

Modern PLANT BREEDING

Genomics, CRISPR and
AI-Driven Crop Improvement



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Genomics, CRISPR and AI-Driven Crop Improvement

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The information presented in this book is intended for academic study, teaching, research, and professional reference in plant breeding, genetics, genomics, biotechnology, and crop improvement. The scientific principles, breeding methodologies, experimental procedures, molecular techniques, genome-editing approaches, computational models, and practical examples are provided for educational and illustrative purposes. Although reasonable care has been taken to ensure accuracy, the Publisher does not guarantee the completeness, reliability, or suitability of the information for specific research, breeding, or commercial applications. Readers are advised to consult current scientific literature, applicable biosafety regulations, institutional guidelines, and relevant legal requirements before applying the methods described.

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Preface

Plant breeding has played a fundamental role in the development of agriculture by improving crop productivity, quality, adaptability, and resistance to biotic and abiotic stresses. From traditional selection practices to modern molecular and computational approaches, the discipline has continuously evolved to meet the changing demands of agricultural production and food security. Recent advances in genomics, genome editing, high-throughput phenotyping, artificial intelligence, and digital technologies have created new opportunities for developing improved crop varieties with greater precision and efficiency.

Modern Plant Breeding: Genomics, CRISPR and AI-Driven Crop Improvement presents a comprehensive account of the scientific principles, methodologies, and emerging technologies shaping contemporary crop improvement. The book integrates the foundations of classical and quantitative genetics with modern developments in molecular breeding, genomic selection, precision genome editing, and computational approaches. It emphasizes the complementary roles of conventional breeding practices and advanced technologies in developing productive, climate-resilient, and resource-efficient crop varieties.

The chapters systematically examine the evolution of plant breeding, genetic variation and germplasm resources, quantitative genetics, breeding strategies, molecular markers, genomic approaches, and advanced crop improvement techniques. Particular attention is given to CRISPR-based genome editing, artificial intelligence, machine learning, high-throughput phenotyping, speed breeding, doubled haploids, and rapid generation advancement. The discussion also addresses the practical integration of these technologies into breeding programmes, considering experimental validation, genetic diversity, sustainability, and the challenges associated with their implementation.

The book highlights the importance of connecting scientific advances with practical breeding objectives. While emerging technologies offer considerable potential to accelerate genetic gain and improve selection accuracy, successful crop improvement continues to depend on reliable phenotyping, appropriate experimental design, effective germplasm management, and multi-environment evaluation. The integration of genomic information, computational tools, and field-based evidence is therefore presented as an essential component of modern plant breeding.

This book is intended for undergraduate and postgraduate students, research scholars, teachers, plant breeders, agricultural scientists, and professionals working in genetics, biotechnology, genomics, and allied agricultural disciplines. It may serve as both a textbook and a reference resource for understanding established breeding principles and emerging approaches to precision crop improvement.

It is hoped that this book will contribute to a clearer understanding of modern plant breeding and encourage the effective application of scientific and technological advances toward the development of improved crop varieties for sustainable agriculture and future food security.

Authors

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About the Book

Modern Plant Breeding explores the transformation of crop *improvement* through the integration of classical breeding, genomics, CRISPR-based gene editing, and artificial intelligence. The book presents the scientific foundations, tools, and emerging applications that are reshaping the development of high-yielding, resilient, and climate-smart crop varieties.

Covering key themes such as genetic variability, molecular markers, genomic selection, phenomics, bioinformatics, precision breeding, and AI-assisted decision-making, this volume bridges theory with modern practice. It is designed as a useful resource for students, researchers, teachers, and professionals in plant breeding, genetics, biotechnology, and agricultural sciences.



Key Features

- Integration of classical and modern breeding approaches
- Clear coverage of genomics and molecular breeding tools
- Insight into CRISPR and gene-editing applications
- Role of AI and data-driven methods in crop improvement
- Useful for students, researchers, and professionals



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