Dedicated to the cowpea farmers of the world.
Crop Science Society of America

The Crop Science Society of America (CSSA) is a progressive international scientific society that fosters plant science for a better world. Based in Madison, WI, and founded in 1956, CSSA is the professional home for 5,000+ members dedicated to advancing the field of crop science. Society members are dedicated to the conservation and wise use of natural resources to produce food, feed, fiber, fuel, and pharmaceutical crops while maintaining and improving the environment.

International Institute of Tropical Agriculture (IITA)

The International Institute of Tropical Agriculture (IITA) conducts research that provides solutions to nourish Africa. IITA’s award-winning agricultural research for development (R4D) focuses on addressing hunger, poverty, and degradation of natural resources in the tropics. IITA works with public and private sector partners to enhance crop quality and productivity, reduce producer and consumer risks, and promote sustainable livelihoods from agriculture. IITA is a nonprofit organization created in 1967 in Nigeria and governed by a Board of Trustees and is a member of the CGIAR Consortium, a global research partnership for a food secure future. IITA has four regional hubs—IITA headquarters in Ibadan (Western Africa), Dar es Salaam (Eastern Africa), Lusaka (Southern Africa), and Kinshasa (Central Africa).
Contents

Foreword ix
Preface xi
Origin, Distribution, and Importance 1
Botany and Physiology 17
Production Constraints 35
Genetics and Breeding 55
Improved Cowpea Cultivation and Seed Production 87
Cowpea Uses and Markets 125
Future Prospects of Cowpea 145
Glossary 158
Selected References 165
About the Author 169
Foreword

The Green Revolution in major cereals has led to a partial success in meeting the world’s food security needs, but nutritional security is still a long way from reality. Cereals, high in carbohydrates, and pulses (food legumes), high in protein and minerals, complement each other well to provide near complete food for a majority of the world’s population, which is vegetarian or who cannot afford to purchase meat, milk, or eggs. Unfortunately, the production of pulses has remained stagnant since the 1960s, resulting in very high prices and making pulses beyond the reach of the common people. Consequently, millions of people in Asia, Africa, and Central and South America are suffering from severe malnutrition because they have drastically reduced consumption of food legumes.

The stagnant production of pulses is partly because most of the good lands have gone to the Green Revolution led cereals, like wheat, rice, and maize, while the food legumes have been pushed to marginal lands. In addition, most of the pulse crops have low yields and they take over 100 to 150 days to mature, and therefore, farmers prefer to grow the high yielding cereals in preference to the food legumes. Therefore, the only solution to produce more food legumes is to develop short duration high yielding varieties of pulses and grow them in the existing niches in cereal and root crop based cropping systems. This will not only avoid competition with cereals, but it would also ensure full use of farmers’ lands, labor, and other resources and result in production of the much needed extra crop of food legumes to provide protein-rich food and fodder and also contribute to soil fertility, thus improving the sustainability of the cropping system.

In view of these opportunities, the research focus in cowpea improvement at the International Institute of Tropical Agriculture (IITA) from the 1980s was changed to develop extra-early cowpea
varieties with erect to semi-erect plant types and a maturity period of 60 to 70 days. This work was led by Dr. B.B. Singh, the author of this book, who was the Principal Cowpea Breeder at IITA from 1979 to 2006, covering more than 27 years. Working through a team of researchers and participatory international testing of the new cowpea varieties, Dr. Singh was able to catalyze the release of over 35 new varieties in over 40 countries, raising the world cowpea production from less than one million tonnes in 1974 to over 7 million tonnes in 2013. The short duration cowpea varieties are now being cultivated as a niche crop in wheat–cowpea–rice, rice–cowpea–rice, maize–double cowpea, sorghum–millet–cowpea, and soybean–cowpea systems in many countries. This has resulted in about a 70% increase in global cowpea production in the last decade, when all the other pulses have remained stagnant. Dr. Singh’s personal conviction that cowpea, the only pulse crop with 60- to 70-day maturity and high yield, would be widely grown as a niche crop and emerge as the most important future food legume in the world in the coming decades has led him to continue working on cowpea improvement even after his retirement from IITA.

Publication of this most appropriately titled book, *Cowpea: The Food Legume of the 21st Century* is very timely and extremely useful because there has not been any comprehensive book written on cowpea before now. This book fills a major gap that has existed for a long time and provides information on the latest research findings as well as important practical aspects of cowpea improvement, production, utilization, and marketing. It is written in semi-technical style to suit a broad range of audiences, covering students, extension workers, farmers, NGOs, and researchers. With the availability of this book and the widespread adoption of the new improved short duration cowpea varieties, it is my firm conviction that cowpea will be a major contributor in solving the problem of protein malnutrition of the masses in the world in the coming decades.

**Dr. N. Sanginga**
Director General International Institute of Tropical Agriculture (IITA)
Ibadan, Nigeria
Preface

The evolutionary history of crops indicates that starchy crops like cereals and root crops and protein rich food legumes co-evolved in tandem, such as wheat and chickpea in the Middle East, sorghum and cowpea in Africa, maize and beans in Central America, cassava and peanuts in South America, and rice, pigeon-pea, and soybean in Asia. The early human settlements also occurred in these areas and used a combination of cereals and food legumes as complete foods. This is well evident in India, which is one of oldest civilizations in the world and where most of the population still depends on food legumes for their dietary protein and minerals. My interest in working on food legumes arose after my graduation in agricultural science in 1963 when I noticed that major research advances were being made in cereals like maize, wheat, and rice, but not much attention was paid to food legumes. When I joined the University of Illinois for my graduate work in 1963, I opted to work on soybean because the university had no program on other food legumes.

