Farmers’ guide to increased productivity of improved legume–cereal cropping systems in the savannas of Nigeria

H.A. Ajeigbe, S.G. Mohammed, J.O. Adeosun, and D. Ihedioha
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Preface

The second phase of the project *Improved crop–livestock systems for enhanced food security and income generation in West Africa*, sponsored by the Gatsby Charitable Foundation UK, started in February 2006 with the aim of wider dissemination of improved cereal–legume technologies and improved practices for feeding livestock. This also coincided with the takeoff of the USAID–MARKETS project, charged with commercializing the agricultural production of selected commodities. Capacity building of both extension agents (EAs) and farmers’ groups was an important aspect of these two projects and included one of the several areas of collaboration between them. Several annual training programs were jointly organized in intervention areas. This manual is a compilation of presentations made during two of such training: the Pre-season training workshop on 8–11 May 2007, at the National Agricultural Extension and Research Liaison Services (NAERLS), Ahmadu Bello University, Zaria, Kaduna State, and the Postharvest training workshop on 5–6 November 2007 at the Kano Station, IITA, Kano, Nigeria. Sixty-four EAs and lead farmers attended the two training. Resource persons were from universities, research institutes, NGOs, ADPs, and IITA. This manual is intended to provide a reference for all those interested in improved on-farm agricultural activities of cereal–legume production, the feeding of small ruminants, and the organization of farmers’ cooperatives.

Hakeem A. Ajeigbe
Acknowledgment

This training manual is an output of a project funded by the Gatsby Charitable Foundation UK, *(Improved crop–livestock systems for enhanced food security and income generation in West Africa)* (GAT2833). The editors are grateful to the Gatsby Charitable Foundation UK for their support of the project for 6 years which allowed both the validation as well as the dissemination phases of the project. We are also grateful to all those who made the pre- and postharvest training of extension agents and cowpea farmers in Bauchi, Kaduna, and Kano States very successful. We are particularly grateful to Dr D. Chikoye, Director, Savanna Program, IITA, who was readily available to offer useful comments and advice, Dr B.B. Singh (former officer in charge and cowpea breeder, IITA, Kano Station) who initiated the project, all the scientists and staff of IITA Kano Station for their support during the various training and stakeholder meetings, Dr Dick Cook of USAID–MARKETS for his support and encouragement, and Mallam Bello Abba Yakasai, the Kano Business Promotion Office Manager of USAID–MARKETS, for his support at all times.

The support of the Program Manager, Kaduna State ADP, Dr A. Kassim, and the Managing Director, Kano State Agricultural and Rural Development Authority, Alhaji Mohammed Umar, deserve our sincere commendation and appreciation for helping to mobilize their farmers, staff, and extension agents for the training programs and on-farm activities. The efforts of the Directors of National Agricultural Extension and Research Liaison Services (NAERLS), National Animal Production Research Institute, and Institute of Agricultural Research, all of Ahmadu Bello University, Zaria, are deeply appreciated. We also thankful for the support of Kaduna and Kano States Ministries for Local Government and Ministries of Agriculture in mobilizing the Local Government Councils and the Chairmen, Heads of Agricultural Departments in all participating LGAs.
We are grateful to the Director, Agricultural Services, Kano State Ministry of Agriculture, Alhaji Abba Datti, who took a personal interest in the project and ensured that project farmers got inputs from the Ministry of Agriculture at government rates, and the Director, Agricultural Services, Kano State Ministry for Local Government, Alhaji Tijani Auwalu, who ensured the participation of the Kano State Local Government extension agents in the training activities. The efforts of Mallam Awalu Musa Abdullahi of Kano State Ministry for Local Government, and Mallam Shaibu of Kano State Ministry of Agriculture for facilitating several activities are appreciated.

We thank the resource persons who helped in the training for their commitment in seeing that things worked out well. The staff and management of NAERLS deserve our appreciation and thanks for being good hosts during most of the training sessions. Last and probably most importantly, we are grateful to the various men and women farmers’ groups for their enthusiastic hard work and hospitality during our several visits.
Foreword

Nigeria is endowed with vast agricultural, mineral, and human resources which, if well harnessed through the use of appropriate technologies, could be major factors in transforming Nigeria’s agricultural sector from one characterized by subsistence farming to one characterized by increasing competitiveness.

This manual, *Farmers’ guide to increased productivity of improved legume–cereal cropping systems in the savannas of Nigeria*, is intended to be a useful guide to the technologies developed through the IITA–Gatsby/MARKETS project to improve our understanding of cowpea production and the opportunities to produce value-added products. The methodologies and approaches described in this publication have been developed and tested in Gatsby and MARKETS for small-to-medium scale farmers and processors.

IITA–Gatsby and MARKETS have focused largely on providing information to increase on-farm productivity and to improve value-added processing. It is through both on-farm and off-farm improvements in productivity and by adding value to products that the agricultural sector could become the important engine for broad-based economic growth, encouraging improvements in on-farm productivity and incomes, generating investment in value addition, and creating off-farm labor markets.

There is a wealth of information here of use to research institutes, ADPs, cooperatives, community-based NGOs, individual entrepreneurs, agri-business managers, and farmers’ groups who want to expand their agricultural businesses. I am certain that the information contained herein will encourage readers to take advantage of the expertise of IITA–Gatsby and MARKETS in establishing and expanding their agri-businesses through the judicious use of these technologies. They have, in fact, been specifically developed and field tested to make local farm and off-farm enterprises more productive and competitive. This publication will assist readers to begin managing their farms and activities for value addition as commercial businesses, striving to achieve increased competitiveness through technological innovation.

Richard Cook
Managing Director, USAID/MARKETS
Introduction

In the first phase of IITA/Gatsby project *Improved crop–livestock systems for enhanced food security and income generation in West Africa*, the project demonstrated the potential for changing the traditional farming system into a dynamic and sustainable commercial agricultural endeavor, and ensuring complete household food security in West Africa. The project had the following objectives: (1) To extend and disseminate improved holistic crop–livestock farming systems in Kano and Kaduna States in Nigeria as pilot sites; (2) To monitor the gains of the improved system in terms of household food security; income generation, and natural resource conservation; (3) To monitor the effect of enhanced food security on the nutrition, health, and quality of life of the contact farmers’ families; and (4) To demonstrate that food production can be sustainably increased in West Africa and sensitize the governments to develop infrastructure for large-scale adoption of the improved technology.

The first phase of IITA/Gatsby improved crop–livestock project commenced on 1 October 2002, with 40 farmers in Kano State and 60 farmers in Kaduna State, Nigeria. These numbers increased to over 684 farmers in 2005, including 135 women farmers. However, combining its leveraging effects through the USAID Seed Project and the DFID Fodder Innovation Project, a total of 3013 farmers, including 627 women farmers, participated in 2005 in the evaluation of the cowpea-based improved crop–livestock system covering Bauchi, Jigawa, Kano, and Kaduna States, and the Federal Capital Territory, Abuja.

The on-farm results from the 2002 to 2004 crop seasons have indicated a gross income/ha ranging from ₦102,000 to ₦167,000 in the improved systems, compared with ₦24,000–₦52,000 in the traditional systems. This is against a total cash investment of ₦8000–₦10,000 for improved seeds, fertilizers, and plant protection chemicals in the improved systems.
On average, participating farmers had 300–500% more income compared with those practicing the traditional systems. The project also included a credit component used to finance both fertilizer and pesticide purchases and basic livestock housing. In 2003 and 2004, this was provided in kind, and in 2005, partly in cash by the National Agricultural and Cooperative Bank through the mediation of Wealth Windows Foundation.

The second phase of the project started in February 2006 with the aim of demonstrating and disseminating improved and sustainable cowpea-based crop–livestock systems in Kaduna and Kano States in northern Nigeria and in the Maradi and Zinder Divisions of the Niger Republic, in partnership with multiple national stakeholders, including crop and livestock farmers, farmers’ groups, the private commercial sector, NGOs, NARES, and other ongoing projects in the region. Its implementation has been participatory in all aspects to ensure ownership by stakeholders to maximize the likelihood of sustainability and the effective scaling out and scaling up of the introduced systems. The project was also linked to other development projects in the region and built synergies for the maximum benefits of farming communities. For example, nine large stores were constructed in nine communities in Kano, Kaduna, and Jigawa States by the Humanitarian Assistance Department of the Embassy of the United States of America for grain storage by the farmers’ groups in and around those communities. The project has therefore taken training of local extension agents and farmers’ groups as an important aspect of implementation and for sustainability. The present publication will also serve as a lasting legacy of the project through which larger numbers of people can be trained on the improved technologies. Not only does the IITA/Gatsby crop–livestock project, on the one hand, make a real difference to the lives of farmers, it also informs policy makers, researchers, and extension agencies of the need to provide essential agricultural services, on the other.

David Chikoye
Director, Savanna Program, IITA
Improved agronomic practices for cowpea production and prospects for mechanized cultivation

Ousmane Boukar and Hakeem A. Ajeigbe
IITA, Kano Station

Introduction
Cowpea (Vigna unguiculata (L.) Walp) is the most important grain legume in Nigeria and widely consumed by the populace. It is a drought tolerant warm weather crop and consequently it is most popular in the dry savanna regions of the country and as a relay crop in the Guinea savanna and derived savanna zones. Cowpea has the ability to fix nitrogen, even in poor soils. Also, it is shade tolerant and, therefore, very compatible as an intercrop with a number of cereals and root crops, as well as with cotton, sugarcane, and several plantation tree crops. The spreading indeterminate or semi-determinate growth of cowpea provides ground cover, thus suppressing weeds and giving some protection against soil erosion. Coupled with these attributes, its quick growth and rapid ground cover have made cowpea an essential component of sustainable subsistence agriculture, especially in the drier regions of Nigeria, where rainfall is erratic and scanty, and soils are sandy with little organic matter. The major constraints to cowpea grain and fodder production are as follows:

1. Low density of cowpea and shading by cereals in intercropping systems
2. Diseases, insect pests, and parasitic weeds, especially Striga gesnerioides and Alectra vogelii
3. Drought stress and low soil fertility
4. Lack of inputs and poor infrastructural development
5. Traditional cropping pattern and poor plant type
Uses
Cowpea is chiefly used as a grain crop or a vegetable, and for animal fodder. Cowpea seeds are a nutritious component in the human diet, as well as a nutritious livestock feed. Cowpea can be used at all stages of growth. The tender green leaves are an important food source in some parts of Nigeria and are prepared as a potherb, like spinach. Green cowpea seeds are boiled as a fresh vegetable. In many areas of the world, cowpea provides the only available high quality legume hay for a livestock feed. Cowpea may be fed to animals when green or as dry fodder. Also it is used as a green manure, a nitrogen-fixing crop, or for soil erosion control.

Growth habits
Cowpea plant types are often categorized as erect, semi-erect, prostrate (trailing), or climbing. There is much variability within cowpea. Growth habit ranges from indeterminate to fairly determinate with the non-vining types tending to be more determinate. Generally speaking, farmers classify cowpea into two categories depending upon the time taken to reach maturity; these are early and late. The early maturing varieties yield little or no fodder, whereas the late maturing varieties are photosensitive with a profuse growth habit and spread to give a lot of biomass or fodder to the farmers. The seed coat can be either smooth or wrinkled and of various colors, white, cream, green, buff, red, brown, and black. Seed may also be speckled, mottled, or blotchy.

Environmental requirements
Cowpea tolerates hot and dry conditions, but is intolerant of water-logging and very low temperatures. Germination is rapid at temperatures above 25 °C; colder temperatures slow germination as cowpea is sensitive to low temperature. Cowpea is grown under both irrigated and non-irrigated regimes. The crop responds positively to irrigation but will also produce well under dry land conditions. Cowpea is more drought resistant than many crops. Drought resistance is one reason why cowpea
Cowpea (IT93K-452-1) harvested in August by a farmer and his family in a maize-double cowpea strip cropping system.

is such an important crop in many underdeveloped parts of the world. Cowpea performs well on a wide variety of soils and soil conditions, but performs best on well-drained sandy loam or sandy soils where the soil pH is in the range of 5.5 to 6.5. Cowpea should not be planted until soil temperatures are consistently above 25 °C and soil moisture is adequate for germination and growth. Seeds will decay in cool, wet soils.

