COWPEA

Research, Production and Utilization

Edited by S.R. Singh & K.O. Rachie

International Institute of Tropical Agriculture

Cowpea Research, Production and Utilization

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Cowpea Research,
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Dedicated to our wives Manju and Mary

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Foreword

The International Institute of Tropical Agriculture (IITA) welcomed the opportunity to be co-sponsor and host for the first World Cowpea Research Conference from 5 to 9 November 1984 at its headquarters in Ibadan, Nigeria. Proof of the worldwide interest in the conference was in the numbers of scientists, extension personnel, government officials and others who attended—203 persons representing 34 countries in Africa, Asia, North and South America and Europe.

It was a good decision to organize this meeting at IITA in Nigeria. Within the Consultative Group on International Agricultural Research, IITA has worldwide responsibility for research on cowpeas, and in carrying out its mandate it maintains close links with national programmes. Farmers throughout the world grow the crop (a total of more than 8 million hectares), but Africa produces more cowpeas than any other continent.

The Bean/Cowpea CRSP cosponsor is the major effort on the part of the United States of America (US) to make the professional resources of the US Land-Grant University system and the US government's agricultural research community available to address important constraints to cowpea production and utilization. As such, it works through support from the US Agency for International Development (AID) to build collaborative research and training relationships between Host Country scientists and scientists in US institutions.

Individual and coordinated efforts of the national programs, the Bean/Cowpea CRSP and IITA have resulted in major contributions to increased availability of cowpeas. Sharing and discussing these accomplishments among the international cowpea research community was all the more critical as the timing of the conference paralleled the severe droughts and the growing food crisis in Africa. Further development and progress in cowpea improvement could help add to food supplies and provide more quality protein for millions of people who depend on the crop as a major source of this essential ingredient. Some of the new IITA high-yielding varieties released for use in many countries have protein content as high as 23 per cent, and improved lines now being tested in trials around the world rate as high as 24.4 per cent.

Participants in the conference pointed out that if progress in cowpea improvement can continue at its present rate, world production could triple

by the turn of the century. The scientists participating in the research programs represented at this meeting have a deep commitment to helping sustain this progress. The research reports and recommendations presented at the conference and published in this book merit close attention and appropriate action by all concerned with improving food supplies, especially in developing countries where food production is inadequate to feed a growing population.

We are grateful to the many donors who generously supported this conference. Their contributions made possible a stimulating scientific meeting, having considerable potential for increasing the availability of this important crop in food deficit areas of the world.

ERMOND HARTMANS
Director General, IITA

Preface

Cowpea, also called southernpea and blackeyed pea, has been cultivated for many centuries in the developing world. The crop is well adapted to the stressful growing conditions of the tropics and has excellent nutritional qualities; its drawback has been its low yields.

Recent advances in genetic improvement, however, have made cowpea into practically a new crop, one that is attractive to smallholders throughout the world. The new elite strains have resistance to many diseases and insects; they mature early (within 60 days) and produce well. Optimal cultural practices for a broad range of growing conditions and uses have also been developed. The whole package of technology promises to expand greatly the role of cowpea in subsistence agriculture, permitting more intensive cultivation of the crop in complex cropping systems with a minimum of inputs.

In recognition of burgeoning global interest in cowpea, and of the need to take stock of developments in research on the crop, the first world cowpea conference was held at the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, 5–9 November 1984. The purpose of the conference was to improve communication among cowpea researchers and promote greater collaboration in the planning of research strategies. The meeting also provided the opportunity to record current production practices and assess the state of the art in plant improvement. Both those tasks have been ably accomplished by the authors of the invited papers presented in this volume (Volume I). Twenty-nine additional voluntary papers were read at the conference and will be published in a separate proceedings (Volume II).

It was particularly appropriate that the world's cowpea experts should come together in Africa. Much of the recent progress in research has been made on this continent, and this is where most of the world's cowpeas are produced and where the crop has the greatest potential for alleviating food shortage. Even so, cowpea is gaining popularity in many other parts of the tropics.

