

*Series on*  
**Genetics, Genomics and Breeding of Crop Plants**

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# Genetics, Genomics and Breeding of Maize

*Editors*

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Jinsheng Lai • Chittaranjan Kole



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A SCIENCE PUBLISHERS BOOK

# Maize Breeding And Genetics

**Mohar Singh, Sandeep Kumar**



## **Maize Breeding And Genetics:**

**Maize Breeding and Genetics** David B. Walden, 1978 History Evolution Breeding Diseases and insects Endosperm Tissue Gene action Cytogenetics *Quantitative Genetics in Maize Breeding* Arnel R. Hallauer, Marcelo J. Carena, J.B. Miranda Filho, 2010-09-28 Maize is used in an endless list of products that are directly or indirectly related to human nutrition and food security Maize is grown in producer farms farmers depend on genetically improved cultivars and maize breeders develop improved maize cultivars for farmers Nikolai I Vavilov defined plant breeding as plant evolution directed by man Among crops maize is one of the most successful examples for breeder directed evolution Maize is a cross pollinated species with unique and separate male and female organs allowing techniques from both self and cross pollinated crops to be utilized As a consequence a diverse set of breeding methods can be utilized for the development of various maize cultivar types for all economic conditions e g improved populations inbred lines and their hybrids for different types of markets Maize breeding is the science of maize cultivar development Public investment in maize breeding from 1865 to 1996 was 3 billion Crosbie et al 2004 and the return on investment was 260 billion as a consequence of applied maize breeding even without full understanding of the genetic basis of heterosis The principles of quantitative genetics have been successfully applied by maize breeders worldwide to adapt and improve germplasm sources of cultivars for very simple traits e g maize flowering and very complex ones e g grain yield For instance genomic efforts have isolated early maturing genes and QTL for potential MAS but very simple and low cost phenotypic efforts have caused significant and fast genetic progress across genotypes moving elite tropical and late temperate maize northward with minimal investment Quantitative genetics has allowed the integration of pre breeding with cultivar development by characterizing populations genetically adapting them to places never thought of e g tropical to short seasons improving them by all sorts of intra and inter population recurrent selection methods extracting lines with more probability of success and exploiting inbreeding and heterosis Quantitative genetics in maize breeding has improved the odds of developing outstanding maize cultivars from genetically broad based improved populations such as B73 The inbred hybrid concept in maize was a public sector invention 100 years ago and it is still considered one of the greatest achievements in plant breeding Maize hybrids grown by farmers today are still produced following this methodology and there is still no limit to genetic improvement when most genes are targeted in the breeding process Heterotic effects are unique for each hybrid and exotic genetic materials e g tropical early maturing carry useful alleles for complex traits not present in the B73 genome just sequenced while increasing the genetic diversity of U S hybrids Breeding programs based on classical quantitative genetics and selection methods will be the basis for proving theoretical approaches on breeding plans based on molecular markers Mating designs still offer large sample sizes when compared to QTL approaches and there is still a need to successful integration of these methods There is a need to increase the genetic diversity of maize hybrids available in the market e g there is a need to increase the number of early maturing testers in the