**Cultural practices**

**Land preparation**: Cowpea has a tap root and needs loose soil. Cowpea may be adversely affected by soil crusting under certain soil and environmental conditions. Soils should be cultivated deeply enough to ensure that no barrier exists (such as a hardpan) to penetration of the soil by the taproot. Two harrowings provide sufficient tilth for good root growth. Ridges can be made thereafter. Otherwise, cowpea can also be planted on the flat, especially where soils are loose and prone to erosion. In these areas, minimum tillage could be used. Ridging could be done by ox-drawn ridger or manually with a hand hoe.
**Spacing:** Spacing of cowpea depends on the variety and cropping system that are used. Recommended planting for the improved varieties is 75 cm between rows and 20 cm within rows. For early and extra-early maturing varieties, the row-to-row spacing can be reduced to 50 cm between rows and 20 cm hill-to-hill spacing. For late maturing and photosensitive varieties, planting on ridges or rows 75–150 cm apart on hills 40–50 cm apart is generally recommended. Three seeds/hill are sown and thinned to two plants/hill, 2 weeks after sowing. Thinning is optional as this may increase labor cost.

**Variety selection:** IITA, in collaboration with several national institutes and universities, has developed high yielding, multiple disease resistant cowpea varieties with varying maturity periods, as well as different seed colors, and adapted to various Nigerian agro-ecological zones (Tables 1a and 1b). Several of these varieties have been released in Nigeria and are being promoted by the State Agricultural Development Projects (ADPs), farmers’ groups, and seed companies. The choice of a proper variety is the most important factor in crop production. Varieties that have resistance to the prevailing biotic and abiotic stresses in the areas should be planted. Other considerations in variety selection are growth pattern, maturity, market value, seed size, and seed color. About 20–25 kg of seeds is needed to plant one hectare of sole crop land, depending on seed size.

**Date of planting:** Cowpea should be planted when there is sufficient moisture in the soil to permit good germination. Cowpea should be planted after a good rain (15 mm and above). Dry planting is not advisable. Planting in the Sudan savanna should be from the last week of June to the first week of July; in the Guinea savanna, cowpea may be planted in August.

**Fertilization:** Cowpea, like most legumes, forms a symbiotic relationship with a soil bacterium (*Rhizobium* spp.). *Rhizobium* makes atmospheric nitrogen (N) available to the plant by
Table 1a. Selected brown seeded cowpea varieties released in Nigeria.

<table>
<thead>
<tr>
<th>S/N</th>
<th>Variety</th>
<th>Salient characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ife Brown</td>
<td>Medium maturing (75–80) days, semi-erect, medium sized seeds, moderately susceptible to insect pests and diseases, requires 3–4 sprays, yields about 800 kg/ha</td>
</tr>
<tr>
<td>2</td>
<td>IAR-48</td>
<td>Medium maturing, semi-erect, medium sized seeds, moderately susceptible to insect pests and diseases, needs 3–4 sprays, yields 1000–1300 kg/ha.</td>
</tr>
<tr>
<td>3</td>
<td>IT84S-2246-4</td>
<td>Early maturing (70 days), medium sized seeds, moderately resistant to insect pests and diseases, needs 2–3 sprays, good for dry season, yields about 1300 kg/ha.</td>
</tr>
<tr>
<td>4</td>
<td>IT90K-82-2</td>
<td>Early maturing (70 days), medium sized seeds, moderately resistant to insect pests and diseases, resistant to <em>Striga</em> and <em>Alectra</em>, needs 2–3 sprays, good for dry season, yields about 1500 kg/ha.</td>
</tr>
<tr>
<td>5</td>
<td>IT89KD-391</td>
<td>Medium maturing, dual-purpose, medium sized seeds, moderately susceptible to insect pests and diseases, needs 3–4 sprays, very good as a relay with cereals, yields 1300–1700 kg/ha.</td>
</tr>
</tbody>
</table>

Table 1b. Selected white seeded cowpea varieties released in Nigeria.

<table>
<thead>
<tr>
<th>S/N</th>
<th>Variety</th>
<th>Salient characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TVX 3236</td>
<td>Medium maturing (80 days), small sized seeds, large brown eyes, resistant to thrips and many diseases, needs 3 sprays, yields about 1000–1200 kg/ha.</td>
</tr>
<tr>
<td>2</td>
<td>IT86D-719</td>
<td>Medium maturing (80–85 days), small sized seeds, large brown eyes, resistant to thrips and many diseases, needs 2–3 sprays, yields about 1000–1200 kg/ha.</td>
</tr>
<tr>
<td>3</td>
<td>IT90K-277-2</td>
<td>Medium maturing (75–80 days), medium sized seeds, some level of resistance to insects and diseases, needs 2–3 sprays, high grain yield about 1500-2000 kg/ha, high fodder yield.</td>
</tr>
<tr>
<td>4</td>
<td>IT93K-452-1</td>
<td>Extra-early maturing (60 days), medium sized seeds, some level of resistance to insect and diseases, yields 1500 kg/ha, good for double cropping.</td>
</tr>
<tr>
<td>5</td>
<td>IT97K-499-35</td>
<td>Medium maturing (75–80 days), medium sized seeds, <em>Striga</em> and <em>Alectra</em> resistant, some level of resistance to insects and diseases, needs 2–3 sprays, high grain yield about 1500-2000 kg/ha, heat and drought tolerant, very good in dry season.</td>
</tr>
<tr>
<td>6</td>
<td>IT89KD-288</td>
<td>Photosensitive, dual-purpose, large sized seeds, resistant to insects and diseases, needs 3–4 sprays, very good as a relay with cereals, yields 1000–1500 kg/ha.</td>
</tr>
</tbody>
</table>
a process called N-fixation. Fixation occurs in root nodules of the plant and the bacteria utilize sugars produced by the plant. Cowpea \textit{Rhizobium} is normally widespread, and seed inoculation with \textit{Rhizobium} is not required. Excess applied N promotes lush vegetative growth, delays maturity, may reduce seed yield, and may suppress N-fixation. The plant will perform well under low-N conditions due to a high capacity for N-fixation if other nutrients are available. A starter rate of about 15 kg N/ha is sometimes required for early plant development on low-N soils.

Adequate animal manure (at least 1 t/ha) is important for cowpea production. This should be followed by the application of 100 kg/ha NPK (15-15-15) as a basal dose or 100 kg/ha of Single super phosphate (SSP). The manure and fertilizer should be broadcast and incorporated into the soil before planting.

\textbf{Weed control}: Adequate weed control is necessary for good growth and high yields. Efforts should be made to keep fields weed free with a first weeding at 3–4 weeks after planting and a second weeding 3 weeks later. Pre-emergence herbicides, such as Galex, Dual and others, can be applied at the recommended rate immediately after planting. One or more inter-row cultivations should also be done when herbicides are used.

\textbf{Disease control}: Many of IITA’s improved varieties are resistant to common diseases. Seed treatment with Benlate, Fernasan D, Apron star, etc., will help to minimize losses from seedling mortality and root rot. Seed dressing is especially beneficial under high rainfall conditions or in fields where cowpea was planted in the previous season. Farmers should therefore treat their seeds with seed dressing chemicals under these conditions.
The following control practices help reduce losses from diseases:

- Treat high quality seeds with seed treatment chemicals such as Apron star.
- Avoid throwing soil against plant stems during cultivation.
- Rotate with other crops.
- Plant seeds into warm, well-prepared soils.
- Plant certified seeds of resistant varieties.
- Control weeds.
- Remove virus-infected plants.
- Spray against aphids.

**Insect control:** There is a good level of resistance to many of the insect pests of cowpea in the improved varieties, but there are no acceptable levels of resistance to *Maruca* pod borer and pod sucking bugs. Because of these two insect pests, 2–3 insecticide sprays are recommended for cowpea production. The first spray should be at flower bud initiation; the second at full flowering and podding. The third spray should be 10–14 days later. The number and type of insecticide sprays will depend on the nature and pressure of insect attack and the cowpea variety.

**Harvest:** Harvesting should be done when 80–90% of the pods are dry. The dry pods can be manually beaten and winnowed. More than one picking may be needed in some varieties.

**Storage:** Seeds should be properly cleaned and well dried before storing. Dry cowpea seeds are cleaned, graded, fumigated, and packed, and stored in airtight containers, such as drums, tins, clay pots, or double and triple polythene bags, and periodically fumigated. Dry cowpea grains stored under triple bagging do not need fumigation. This storage method will be treated in paper 10.
Prospects for the mechanization of cowpea cultivation

The term mechanization is used to cover any mechanical means, from the simplest to the most complicated, for carrying out agricultural operations from land preparation to the final preparation of the harvested product for sale. The constraints to the full mechanization of cowpea cultivation are as follows:

- Cost of machinery
- Lack of technical know-how and difficulties in handling machines
- The size, generally small, of individual land holdings
- Lack of a spirit of cooperation among small-scale farmers which would allow the efficient shared use of equipment for large-scale cultivation
- Unfavorable climatic conditions
- Limited number of cowpea varieties with synchronized flowering and maturity
- Traditional intercropping planting system
- Poverty and the subsistence approach to food crop production

However, prospects for the commercialization of cowpea cultivation are high, especially with the recent industrial interest in the crop. Mechanization of cowpea cultivation is an important tool for commercialization. In countries such as Brazil, cowpea is cultivated in commercial farms and almost all agronomic practices are mechanized. Mechanization is easier under large-scale and commercialized systems but this is not the situation for now in Nigeria. Most of the cowpea production is from small farm holdings with an average size of less than 1 ha. For mechanization to be possible, certain conditions must be met and one of these is an increase in individual farm sizes. Alternatively, cooperative farming could be organized where several small holdings come together and pool resources for the cultivation of the crop.

Some operations in cowpea cultivation already allow mechanization in Nigeria. Land preparation using tractors or bull-drawn ridgers is common. The combined planter and fertilizer
applicator in use for maize and other grain crops can easily be adapted for cowpea. Weed control using herbicide will be important under mechanization. In large farms, farmers would rely more on chemical weed control than on manual methods. Pre- and post-emergence herbicides are available that can be and are being used in cowpea cultivation. Protection against insect pests is a major activity in cowpea production. This can be done using the manual knapsack sprayer, motorized sprayer, or tractor-mounted boom sprayer, if the field is large enough.

In the large-scale cultivation of cowpea, harvesting is a labor demanding operation and mechanizing harvesting will require technical know-how. For the mechanized harvesting of cowpea, the following requirements must be met: the crop must have synchronized maturity (determinate growth); the crop should mature under a suitable climatic condition for mechanical operations; location of the pod within the plant canopy should be favorable. Cowpea varieties that have synchronized flowering and maturity easily lend themselves to mechanization. Most of the cowpea produced under the small holdings is threshed by women and children and this provides valuable part-time employment at the rural level. However, with an increase in average acreages, mechanical threshing would be desirable. Suitable threshers of various makes, types, and capacities are available for threshing cowpea. Some of these include the multipurpose threshers that are being used by many of the medium and large-scale farmers and in various research institutes.

Animal traction for land preparation, planting, and weeding is a significant step toward mechanization and this is possible under small and large-scale production. Smallholder crop–livestock farmers know that the use of animals for draft purposes offers them the extra labor capacity they need for the cultivation of extra land. The use of draft animals for land preparation, weeding, and transport is a fairly simple and easy-to-learn mechanized system for smallholders.
In conclusion, mechanization can be in stages. Operations such as land preparation, planting, weeding, spraying, and threshing can be mechanized while mechanized harvesting can come with improved technologies. With an increase in cultivation and the apparent interest in cowpea as an industrial crop, mechanization of the various operations in cowpea cultivation is a matter of time.

Suggestions for further reading
Improved agronomic practices for cereal production

James O. Adeosun¹ and Sanusi G. Mohammed²
¹NAERLS, Ahmadu Bello University, Zaria
²Department of Agronomy, Faculty of Agriculture
Bayero University, Kano

Introduction
Sorghum, millet, and maize are the most important cereal crops of the Nigerian savanna. These three crops have some similarities in relation to their agronomic practices. The ultimate yields realized depend to a larger extent on the type of management employed; all things being equal. The major concern is that cereal production is not keeping pace with the rate of population growth and the food situation is fast deteriorating, especially in sub-Saharan Africa. Therefore, to feed and satisfy the needs of the burgeoning population, there is a need to increase the production of sorghum, millet, and maize, the three most important cereal crops cultivated in the region. Adequate attention should be paid to all the necessary agronomic practices to ensure good yields. With the increased cost of production, it is important that efforts are made to make efficient use of the production inputs so as to increase the average production per unit area. The efficient use of the inputs implies using improved production inputs at the optimal level to produce yields that give appreciable returns to the farmers.