This book is the first comprehensive review of cowpea-production constraints and of research being conducted around the world to overcome them. It explains the origin, taxonomy, genetics and physiology of the plant and describes current efforts to breed cultivars that are disease- and pest-resistant, drought-tolerant, efficient in nitrogen fixation, high-yielding, and well suited

to the climate and soils of Africa, Asia, Latin America and the United States. Papers on the major insects and nematodes that attack cowpea cover their distribution, life cycles, economic importance in terms of grain-yield losses, and the prospects for their control. The chapter on pathology gives the most up-to-date information on viral, fungal and bacterial diseases prevalent in the major production areas. There are also thorough treatments of agronomic practices and of innovations in processing designed to produce convenient, nutritious foods that are acceptable to consumers in different parts of the world.

The need for a book such as this has been evident for some time, but it simply was not possible to undertake the project until an international effort had been mounted to improve and develop cowpea. This has now been brought about through close cooperation among (1) IITA, which has a world mandate for cowpea research within the Consultative Group on International Agricultural Research, (2) the Bean/Cowpea Collaborative Research Support Program (CRSP) which opens an avenue to the research establishment of the US Land-Grant University system and the US Government Agricultural Research Community and (3) cowpea scientists and development specialists in 55 countries throughout the world. In a relatively short time these researchers have established a solid record of achievement and formed a rapidly growing body of information about the crop.

We hope that this book, in addition to being a valuable source of information about cowpea improvement, will lead to other reference works on particular aspects of the crop.

This first volume could not have been written without the enthusiastic and dedicated efforts of the conference participants and the generous support of several donors. The information presented here represents the joint contribution of many scientists and organizations, who along with IITA, included numerous regional programmes in Africa, Asia and Latin America; the University of Gembloux in Belgium; the University of Reading and Imperial Chemical Industries in England; Rhone-Poulenc Agrochimie, France; and in the United States, the US Department of Agriculture, the University of California at Riverside, the Boyce Thompson Institute at Cornell University, the University of Georgia, Michigan State University and Texas A&M University. Many of the papers from the United States, and several of those from national programmes, reported research wholly or partially supported by the Bean/Cowpea Cooperative Research Support Project (CRSP). We are particularly indebted to Dr P. W. Barnes-McConnell, Director, Bean/Cowpea CRSP,and the members of the CRSP Technical Committee for co-sponsoring this conference with IITA.

We also owe special thanks to the entire IITA Grain Legume Improvement Program staff for their assistance, to Dr L. E. N. Jackai, entomologist, and Bernadette Bakare, conference officer, both of IITA, for their unflagging

support before, during and after the conference; to Amy Chouinard for her careful editing of the conference papers; to Gerry Cambier, Eloy Molinero and Godfrey Spencer for simultaneous French–English interpretation during the conference; and, finally, to Dr E. H. Hartmans, director general of IITA, without whose continuing support of cowpea research the meeting would not have been possible.

We sincerely hope that this publication will be of value to agricultural researchers, administrators and funding agencies around the world.

S. R. SINGH and K. O. RACHIE

Introduction

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In some areas of the semihumid tropics the cowpea, *Vigna unguiculata* (L.) Walp., provides more than half the plant protein in human diets. In fact it is a key staple for the poorest sector of many developing countries of the torrid zone—a pulse crop high in protein as well as other essential nutrients. As a dietary staple it greatly improves an otherwise bland, unbalanced diet. As a food it is eaten in the form of dry seeds, green pods, green seeds and tender green leaves. It is also utilized for fodder and as a quick-growing cover crop under a wide range of conditions. On account of its ability to fix nitrogen efficiently—up to 240 kg N/ha—the cowpea provides a high proportion of its own nitrogen requirements, besides leaving a fixed-N deposit in the soil of up to 60–70 kg/ha for the succeeding crop. The cowpea is also highly compatible as a companion with a wide range of food and fibre crops. Moreover, it is early—some new varieties mature in 60–65 days—and drought-tolerant as well as being tolerant of most soil stresses.