northern U S Public programs can still develop new and genetically diverse products not available in industry However public U S maize breeding programs have either been discontinued or are eroding because of decreasing state and federal funding toward basic science Future significant genetic gains in maize are dependent on the incorporation of useful and unique genetic diversity not available in industry e g NDSU EarlyGEM lines The integration of pre breeding methods with cultivar development should enhance future breeding efforts to maintain active public breeding programs not only adapting and improving genetically broad based germplasm but also developing unique products and training the next generation of maize breeders producing research dissertations directly linked to breeding programs This is especially important in areas where commercial hybrids are not locally bred More than ever public and private institutions are encouraged to cooperate in order to share breeding rights research goals winter nurseries managed stress environments and latest technology for the benefit of producing the best possible hybrids for farmers with the least cost We have the opportunity to link both classical and modern technology for the benefit of breeding in close cooperation with industry without the need for investing in academic labs and time e g industry labs take a week vs months years in academic labs for the same work This volume as part of the Handbook of Plant Breeding series aims to increase awareness of the relative value and impact of maize breeding for food feed and fuel security Without breeding programs continuously developing improved germplasm no technology can develop improved cultivars Quantitative Genetics in Maize Breeding presents principles and data that can be applied to maximize genetic improvement of germplasm and develop superior genotypes in different crops The topics included should be of interest of graduate students and breeders conducting research not only on breeding and selection methods but also developing pure lines and hybrid cultivars in crop species This volume is a unique and permanent contribution to breeders geneticists students policy makers and land grant institutions still promoting quality research in applied plant breeding as opposed to promoting grant monies and indirect costs at any short term cost The book is dedicated to those who envision the development of the next generation of cultivars with less need of water and inputs with better nutrition and with higher percentages of exotic germplasm as well as those that pursue independent research goals before searching for funding Scientists are encouraged to use all possible breeding methodologies available e g transgenics classical breeding MAS and all possible combinations could be used with specific sound long and short term goals on mind once germplasm is chosen making wise decisions with proven and scientifically sound technologies for assisting current breeding efforts depending on the particular trait under selection Arnel R Hallauer is C F Curtiss Distinguished Professor in Agriculture Emeritus at Iowa State University ISU Dr Hallauer has led maize breeding research for mid season maturity at ISU since 1958 His work has had a worldwide impact on plant breeding programs industry and students and was named a member of the National Academy of Sciences Hallauer is a native of Kansas USA Jos B Miranda Filho is full professor in the Department of Genetics Escola Superior de Agricultura Luiz de Queiroz University of S o Paulo located at Piracicaba Brazil His research interests

have emphasized development of quantitative genetic theory and its application to maize breeding Miranda Filho is native of Pirassununga S o Paulo Brazil M J Carena is professor of plant sciences at North Dakota State University NDSU Dr Carena has led maize breeding research for short season maturity at NDSU since 1999 This program is currently one the of the few public U S programs left integrating pre breeding with cultivar development and training in applied maize breeding He teaches Quantitative Genetics and Crop Breeding Techniques at NDSU Carena is a native of Buenos Aires Argentina <http://www.ag.ndsu.nodak.edu/plantsci/faculty/Carena.htm>

Genetics, Genomics and Breeding of Maize Ramakrishna Wusirika, Martin Bohn, Jinsheng Lai, Chittaranjan Kole, 2014-08-05 Sequencing of the maize genome has opened up new opportunities in maize breeding genetics and genomics research This book highlights modern trends in development of hybrids analysis of genetic diversity molecular breeding comparative and functional genomics epigenomics and proteomics in maize The use of maize in biofuels phytoremediation and *Maize Genetics And Breeding In The 20th Century* Peter A Peterson, Angelo Bianchi, 1999-01-18 This book provides the biographies and a related summary of geneticists and breeders of maize who have contributed to the major discoveries in the 20th century Their relationships to one another as well as the general developments in maize genetics and breeding growth are included Photographs of events and related personnel all part of the biographic presentation portray the maize community and its growth Most of the geneticists and breeders have a common origin in their training and their successors are among the current contributors to maize development

**Impacts of International Maize Breeding Research in Developing Countries, 1966-98** Michael L. Morris, 2002 Why maize is different from other crops Investment in maize breeding research Products of maize breeding research Adoption of modern varieties MVs Economic benefits associated with MV adoption