Improved agronomic practices for maize
Maize is the third most important cereal of the Nigerian savanna after sorghum and millet. Maize was initially confined to the southern parts of the country, particularly the southwest, but with the development of early and extra-early maturing varieties, its cultivation has spread to the Sudan ecological zone. The cultivation of maize has spread more than that of
sorghum, possibly due to the higher yields that are obtained with improved varieties of maize when adequate quantities of fertilizers are applied.

**Site selection**
Select a good soil for optimum yield. Maize requires a deep loam soil, high in organic matter, with a neutral pH range of 5.5 to 7.5. It does well in areas with an annual rainfall of 80–150 cm that is evenly distributed throughout the season. Usually, a short wet season with periods of high insulation is ideal. This makes the Guinea savanna a better maize growing belt than the rainforest.

**Land preparation**
The major land preparation operations include land clearing, plowing, harrowing, and ridging. These operations may not be applicable in all situations particularly where the tillage equipment is not readily available to farmers. Consequently, after land clearing, ridging could commence on the fields that have been cropped in the past years. The aim of land preparation includes the following.
To reduce soil compaction which could lead to poor seedling emergence
• To encourage free drainage and good water retention
• To increase soil aeration
• To encourage good root development, and
• To allow effective weed control
• Ridging should be done after harrowing at 75 cm apart.

Varieties
To realize good yields, appropriate varieties should be used. The researches of international and national agricultural institutes have led to the production of suitable maize varieties for specific locations in the country. It is important that adequate information be sought from the extension agents for appropriate linkage to the seed companies so that appropriate and suitable varieties could be obtained. There are quite a number of improved maize varieties obtainable from research stations, ADPs, and accredited seed companies.

Planting
Planting should be done as the rain is established, possibly between mid-May and late June, depending on the location, the time of rain establishment, and varieties to be planted. Prior to planting, seeds should be dressed if this has not been done with any of the seed dressing chemicals recommended. Plant one seed/hill at an intra-row spacing of 25 cm. Two plants/hill can be maintained at an intra-row spacing of 50 cm apart. At a spacing of 75 × 25 cm, a plant population of 53,333/ha can be attained. These recommendations are based on a sole maize crop only. The population will change in the intercropping or strip cropping systems.

Table 1. Some of the available varieties for north-west zone.

<table>
<thead>
<tr>
<th>Variety Type</th>
<th>Varieties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early and extra-early maturing</td>
<td>EVDT, 95 TZEEW, 99TZEEY, 2000SYN.EE, 2004SYN.EE TZE COMP5, 2000 SYN EE</td>
</tr>
<tr>
<td>(open pollinated)</td>
<td></td>
</tr>
<tr>
<td>Medium and late maturing</td>
<td>Across 97, Obatanpa, TzeComp 5, TZSRY-W-1, TZSRY-Y-1, TZL COMP1.SYN, etc.</td>
</tr>
<tr>
<td>(open pollinated)</td>
<td></td>
</tr>
<tr>
<td>Hybrids</td>
<td>OBA super 1, OBA super 2, New Kaduna, etc.</td>
</tr>
</tbody>
</table>

![Table 1. Some of the available varieties for north-west zone.](image_url)
Fertilizer application

Maize is a heavy nutrient feeder requiring nitrogen (N) especially. Normally, any fertilizer application should be based on a soil test. However, based on already completed work on crop nutrition across the country, the generalized fertilizer requirement of maize is as stated in Table 2. Application of N should be in two split doses, half at planting or land preparation and the balance at 5 weeks after planting. Proper placement and covering of the fertilizer are very important in achieving a good response. Fertilizer must not be placed too close to the roots, especially at the early stages of the crop. It is safe to place the fertilizer at about 5 to 10 cm away from the crop. A practical approach for smallholder farmers is to apply two full bottle covers/hole for NPK and 1 for urea. (The covers are the “crown cork” type, found on beer bottles.) A hole about 5 cm deep is dug, fertilizer is applied and then covered with soil. This protects the fertilizer from being carried away by rainwater or affected by the sun in the case of urea. Where possible, apply 3 to 6 t of farmyard manure in the old furrows before splitting the ridges. The generalized fertilizer recommendation for the Sahel, Sudan, and northern Guinea savannas is 120:60:60 NPK for open pollinated varieties and 150:60:60 NPK for hybrids.

Table 2. Fertilizer recommendations for open pollinated maize based on soil fertility class.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Fertility class</th>
<th>Nutrient rate/ha</th>
<th>Fertilizer rate and source/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>Low</td>
<td>120 kg/N</td>
<td>NPK 15-15-15 400 kg (8 bags) and 125 kg urea as top dressing at 5 WAP</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>60 kg/N</td>
<td>NPK 15-15-15 400 kg (8 bags)</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>30 kg/N</td>
<td>NPK 15-15-15 200 kg (4 bags)</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>Low</td>
<td>60 kg/P&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;5&lt;/sub&gt;</td>
<td>SSP 333 kg (7 bags)</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>30 kg/P&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;5&lt;/sub&gt;</td>
<td>SSP 167 kg (3 bags)</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Nil</td>
<td>–</td>
</tr>
<tr>
<td>Potassium</td>
<td>Low</td>
<td>60 kg/K&lt;sub&gt;2&lt;/sub&gt;O</td>
<td>MOP 100 kg (2bags)</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>30 kg/K&lt;sub&gt;2&lt;/sub&gt;O</td>
<td>MOP 50 kg (1 bag)</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Nil</td>
<td>–</td>
</tr>
</tbody>
</table>
Table 3. Some recommended herbicides for chemical control of weeds in maize.

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Rate L/ha and kg a.i/ha</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metolachlor 1.33 kg a.i + Atrazine 0.67 kg a.i/ha (Primextra)</td>
<td>4 L</td>
<td>Apply pre-emergence. Good control of broadleaves and grasses.</td>
</tr>
<tr>
<td>Metolachlor 1.0 kg a.i + Atrazine 1.0 kg a.i/ha (Primagram)</td>
<td>4 L</td>
<td>Apply pre-emergence. Good control of annual weeds.</td>
</tr>
<tr>
<td>Dimethametryn + Diflufenica</td>
<td>1.0 + 0.4 kg a.i</td>
<td>Directed application for post-emergence. Poor control of itch grass and sedges.</td>
</tr>
<tr>
<td>Atrazine + terbuthylazine</td>
<td>1.5–2.0 kg a.i</td>
<td>Apply pre-emergence. Controls most broadleaf weeds and grasses. Low rate should be used on light soils. All pre-emergence herbicides may need supplementary hand weeding at 6 WAP or direct application of dimethametryn at 1.0 kg a.i/ha at 6 WAP.</td>
</tr>
</tbody>
</table>

Weed control

Weeds generally cause stress conditions to the maize crop by competing for moisture, nutrients, and solar radiation. Weeding operations must be timely and adequately done so that maize crop can exhibit its genetic potential. The common method of weed control in Nigeria is hand weeding which consists of hoeing and hand pulling. Depending on the land preparation method, type of weeds, and intensity of the rain, 2 to 3 hand weedings will be required in maize production. It is obvious that in large-scale maize cultivation, hand weeding is laborious, time consuming, and sometimes could inflict injury on the crop. Herbicide application is a practical weed control method and an alternative to hand weeding. There are available herbicides for weed control in maize (Table 3).

If *Rottboelia exaltata* constitutes a problem, use Pendimethalin + atrazine at 2.0 + 2.0 kg a.i/ha (6 L Stomp + 4 L Gesaprim 500FW/ha pre-emergence). Where *Striga* is endemic, use resistant varieties in addition to other cultural management practices.
Crop protection
The important pests of maize are stem borers, army worms, grasshoppers, and termites. These pests are generally controlled by the use of insecticides and good farm hygiene. Good farm hygiene includes timely weeding, roguing of diseased plants, adequate application of fertilizer, and other important cultural practices. Use chemicals as a last resort. Use Vetox 85 at 1.68 a.i /ha in 225 L of water. Army worms can be controlled by the use of appropriate insecticides. In the case of termites, all anthills within the vicinity should be destroyed. Common diseases of maize include leaf blight, smut, rust, ear rot, stem rot, root rot, streak virus, and downy mildew. The use of resistant varieties and seed dressing chemicals before planting will reduce the effect of downy mildew.

Harvesting, threshing, and storage
Harvesting of maize should be timely to avoid losses to pests (rodents) and bad weather. Maize can be harvested green or as dry grains when the crop is fully mature. For dry grains, the cobs should be harvested when the color changes to brown. The cobs could be removed from the stem and dehusked or the stems could be cut and heaped at specific locations for dehusking later. They should be allowed to dry to a moisture content of about 14% for easy shelling. After shelling, the grains can be further dried before bagging and stored in a weevil-free store until used for consumption or for sale.

Improved agronomic practices for sorghum
Sorghum is the most important cereal of the Nigerian savanna. It occupies about 44% of the total land area devoted to cereals in Nigeria. Sorghum is a staple food crop, grown primarily for human consumption and sometimes as stock feed.

Land selection
Select good land. Although sorghum tolerates a wide range of soil, the selection of suitable land is critical to the optimal yield of sorghum. A fertile well-drained soil that has not been
subjected to the continuous cropping of sorghum will be an ideal soil for good sorghum production and yield.

**Land preparation**
This is similar to that of maize, as discussed earlier.

**Varieties**
Seeds are critical to any crop production. Good seeds of high yielding varieties will give a better yield and higher returns. Some of the improved varieties of sorghum include SAMSORG 2, SAMSORG 3, SAMSORG 4, SAMSORG 17, SAMSORG 21, ICSV 400, and ICSV 111. Apart from these and other improved varieties, there are some local varieties that give reasonable yields but they are late maturing.

**Planting**
Planting should be done as soon as the rain is established depending on the varieties selected. For example, early maturing varieties such as ICSV 400 should not be planted earlier than July in Kaduna State so as to avoid the grain maturing in the middle of the rainy season. Prior to planting, ensure that seed dressing has been done. Plant 2 to 3 seeds/hill at 25 cm intra-row spacing on ridges 75 cm apart and thin to 1 plant/hill. This will give a plant population of 53,333/ha. Some people prefer 30 cm intra-row spacing which will give a plant population of just 45,000/ha. Planting should be done at about 2.5 cm deep and the seeds should be covered moderately. These recommendations are based on sole crop sorghum only; under mixture, the spacing changes, depending on the type of mixture.

**Fertilizer**
Where possible, apply 3 to 6 t of farmyard manure in old furrows before splitting the ridges. Apply 64 kg of N, 32 kg of P₂O₅, and 30 kg of K₂O. The method of application is similar to that in maize.
**Weed control**

1. Hand weeding 2 to 3 times

2. Use appropriate herbicides such as Gardoprim A at 4 L/ha, Atrazine 500FW at 5–6 L/ha. Low rates should be used for lighter soils. Care must be taken when herbicides are used. All operational requirements must be followed, such as the correct calibration, the right nozzle, the right speed, time of application, etc. Pre-emergence herbicides may require supplementary hoe weeding or the use of post-emergence herbicides, as with maize. In the case of problems with *Striga*, use tolerant varieties such as ICSV 400, ICSV 111, and ICSH 89002NG, etc. You can also use high doses of N to suppress the effects of *Striga*, as well as crop rotation.

**Crop protection**

Common pests of sorghum include sorghum midge, stem borers, and termites. For stem borers and termites, control methods apply, similar to those used in maize. For sorghum midge, the infected heads should be destroyed. Insecticides could also be used. Smut is another common disease of sorghum. Control measures employed for maize could be employed for sorghum as well. Ensure every smut infected plant is rogued. Crop rotation and seed dressing can also reduce the prevalence of smut in sorghum.

**Harvesting, winnowing, and storage**

The time of harvesting sorghum will vary with the variety. The golden rule is to harvest promptly to avoid losing the grains to bird. Harvesting should be done when the moisture content is about 12%. The heads could be cut using a sharp knife or the stalks could be cut and heaped at a specific location where the heads will be cut and dried further before threshing. Threshing is done as soon as the heads have dried enough. The heads are piled up on a clean floor before being beaten with sticks. The
threshed grains are winnowed and further dried, if need be, before being stored in bags. Storage must be done properly to avoid losing the grains to weevils or rodents. Protection similar to that given to maize could be done in storage for sorghum. Stores should be rodent proof to prevent rats and other rodents from entering and damaging the bags. Periodic inspection is important to ensure that products are well kept.

