

Innovation for Sustainability of the Sugar Agro-Industry

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The World Commission on Environment and Development (WCED) defines sustainable development as that which meets the needs of the present without compromising the possibility of future generations to meet their own needs. In order to make the sustainable development concept effective, it is necessary to consider it the confluence of social, environmental, and economic issues—the triple bottom line. One of the key areas that has been intimately associated with sustainable development is the role of innovation in enhancing various facets of sustainability. All major

sustainability issues can in principle be tackled based on innovation-centric approaches as they are key elements through which organizations, institutions, communities, regions, and countries can implement effective programs. However, in addition to the triple pillars, the importance of cultural and political dimensions, as well as the stage of development of countries, should not be overlooked.

The global sugar industry should aim at continually adapting to remain competitive in an environment of rising production costs, climate variability, biotic and abiotic stress, compliance costs, and change in production and consumption patterns due to recent pandemics. Nevertheless, the sugar industry has the required potential to positively influence and contribute toward a number of key issues related to inclusive and sustainable development in different ways. These include harnessing the potential of technological innovation in areas like bio-energy, green harvest and sustainable uses of trash, C-sequestration, climate resilient varieties, agriculture 4.0 and agro-technologies, bio-intensive crop production and protection technologies, water management in field and process, zero pollution discharge, recycling of steam, valorization of biomass, cellulose, lignin, molasses, PMC, vinasse, CO₂, cellulosic ethanol, H-fuel cell technology, bio-fuels and aviation fuel, organic and specialty sugars, green fertilizer, and bio-degradable plastic and bio-based products of pharmaceutical, medicinal, and industrial importance.

One of the key pathways to a sustainable future for the sugar industry is to adopt bio-refinery models which have the capacity to generate higher value products from sugar crops and its processed residues. Biofuels production can help speed up and leverage the transition to a low carbon economy. The emerging global bio-economy is creating new market opportunities for the sugar industry while

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underpinning the viability of existing crop products and supply chains. The development of innovative technologies, knowledge, and capacity to increase revenue from the existing sugar complexes with speedy paths to market will ensure increased productivity, profitability, competitiveness, and sustainability. Sugar industry is already an example of a sustainable economy, ecologically prudent and socially reasonable, and through science and innovation the contribution to social well-being will be even greater.

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Dr. Sushil Solomon joined Agricultural Research Service of Indian Council of Agricultural Research (ICAR- Ministry of Agriculture and Farmers Welfare) in 1977. As a Director of Indian Institute of Sugarcane Research, Lucknow (2012–2014), he was actively involved in the development and transfer of relevant technologies to the sugarcane farmers and industry for the sustainable development of Indian sugar industry. During

his 36 years of research career, he has published over 120 research papers, 22 books, and many technical reports for the benefit of global sugar industry. Dr. Solomon is the president of *Society for Sugar Research and Promotion* and vice-president of the *International Association of Professionals in Sugar and Integrated Industries (IAPSIT)* and on the advisory bodies of many international apex organizations. He has visited Brazil, Australia, China, Vietnam, Egypt, Iran, Sri Lanka, Cuba, Thailand, Taiwan, etc., to represent Indian sugar industry. He is the Editor-in-Chief of an international journal-*Sugar Tech*, published by Springer Nature and also organized many national and international conferences. Dr. Solomon is recipient of the most prestigious honours such as *Friendship Award* and *Jin Xiu Qui Award*, P.R. China (2005), *Award of Excellence-IAPSIT* (2006), *Sinai University Peace Award*, Egypt (2008), *Global Award of Excellence-IAPSIT* (2008), *Noel Deerr Gold Medal-STAI* (2014 and 2016), and *Leadership Excellence Award* (2018) from Thailand Society of Sugarcane & Sugar Technologists (TSSCT).

Dr. Solomon was appointed Vice-Chancellor of CSA University of Agriculture & Technology, Kanpur (December 2016–February 2020), a premier Agricultural university in north India. Acknowledging his relentless contribution to agricultural education and research, he was given Dr. *Sampoornanand Rangbharti* and ICN awards.



