Preface

There have been significant increases in crop yields since the 1950s, which made food cheaper and more affordable. World crop production must, however, increase in the next three and a half decades to feed the ever-growing population. It should occur mostly in lands that are already under cultivation. Plant breeding, the subject of this book, provides means to address this priority global challenge.

During the twentieth century the conservation of plant genetic resources, through national, regional, and international gene banks, became well established, and as a result, major collections are available today for most crops. The use of this crop genetic endowment in plant breeding remains, however, limited due to the lack of systematic research to provide a comprehensive framework for the efficient identification and introgression of beneficial variation for both on-going priority traits and for novel added-value traits. Quantitative and population genetics are very important for germplasm conservation, genetic enhancement, and improvement of breeding methods. Understanding the types of gene action for economically important traits will improve plant breeding efficiency. Advances in omics research and in computational systems allow developing efficient approaches for plant breeding.

The first part of this book gives an overview of plant breeding and its role in producing high-yield cultivars that increase farming profitability and sustainability. Plant genetic resources and diversity are the focus on Chap. 2, which also refers to germplasm enhancement (or pre-breeding), which can be used after identifying a useful trait to "capture" its genetic diversity and put it into a "usable" form. Wild species and landrace germplasm are useful sources for developing germplasm adapted to stressful agroecosystems. Inbred lines (Chap. 3) are useful in genetic research, allele mining, or directly as cultivars in self-fertilizing species and as parents of hybrids and synthetic cultivars. Chapter 4 deals with population improvement methods such as mass and recurrent selections. Both Chaps. 3 and 4 include references about dissecting the genetics of traits or using DNA markers for introgressing or incorporating genes and quantitative trait loci.

Hybrid cultivars are among the main achievements of plant breeding in the twentieth century (Chap. 5). They ensued from exploiting heterosis, which led to a significant edible yield increase in various seed crops. Interspecific hybridization facilitated the successful introgression of wild genes into the cultigen pool. Muta-

tion breeding was used to develop cultivars of 200 species that are grown elsewhere (Chap. 6). Mutants also allow gene isolation, identification, and cloning, which can be also useful for plant breeding.

Chapter 7 provides up-to-date information on transgenic crops, which appear to perform better than their conventional counterparts in terms of yield, production costs and gross margins, and reduction in chemical pesticide use, and gives details on new breeding technology based on genetic engineering. It also argues that a regulatory system should be based on the traits of the bred crops, rather than on the method used to develop them. Genome sequencing, other omics, and synthetic biology are the topics of Chap. 8, which presents an overview on methods that reveal variation and manage them, thus assisting both crossbreeding and genetic engineering.

Examples of breeding self-fertilizing (rice, tomato, and wheat), outcrossing (cassava, cotton, and maize), and polyploid (banana/plantain and potato) crops are included in Chaps. 9, 10, and 11, respectively. These crops differ in their breeding systems, inheritance (disomic versus polysomic), propagation (sexual or vegetative), production system (annual or perennial), and use (food, feed, and fiber), whose overview provides a good conceptual underpinning of plant breeding and genetics, as well as knowledge about the sustainable use of genetic resources in crop improvement.

Chapter 12 refers to seed production, which is a key step for the success of a plant breeding program aiming cultivar development. The focus of the last chapter is on intellectual property and plant variety protection—proactively sought by those seeking rewards for innovations and believing that society welfare improves through inventions.

This book aims that the reader learns from the past and looks at the future of crop improvement. Plant breeding today, as it was before, depends on crop biodiversity and its sustainable use, which can be further facilitated by advances in omics and bioinformatics. It starts with assessing plant genetic resources (wild species, landraces, obsolete cultivars, and genetic stocks) variations aiming to enhance the cultigen pool. Research on genetics—aided nowadays by omic tools—should lead to designing knowledge-based plant breeding, which could bring further genetic gains in the breeding pools. Nonetheless, plant breeding will increasingly require pursuing a holistic interdisciplinary approach based on integrated system-oriented thinking.

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