**Improved agronomic practices for millet**
Millet is one of the most important cereal crops extensively grown in the northern parts of Nigeria.

**Site selection**
Millet tolerates a wide range of soils but does better on sandy loam soils.

**Land preparation**
This is similar to that for maize and sorghum but preferably ridging should be done 90 cm apart.

**Variety**
Several millet varieties are available that are adapted to the climatic conditions of northern Nigeria. These include SOSAT C88, Ex-Borno, SAMIL 2-7, and several local varieties.

**Spacing and seed rate**
Plant 5 to 6 seeds/hill at 45 cm intra-row spacing which should be thinned to 2 plants/hill about 10 days after planting. The spacing will give a plant population of 50,000 plants/ha. The tillering ability of millet compensates for the wide spacing.

**Planting**
Millet should be planted at the beginning of the rains. This will ensure that the crop matures early which is a good factor for relay cropping.
Fertilizer
Apply 60 kg/ha N, 30 kg/ha P₂O₅, and 30 kg/ha K₂O. Where possible, apply 3 to 6 t of farmyard manure in the old furrows before splitting the ridges.

Weed control
Hand weeding twice is required. You can also use Gadoprim A at 4 L/ha as a pre-emergence herbicide.

Crop protection
Stem borers should be controlled, as indicated for sorghum.

Harvesting, threshing and storage
Harvesting should be done when the grain is thin or hard and during a suitable dry period. Before threshing, heads usually require further drying after removal from the field. Threshing is done in a way similar to that for sorghum. Millet should be stored well, taking the necessary precautions as earlier discussed for maize and sorghum.

Striga
Striga is a serious problem of cereal crops and several species have been reported to attack and destroy them. The most common and devastating is Striga hermonthica. Striga seeds are small, approximately 0.2–0.3mm long. One Striga plant can produce up to 50,000 seeds that can remain viable for up to 15 years in the soil.

The Striga seeds will germinate only in the presence of a stimulant normally exuded by the roots of a host plant. The germinated seedlings grow towards the roots of the host and eventually penetrate and attach themselves to the roots of the host plant. After attachment, the Striga plant lives and derives nourishment from the host plant. The greatest damage to the host plant occurs underground, before the emergence of the Striga plants from the soil. The symptoms of Striga damage on the host cereal crops can be seen, even before the emergence
of the parasite. These include, among others, stunted growth, wilting, yellowing and scorching of leaves, lower yields, and the death of severely affected plants. The effects of *Striga* infestation are more devastating on a crop where the soil fertility is low.

**How *Striga* spreads**
Because the seeds are very tiny, they can easily be spread through dispersal to other fields by contaminated host seeds, the movement of people and animals, farm machinery and tools, and wind and water.

**Striga control**
*Striga* is best controlled through an integrated approach (a combination of various methods). Controlling *Striga* by agronomic practices has always been achieved on a long-term basis.

1. **Prevent the spread of *Striga***
   - use *Striga*-free planting material
   - avoid grazing livestock in *Striga* infested fields
   - clean up shoes and farm implements after working in infested fields

2. **Prevent *Striga* seed production**
   - uproot (rogue) and burn *Striga* before it produces seeds

3. **Reduce the *Striga* seed bank**
   - plant trap crops or false hosts (use crop rotation, strip cropping, or intercropping). Legumes used as trap crops cause the suicidal germination of *S. hermonthica* seeds. They stimulate the germination of the *Striga* but the parasites find no hosts to feed on, and subsequently die.
   - practice soil fertility improvement (use organic and inorganic fertilizer, plant legume crops, incorporate crop residues, apply mulch on the growing crop, practice fallowing).
4. Chemical control
Use Dimepax 500EC + Quartz 500SC (2.9L + 1.0L), applied post-emergence at 10 days after the first flush of *Striga*. The major disadvantage of using these chemicals is that, since the application is post-emergence, damage to the crops would already have been done. Secondly, the chemicals cannot be applied when the cereals are grown in mixture with other crops, especially legumes or cotton as these are broad-leaved plants like *Striga*.

A new approach is the Imidazolinone-resistant maize (IR-maize) technology which is based upon the inherited resistance of maize to a systemic herbicide (imazapyr). The seed of IR-maize can be treated (seed-coated) with Imidazolinone to provide an effective protection against *Striga*. The herbicide kills *Striga* while the maize plants survive. IR-maize can also be grown in areas not affected by *Striga*, like any other maize cultivar. IR-maize varieties can also be used alongside other appropriate *Striga* management practices. These complementary packages include crop rotation, where maize is grown in rotation with cowpea, soybean, or groundnut, with the latter acting as trap crops.

5. Use tolerant/resistant varieties
*Striga* tolerant maize varieties, such as Acr 97 TZL Comp 1-W, have the ability to yield well despite high levels of *Striga* infestation.

Suggestions for further reading
Agronomy of improved cowpea–cereal planting pattern

Hakeem A. Ajeigbe
IITA, Kano Station

Introduction
Projections have shown that the human population of sub-Saharan Africa (including Nigeria) will increase rapidly between now and 2025. These changes will lead to rapidly increasing demands for food. These demands should be met with increased production locally because, on the one hand, foreign exchange for importation is scarce, and on the other, national food security is important. Whenever possible, food should be produced locally instead of depending on importation. To increase the production of food, emphasis must be on increasing the productivity of existing farmland rather than on expansion. Therefore, the traditional farming systems must be improved or modernized to increase productivities. Modern agriculture is characterized by the use of improved varieties, adequate amounts of fertilizer and minimal use of chemicals, good farm management practices, and ample infrastructure for the storage and marketing of farm produce. This is a well proven way, and if Nigeria agriculture is to be modernized, this is the way to follow.

Some progress has been made, and certain modern agronomic practices and appropriate planting patterns have been developed. Also new and improved varieties of major food crops are available through the concerted efforts of international and national agricultural research institutes in collaboration with the State ADPs and other stakeholders. This paper will discuss the common traditional cowpea–cereal planting practices and the new improved practices being extended to farmers.
Traditional farming practices

The traditional cropping systems are associated with low yields, lack of inputs (fertilizer and pesticide), and traditional varieties. The general objective of the farmers is a sustained production at minimal risk to satisfy subsistent needs; only the excess is taken to market. The importance of a particular crop is area-specific and could be influenced by food preferences, crop rotation, and/or the market situation. Fallows, legumes, and manure play vital roles in the maintenance of soil fertility. Among the legumes, cowpea is the most important for food, fodder, cash, and the maintenance of soil fertility. A cereal crop may be grown in a mixture with a legume, such as cowpea, groundnut, or soybean. In this system, the legume is planted 3 to 6 weeks after the cereal has been sown. This is a common or widespread practice in northern Nigeria. Competition between crops in the same field can have a negative impact on production. With the rapid increase in population, the productivity levels of these systems may not be adequate to meet the demand for food. Traditional farming systems are breaking down under the pressure of human and livestock populations. In many farming systems there are short or no fallow periods.

Livestock are kept by farmers, under extensive management. The livestock and crop enterprises seldom integrate to gain the advantages of mixed farming. The farmers take manure to the farm but most of the manure is lost while the animals are roaming about by the road sides or in the bush in the name of grazing. Also, as fallow systems are reduced and evolve to continuous cropping, the yields of crops and land productivity would decline and sustainability would be threatened. Ultimately, the integration of crop and livestock offers a viable solution because of the complementary effects.

Constraint to production

The major constraints of increased productivity of the traditional systems include the following:
Improved cowpea variety with purple pods.

1. Low planting density and shading of legumes in intercrop.
2. Diseases, insect pests, and parasitic weeds.
4. Lack of inputs which include fertilizers, seeds of improved varieties, and insecticides.
5. Livestock diseases and parasites.
6. Poor and inadequate nutrition of livestock.
7. Low productivity and genetic potential of livestock.
9. General infrastructural inadequacies, including input supply, marketing channels/opportunities, and value addition.

There are short and medium-term solutions to these problems:
1. Development of resistant and improved crop varieties.
2. Use of adequate inputs.
3. Soil fertility correction and maintenance.
4. Improvement of legume productivity in the cropping systems.
5. Appropriate planting patterns.
6. Crop–livestock integration
7. Commercialization and mechanization of production practices.
8. Value addition and improved processing (postharvest activities).
Improved cropping systems

1. Sole cropping and crop rotation
Where inputs are not limiting, sole cropping is the system of choice. Sole cropping allows mechanization and commercialization with its associated efficiencies. Continuous cropping of a piece or land with cereals leads to an increase in disease and pest infestation and therefore a decline in yield. When sole cropping is practiced, the field should be rotated between cereals and legumes to maintain soil fertility. To obtain maximum yield, it is necessary to follow recommended agronomic practices for the respective crops.

Sole cowpea is most profitable when the value of the total produce is being considered. However, farmers also need cereals for home consumption and would like to produce a large proportion of these rather than purchasing them with returns from the sales of cowpea. Therefore, systems that will guarantee cereal production are likely to be adopted. Farmers who are interested in intercropping should practice the improved intercropping system (strip cropping), which guarantees their yields of cereals and provided higher yields of legumes for food, cash, and livestock feed.

2. Improved cereal–legume cropping systems
Fortunately, IITA has rigorously studied various row-to-row cereal–cowpea planting patterns and has adopted the 2:4 cereal:cowpea planting pattern. This system was extensively tested on farmers’ fields and is widely accepted by farmers. The system encourages intensive cultivation, such as the double cropping of cowpea within the strips, optimum usage of fertilizer through selective application, and the spraying of insecticides on cowpea. The advantages of the 2:4 row-to-row cereal–cowpea planting pattern include the following:

a. Increased income to farmers (poverty alleviation) through increases in the production of legumes.
b. Maximum use of selected resources (fertilizers on cereals and insecticides on cowpea).
c. Crop rotation for soil fertility improvement/maintenance.
d. Increased legume productivity with less competition from the associated cereals.
e. Improved quantity and quality of resulting crop residues.
f. Crop–livestock integration is encouraged.
g. Specialization in crop production is allowed. Crop-specific agronomic activities can be practiced on the strips.

**Important points to consider in the improved strip cropping planting pattern**

1. Specific needs of component crops must be met to guarantee high yield, e.g., cereals need adequate fertilization; cowpea needs insecticide sprays.
2. Choice of component crops (cereals: maize, sorghum, or millet; legumes: cowpea, groundnut, or soybean).
4. Choice of planting geometry/pattern (row arrangements) e.g.,
   - 1 row cereal: 1 row legume: traditional system, too harsh on legumes
   - 2 rows cereal: 2 rows legume: improved system but still harsh on legumes.
   - 1 row cereal: 4 rows legume: improved system, however, cereal production is minimal.
   - 2 rows cereal: 4 rows legume: improved system, allows for component crop agronomic activities, maximization of limited inputs, is best in enhancing the socio-economics of farmers.
   - Relay intercropping/double cropping: feasible where the rainy season is long and with extra-early maturing cowpea varieties. It can, however, fit into the 2:4 system.

**Agronomic practices of 2 rows of cereal: 4 rows of legume planting pattern**

**Land preparation:** Land preparation for both component crops is same: plowing followed by harrowing twice, manual broadcasting of fertilizer, and then ridging. The ox-drawn ridger could also be used as well as ridging manually with the hand hoe.
**Fertilizer applications:** It is necessary to satisfy the fertilizer needs of the component crops. Cowpea and other legumes generally need less N fertilizer but would benefit from an adequate amount of P. The first dose of fertilizer is applied at planting or after harrowing and should satisfy the legumes; the cereals could require one or more top dressings. A basal application of 15 kg each of N, P, and K as NPK fertilizer is therefore recommended; this is followed by the top dressing of the cereal rows by the application of approximately 70 kg N as a split or single dose. For practical purposes this is equivalent to applications of 100 kg of NPK 15 15 15/ha as basal and 50 kg of urea on the cereal rows as top dressing.

The need for the maintenance of soil fertility is one of the most important considerations in sustaining crop yields under systems with a short fallow or continuous cropping, in addition to dealing with pests, weeds, and to some extent soil erosion. Excessive use of inorganic fertilizer can lead to soil acidification, nutrient imbalance, and low yields. Soil organic matter, which is low in Nigerian soils, becomes even lower, with the continuous use of inorganic fertilizers. Manure applications promote the accumulation of organic matter and contribute to soil nutrition. For sustainability and consistent high productivity of the system, the basal annual application of 1–3 t/ha of manure is also recommended.

