Preface

Alien gene transfer in crop plants has emerged as a boon to humanity as well as science. Since the beginning of plant breeding as a systematic endeavour, scientists have spent a major proportion of their energy, time and resources in planning and executing sexual hybridizations with an objective to create additional genetic variability hitherto not available in nature, followed by selections of desirable recombinants to develop improved genotypes which would be even more beneficial to mankind. After the rediscovery of Mendelism and subsequently our improved understanding of plant traits, their genetic control and inheritance, interest started growing towards transferring genes conferring traits of interest from distant and wild relatives, and even from across genome boundaries.

Wild crop genetic resources are rich reservoirs of useful alien genes. These have contributed tremendously in unleashing the basic and fundamental questions of life including those on origin, history and evolution of crop plants, their phylogenetic relationships and inheritance of simple as well as complex traits. Some of them have even served as excellent model plant species, helping to resolve several mysteries associated with crop flora as well as elucidation and interpretation of several plant species genomes. They also provided numerous donors for genetic improvement of the cultivated types providing sources for disease and insect-pest resistance, resistance/tolerance to climate extremities and problem soils, improved quality traits and keeping quality, and biofortification. During the progression of alien gene transfer technologies, several novel concepts and theories, for example, doubled haploid breeding, were also promoted. Encouraged by the success of alien transfers in genetic amelioration of crop plants, the researchers started looking for alien genes even across genome boundaries and devised horizontal gene transfer strategies, genetic transformation becoming one of the most powerful tools in changing our lives and way of living. The impact of genetic transformation can be realized from the fact that the development, application, and socio-economic and political implications of transgenic crops now affect the agrarian policies and economies of several countries despite the fact that a large group of environmentalists, scientists and consumers is highly sceptic about their use and after effects. Nevertheless, even

severe criticism could also not deter the researchers in furthering their quest for newer genes and prompted them to come out with the concepts of cisgenesis and intragenesis to address the concerns of those worried about the safety and utility of GM crops. All these alien gene transfer techniques, aided by in vitro procedures, hormonal manipulations, polyploidization and mutation, and of late, molecular marker technology and precise detection of alien genes through molecular cytogenetics have led to introgression of hundreds of genes of interest in cultivated backgrounds of crop plants, thereby improving their genetic potential for yield, quality and economic viability. The introgression of *Lr* genes in wheat, development of high-yielding and input-responsive rice and maize, noblization of sugarcane and development of *Bt*, Flavr Savr and Roundup Ready GM crops are just a few of the glorious examples of how alien gene transfer can revolutionize the global agriculture. Some of the early developments in alien gene transfer, of course most of them achieved through conventional breeding, coupled with better agronomic inputs and irrigation triggered the historical "Green Revolution," which changed the lives and fate of millions of people in the tropical wetlands of developing and newly industrializing countries such as India, Pakistan, Indonesia, Bangladesh and China.

Fascinated by the miracle of alien gene transfer in crop plants and revisiting the green revolution of India several times during the course of our study and research, we initiated prebreeding work in two important food legumes of the Indian subcontinent, *Vigna* and lentil, when we joined our current position at the Indian Institute of Pulses Research, Kanpur. However, it was only then when we realized that alien gene transfer, whether vertical or horizontal, is associated with numerous promises and opportunities and even more problems and constraints. As we proceeded with the gene transfer procedures in our respective crops, each step required a lot of stopgap, discussions and relook into the literature, more so because hybridization, in general, is difficult in pulses and also, these are recalcitrant to in vitro techniques. We had to often look into so many periodicals, journals, reports, and research notes and search internet for long before we could find suitable literature helping us or even sometimes, nothing was found at all. We realized that while some crops have been tremendously benefited from alien gene transfer, in other crops it could not have been successful at all. It is then when we conceived the idea to bring the most relevant information on alien gene transfer at one platform so that the academicians, researchers and post-graduate students in agriculture and biology have a ready reference with them on the most important aspects of alien gene transfer. Nonetheless, the scope of this subject is so vast that we decided to go with two volumes; one on the theoretical aspect of innovations, methods and risks associated with alien gene transfer and the second one, of more practical nature, on the achievements and impacts of alien gene transfer, covering mainly the agricultural crop plants, which is the area of our specialization. The first volume is already available, and probably you might have got a chance to read it.