**Genetic Variance and Small Number of Parents in Maize Breeding Populations** Dindo Agustin Tabanao, 2006

**Advances in Genetic Enhancement of Early and Extra-Early Maize for Sub-Saharan Africa** Baffour Badu-Apraku, M.A.B. Fakorede, 2017-11-10 The book focuses on the principles and practices of tropical maize improvement with special emphasis on early and extra early maize to feed the increasing population in Sub Saharan Africa It highlights the similarities and differences between results obtained in temperate regions of the world and WCA in terms of corroboration or refutation of genetic principles and theory of maize breeding The book is expected to be of great interest to maize breeders advanced undergraduates graduate students professors and research scientists in the national and international research institutes all over the world particularly Sub Saharan Africa It will also serve as a useful reference for agricultural extension and technology transfer systems Non governmental Organizations NGOs and Community Based Organizations CBOs seed companies and community based seed enterprises policy makers and all those who are interested in generating wealth from agriculture and alleviating hunger and poverty in Sub Saharan Africa

**Handbook of Maize** Jeff L. Bennetzen, Sarah C. Hake, 2009-01-16 Maize is one of the world s highest value crops with a multibillion dollar annual contribution to agriculture The great adaptability and high yields

available for maize as a food feed and forage crop have led to its current production on over 140 million hectares worldwide with acreage continuing to grow at the expense of other crops. In terms of tons of cereal grain produced worldwide maize has been number one for many years. Moreover maize is expanding its contribution to non food uses including as a major source of ethanol as a fuel additive or fuel alternative in the US. In addition maize has been at the center of the transgenic plant controversy serving as the first food crop with released transgenic varieties. By 2008 maize will have its genome sequence released providing the sequence of the first average size plant genome. The four plant genomes that are now sequenced come from unusually tiny genomes and of the most complex genome sequenced from any organism. Among plant science researchers maize has the second largest and most productive research community trailing only the Arabidopsis community in scale and significance. At the applied research and commercial improvement levels maize has no peers in agriculture and consists of thousands of contributors worthwhile. A comprehensive book on the biology of maize has not been published. The Handbook of Maize the Genetics and Genomics center on the past present and future of maize as a model for plant science research and crop improvement. The books include brief focused chapters from the foremost maize experts and feature a succinct collection of informative images representing the maize germplasm collection.

**Plant Genetic Resources** B. S. Dhillon, 2006 Food is the basic need of human beings. The increasing population and enhanced standard of living are placing greater demands on food related requirements in terms of quantity quality and diversity. The Green Revolution which significantly enhanced productivity of important food crops nevertheless resulted in certain fallouts as genetic erosion soil degradation chemical pollution and aquifer depletion. Amongst these decrease in plant genetic diversity is an irreversible loss. As the basic raw material for future plant breeding plant genetic resources of foodgrains are the key to future food security. Though plant breeding has attracted the attention of many authors plant genetic resources remain somewhat neglected. This book gives an overall perspective current status of genetic resource of important foodgrain crops wheat rice maize barley sorghum millets pulses and legumes and underutilized crops. It provides a comprehensive compilation on current status of information on origin taxonomy diversity collection exchange evaluation utilization molecular characterization and conservation for food grain crops. Eminent scientists and crop specialists have critically analyzed the information in view of the present and future research priorities. In addition management issue related to plant genetic resources are also discussed. At present such information on these crops is lacking and this book fills in the void. It shall serve as reference for genetic resource managers researchers teachers students and policy makers in biology and agriculture.

**Principles of Plant Genetics and Breeding** George Acquaah, 2009-03-12 Until recently plant breeders have depended primarily on classical tools to develop new and improved products for producers and consumers. However with the advent of biotechnology breeders are increasingly incorporating molecular tools in their breeding work. In recognition of the current state of methods and their application this text introduces both classical and molecular tools for plant breeding. Topics such as biotechnology in

plant breeding intellectual property risks emerging concepts decentralized breeding organic breeding and more are addressed in this state of the art text The final 8 chapters provide a useful reference on breeding the largest and most common crops In addition over 25 plant breeders share their professional experiences while illustrating concepts in the text Features include Comprehensive presentation of both classical and molecular plant breeding tools Industry highlight essays from over 25 professional plant breeders Chapter introductions summaries and discussion questions Easy reference glossary Reference chapters on breeding 8 of the largest and most common crops Artwork from the book is available to instructors online at <http://www.blackwellpublishing.com/acquaah> An Instructor manual CD ROM for this title is available Please contact our Higher Education team at [HigherEducation@wiley.com](mailto:HigherEducation@wiley.com) for more information Maize genetic resources, 1995