**Variety:** Generally improved varieties of cowpea are recommended for high grain and fodder yields. IT90K-277-2, IT93K-452-1, and IT97K-499-35 have been tested and found suitable for the system. In addition, IT93K-452-1 can be planted at any time of the year, provided there is sufficient moisture. In the Guinea savanna zone where rainfall is higher, double and triple cropping of cowpea is possible. Improved or local varieties of cereals can be used, including hybrid maize. Other legumes, including soybean and groundnut, can be used in place of cowpea.
Spacing: Row-to-row spacing of 75 cm is generally recommended. Spacing within the row, however, depends on the component crops. Cowpea should be planted at 20 cm within the row; maize and sorghum are planted at 25 cm within the row. Millet should be planted at 50 to 100 cm within the row, depending on the tillering ability of the variety. Soybean and groundnut should be planted at 10 to 20 cm within the row. Plant 3 seeds/hole of cowpea and maize and thin to 2 plants/hole at 2 weeks after sowing. Plant 5 seeds/hole of millet and sorghum and thin to 2 plants/hole at 2 weeks after sowing; soybean and groundnut should be planted at 2 to 3 seeds/hole without thinning.

Planting dates of component crops: Cereals and cowpea should be planted on the same day or as near to that as possible, if the cereals were planted first. Planting should be done only when the rains have established. This could be at the beginning of June in most parts of Kaduna State (northern Guinea savanna) and at the end of June in Kano State (Sudan savanna).

Insecticide spraying: Cowpea in the system needs to be sprayed with insecticides, 2–3 times. The first spraying should be at bud initiation, the second at full flowering and podding, and the third should be 10–14 days later. The number and type of insecticide sprays will depend on the nature of the insects, and the severity of the attack, and also the cowpea variety. Occasionally, groundnut may need protection against aphids.

Weeding: Adequate weed control is necessary for good growth and high yields. The improved system would need 2–3 manual weedings, the first at 3–4 weeks after planting and the second 3 weeks thereafter. Tractors or ox-drawn ridgers or cultivators can be used to ridge up as well.
**Harvesting**

In the improved cereal–cowpea system, cowpea usually matures earlier and needs to be harvested before the cereal. In the maize–double crop cowpea system, as practiced in the northern Guinea savannas of Kaduna and Bauchi States, the first cowpea crop is planted in May/June and harvested in August, which is the peak of the rainy season. It is recommended that harvesting should be done on a clear, sunny day. Harvesting should be done in time to avoid the mature plants falling on moist soil. It may be necessary to harvest more than once, first when about 70% of the pods are dry. During the first harvest, only the dry pods should be harvested. The second harvest should be about 7 to 10 days later. After harvesting, the pods should be spread out to dry in the sun. Threshing should be done immediately. Alternatively, the harvested pods could be spread in the shade until they are dry enough for threshing. Harvested pods should never be heaped as this will encourage mold and the subsequent rotting of the pods and grains. The second cowpea crop is planted in August and matures in October/November. This allows for the thorough drying of the mature pods on the field. Harvest when over 90% of crop is mature and dry. After harvest, the pods should be sun-dried to a safe percentage of moisture.

In the improved cereal–cowpea systems of the Sudan savanna, the improved cowpea varieties are planted in June/July and harvested in September. Harvesting and threshing follow the same procedure as for second cowpea crop in the Guinea savanna, described above. Some farmers in the Sudan savanna have tried double cropping cowpea with varying degrees of success. Here, the first cowpea crop is planted with the first rains in May or early June, harvested in August, and the second crop is planted immediately. Threshing should be done carefully so as not to damage the seeds as this will reduce germination. After threshing, cowpea grains should be sun-dried, preferably with the use of a black polythene sheet, before bagging and
storage. Most storage pests infest grains from the fields and effort should be taken to minimize this effect. Triple bagging of the dried cowpea offers a cheap, effective, and non-chemical storage method. This is discussed in paper 10.

Suggestions for further reading
Farmer-to-farmer seed diffusion: tips on how to maintain the purity of seed supply to rural farmers

Hakeem A. Ajeigbe
IITA, Kano Station

Introduction
Food production can be increased simply by ensuring the availability of good quality seeds. Seeds are the starting point of agriculture; they are the source of continuity, change, and restoration. Seeds and other required inputs can be used to rapidly rehabilitate agriculture in the wake of natural disasters, such as flood, drought, or blight from insects or plant diseases. Every serious farmer takes steps to ensure an adequate seed supply. If seeds are not saved, there can be no agriculture next season.

Collaborative research between international agricultural research centers and various national programs has led to the development and release of a range of improved varieties of the major food crops in the country. However, because of various constraints, these varieties, especially the legumes, are not being multiplied and distributed in sufficient quantities. Consequently, most farmers continue to grow traditional varieties in their own systems. For agricultural productivity in Nigeria to improve, farmers must adopt improved varieties of crops and improved production systems. This paper discusses the farmer-to-farmer diffusion of seeds and how to ensure the purity of the seeds available to our farmers.

Development and distribution of improved seeds in Nigeria
The seed industry in Nigeria can be grouped into formal and informal seed systems. The formal system consists of institutions, such as the government seed agencies and the organized private seed sector. The informal seed system
consists of the traditional, time-tested strategies used by farmers involving their personally saved seeds, and the farmer-to-farmer seed exchange.

The first formal Nigerian seed industry began in 1975 when the FAO/UNDP Assisted Seed Project was initiated and a national policy on seed multiplication was formulated. Four interrelated institutions were established at Federal and State levels and charged with the responsibilities for seed production.

1. The National Seed Committee (NSC)
2. The National Seed Service (NSS) now National Agricultural Seed Council (NASC)
3. The State Seed Multiplication Project (SMPS)
4. The National Seed Certification Unit (NSCU)

The key goals of the national seed policy were focused on the support for varietal development and release, the improvement of the quality of seeds sold to farmers, appropriate seed prices affordable by most farmers, and the encouragement of private enterprises in seed production and marketing. However, 30 years after the first formal Nigerian seed industry was initiated, there are only a few organized private seed companies in the country and they produce only limited quantities of improved seeds. Also, they concentrate mainly on the production and marketing of cross pollinated crops and hybrid seed production of crops such as maize because of the obvious economic advantages. Consequently, self-pollinating crops, such as cowpea, soybean, and groundnut, are at a disadvantage with a very limited seed supply to the farmers who grow them. The majority of the farmers, therefore, rely on the informal seed sector for their sourcing of seeds of these crops.

**Informal seed distribution**

Many examples of the informal seed sector operate in Nigeria. They consist of large numbers of farmers who produce and select their own seeds. Some of the farmers in this group also sell seeds at rural markets. This system is mostly dependent on the local cultivars and very rarely uses the improved varieties
developed by the formal research institutes. A survey of 105 farmers from 15 villages in Kano State by IITA Kano Station indicated that 58% of farmers saved cowpea seeds for the next planting; 38% purchased seeds, and 4% received seeds as a gift from others. Of the 58% of farmers who saved seeds, 36% had enough only for their own use; 22% had a small surplus for sale. The majority of those who purchase seeds, however, purchase them from other farmers and not from seed companies.

Farmer-to-farmer seed diffusion
Farmer-to-farmer seed diffusion (FTFSD) is an aspect of the Community Seed Development Program (CSDP) that was approved in 1998 by the National Council for Agriculture. It is aimed at making improved seeds available in rural areas. CSDP is necessary for the following reasons.

1. The number of seed companies in the country is grossly inadequate.
2. The outlets of these seed companies are mainly in the State capitals.
3. Improved seeds do not reach resource-poor farmers at the right time, quantity, quality, and price.
An essential component of FTFSD is the distribution of seeds of improved varieties to selected farmers for planting. The participating farmers are trained in improved agronomic practices for the production of the seed crop. The quality control service is provided by NSS. Farmers are then encouraged to sell the seeds produced to other farmers and the cycle continues. New breeder seed lots will have to be periodically infused into the system by research institutes, NSS, seed companies, or other agencies. The time of injecting new foundation seed lots into the system will depend on a number of factors which include the crop, the efficiency of quality control, and the success of farmers in adopting the seed production techniques.

**Essential elements for the success of FTFSD**

1. **Genetic superiority**
The new varieties should be noticeably superior to local types in yield and other attributes, such as insect and disease resistance, faster growth and better adaptation to special niches, and better quality. These differences should be visible, even under low input management. When a change of variety alone makes a perceptible difference to a farmer, the seeds themselves become the main driving force for diffusion.

2. **Breeding behavior**
Maintenance and diffusion of varieties are easier in self-pollinated than in cross-pollinated crops for obvious reasons. High multiplication ratios and lower seed requirements per unit area will also facilitate the rapid diffusion of new varieties among farmers.

3. **Ease of cultivation**
The new variety should not require any extra purchased inputs or major change in cultivation practices compared with the local types. However, it is recommended that new cowpea varieties be sown at higher plant densities than local varieties for higher yields and productivity.
4. **Technical backstopping and training**
Research and extension staff should monitor the diffusion of new varieties and provide guidance to farmers. Establishing demonstration plots will allow farmers to observe new varieties and acquaint themselves with specific management requirements. Farmers also need advice on how to maintain genetic purity and viability in farmer-saved seeds.

**Periodic infusion of fresh foundation seeds**
In order to ensure a reasonable level of genetic purity over time, fresh foundation seeds should be periodically provided to selected seed growers who are the key sources of seeds within a community. The foundation seeds are provided by the ADPs, research institutes, or seed companies who are networking the seed producers as contract growers.

**Awareness campaign**
Information about the benefits of growing new varieties and availability of seeds with farmers in different local government areas should be widely disseminated. This could be done through the media (radio and television) and other communication channels (market and trade associations, cultural and religious groups), etc.

**General tips on seed production**
Availability of pure healthy seeds is the first prerequisite for obtaining high yields. Cowpea is a self-pollinating crop, therefore the maintenance of genetically pure seeds is relatively easy, provided that adequate care is taken to rogue off-type plants from the field and minimize physical mixing during seed processing. The production practices are the same as for the general cowpea production, described previously. The following specific operations must be adhered to, if the crop is being produced for seed purposes.
1. **Begin with pure seeds**  
Obtain pure seeds of the variety from the research institute responsible for developing the variety or from registered growers in the area. Pure seeds could also be obtained from reputable seed companies and certified seed dealers.

2. **Contact Seed Certification Officers**  
Contact the nearest NSS office for advice and field inspection. The Seed Certification Officer will inspect your seed plot as and when during the season and at processing. If your seeds meet the minimum standard, you would be given a certificate that allows you to sell your produce as seeds. This is important for farmers who want to sell their produce as seeds to the communities or to farmers’ groups who are interested in seed production. Certification ensures that seeds can be purchased by seed companies who can market seeds in locations other than the communities where the seeds were produced. Certification costs will be paid by the seed company who contracted the seed growers. However, wherever the seed growers are in a cooperative or operate independently, they are encouraged to ask for and pay the certification cost.

3. **Maintain isolation from other fields**  
Plant in a field where other cowpea varieties were not grown in the previous year. The isolation distance differs for the different crops. An isolation distance of 5 m is generally recommended for cowpea, i.e., the field should be at least 5 m away from other cowpea fields.

4. **Follow recommended agronomic practices**  
Follow the recommended agronomic practices for the production of the crop. The application of organic and inorganic fertilizers, timely planting, weeding, and insecticide spraying, are very important in cowpea seed production. The cowpea seed plot should be sprayed with insecticides at least three times and should be kept weed free.
5. Rogue off-type plants
Remove off-type plants from the field at vegetative, flowering, and podding stages during the growing season. Off-type plants can be identified by having leaf types, flower colors, pod colors, or maturity periods that are different from the variety being multiplied. A good seed production plot should not have more than 0.5% of off-type plants after roguing has been completed, i.e., not more than 5 plants out of 1000 plants sampled. Diseased and stunted plants should also be removed.

6. Harvest and thresh carefully
Harvesting should be done in time, when about 90% of the pods have dried, to avoid field weathering. Threshing should be done carefully so as not to damage seeds as this will affect germination. Most storage pests infest grains from the fields. It is preferable to use the first harvest as seeds for the next planting; subsequent harvests can be used as grains.

7. Remove off-type seeds
The threshed seeds should be examined for any possible admixtures and these should be removed. Seed mixtures can be easily identified if they have different seed coat colors, sizes, and textures.