The second volume is now in your hands and has been divided into four sections dealing with cereals, pulses, oil crops and some other important crops. Cereals is the group that has been benefitted most from alien gene transfer. The first section describes achievements and impacts of alien transfer in cereals covered in first five

chapters, one each on wheat, barley, corn, oats and pearl millet. Achievements through alien gene transfer have been variable in pulses owing to difficulties as mentioned earlier and the next section describes pulses in subsequent four chapters (Chaps. 6–9) each on four most important pulse crops viz., chickpea, pigeonpea, *Vigna* species and lentil. The third section is on oil crops and elaborates *Brassica*, oilpalm and coconut, groundnut and sunflower spread over four chapters from Chaps. 10–13. The last section covers sugarcane, one of the most important commercial crops (Chap. 14) and two important vegetable crops of the Solanaceae family viz., tomato and eggplant (Chaps. 15 and 16). All the chapters have been well supported by classical as well as current references, tables and colourful illustrations, wherever necessary.

For this volume, initially we had planned to include a few more crops in each section. However, we had to exclude some of the topics later due to either very less work done on this theme in some of the crops or a few authors not responding at the last moment leaving no time with us to make alternative arrangements. A few authors also had delayed manuscript submissions due to some unavoidable personal or professional circumstances. Nevertheless, all scientists who finally contributed to this volume are well recognized and accomplished researchers in their fields and we sincerely thank all of them for writing their chapters meticulously and with great zeal and responsibility.

We will be failing in our duties if we do not convey our heartfelt gratitude to the people who have directly or indirectly contributed in successful completion of this volume. First of all, the authorities in the Indian Council of Agricultural Research (ICAR), New Delhi, Dr. S. Ayyappan, Secretary, Department Agricultural Research and education (DARE), Government of India and Director General, ICAR; Prof. Swapan Kumar Datta, Deputy Director General (Crop Science), ICAR and Dr. B.B. Singh, Additional Director General (Oilseeds and Pulses) deserve our heartfelt thanks for providing us state-of-the-art facilities for furthering our research and academic pursuits, especially in the field of prebreeding and alien gene transfer. We are extremely grateful to Prof. M.S. Swaminathan, the living legend and popularly known as the "Father of Green Revolution" in India for blessing us for the success of our scientific endeavors and writing the preface of this Volume. The name of Dr. N. Nadarajan, Director, Indian Institute of Pulses Research deserves a special mention for being a driving force in motivating us to undertake this endeavour. We are also grateful to our colleague Debjyoti Sen Gupta and the research scholars working with us, Nupur Malviya, Rakhi Tomar, Ekta Srivastava and Mrityunjaya Singh, for their help in compilation of references, typing some of the materials and searching voluminous literature related to the topic. The entire team at Springer, especially Hannah Smith, Mellisa Higgs and Kenneth Teng, the commissioning editors and Daniel Dominguez, the developmental editor, have always been cooperative and helpful during the preparation of this volume and deserve our genuine appreciations. Their thorough professional approach appreciating our difficulties and being accommodative for the last-minute changes deserve special acknowledgements. Our lovely kids Puranjay, Neha and Gun always kept us going with their charming smile and their childish freshness and a

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It is our sincere hope that this book will be a useful knowledge resource to the researchers, students and scholars who are involved in teaching, research and studies of gene transfer in crop plants and development of new crop varieties for the betterment of mankind. Nothing than the words of Dr. Norman E. Borlaug can be better to conclude the preface of this volume who said in the first press conference after his Nobel Peace Prize was announced that "the work of his institute, and any similar work would only win us all perhaps 20 years breathing space. The potential resources of food were limited. Unless the growth of population could be controlled, then we should destroy the species." Perhaps until then we will have to keep our quest alive for always searching new genes for improving the crop plants further to support mankind.

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