**The Genetics and Exploitation of Heterosis in Crops** CIMMYT, 1997 **Broadening the Genetic Base of Grain Cereals** Mohar Singh, Sandeep Kumar, 2016-09-13 This book offers comprehensive coverage of important grain cereals including their origin and distribution crop gene pool level of diversity production constraints traits of importance for genetic base widening crop improvement methodologies genome mapping genomics for breeding and future strategies The chapters contributed by eminent crop researchers from around the world provide rare insights into the crop specific constraints and prospects drawing from their substantial experience As such the book offers an essential source of information for grain cereals scientists teachers students policy planners and developmental experts alike Grain cereals which comprise rice wheat maize barley oats sorghum and millets are members of the grass family These crops are vital to human nutrition thanks to their roles as staple food crops in different parts of the globe Some of them are rich sources of carbohydrates which provide energy while others are important sources of minerals vitamins and proteins in addition to their medicinal properties In most cereals the existing variability among elite germplasm has been exploited to attain a desirable level of productivity However to make further breakthroughs in enhancing yield and improving stability in future crop cultivars new sources of genes alleles need to be identified in wild weedy species and incorporated into the cultivated varieties Though there have been many publications on various aspects of grain cereal improvement in the recent past to date this essential information has remained scattered among different periodicals **Genomics-Assisted Crop Improvement** Rajeev K. Varshney, Roberto Tuberosa, 2007-12-13 This superb volume provides a critical assessment of genomics tools and approaches for crop breeding Volume 1 presents the status and availability of genomic resources and platforms and also devises strategies and approaches for effectively exploiting genomics research Volume 2 goes into detail on a number of case studies of several important crop and plant species that summarize both the achievements and limitations of genomics research for crop improvement

**Corn** C. Wayne Smith, Javier Betrán, Edward C. A. Runge, 2004-03-08 Your all in one guide to corn This book provides practical advice on planting techniques and rates seed production treating plant diseases insect infestation and weeds

harvesting processing and worldwide utilization This is the fourth and final volume in the series of comprehensive references on the major crops of the world Covers new biotechnology techniques for plant breeding and pest management Provides practical advice on planting techniques and rates seed production treating plant diseases insect infestation and weeds harvesting processing and worldwide utilization

**Cereals** Marcelo J. Carena, 2009-04-21 Agriculture depends on improved cultivars and cultivars are developed through proper plant breeding Unfortunately applied plant breeding programs that are focused on cereal commodity crops are under serious erosion because of lack of funding This loss of public support affects breeding continuity objectivity and perhaps equally important the training of future plant breeders and the utilization and improvement of plant genetic resources currently available Breeding programs should focus not only on short term research goals but also on long term genetic improvement of germplasm The research products of breeding programs are important not only for food security but also for commodity oriented public and private programs especially in the fringes of crop production Breeding strategies used for long term selection are often neglected but the reality is that long term research is needed for the success of short term products An excellent example is that genetically broad based public germplasm has significantly been utilized and recycled by industry producing billions of dollars for industry and farmers before intellectual property rights were available Successful examples of breeding continuity have served the sustainable cereal crop production that we currently have The fact that farmers rely on public and private breeding institutions for solving long term challenges should influence policy makers to reverse this trend of reduced funding Joint cooperation between industry and public institutions would be a good example to follow The objective of this volume is to increase the utilization of useful genetic resources and increase awareness of the relative value and impact of plant breeding and biotechnology That should lead to a more sustainable crop production and ultimately food security Applied plant breeding will continue to be the foundation to which molecular markers are applied Focusing useful molecular techniques on the right traits will build a strong linkage between genomics and plant breeding and lead to new and better cultivars Therefore more than ever there is a need for better communication and cooperation among scientists in the plant breeding and biotechnology areas We have an opportunity to greatly enhance agricultural production by applying the results of this research to meet the growing demands for food security and environmental conservation Ensuring strong applied plant breeding programs with successful application of molecular markers will be essential in ensuring such sustainable use of plant genetic resources