8. Clean and dry the seeds well
Seeds should be properly cleaned and dried. Normally, the moisture content should not be more than 10%. A well-dried seed makes a cracking sound when crushed with the teeth.

9. Store the seeds properly
Seeds should be stored in airtight containers such as double or triple polythene bags, drums, and clay pots or tins and placed on wooden racks in a seed store. Label the containers inside and outside. If the seeds are kept in airtight containers they can be treated with a fumigant, such as phostoxin at the rate of 1 tablet to 100 kg of seeds. Handle the fumigant carefully and avoid direct contact with the product.
Conclusion
Little competition or conflict is expected between the formal and informal seed sectors. FTFSD will be more effective as a strong formal seed industry develops. A combination of strong formal and informal seed sectors will result in the faster diffusion of improved varieties because every farmer who purchases seeds of new varieties becomes a potential source of seeds to many farmers.

Suggestions for further reading
Field certification for seed production

A.Y. Mohammed
NSS
Field Office, Kano

Introduction
Seeds are a crucial basic input to increase the agricultural production of developing countries. The advent of modern plant breeding and technological advances have played significant roles in quick succession which has resulted in the supply of good quality and dependable seeds to farmers for rich harvests.

High standards of varietal purity can be assured only through the controlled production of seeds at various stages of multiplication. The National Seed Service (NSS) is vested with the responsibility of carrying out that assignment in Nigeria.

The NSS is a non-profit public service organization. It was established in the early 1970s. The Federal Government of Nigeria commenced an organized seed program under the auspices of what was then a department within the Federal Department of Agriculture and funded by FAO/FGN. Since then, the seed program has become largely dominated by the public sector and this is typical of the trend in most developing seed systems throughout the world.

Seed field certification
Certification can be defined as a scientific, systematically designed process to ensure, maintain, and make available to farmers, seeds and vegetative propagating materials of superior crop varieties, grown so as to ensure genetic identity, physical purity, a high capacity of germination, and to be free from seed-borne diseases, while conforming to minimum seed certification standards.
To ensure compliance with the above objectives, well-trained and experienced personnel from the Seed Certification Agency of the Federal Department of Agriculture are all over the 36 States of the Federation, with the sole aim of carrying out seed quality control. The Seed Certification Officers are to ensure that only certified and dependable seeds are sold to the public.

### Procedure for seed certification

To ensure the supply of good and high quality seeds, the following procedures are followed by Certification Officers.

#### 1. Field inspection

Field inspection is necessary to ascertain uniformity, distinctiveness, and stability. The Field Inspector is expected to walk round the field and make estimates of off-type varieties and impurities, and diseased plants, and to observe the general crop conditions, the possibly expected yield in tonnage, and determine the hectarage. The time and number of inspections depend on the nature of the crop and its pollination behavior (Table 1).

In a nutshell, field inspection is to ascertain if the producer has adhered to established production procedures, and whether or not his field and seeds have met established minimum standards.

#### 2. Cropping history

Knowledge of the previous cropping history of a plot prevents possible genetic/mechanical contamination in a seed crop by volunteer plants. As far as possible, sources of contamination

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**Table 1. Inspection schedule of selected crops.**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Minimum no. of inspections</th>
<th>Crop stage at inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cowpea</td>
<td>2</td>
<td>One before flowering and second at flowering and podding</td>
</tr>
<tr>
<td>Hybrid maize</td>
<td>4</td>
<td>One before flowering and three during flowering</td>
</tr>
<tr>
<td>Hybrid sorghum</td>
<td>4</td>
<td>One before flowering, second and third during flowering</td>
</tr>
</tbody>
</table>

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should be destroyed by pre-irrigation, or by plowing or harrowing the land prior to sowing the seeds in the field.

3. Verification of seed source
The breeder seeds used for the production of foundation seeds should come from a recognized/approved source. The multiplication of breeder seeds should be taken up under the supervision of breeders. Breeder seeds are not expected to be inspected by the NSS. The certification authority has to certify that the foundation seed sources are from the breeder of the variety or the designated institution.

4. Field standards for cowpea

<table>
<thead>
<tr>
<th>Class of seeds</th>
<th>Purity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breeder seeds</td>
<td>100%</td>
</tr>
<tr>
<td>Foundation seeds</td>
<td>99.9%</td>
</tr>
<tr>
<td>Certified seeds</td>
<td>99.5%</td>
</tr>
</tbody>
</table>

5. Roguing
For quality seed production, roguing should be a continuous process until harvest. It implies the removal of plants that are not true to type in the field and those infected by diseases. In the case of hybrid seed production, particularly maize, the detasselling operation in seed parent rows must be completed.
before the receptive silk reaches a level of 5% emergence. In sorghum and millet, the pollen-shedding heads are removed from seed parent rows before the dehiscence of pollen grains. It is advisable to effect roguing in both the parents to ensure complete genetic purity.

6. Isolation distance
Isolation as applied to certification entails the separation of the seed crop from all possible sources of contamination during the growing period. For example, cross-pollinated varieties have long isolation distances compared with self-pollinated varieties. Cowpea varieties being multiplied should be at least 5 m away from other cultivated cowpea crops.

7. Postharvest handling
Supervised harvesting and care in the postharvest handling of the seed crop are integral parts of certification schemes. The time, energy, and money spent in growing genetically pure and disease-free seeds in the field may be wasted if adequate care is not exercised during the threshing and processing periods.

Thorough threshing, cleaning, drying, and seed treatment, bagging, labeling, sealing, and finally storage are of paramount importance for maintaining good quality seeds.

8. Grant of certificate
The certificate is granted to farmers, subject to compliance with the established field and minimum seed standards prescribed by the NSS. The certificate serves as an authorization to sell seeds to the public.

Conclusion
Due to the level of the Nigerian seed industry, which is still largely underdeveloped, the informal seed system still provide the largest volume of seeds used today by many farmers in the rural areas. The Federal Government should properly fund the seed industry, create awareness among rural farmers, and stimulate their desire to use improved and certified seeds for bumper harvests.
Safe use of agrochemicals and criteria for selection of environmentally friendly crop protection products

Ibrahim Suleiman
Northern Nigerian Business Promotion Office Manager
USAID–MARKETS Project, Kano

Introduction
Crop protection products (CPPs) are pesticides; they are substances in formulations that kill pests. Pests are organisms of economic importance in the wrong place and at the wrong time that can cause damage to crops and reduce crop yield and quality. Example of pests can be flora—weeds—and/or fauna—insects.

Integrated pest management
Integrated pest management (IPM) is an effective and environmentally sensitive approach to pest management that relies on a combination of commonsense practices. IPM programs use current, comprehensive information on the life cycles of pests and their interaction with the environment. This information, in combination with available pest control methods, is used to manage pest damage by the most economical means, and with the least possible hazard to people, property, and the environment. This is an ecologically based control of plant pests, (where pests include, pathogens, arthropods, and weeds) that uses a combination of techniques to reduce pest populations to levels below those that cause economic damage to the crop.

*IPM is not a single pest control method but, rather, a series of pest management evaluations, decisions, and controls. In practicing IPM, growers who are aware of the potential for pest infestation follow a four-tiered approach. The four steps are (1) Set action thresholds; (2) Monitor and identify pests;(3) Prevention, and (4) Control.*
IPM relies mostly on the use of cultural practices, biological control agents, and host plant resistance, and uses chemical control only when it is absolutely necessary, i.e., on a need basis. IPM began in the 1960s because of a heavy dependence on chemical control and this has several disadvantages. These include risk to human and livestock health, environment pollution, pest resistance to the chemical and therefore the need for a heavier dosage to obtain good control. IPM is mainly a management of biological control resources, with agronomic measures and, to some extent, plant resistance contributing to the efficiency of natural enemies and to their conservation.

**Why use pesticides?**
In the IPM strategy described above, pesticides are used only when the pest population has passed the economic threshold level. Pesticides are used to reduce losses associated with pests, both on the field and in the store. In practice, pesticides are not used to increase the yield of crops but to enable the farmers to realize optimum yields.

**Weeds as a pest**
Yield losses due to weeds on the farmlands can be as high as 25–88%. The emergence of weeds on the farms during the first 3–4 weeks after planting suppresses crop development at this period of critical growth. Weed infestation during the initiation or ripening stage will lead to loss of nutrients and attack by rodents, increase harvesting costs, and reduce the quality of produce in addition to the following:

- Compete for moisture, nutrients, air, and light
- Can produce toxins which inhibit crop growth
- Act as hosts for pests and diseases
- Can be a barrier to irrigation schemes and water management channels
- Can introduce impurities into seeds and grains
- Demand an average of 32–95 man-days/ha for hand weeding
Insect pests
Yield losses from insect pests’ attack in Africa are estimated to be up to 30% in the uplands and as high as 100% in the lowlands. Insect pest attack has become more serious since the release of improved varieties of crops and an increase in the intensity of cultivation, e.g., short duration, high yielding, allow for two or more cropping periods within one season, ensuring an abundant supply of host plants during the season.

Types of pesticides
Pesticides are grouped and classified based on their functions and targeted organisms. Examples are herbicides (control weed pests); insecticides (control insect pests); fungicides (control fungi), and avicides (control bird pests).

Herbicides are further classified as post-weeds, (post-emergence and pre-crops), pre-weeds/pre-crops (pre-emergence), post-weeds/post-crop (post-emergence).

Pesticides are further classified based on their mode of action, contact or systemic.

Approach to the safe use of pesticides
The approaches to the proper use of PPS are divided into two. These approaches minimize the risk factor inherent during the use of pesticides. The approach methods are handling and effective safe use.

Handling: This process is fundamental to the overall operation and safe use. It is the first step of ensuring that CPP are handled with the utmost safety. In product handling, consideration should place emphasis on this. Always read the label before purchase, recommendation, or use. Product and control details should be strictly followed. The details for products include the following: Registration: international and national; Manufacturer: registered/authorized; Importer: registered/authorized; Formulation: (suitability, pre/post-emergence, selective) and
packaging (durability/size). For control, the following should be considered: preventive or curative, pre-/post- emergence, persistent or non-persistent, and total or selective.

**Effective safe use:** A lot of consideration during safe use is placed on the following: pack, spraying, spillage, disposal, and first aid.

**Pack:** Don’t use if there is no original label, no user information, the chemical has been decanted from another container, if the batch no. (registration no.) is tampered with, if the product is past its recommended shelf life, and if no visible contact address is sighted.

**Spraying:** During the spraying operation always ensure the following precautions are taken.

- Long sleeved shirt, trousers, covered shoes, and eye protections are to be worn.
- The correct nozzle is used for the right operation.

Choosing the right nozzle is essential to getting the best performance from the chemical that you are applying. In selecting the nozzle, consider the nature of the target and the mode of action of the chemical. Once you have decided on the
nozzle type that you need, select the correct flow rate from the tables provided for each nozzle. There are three types of nozzles which can be distinguished by their color.

**Flood type**—(color generally green or purple) coarse spray
A non-blocking nozzle is needed that delivers a coarse spray suitable for soil acting or systemic herbicides where there is plenty of weed growth. It should have options for a variable swath width.

**Even spray**—(color generally pink or pinkish red) medium spray
A medium spray is suitable for a wide variety of spraying jobs.

**Hollow cone**—(red or yellow) fine spray
A fine spray gives good coverage. It is suitable where good spray coverage is needed, including with contact acting herbicides, insecticides, and fungicides.

Knapsack nozzles are particularly at risk from damage. Always carry spare nozzles and ensure that your nozzles are in good condition before spraying. Do not poke anything into a nozzle orifice to clean it.

**Never**
- spray against the wind or stand down-wind
- spray when it is too windy or there is no wind
- walk directly into the field where the crop has just been sprayed
- leave CPP in an open container
- raise the trigger completely above knee level
- smoke, eat, or drink anything during spraying

**Spillages:** Accidents can occur during spraying and product handling. If any unexpected incidents occur, please comply with the following, as instructed below.
- Keep people and animals away.
- Wear relevant protective clothing.
- Do not smoke or drink.
• Spread sand or soil over the spillage (dispose properly).
• Sweep up contaminated sand/soil in a marked container and bury or dispose of it properly.
• Ventilate the store properly.
• Wash the body and protective clothing.

**Disposal:** This is critical during pesticide applications. Usually, stock unused exists in different quantities and it involves different approach/methods for disposal.

**Old stock** < 5 L – bury
> 5 L – high temperature incineration. This should be done by the appropriate authority, mostly the waste disposal units.

