Physiological, Molecular, and Genetic Perspectives of Wheat Improvement

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Editors

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This book is dedicated to Dr. Sanjaya Rajaram

Dr. Sanjaya Rajaram, a globally decorated scientific laureate covered in various communications outlets like Wikipedia, news, and magazines. This dedication is additive to those for an exuding format and diction similarities as composed here. Sanjaya Rajaram was born in 1943 in a small farming village Raipur, District Varanasi, in the state of Uttar Pradesh in northern India. His family, including his parents, an older brother, and a younger sister, made a living on their five-hectare farm growing wheat, rice, and maize. Unlike most children in his socioeconomic position, he was encouraged to pursue an education by his parents and graduated from secondary school as the top-ranked student in the Varanasi District.

Rajaram went on to earn a BSc in agriculture from the University of Gorakhpur; an MSc in genetics and plant breeding from the Indian Agricultural Research Institute (IARI) in New Delhi, studying genetics and plant breeding under Dr. M. S. Swaminathan; and a PhD in plant breeding from the University of Sydney.

In 1969 Rajaram began working as a wheat breeder at the International Maize and Wheat Improvement Center in Mexico. He worked alongside scientist Norman Borlaug, in experimental wheat fields in El Batan (Texcoco), in Toluca and Ciudad Obregon, Sonora.

After Borlaug won the Nobel Peace Prize in 1970, he sought to address the growing agricultural needs across China and India. During this time, Rajaram was entrusted greater responsibility to execute the wheat breeding program, which he eventually inherited after Dr. Borlaug's retirement, thus taking over the work he had begun in Mexico.

Rajaram was instrumental in executing the unique "shuttle breeding" program and pioneering the crossing of the winter with the spring wheat type, which would usually never come into contact with one another, a strategy that revolutionized wheat varietal improvement across the world. His breeding techniques have resulted in enhanced nutrient-rich wheat product resistant to rusts, the major challenge of growing wheat in many parts of the world especially the Middle East and Asia.

Over his career, Dr. Sanjaya Rajaram has been instrumental in ushering in significantly enhanced production by breeding a series of wheat clusters initially from the famous winter/spring crosses that produce the VEERY, followed by Kauz and Attila wheat. Of this, Attila was adopted by many nations under various names due to its 15% higher yield over the rest. His plant-breeding accomplishments rendered the second push to the seeds of confidence that Borlaug developed, paving the way to the "Wheat Revolution."

After 33 years at CIMMYT, including the last seven as Director of the Global Wheat Program, Rajaram joined the International Center for Agricultural Research in the Dry Areas (ICARDA) as Director of Integrated Gene Management, before formally retiring in 2008.

Among several other international accolades, Rajaram is an elected Fellow of the National Academy of Agricultural Sciences and currently the owner and director of Resource Seeds International, a small private company specializing in wheat development and promotion based in Mexico.

In 2001, the Government of India awarded Rajaram the Padma Shri, the fourth highest civilian honor. In 2014, Rajaram received the prestigious World Food Prize for his scientific contributions and in developing 480 wheat varieties grown in 51 countries. His contribution has led to an increase in world wheat production, by more than 200 million tons, building up the Green Revolution a success.

"Rajaram's work serves as an inspiration to us all to do more, whether in the private or public sector," said US Secretary of State John Kerry at an event where he delivered the keynote address. "When you do the math, when our planet needs to support two billion more people in the next three decades, it's not hard to figure out: This is the time for a second green revolution," Kerry said. It is befitting to cap his career by the biographical assemblage of his immense contributions as done by Venkataramani Govindan in 2015 explicitly elucidates Sanjaya Rajaram "Mr. Golden Grain: The Life and Work of the Maharaja of Wheat Dr. Sanjaya Rajaram."

Preface

Wheat is a staple crop of approximately 20% of the world populace. There is a dire need for significant yield advancement and improvement in the nutritional quality of wheat. Though wheat production has improved significantly since 1960, to keep pace with the growing demands of the projected human population, wheat productivity requires a 60% increase by 2050. While for global food security, we need increased yields, climate change is posing a severe threat to wheat productivity. The food insecurities due to the changing climate will negatively impact the socio-economic status, particularly in developing countries.

Traditional breeding methods and advanced crop production technologies have resulted in considerable augmentation of wheat production in Mexico, India and other Asian countries. However, due to increasing demands and projected threats to wheat productivity due to global climate change, it is indispensable to have a multi-disciplinary global effort to mitigate climate change and improve yields. This goal can be achieved by bringing together plant geneticists, molecular biologists, plant pathologists, and plant physiologists to develop wheat that yields better both in terms of quantity, quality, and resilience to environmental fluctuations.

Wheat is consumed in a variety of food products ranging from bread, cereals, pasta to cakes, and pastries. Thus, increasing the nutritional qualities of wheat will potentially contribute to reducing malnutrition and dietary mineral deficiencies. Nutritious wheat thus will aid in healthy growth and reduce mineral deficiency related ailments, particularly in children. Several chapters in the book summarize the efforts undertaken by scientists around the globe in developing better quality wheat along with reducing immunogenicity in wheat.

Climate change is posing a threat to food security. Wheat as a temperate crop is sensitive to heat stress. The Asian subcontinent, with more than half of the world population, is particularly vulnerable to changing climate. Recent advances in understanding the thermotolerance in wheat are summarized in two chapters in the book. Similarly, advances in molecular marker technologies, genome selection, and genome editing for improving wheat yield and quality are also presented in detail in the book.

The editors show appreciation to the contributors of different chapters. Authors of this book were chosen from a broad array of organizations, based on their expertise in the subject and to ensure the contributors are diverse. Author's profound perspective on specific topics has made this volume a state-of-the-art reference material. Our sincere gratitude goes to the young authors for their contributions and for sharing their current research. The book will serve as a ready reference for undergraduate and postgraduate students studying Wheat physiology, genetics, and genomics, in particular, and crop breeding, molecular genetics, and genomics. The book will be a good reference to wheat scientists, cereal researchers, and academicians. Libraries of institutions teaching crop science and molecular biology may need this book as a review material for students and teachers. The editors wish to show appreciation to all the contributors and the editorial workforce of Springer for their cooperation and speedy production of this book.

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