

M. S. Swaminathan: Legend in Science and Beyond. P. C. Kesavan. World Scientific Publishing Co. Pte Ltd, 5 Toh Tuck Link, Singapore 596224. 2017. 276 pages. Price: US\$ 118.

This biography of M. S. Swaminathan combines elements of a textbook based on his original contributions to cytogenetics of crops and their improvement using radiation and chemical mutagenesis, and his notable transition as a crusader of a hunger-free world. In the early chapters, it traces Swaminathan's landing in Wageningen, the Netherlands in 1949 and the beginning of his tryst with cytogenetics of potato successively in Wageningen, Cambridge (England) and Wisconsin (USA). Potato was a tough and even unsuitable plant for in-depth cytogenetic research and improvement by breeding across the ploidal levels. The cultivated potato is a tetraploid ($2n - 4x = 48$), whereas species having the genes to shield against nematodes and frost are diploids ($2n = 2x = 24$). The author, Kesavan clearly describes Swaminathan's original research papers on these and also brings out the ideas and planning that preceded the execution in the laboratory and experimental field. Kesavan's imaginary description of potato beckoning to Swaminathan to improve it genetically (p. 22) and the latter obliging, provides an unusual but emotional introduction to the bonds between the two.

The noteworthy contribution of Swaminathan is the demonstration that potato originated as an autotetraploid and its behaviour in meiosis largely as a diploid is due to progressive diploidization. This has been discussed in 1954 (*Journal of Heredity*, **45**(6), 265–272) and shown to involve chromosome 5B by Riley and Chapman in 1967 (*Journal of Heredity*,

52, 22–26). Kesavan also brings out a significant finding by Swaminathan that with polyploidization, the chromosome length of the polyploids did not increase proportionately; in fact, DNA elimination occurred as a means for suppression of multivalent formation in conjunction with the gene suppressor.

In chapter 3 on 'Basic research in frontier areas of life sciences', Kesavan reveals Swaminathan's insatiable thirst for new knowledge in technology development for improving agricultural crops. It deals with setting up a 'Gamma Garden' to expose crop plants to chronic irradiation for inducing desirable mutations. In using ionizing radiation for mutation breeding, Swaminathan goes deep into several radiobiological complexities and phenomena. His basic research deals with biological effects of low and high LET radiations and how radiobiological oxygen effect could be modified with appropriate choice of radiation. His paper on the use of neutron radiation in agriculture and applied genetics in 1966 at the IAEA Symposium at Brookhaven, USA is epoch-making. Swaminathan and his co-workers demonstrated that radiobiological effects could be observed in organisms *not* directly exposed to radiation, but to irradiated media. This work became highly relevant to radiation preservation of readily perishable food materials. The author illustrates that Swaminathan's strength in basic sciences helped develop a clear-cut approach for practical applications of technologies.

In chapter 4, the author describes Swaminathan as an individual with an undiminished child's curiosity. He found out how many DNA molecules form a chromatid visible under light microscope. Swaminathan and his student showed that chromatid is composed of just one DNA double helix and it becomes visible under the light microscope due to its condensation and association with other molecules. Today, we know how nucleosomes (DNA + histones) are organized.

In chapter 5, the author shows how curiosity matched social responsibility, and basic research combined excellence with social relevance. For instance, the doomsday scenarios of the 1960s by Paddock Brothers, Paul Ehrlich, etc. were belied by the 'Green Revolution' ushered in by Swaminathan using dwarfing genes of Norin 10, obtained from Norman Borlaug. Kesavan also brings out how Swaminathan accorded priority

for biodiversity conservation, citing his famous Presidential Address in 1983 at the XV International Congress of Genetics, New Delhi. The reason for his attachment to biodiversity conservation is attributed to dwarfing genes without adverse pleiotropic effect on panicle length as a gift of nature. Swaminathan acknowledged that this trait could not be induced by Mendelian or mutation breeding or the use of plant hormones. His innate humility and contributions to genetics provided the courage to declare that nature's secrets are never fully revealed and humans can never conquer nature.

In chapter 6, Swaminathan's role in bringing about yield revolution in wheat and through it the Green Revolution that changed India's image from a 'begging bowl' to a 'bread basket' is discussed. Swaminathan referred to it at the 55th Indian Science Congress at Varanasi in 1968 as 'exploitative agriculture' that could result in agricultural doom. How Swaminathan walked the talk in transforming the Green Revolution into an 'Evergreen Revolution' – for productivity in perpetuity without ecological or social harm. The 'systems approach' of concurrent attention to soil, irrigation water, biodiversity, etc. constitutes the ecological foundation for sustainable agriculture and Evergreen Revolution. The resource base for rural livelihoods is enhanced with food security at household level, requiring 'access' and 'availability' of food. Kesavan describes how Swaminathan focused on this in his famous 1972 Leelavathi Memorial Lecture in Mysore University. Swaminathan's prescription of 'do ecology' in the Indian context, as against the 'don't ecology' of the developed countries, in the 1972 Coromandel Lecture is elegantly presented. The biography in textbook style details the transformation of the Green Revolution into the Evergreen Revolution. Rural on-farm and non-farm eco-enterprises with market linkages enhance 'access' to food. Swaminathan's 'biological software' is the term for biofertilizers and biopesticides, while he coined 'techniracy' to describe a pedagogic method of learning by doing for skill empowerment of rural women and men. Towards skill enhancement for management of natural resources (i.e. conservation and their sustainable use), Swaminathan set up 'biovillages', a flagship programme of the M.S. Swaminathan Research

Foundation (MSSRF) set up by him in 1988 in Chennai. Kesavan refers to it as Swaminathan's 'magnum opus'. Since skill enhancement needs knowledge/awareness integration, the author describes how modern information and communication (ICT) technology for rural communities was facilitated. Swaminathan's 'Village Knowledge Centres' spreading all across India parallel his other accomplishments such as the Green Revolution and Evergreen Revolution. The organization of 'biovillages' and Village Knowledge Centres are dealt with at length in chapters 8 and 9 respectively.