**Unused solution:** Dilute 10-fold and spray on fallow lands away from the public, and water sources, Try to indicate some kind of a WARNING.

**Unused CPP containers:** rinse containers three times and drain the spray solution and spray tank for disposal on fallow land.

**Bury pit construction:** Select a site where seepage does not occur or with no risk of flooding. Always avoid having a pit site on sandy soil. Dig below 2 m deep and 2 m wide and add only crushed and punctured containers. Cover with soil, leaving at least 0.5 m between the top of the buried containers and the surface of the soil. When filling the pit, always cover with limestone before using earth.

**First aid**
Accidents do occur at every stage of pesticide application. So users should as much as possible observe safety procedures. However, in case of an accident, the following should serve as a guide to manage the event.

• Keep calm.
• Move the patient away to a recovery position at a distance from the contamination.
• Read the product label for first aid.
• If the patient has poor breathing, use artificial respiration.
• Make water available for washing the eyes and skin.
• Remove contaminated clothing and items.
• Do not induce vomiting unless the label recommends this.
• Seek medical attention immediately.

Source of product information
To build our capacity in terms of product knowledge, any person engaged in the use of CPP should always seek information on the product. The acquisition of product knowledge should be a continuing process. This has become necessary because companies are always updating products. The following are reliable sources for product information: product label, product literature/fact sheet, advisors (research institutes), and distributors.

Criteria for the selection of environmentally friendly CPP

Reading the pesticide label
Always read the label before use. The product label contains instructions on how to handle and use the pesticide effectively and safely. There are a number of important sections on each pesticide label. Usually the label is made up of three panels. The center panel usually contains the product name, formulation, composition and active ingredient(s), danger warning triangle, volume or mass of the contents, registration number, usage declaration, and manufacturer’s logo. The two side panels usually contain directions for use, warnings and precautions, symptoms of poisoning and first aid instructions, notes for physicians, compatibility, batch number and date of manufacture, date of expiry, storage instructions, warranty, distributor’s details, and other notes.

1. Product or trade name: This is the name given to the product by the manufacturer, which distinguishes it from those of other manufacturers. Note that several products contain
the same active ingredient(s). A trade name is owned by a company and cannot be used by any other for a particular pesticide. This is enforced by international legislation. For example: Gramoxone, Bravo.

2. **Formulation**: For the pesticide to function properly or to be applied, it has to be suitably formulated. There are many possible formulations, the most common being liquids, such as emulsifiable concentrates, powders, such as wettable powders, and granules.

3. **Active ingredient (a.i.) and composition**: The active ingredient is the chemical name given to that part of the pesticide formulation which controls or kills the target pest(s), and it is recognized internationally. The composition indicates how concentrated the product is. For example: 150 g/L. Check that this remains the same when you change manufacturers or batches.

4. **Toxicity of the pesticide (danger warning triangle)**: This is indicated by a colored triangle: green = harmful if swallowed; orange = poison; red = dangerous poison; purple = very dangerous poison.

5. **Net volume or mass**: This indicates how much of the pesticide is in the container.

6. **Product registration number**: This is the official registration number of the pesticide, according to regulations.

7. **Usage declaration**: This states what the product will control or what it may be used for, the target crops and pests.

8. **Manufacturer’s logo**: Sometimes the manufacturer’s emblem or logo appears on the front or on the side panel of the label.

9. **Directions for use**: These are the recommendations, including the crops and application or dilution rates, such as g/L and L/ha as well as the methods of application, and harvest intervals.
10. **Warnings, precautions, or safety instructions:** This indicates to the user what precautions to take when using the pesticide.

11. **Symptoms of poisoning:** These highlight to the user what symptoms will be if poisoning has occurred and what first aid measures to carry out.

12. **First aid instructions:** This lists the immediate actions to be taken when a suspected case of poisoning occurs.

13. **Notes to physicians:** These instructions for the doctor advise him on what to administer in the case of a poisoning.

14. **Container storage:** This explains how to store containers.

15. **Compatibility:** This lists what the pesticide can and cannot be mixed with.

16. **Date of expiry/manufacture, batch number:** This is important information, as expired pesticides must not be used.

17. **Warranty:** These are declarations from the manufacturer or distributor on the contents or activity of the pesticide.

18. **Other notes:** There may still be other notes from the manufacturer, so always read them.

**Substitutions**

Suppliers may replace one product with another where the active ingredient is the same. Do not accept substitutions until you have checked that the substitute product may be used on the crops that you wish to treat. If you are not sure, check with the owner or manager.

**NB. Always act safely all the time when handling crop protection products.**
Major field insect pests of cowpea and maize and their control

Rabiu S. Adamu¹ and Samuel O. Okunade²
¹Department of Crop Protection IAR, ABU, Zaria
²Nigeria Stored Product Research Institute (NSPRI) Kano Station, Kano

Introduction
Cowpea (Vigna unguiculata) is grown for the leaves, pods, seeds, and nutritious fodder. The dried seeds can be cooked into soups or stews or boiled. Maize (Zea mays) is a staple food in Nigeria. It is also an important food for livestock, especially the poultry industry. The grain is used industrially for starch and oil production, among other uses. The following are some of the major pests of economic importance and their control strategy.

Aphid – Aphis craccivora
• Aphid is an important pest of cowpea; damage may be seriously sporadic, especially during dry spells when its population increases rapidly.
• Aphid is a vector of several viruses.
• Aphid primarily attacks seedlings and can be seen feeding in large colonies on the under-surface of the leaves.
• In older plants, green pods can be attacked.
• Sap sucking by large number of aphids can cause plants to wilt in hot weather, leading to loss of vigor and reduced yield.
• Leaves and shoots become distorted, buds may be shed prematurely, and flowers and green pod shrivel, producing few usable grains.
• Severe infestations can cause the death of the plant.
• Sticky honeydew is produced by aphids, encouraging the growth of molds.
Control: Resistant varieties are the cheapest form of control of aphids. Drought conditions exacerbate infestation. Insecticide spraying is a common control measure using chemicals such as Imidacloprid, Pirimcarb, Dimethoate, Lambda, Cyhalothrin, and Thiometon.

Thrips – *Megalurothrips sjostedti*
- Damage is caused by both adult thrips and nymphs which feed on the shoots and flower buds.
- They cause distortion and the drying up of flowers and flower shedding.
- Thrips populations are generally low during heavy rains, but increase under the dry conditions associated with the later stages of crop growth.
- Damage done before 42 days after planting does not normally lead to yield loss.
- Thrips are vectors of *Cowpea yellow mosaic virus*.

Control
- Intercrop cowpea with sorghum, millet, or cassava to reduce thrips populations.
- Plant resistant varieties (several of the improved varieties have good levels of resistance to thrips).
- Plant early maturing varieties that may escape the period of high infestation by thrips.
- Use insecticidal control with Cypermetrin, Deltamethrin, Melathion, and Monocrotophos, etc.

Legume pod borer – *Maruca vitrata*
- It is a regular pest of cowpea. The larvae damage both flowers and pods.
- Uncontrolled infestations can lead to as much as 70% yield loss.
- Young larvae bore into the flowers, feeding inside and causing flower drop. Young stems, terminal shoots, and peduncles are also damaged.
- Signs of larval feeding include the webbing of flowers, leaves, and pods.
Later larval stages are highly mobile and cause damage by feeding on flowers and boring into green pods to feed on the developing grains.

- Larvae are mostly active by night; during the day they shelter in flowers, pods, stems, and leaf debris beneath the plants.

Control
- Plant early and extra-early varieties which may escape high infestation by *Maruca*.
- Use insecticidal control as this is the most effective measure against *Maruca* infestation with chemicals such as Cypermetrin, Lambda, Dimethoate, etc.

Pod sucking bug (PSB) complex – *Clavigralla tomentosicollis, Riptortus dentipes, Mirperus sp., Anoplocnemis curvipes*
- These are serious pests of cowpea; large populations cause severe yield loss.
- Both nymphs and adults suck sap from green pods causing dimpling of the seed coat, pod abscission, abortion, deformation through premature drying or shriveling, incomplete pod fill, and deformation of seeds.
- The nature of damage caused by other pod sucking bugs of cowpea is similar to that of *Clavigralla*. 
Control
- Plant early and extra-early varieties which may escape high infestation by PSB.
- Use insecticidal control, such as a mixture of dimethoate + cypermetrin, as this is the most effective measure against PSB infestation.

General recommendation for the control of cowpea insect pests
1. Intercropping cowpea and cereals reduces *Maruca* infestation.
2. Plant early maturing varieties.
3. Plant resistant varieties.
4. Use insecticidal control. The number of sprays and types of insecticides to use should be modified according to the nature and severity of the pest attack.
   - About 2–3 sprays may be required for improved varieties
   - Up to 4 sprays for local varieties.

Targeted sprays
No. 1. Apply 30–35 days after planting when bud initiation has started, for the control of thrips, aphids, and early *Maruca* attack.
No. 2. Apply 40–45 days after planting when the crop is in full bloom and beginning to pod, for the control of thrips and *Maruca*.
No. 3. Apply 50–60 days after planting when the crop is in the rapid pod filling stage. This will control *Maruca* and PSB.
No. 4. (as needed) Usually applied 65–75 days after planting, especially for medium maturing varieties and where there is heavy PSB infestation.

Note:
- If one spray is to be used on the crop, it would be most effective if applied at either budding or flowering.
- If two sprays are to be given, they would be most beneficial if applied at early flowering/podding and late podding.

Storage pests (weevils) – *Callosobruchus maculatus*
- *Callosobruchus maculatus* is the most important storage pest of cowpea.
- Infestation in the store usually originates from the farm.
Larvae bore into the beans. Infested pods are harvested and taken into the farm stores where further development takes place.

Eggs are laid in the pods by the female on the seed surface. Each female lays up to 90 eggs. Hatching takes about 6 days.

Larvae spend their entire life cycle within the beans. Larval period is about 4–5 weeks.

**Control**

- Avoid growing cowpea very close to the farm stores.
- Harvest promptly in areas at risk to reduce attack levels.
- Dry the harvested pods well.
- Use triple bagging of cowpea for hermetic storage (non-chemical method)
- Use insecticidal protection.
- Use fumigants – such as phostoxin tablets in airtight sacks/containers. Use one tablet/bag.
- Use neem oil at 2–3 mL/kg of cowpea seeds.
- Protect against weevils for up to 6 months with groundnut oil at 5 mL/kg of cowpea seeds.

**Warning**

You should not use more than the recommended dose of pesticide. Buy the pesticide from a reputable company, dealer, or retailer. Read the label and follow the instructions strictly.

**Maize stem borer – Busseola fusca**

- This is the most important pest of maize in Nigeria, particularly in the dry savanna.
- Damage is through larvae feeding on leaves or tunneling into young plants.
- Larvae scoop the inner layers of tissue away from the leaf, leaving holes or “windows”.
- In severe attacks, the central leaves may die, giving the “dead heart” effect.
- Larvae bore into the main stems of mature plants and later generations bore into tassels and cobs.
- One to two larvae/maize plant can reduce yield by as much as 25%.
Pink stalk borer: *Sesamia calamistis*
- It is a sporadic pest of maize.
- It usually attacks late maize crops.
- Larvae do not wander over the plant and feeding may result in “dead heart”.
- Tunneling and girdling activities of the larvae may cause stem breakage.

**Control**
- Remove damaged stems and cobs from the field to reduce the number of larvae pupating or entering diapause.
- Partial burning of maize stalk kills larvae inside the stalk; plow or dig in crop residues.
- Insecticide control is costly.
- Non-systemic insecticides can be sprayed before larvae begin boring into the stem.

Maize earworm – *Helicoverpa armigera*
- This is common in wetter areas.
- Larvae attack cobs, feeding on grains usually at the tip and around the silk channels.
- Feeding damage reduces the marketability of cobs.

**Control**
- Apply contact insecticides.

Leaf hopper – *Cicadulina mbila*
- This is a vector of *Maize streak virus*.
- Adults and nymphs pierce plant tissues and feed on sap.
- High numbers of feeding adults may cause withering of the plant.
- High populations are common at the end of the growing season. Late sown maize is highly vulnerable.