PRODUCTION

Worldwide cowpea production in 1981 was estimated at 2.27 million tonnes from 7.7 million hectares. Cowpeas are grown extensively in 16 African countries, with this continent producing two-thirds of the total. Two countries—Nigeria and Niger—produce 850,000 t and 271,000 t annually or 49.3 per cent of the world crop. The second-highest producing country is Brazil where 600,000 t of dry seeds or 26.4 per cent of the worldwide total was produced in 1981. Other major producers in Africa include Burkina Faso (95,000 t), Ghana (57,000 t), Kenya (48,000 t), Uganda (42,000 t), and Malawi (42,000 t). Tanzania, Senegal and Togo each produce annually from 20,000 t to 22,000 t.

Current estimates of production vary widely according to source, but the statistics are probably conservative. For example, Asian production, including that of long beans as a vegetable, may be underestimated by a factor of 10

or at a level of about 1 million hectares, concentrated in India, Sri Lanka, Burma, Bangladesh, Philippines, Indonesia, Thailand, Pakistan, Nepal, China and Malaysia. India alone is estimated to cultivate more than half or 500,000 ha in all forms—dry seed, fodder, green pod, green manure and cover crops. Similarly, production estimates may be low for Africa and the Western Hemisphere where cowpeas are traditionally included as associated crops in peasant-farming systems. Thus, realistic production levels may approach or exceed 2.5 million tonnes of dry seeds on about 9 million hectares. The only developed country producing large amounts of cowpea is the USA (60,000 t).

Low yields are a significant attribute of production estimates, particularly in Africa and Asia where 240–300 kg/ha are typical. The reasons include heavy biotic pressures—particularly from insects and other pests, which often affect the plant throughout its life cycle and the seeds in storage. Literally dozens of insects attack cowpea, but the chief ones in the major growing region are: bud–flower thrips, pod borers, aphids, leafhoppers, curculio, pod suckers and bruchids. In addition, several diseases can be devastating.

Other factors contributing to low yields are problem soils—especially low-pH, high-Al, fertility-depleted or high-pH, saline soils—excessively high temperatures, and drought or excessive moisture, and inadequate management and plant protection. Suboptimal planting dates, low plant populations, poor soil physical properties, low-fertility soils, poor weed control and mixed cropping all reduce yields.

This long list of problems indicates the urgency for research and national production programmes geared to help farmers obtain inputs and adopt improved technologies. Unfortunately there are comparatively few researchers working on this crop, and most projects were established or strengthened within the past 2 or 3 decades.

Regional utilization

In tropical Africa cowpeas are primarily used in the form of dry seed cooked as a pulse in a large variety of dishes. Preference is for brown, white or cream seeds with a small eye and wrinkled or rough seed coat. In many areas of both West and East Africa the tender green leaves are cooked like spinach or as a relish. Generally the grower also likes to obtain some dry-seed yields from the plucked crop. Green beans or cut green pods used as a vegetable are of secondary importance. Cowpeas are also grown for fodder, groundcover or green manure but to a much lesser extent than for pulse.

Cowpea is practically never grown as a sole crop in Africa; it is a component of cropping systems, frequently being grown in association or relays with sorghum, millet and maize. However, some workers discourage the growing of cowpeas with roots and tubers, as the system appears to favour

the build-up of nematodes. Short-season cowpeas (60–65 days) are sometimes grown in a monoculture system or as a late relay crop in sorghum or maize to use residual moisture in the soil.

In Asia the pulse uses of cowpeas are important primarily in the drier regions such as India where increasing amounts of the crop are used in dhal. In the more humid areas of Southeast Asia and southern China the long bean is the predominant form and is used as cut green beans. Seed-quality preferences are somewhat broader than in West Africa where brown and white seeds are preferred. The dry-seed types may be grown both in mixed-cropping systems and in monoculture, but long beans are mainly grown with supports—trellises or standing-crop residues like maize stalks.