After completing my Ph.D. in soybean breeding in 1967, I joined the G.B. Pant University, India as a soybean breeder, but I was asked to work on all the food legumes until a grain legume breeder was appointed. Thus, I worked on soybean, pigeon-pea, chickpea, lentils, green gram, and black gram for two years, which gave me a good feel for agronomy and the genetic potential of all the food legumes. The university appointed a legume breeder in 1970, who took over the legume work, and I continued working on soybean until 1979, when I was offered a soybean breeder position at the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. As fate would have it, when I joined IITA, I was posted at Ilonga in Tanzania to work on a IITA/USAID Project involving important grain legumes in Africa, such as cowpea, pigeon-pea, mung-bean, common bean, and soybean.
This was my first exposure to cowpea, and I noticed a few weak but very early maturing plants (55–65 days) in the germplasm materials that I had brought from IITA. This gave me the idea of breeding extra-early cowpea varieties that would fit as a niche crop in many cropping systems as well as can be grown in areas with short rainy seasons. Taking advantage of the tropical climate at Ilonga, I started growing four crops each year and came up with several high yielding extra-early maturing cowpea lines that were collectively called “60-day” cowpeas. The IITA/USAID project in Tanzania ended in 1981, and I was transferred to IITA headquarters at Ibadan, Nigeria as a cowpea breeder, where I continued working on breeding cowpea varieties with improved plant type and early maturity until my retirement in 2006.

This book is a compilation of all that I have learned about cowpea and its emerging importance in many countries as a major food legume in the coming decades. The book has been written in a semi-technical style with relevant illustrations to suit a broad range of users, and the chapters have been arranged in a logical sequence, starting with its origin and distribution, botany and physiology, production constraints, genetics and breeding, improved cultivation practices, utilization and marketing, and finally its future potential as a crop. It is my earnest hope that this book will be useful to everyone involved in food legumes teaching, research, and development and also attract and stimulate younger scientists to work on cowpea to help alleviate the problem of increasing protein malnutrition in the weaker sectors of society.

I owe sincere gratitude to many people, starting with my mother and father, my wife and sons, my immediate family and friends, who gave me immense love, affection, and encouragement throughout my personal and professional life’s journey so far. I am extremely grateful to USAID, the University of Illinois, and the government of India for establishing the first agricultural university in India at Pantnagar where I graduated from and for arranging a special scholarship to continue my graduate studies at the University of Illinois. I am also thankful to Drs. W. Gamble, E. Hartmans, L. Stifel, L. Brader, P. Hartmann, and N. Sanginga,
the past and present Director Generals of the International Institute of Tropical Agriculture, who took personal interest in my work and provided unflinching support, guidance, and encouragement throughout my 27 years at IITA. I am extremely grateful to my research collaborators from many countries and to the G.B. Pant University, India for providing me facilities to carry out cowpea research relevant to wheat–rice systems in India.

I wish to express my heartfelt gratitude to Dr. David Baltensperger, Head of the Soil and Crop Sciences Department, Texas A&M University, who invited me as a visiting professor and provided all the support to continue my cowpea research after my retirement from IITA. He also prompted me and encouraged me to write this book and helped in its publication process. I am grateful to Drs. Hakeem Ajeigbe, Principal Scientist, ICRISAT; Francisco Freire-Filho, Cowpea Breeder in Brazil; and Isa Drabo, Cowpea Breeder in Burkina Faso, who reviewed the book and made valuable suggestions.

I am also extremely grateful to IITA for agreeing to co-sponsor the book. Their generous support has helped make this book possible and allowed for additional distribution to those who can most benefit from its contents.

Finally, the book would not have become a reality without the hard work of the staff of the Crop Science Society of America, particularly Nicole Sandler, Lisa Al-Amoodi, and Madeline Fisher, who showed extreme patience in helping shape, reviewing, editing, and designing the book and getting it printed with an attractive look.

B.B. Singh
The story of cowpea (black-eyed peas) is a fascinating example of how science can solve the world's biggest problems—even more fascinating is the story of the scientist behind the research.

B.B. Singh wrote this book to serve as an accessible summary of cowpea breeding, management, and use. He has devoted his life's work to solving the "protein gap" of the Green Revolution in which the emphasis on corn and wheat neglected the protein-rich legumes vital to plant-based nutrition. Today, under his careful tending, cowpea truly has become the food legume of the century.

From genetics to recipes, he gives a full account of how cowpea belongs in our global agriculture and in every diet. Along the way, he shares his inspiring story.

Dr. Singh is best known for his work in developing new varieties of cowpea, short season varieties that ensured one crop, and in years when rain fall was adequate, two crops. This scientific accomplishment was great in and of itself, but his follow-up actions that resulted in changes in social and cultural practices was what really led to his scientific accomplishments being utilized to the fullest extent. His mission oriented scientific work combined with his untiring desire to help people has markedly improved the lives of millions of people in underdeveloped countries.

—Germán Bollero, Professor and Head, Crop Sciences Department, University of Illinois

B.B. Singh has served as a model international crop scientist. He has made outstanding international scientific contributions in the area of plant genetics and crop improvement for three important crops. He has been a mentor to scientists around the world, and his advice and counsel are highly sought. He has had enormous scientific and economic impact, but by far his most important contribution has been in improving the lives of literally millions of small holder farmers.

—William A. Payne, Dean and Director of CABNR/NAES

Dr. Singh is a person of purpose who has dedicated his life to making a difference. The impacts of his scientific achievements in cowpea germplasm conservation and genetic improvement are unequaled by his peers.—Dr. Irvin E. Widders, Dry Grain Pulses CRSP