Heterosis and Hybrid Seed Production in Agronomic Crops Amarjit Basra, 2024-11-01 Heterosis and Hybrid Seed Production in Agronomic Crops discusses how heterosis or hybrid vigor has played a major role in improving crop productivity and quality in order to feed the ever increasing human population particularly in developing countries Plant breeders agronomists seed producers and farmers will discover why the development of hybrids in the world s major food crops and why the methods of hybrid seed production are critical for achieving this goal This landmark book deals with heterosis and hybrid seed



production of major agronomic crops such as wheat rice maize sorghum cotton sunflower and rapeseed Through Heterosis and Hybrid Seed Production in Agronomic Crops you will discover valuable information on hybrid seed production methods that is not available in any other single volume This unique book contains relevant and essential information about important procedures to help increase crop yield including methods for deriving second cycle inbred lines for hybrid maize possibilities for hybrid seed production in wheat techniques of hybrid sorghum seed production production of hybrid seeds using male sterile lines of cotton agronomic management in seed production plots of sunflower seed production technology of hybrid rapeseed advances in hybrid seed production technology of rice in China Heterosis and Hybrid Seed Production in Agronomic Crops gives you a global perspective on essential food crops in all parts of the world This informative guide will help you use hybrid seed production methods with important agricultural crops and increase the quality of these vital and essential food sources Genetics, Biotechnology and Breeding of Maize and Sorghum Eucarpia. Maize and Sorghum Section.

Congress,1997 This book indicates our present state of knowledge in this important and broad field with particular emphasis given to the use of maize as a model and representative species *Isozymes: Organization And Roles In Evolution, Genetics And Physiology, Proceedings Of The Seventh International Congress On Isozymes* C L Markert,John G Scandalios,Hwa A Lim,O L Serov,1994-07-26 Organisms frequently synthesize enzymes in multiple molecular forms to catalyze the same basic biochemical reactions Each of these enzymes exhibit somewhat different kinetic properties and perhaps are also located in a specific part of the metabolic structure of the cell This isozymic multiplicity only emphasizes the biochemical versatility and refinement of the genetic enzyme structure of organisms Since the isozyme concept was formulated some thirty five years ago and especially after the advent of transgenic technology the deep interest in the area has led to thousands of research investigations and many international conferences on the subject This volume is a collection of selected oral presentations from one such conference which is by now well known Topics includes isozymes in population and evolution genetics isozyme markers in gene mapping isozymes in plant genetics role of isozymes for normal physiology the use of isozymes in human population biology molecular organization and developmental regulation of isozymes and other related topics **Plant Male**

**Sterility Systems for Accelerating Crop Improvement** Abhishek Bohra,Ashok Kumar Parihar,Satheesh Naik SJ,Anup Chandra,2022-10-11 This book covers all aspects of hybrid breeding technologies applied for crop improvement in major field crops The different male sterility systems such as genetic male sterility GMS cytoplasmic male sterility CMS cytoplasmic and genetic male sterility CGMS and male sterility induced by the photoperiod PGMS temperature TGMS and chemicals are discussed in detail The different chapters in this book provide a timeline of the key breakthroughs witnessed in the field of plant male sterility technologies their application in hybrid breeding and the relevance to the current need for food security In depth insights into the genetic and regulatory mechanisms of plant male sterility have been presented This includes discussion on a variety of molecular players that induce male sterility and rescue male fertility in the hybrid plants To

enhance this book's appeal more emphasis has been given on the modern emerging approaches such as construction of heterotic pools that could boost hybrid breeding for enhanced crop performance amid climate change and growing population worldwide. This book is a guide for growers and industries related to field and horticultural crops. Further, it is a useful reference for plant breeders, researchers, extension workers, and students. The material can also be used for teaching undergraduate and postgraduate courses.

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