In chapter 10, the author unravels Swaminathan's innovations and strategies to link biodiversity conservation with livelihood and food security of rural and tribal people. Kesavan describes how Swaminathan played crucial roles in preservation (e.g. Svalbard, Norway, frozen seed in a frozen mountain) and *in situ* conservation of landraces. His unique idea of 'banks with a difference' – gene bank → seed bank → grain bank → fodder bank → water bank – integrates functions of conservation and lending of food grains/fodder in crisis caused by extreme natural events. Kesavan also describes Swaminathan's role in developing the 'Plant Variety Protection and Farmers' Right Act' enacted by the Parliament of India in 2001, that recognizes the role of farmers as conservers of biodiversity and breeders in addition to their traditional role as cultivators. The footprints of Swaminathan in revitalizing biodiversity conservation in developing countries are well reviewed. Kesavan elaborates on Swaminathan's outstanding contributions in the formation of 'Iwokrama International Centre for Rainforest Conservation and Sustainable Development' in Central Guyana and of the Amerindian legend that forests are foundations of life, not just carbon sink. The chapter discusses Swaminathan's role in establishing a Global Network of Mangrove Genetic Resources Conservation Centre, in the Gulf of Mannar Biosphere, below sea level cultivation of paddy in Kuttanad (Kerala) and in getting it the recognition of 'globally important agricultural heritage system'.

Chapter 11 places in context how Swaminathan was in the 1980s cautioned against impending adverse effects of global warming on agriculture, when climate change was not an issue at all. In

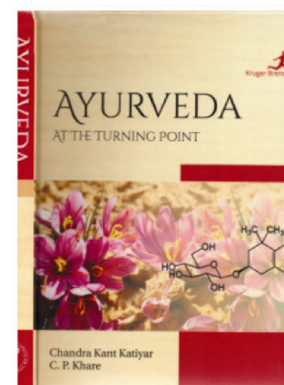
1998, Swaminathan was the first agricultural scientist to write on 'El Niño and monsoon management', and in the 1997 Japan Climate Conference he drew attention to sea-level rise due to global warming, melting of glaciers and how ingression of sea water could cause salinization of land and aquifers. While genetically shielding coastal agricultural crops with salinity, drought and submergence tolerance, he also led a programme at MSSRF to develop salinity-tolerant rice varieties.

In chapter 12, the author describes Swaminathan's deep concerns on hunger and under-nutrition. The then UN Secretary General, Ban Ki-Moon launched a 'Zero Hunger Challenge' in 2012, for the elimination of hunger, malnutrition and food insecurity. Kesavan describes how the innovative idea of 'farming system for nutrition' of Swaminathan was designed as a pathway to achieve nutrition security – a system for enhancing farmers' income while alleviating nutritional maladies with agri-horticultural remedies.

With a plethora of facts, analyses and deep insight, this book reflects the close collaboration Kesavan has had with Swaminathan and his family for over five decades. More than a traditional biography, it brings out Swaminathan's leadership. Kesavan's excellent authorship makes the connect between friendship with the Swaminathan family and intellectual skills to find a balance between involvement on the one hand and objectivity on the other. The book is an important and stimulating piece of work that all those interested in the role of science in society and those seeking commitment of young and old scientists, must read.

RUDY RABBINGE

*Professor of Sustainable Development
and Food Security,
University of Wageningen,
The Netherlands
e-mail: rudy.rabbinge@wur.nl*



Ayurveda: At the Turning Point.
Chandra Kant Katiyar and C. P. Khare.
Kruger Brentt Publisher UK Ltd, 68 St
Margarets Road, Edgware, Middlesex
HA8 9UU, UK. 2018. 644 pages. Price:
£ 80. ISBN: 978-1-78715-005-8

While modern science was progressing in the West leading to Renaissance and Industrial Revolution, the geopolitical situation in India was not conducive for research or development. Although significant knowledge, wisdom and competence existed in this region, hardly any scientific advancement was possible. Indian communities were more concerned about preserving knowledge. This, in a way, led to the compartmentalization and monopolization of knowledge. India has witnessed a long period of great stagnancy that continued even during the pre- and post-independence periods.

India has a long history of knowledge generation. The Vedic and Upanishadic periods have marked excellence and leadership in several knowledge domains. Charaka (400 BC), considered as the 'Father of medicine', is the best representative example. His rational and critical approach opened a new era of cause-effect relationship and evidence-based medicine as opposed to prevalent ritualism. He compiled a comprehensive encyclopaedia of medicine, the *Charaka Samhita*, which elaborates principles, diagnoses and treatments. This classic text provides detailed knowledge of human anatomy, embryology, pharmacology, blood circulation, and diseases like diabetes, tuberculosis, heart disease, and of thousands of medicinal plants used in Ayurveda. This legacy was interrupted when India was in turmoil of invasions and instability. However, the situation started changing during the last two decades and has gained momentum during