Dr. Glaucia Mendes Souza is a Full Professor at the Institute of Chemistry, University of São Paulo, and coordinates the FAPESP Bioenergy Research Program BIOEN. She works on bioenergy sustainability and participates in several international initiatives to disseminate knowledge and advise policy including the International Energy Agency, the Global Bioenergy Partnership (GBEP) and the Biofuture Platform. She is a Board member of the Sci-

entific Committee on Problems of the Environment (SCOPE), the World Bioenergy Association (WBA), and the Brazilian Society of Bioenergy (SBE). At the International Energy Agency Bioenergy TCP, she is the co-leader of the Biofuels to Decarbonize Transport Task Force. She is a member of the Federation of Industries of the State of São Paulo Bio-economy Committee. She is an Eisenhower Fellow. Her work has been selected among the 100 international best practices on the Sustainable Development Goals set by the United Nations, the 5th Global Entreprs Awards. She has won several awards including the Invention Award for licensed patents in 2019 and 2020. Dr. Souza started her career as a molecular biologist. Her PhD degree versed on the cellular decision to transition from growth to development. She did two postdoctoral trainings in molecular genetics in the USA at the La Jolla Cancer Research Foundation and Baylor College of Medicine. Her laboratory focuses on sugarcane biotechnology and bioinformatics. She is currently developing a genomics platform for plant improvement to select future-climate resilient plants and working on a systems biology approach to identify metabolites that might be of interest for bio-based chemicals applications and yield improvement.



Dr. Raffaella Rossetto is a senior researcher at the Agronomic Institute of Campinas (IAC), Agriculture Secretary of Sao Paulo state government, Brazil. In more than 20 years of career, she has coordinated several projects and guided students in sugarcane nutrition and fertilizer uses. She has also devoted much of her research to the environmental impacts of using fertilizers and residues as sources of nutrients for sugarcane. Dr. Rossetto started her

career in soil microbiology working with nitrogen biologic fixation and mycorrhizal fungi. Soon after, she studied isotopes technologies in plant nutrition, soil fertility and fertilizers use, and she earned her master and PhD degree at Nuclear Energy in Agriculture Centre at University of São Paulo (CENA-USP). She did a postdoctoral training in energy plants in the USA at University of Florida. She is currently a specialist in the use of residues, such as vinasse, filter cake and other organic residues in sugarcane and develops studies on greenhouse gases emissions, ion leaching, N volatilization and interrelationships between sugarcane and soil microorganisms, contributing to greater sustainability in sugarcane management. She has dedicated a large part of her career to spreading and teaching concepts of sustainability in soil and nutrient management in sugarcane cultivation. For over 18 years, she has been the vice-president and treasurer secretary of Brazilian Society of Sugar and Ethanol Technologists (STAB),

organizing congresses, conferences, and technical-scientific events. She was a member and Brazil's representative on the board of important International Institutions such as International Society of Sugarcane Technologists (ISSCT) and International Association of Professionals in Sugar and Integrated Technologies (IAPSIT). She is also a board member of Brazilian Society of Bioenergy (SBE) and President of Sugarcane Irrigation and Fertigation Association (GIFC). She has experience in research management and was head of the Piracicaba Experimental Station for several years, coordinating the unit's research activities. She is currently head of the Jaú Sugarcane Experimental Unit, belonging to Sugarcane Research Centre, IAC.



Dr. Noé Aguilar-Rivera is a professor at the Universidad Veracruzana, Faculty of Biological and Agricultural Sciences in Córdoba Veracruz, México. He specializes in the area of sustainability of agro-industries and circular economy. Dr. Aguilar-Rivera is chemical engineer with specialty in cellulose and paper and PhD degree in environmental sciences at Autonomous University of San Luis Potosi Mexico (UASLP). He did a postdoctoral

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Nuevo León Mexico (UANL). He was awarded by International Society of Sugarcane Technologists (ISSCT) for the best poster in the co-products area in 2010. He is currently a member of the Association of Sugar Technicians of Mexico (ATAM). As a researcher since last 20 years, he has been actively involved in teaching at postgraduate level, guiding doctoral theses, and developing and supervising various interdisciplinary projects on sustainability and diversification of the sugar industry, precision agriculture, by-product and waste management, and green products and technologies. He is an editor of the Sustainability Science and editorial board member of Discover Sustainability journals published by the Springer Nature and an active reviewer of numerous academic journals. During his 25 years of research career, he has published as over 100 research papers as author and co-author, books, book chapters, conference proceedings, and technical reports related to the sustainable development of sugar industry and the competitiveness of agribusiness.