaminathan established National Bureaus of Plant, Animal, and Fish Genetic Resources in India. He took initiatives to launch special expeditions to collect wild

rice species from hotspot locations, and established the International Rice Germplasm Centre with an International Advisory Board at the International Rice Research Institute (IRRI). He helped establish a Commission on Plant Genetic Resources in 1983, and developed the concept of Farmers' Rights and the International Undertaking on Plant Genetic Resources (IUPGR).

As President of the International Union for Conservation of Nature (1984-90), Swaminathan helped in developing the draft on Convention on Biological Diversity. The draft of the Biodiversity Convention was then finalised under his Chairmanship of the IUCN General Assembly at San Jose (February 1-10, 1988). During this period, the Keystone International Dialogues on Plant Genetic Resources (1988-1991) were organised under the chairmanship of Swaminathan. The dialogues resulted in a landmark decision on benefit sharing with the primary conservers of agrobiodiversity. This was followed by preparing a Multilateral System (MLS) for the exchange of germplasm of the crops of importance to global food and nutritional security under the FAO's International Treaty on Plant Genetic Resources for Food and Agriculture (the treaty was signed in 2001 and came into force in 2004).

Swaminathan played a key role in the establishment of the Svalbard Global Seed Vault

The Svalbard Global Seed Vault was built by the Norwegian Government in the Norwegian Village of Longyearbyen on Spitsbergen Island, in Norway's Svalbard archipelago in 2008. Its objective was to conserve genetically diverse seeds of millions of crop accessions. The seed of an international genetic resources repository under permafrost conditions was sown by Swaminathan in 1983, when he stressed the need of agrobiodiversity conservation in his Presidential Address to the International Congress of Genetics in New Delhi. Swaminathan said

> Although plant conservation on farms and in the wild is the ideal approach to preserving genetic diversity in crop plants, these methods are constantly jeopardized by invasive species, human destruction of habitat, and market factors. Therefore, other preservation strategies like ex-situ preservation become essential.

Currently, the Svalbard Global Seed Vault holds 1,214,827 duplicate seed samples – the most diverse collection of food crops in the world – as insurance for future food security. I was fortunate to be able to make the first official seed deposit from India in the Svalbard Global Seed Vault in April 2014.

Swaminathan was also involved in a major way in promoting sustainable agriculture and rural development using innovative paradigms such as ecotechnology-based bio-villages and modern information and communication-based Village Knowledge Centres.

Swaminathan's key role in preparing the first draft of India's legislation on Plant Variety Protection and Farmers' Rights

In the 1990s, legislation concerning plant variety protection and farmers' rights became necessary in order to ensure the implementation of the equity-related provisions of the Convention on Biological Diversity (CBD). Swaminathan, who emphasised the crucial role of farmers and rural farming families and Scheduled Tribe households in conserving and protecting agrobiodiversity, played a pivotal role in developing the Protection of Plant Varieties and Farmers' Rights Act of 2001 in India. His interventions to strengthen the conservation ethos (mainly with respect to landraces of rice) of Scheduled Tribe women in Koraput led to the women winning the prestigious Equator Initiative Award at the United Nations Conference on Sustainable Development at Johannesburg in 2002 and the Genome Saviour Award of the Protection of Plant Varieties and Farmers' Rights Authority of India in 2007.

Swaminathan's landmark initiatives in the conservation of mangroves and millets

Swaminathan was instrumental in establishing the International Society of Mangrove Ecosystems in 1992, and was its founder President. MSSRF played a pivotal role in protecting and restoring degraded mangrove forests in the coastal regions of West Bengal, Odisha, Andhra Pradesh, and Tamil Nadu. The massive effort by MSSRF helped reduce the devastating effect of the tsunami that shook the coastal regions of Tamil Nadu in 2004. Further, Swaminathan's contributed to the conservation and use of millets as climate-smart "nutri-cereals" in the International Year of Millets 2023. He called attention to the potential of millets as a means of income generation and poverty reduction and of enhancing nutritional security. He proposed that conservation, cultivation, consumption, and commerce be the four pillars of the Millet Mission announced by the Government.

My interaction with the champion and supporter of germplasm conservation

I became Director of the National Bureau of Plant Genetic Resources (NBPGR) in 2010, and was acutely aware of the importance of plant genetic resources for food and nutritional security. NBPGR has a treasure trove of germplasm resources (over 450,000 accessions) conserved in the National Genebank. I have had many opportunities to visit the M. S. Swaminathan Research Foundation in Chennai and my regular interaction with Swaminathan helped me build a deeper understanding on the usefulness of germplasm resources, particularly for climate resilience in agriculture. At this juncture, building on the interest I have had in wheat since my days as a Ph D student, I developed a project on climate resilience in wheat. I decided to conduct a comprehensive and systematic evaluation of the entire untapped collection, that is of about 22,000 accessions conserved in the Indian National Gene Bank. The study was carried out at different hotspots in the country

over seasons and resulted in the identification of promising lines that were resistant to a wide range of diseases and heat stress. The study was featured on the cover of the November-December 2020 issue of *Crop Science*. More importantly for me, however, Swaminathan visited NBPGR in 2013 and wrote to me in appreciation of the work done there:

> I am particularly happy that you are converting NBPGR into a functional conservation centre so that the seeds preserved in cryogenic seed banks become the progenitors of revolutionary progress in different crops maintained by NBPGR.

Swaminathan pointed out that not only preservation but also sharing of genetic resources have been the mainstay of global food and nutritional security. In order to realise Swaminathan's dream of evergreen revolution in the contemporary world, it is essential to ensure the free flow of information associated with plant genetic material.

Swaminathan will always be remembered for his scientific acumen and brilliance, his vision, and his immense contributions to the achievement of global food and nutritional security, and the reduction of world hunger.

M. S. Swaminathan and Marie Haga, Executive Director, Global Crop Diversity Trust at the National Genebank, National Bureau of Plant Genetic Resources, 2013. The author is first left.