In South America cowpeas are grown mainly as pulse with a wide range of seed colours, blackeye-whites, reds, yellows, browns, black and mottled. Although the major producing areas are the drier lowlands like northeastern Brazil, there is increasing interest in cowpeas for the humid interiors like the Amazon Basin where cowpeas are better adapted to low-pH, high-Al soils than *Phaseolus* beans and other crops. Cowpeas are also utilized in cropping systems similar to those in Africa and Asia. Sometimes they are used as forage, hay and cover; and the seeds may replace soybean or other protein sources used in animal feed.

In the USA dry seed is grown mainly in California and western Texas, whereas green peas for canning, freezing or fresh peas are mainly produced from eastern Texas to Florida and the Carolinas. Sometimes cowpeas are also grown for forage and as a cover crop, particularly in the southeastern USA.

RESEARCH NEEDS

Rapid progress in cowpea improvement has been made during the 2 decades up to the mid-1980s. Most spectacular contributions are the multiple disease- and pest-resistant, high-yielding and short-duration strains together with more efficient production practices designed for a broad range of growing conditions. These advances are combining both to increase production in traditional growing regions and to allow expansion into new areas. For example, the cowpea appears to have a particularly bright future in rice-based systems of Southeast Asia. However, there remains much to be done on both current problems and in new areas.

Continuing challenges

The cowpea is remarkably attractive to pests—especially in southern Nigeria. There are at least 12–14 important diseases, an equal number of harmful insects, and two or three nematode species afflicting the crop in this one area.

Throughout the world, production and improvement are currently being constrained by:

○ Insect pests, which will continue to be the most serious biological problem in the tropics. Excellent progress has been made in identifying sources of genetic resistance, and the breeding approach is clear—enhance or pyramid resistance genes and combine with resistance to as many insects and diseases as possible. However, it would be risky to short-circuit other methods of pest management as progress is made on host-plant resistance. A valuable lesson came with the several biotypes of the rice brown leafhopper in Southeast Asia: when resistance breaks down a national disaster occurs.

○ Diseases, which are shifty enemies—new ones emerging just when a major problem is solved. Both pathologists and plant breeders must be vigilant even as they pyramid several resistances in advanced lines of commercial varieties. As with insects, diseases will continue to require study—not only their epidemiology but also alternative approaches to their control. In addition, root-knot and lesion nematodes and the devastating plant parasite *Striga* merit study in endemic regions.

○ Problem soils, which characterize not only lands subjected to continuous cropping but also the frontiers of the future—the vast tracts of humid forests being rapidly settled from Southeast Asia to the Amazon. These are often highly leached, low-pH, high-Al soils called red–yellow podsols in Asia and oxisols or ultisols in the Amazon region. These new areas may have the greatest potential for expanding cowpea production, but the problems are acute: high Al sometimes combines with toxic levels of Fe and Mn; low availability of soil nutrients, especially N, P and Ca, and, at times, K; and often excessive moisture but sometimes drought.

○ The symbiont, which is the bacterium providing legumes with the capacity to fix nitrogen. Not only must the plant have the capacity to attract and maximize the association but also the N-fixers must receive attention. Although good progress has been made in developing high-temperature strains of *Rhizobium*, to date there have been no strains efficient in problem soils or in competition with indigenous soil rhizobia.

○ The yield barrier, which derives from the uncertainty about the definition of high-yielding idiotypes. Should plants be erect, large, small, spreading, profusely branching and tolerant of high populations? Or are numbers of branches, peduncles, pods, seeds/pod and seed size paramount—and in what order?

○ Cultural practices, which depend ultimately on the prevalent growing conditions in a producing area. A large amount of information and experience on optimal management of cowpeas has been accumulated for a wide range of growing conditions. However, there always seem to be new permutations of environmental conditions, fertilizer levels to test, uses to