**Control**
- Plant early.
- Burn all infected plants as soon as possible.
- Spray with carbaryl to control the hoppers.
Termites
- Although damage to maize is incidental, they can cause the death of plants.
- They attack plants of any age, but usually established plants.
- Attacks are more common where the plants are under heavy water stress.
- Older plants suffer attack to their roots and lower stems, as termites build nests around the plant base where they feed.
- Feeding causes weakening of the plant, leading to lodging
- Damage to vascular tissues causes wilting, especially under water stress.

Control
- Avoid continuous cultivation on the same area of land to prevent termite population buildup.
- Practice crop rotation.
- Avoid heaping crop residues and manure.
- Dress seeds with insecticides.
- Chemical control is difficult and should be the last option.

Maize weevil – *Sitophilus zeamais*
- The buildup of the weevil begins with warm, wet weather at the beginning of the rains.
- Grains may be attacked in the field or in the store.
- Grains are damaged by larval feeding within the grains, making tunnels or circular holes in the surface.
- Adults emerge through circular holes on the surface.

Control
- Dry the maize cobs/grains thoroughly.
- Use a fumigant – Phostoxin, 1–2 tablets/bag in airtight sacks/containers.
- Use insecticide.
  - Actellic dust 200–500 g/t of maize grain
  - Simuthion dust 4–5 g/t of maize grain
Crop residue management, livestock feeding strategies during the dry season and benefits from crop–livestock integration

Abubakar Musa¹ and Roger J. Tanko²
¹ILRI, Kano
²NAPRI Shika, ABU, Zaria

Introduction

Inadequate feed particularly during the dry season is a major constraint to ruminant animal productivity especially in the dry savannas of Nigeria. Human population is on the increase and therefore the demand for food and arable land for its production is also increasing. Also a lot of grazing, fallow, and arable farmlands have been annexed for use as residential, recreational, and industrial uses. This has led or pressured farmers to integrate livestock into their cropping systems in order to meet the demands of the increasing population in terms of animal protein and energy as well as maintaining/sustaining the productivity of the diminishing farmlands. Throughout the developing world there is an increasing emphasis on integrating crop and livestock production to promote more sustainable agricultural systems. Crop–livestock integration to improve natural resource management for increased productivity is also evolving in Nigeria. Cowpea, groundnut, and other leguminous herbaceous crops can make a valuable contribution to livestock feed and supply nitrogen to the soil. The use of these legumes provides grains for human consumption and fodder for livestock. They are becoming attractive, especially where land is becoming increasingly scarce and sustainability is threatened. Crop residues, however, have to be managed properly to provide their full benefit and improve livestock and crop productivities.
Management of crop residues

The major crop residues in use in the dry savannas for feeding ruminants are mainly the stalks of cereals (maize, millet, and sorghum) and haulms of legumes (cowpea and groundnut). In order that good use may be made of crop residues, efficiently and judiciously, by ruminant animals, farmers should take note of the following.

Leguminous residues

- For good cowpea fodder, cut after the second picking of pods (groundnut is normally uprooted and pods are separated) at the end of the rains. (This ensures the retention of leaves and fairly soft stems for optimal animal intake.)
- Use dual-purpose varieties of cowpea and other legumes.
- Practice relay cropping of cowpea with cereals to ensure that cowpea matures after the rains to ensure good quality fodder.
- Bundle into smaller heaps immediately and allow sun-drying on the field for about 5–6 days. Turn the heaps after 3 days to ensure uniform drying.
- Pack immediately after drying. (Good fodder is characterized by the greenness of both stems and leaves in the dry state.)
- Store on roof tops/tree forks or break up the fodder and put it in sacks and store in a well-ventilated room/local silo. (If it is stored on roof tops or in tree forks, cover the top with a mulch to prevent leaching or loss of nutrients from heat/sunlight.)

Cereal residues

After heads/cobs are harvested:

- Allow the cereal stover to sun-dry after being cut on the field.
- Do not allow termite attacks on the field while sun-drying the stover.
- Bundle and stack the stover in a standing position.
- Store your stover near home/on the farms closer to home.
- Cover with mulch to prevent leaching.
Livestock feeding
Traditionally, farmers allow their livestock to go for free grazing of crop residues at the end of harvest. At the onset of the dry season farmers should confine their animals and start feeding the stored residues.

Sheep/goats
Offer 1 kg /animal/day of cereal stover (preferably chopped into pieces 5–10 cm in length).
Offer 200–300 g of leguminous fodder/animal/day.
Supplement with grain byproducts when available and affordable (bran of wheat/maize/millet/sorghum/soybean).

Cattle
Feed about 2–3% of the animal’s body weight/day.
Offer cereal–legume mixtures in the ratio of 2:1 on a daily basis.
Supplement with grain byproducts when available and affordable (bran of cereals and legumes).

Benefits of feeding
• The live weight of livestock is maintained during the dry season feed shortage.
• Confined animals allow farmers to effectively monitor their health status.
• Better fed animals increase their fertility by inducing multiple ovulations.
• Better quality and higher quantity manure is produced which is returned to the farmland for increased productivity.
• Animals are secure (under close watch at home and hence wandering, leading to loss or theft, is avoided).
• Daily feeding can be stretched well into the rainy season because improved legume and cereal varieties produce more fodder.
• More animals could be purchased or excess fodder sold to provide income.
Benefits of crop–livestock integration

Agronomic benefits
In the dry savanna agro-ecological zone of Nigeria, cowpea and groundnut fodder are vital resources for livestock feed. Farmers plant cowpea and groundnut, usually in intercropping arrangements with cereals that favor the production of good quality residues for livestock feed. The legumes are included to improve the quality of the resulting crop residues. The advantages of legumes in the cropping systems are mainly derived from their symbiotic N-fixing capability. Other benefits of integration include the recuperation and maintenance of the soil’s productive capacity through the application of animal manure generated from the judicious use of crop residues from the farm plots and fed to ruminant animals kept in confinement. This in turn ensures the achievement of good crop harvests in terms of both grain and fodder. Cowpea and groundnut haulms compare very well with other forage legumes in higher crude protein, digestibility, and
mineral contents, and lower fiber. In the dry season, these legume fodders contain sufficient protein and minerals to meet the needs of ruminant animals for relatively high levels of production.

**Economic benefits**

Crop–livestock integration allows a more uniform distribution of income through product diversification (grains, seed, fodder, meat, and milk). The integration of livestock into crop production systems offers immense opportunities for more profitable farm enterprises in Nigeria and West Africa in general. Another economic benefit that is relevant at the moment is that it helps in reducing rural–urban migration, thereby creating more rural employment opportunities, such as markets, small-scale industries, and labor utilization. Livestock also serve as a physical asset and a form of savings for small-scale farmers in the rural areas and allow them to sell their crop produce at a higher rate of return. Higher yields and better quality crop and livestock produce are generated at a lower cost because of the higher positive correlation that has long been established between crop and livestock farming.

Gainful employment is made available, especially in the rural sector, which drastically cuts the rural–urban drift specifically of the youth who are considered the most productive age group in agricultural systems in sub-Saharan Africa.

There is also the provision of more flexible utilization of crops and livestock and their products or byproducts. Farmers are also able to get a higher income through the sales of crop residues as livestock feed. It gives more room or opportunity for farmers to acquire cash reserves as opposed to monocropping or livestock rearing alone. Livestock also serve as live banks to the resource-poor farmers. This resource also appreciates with time, irrespective of inflation or otherwise. Animal traction provides additional income to farmers. Integration generally leads to reduced poverty, especially for the resource-poor farmers of the developing and the less developed world.
Ecological and environmental benefits
Crop–livestock integration helps in the reduction of crop pests because of diversification and hence a lower use of pesticides. With the increase in livestock manure generated through the keeping of livestock, the farmers are able to reduce the use of inorganic fertilizer and increase the use of organic fertilizer which is ecologically sustainable. With a well-maintained and fertile farm, the menace of erosion is controlled or held at a manageable level. The use of crop residues as feed instead of being burned is another important ecological consideration as well as the use of household/community waste for livestock feed.

Nutritional benefits
The rearing of livestock and cropping of land by farmers ensure that both food crops and livestock are available at the household level for consumption. This implies improved household nutrition which ensures the food security of the family through the use of a variety of foods, the provision of nourishment, and better living conditions. With the intake or provision of a variety of foods of both plant and animal origin, the health of households and communities is ensured.

The advantages of crop–livestock integration could be summarized as follows:

- It increases grain and animal production.
- It reduces production costs.
- Farmers acquire more capital.
- The soil’s productive capacities are conserved and improved.
- The rural sector is developed.
- There is greater economic stability.
- Direct and indirect employment is created.
- Crop–livestock production is sustainable.

Conclusions
The integration of the crop and livestock production systems constitutes a new paradigm for agriculture and animal husbandry in the savanna region of Nigeria in particular, and
the West African savannas in general. The achievements from crop–livestock integration in these ecological areas show the benefits of this system in agriculture and livestock production and in the improvement of the physical, chemical, and biological properties of the soils. It is therefore necessary to encourage the adoption of systems that encourage the integration of the crop and livestock enterprises.
9
Cowpea on-farm processing techniques

James O. Adeosun
NAERLS
ABU, Zaria

Introduction
Cowpea is one of the most ancient crops known to man. Its origin and subsequent domestication are associated with pearl millet and sorghum in Africa. It is now a broadly adapted and highly variable crop, cultivated around the world primarily for grain, but also as a vegetable (for leafy greens, green pods, fresh shelled green peas, and shelled dried peas); it is a cover crop and also grown for fodder. On-farm processing techniques involve all the operations carried out when the cowpea crop is fully mature. Cowpea is a high-value crop compared with cereals, such as maize. Therefore, adequate attention must be paid to the on-farm processing of cowpea. The quality of processing carried out at harvest largely determines the quality of the grains or seeds in storage.

Harvesting
Harvesting of dried cowpea commences as soon as the pods are dry enough. Depending on the variety grown, 2 to 3 harvests may be carried out. It is essential that only the mature, dried pods are picked. Immature pods, apart from reducing the quality of the grains, are not easily threshed. It is essential that the harvested pods are spread out and not piled up. Wet pods could lead to mold damage.

Threshing
The cowpea pods must be well dried on the field before harvesting. In most cases, there may still be some pods that have not dried enough, hence the need for additional sun-drying for 2–3 days before threshing. Threshing can be done either manually or mechanically. Whichever threshing method is employed, the essential thing is that care must be taken to avoid damaging the grains. Broken grains reduce the quantity and market value of
cowpea. Machines are available in various sizes and shapes run by petrol, diesel, or electricity, for the small, medium and large-scale threshing of cowpeas. Also different types of multipurpose thresher are now available in Nigeria that can thresh several of the grain legumes by a change in the sieve and speed of the motor.

**Threshing for seeds**

It is expected that all the field rules for seed production were followed on the cowpea farm prior to harvest. The quality of seeds is critical in seed production. Therefore, the emphasis should be on how to maintain pure and viable seeds because of the high premium placed on seeds. It is assumed that prior to harvesting, all off-types have been rogued, harvesting was done at the optimal time, and harvested pods were kept in well-ventilated places to prevent molds. Care should be taken to avoid mixing seeds of different varieties while drying them and on the threshing floor.

**Care for seeds**

- Sun-dry the pods for 2 to 3 days or spread them in a ventilated room with free air circulation to ensure rapid drying and prevent molds.
- Inspect the pods for any off-type pods or other debris, such as the seeds of weeds or other plants. Any of this
debris should be removed and should not be allowed to contaminate the cowpea seeds.
• This inspection will ensure the good quality of the seeds.

Care for cowpea grains
• It is essential that quality grain production is guaranteed.
• Avoid mottling grains, due either to improper drying or the effect of rain from a delay in harvesting.
• Poor quality grains reduce the market value of cowpea.

Threshing operations
• Threshing commences as soon as the pods are well dried.
• The level of dryness can be tested by rubbing a few pods between the palms.
• If the pods are well dried, some of the grains will be released.

Method
• Threshing can be done manually or mechanically.
• Manual threshing is the common practice for smallholders.
• Common methods include heaping the pods and beating them gently with sticks to avoid damaging the grains.
• Some use a pestle to beat the pods gently in a mortar, especially when the quantities are small.

Winnowing
• Winnowing is the separation of the grains from the chaff.
• Immature grains and other debris are removed during winnowing operations.
• Winnowing is done against the air drift so that the inert materials, such as chaff and broken seeds, are blown away by the wind and the grains are collected in a clean container.

Advantages of proper drying before threshing
• It reduces the labor requirement.
• It reduces the risk of grain damage.
• It reduces the risk of mold.
• It enhances the quality of grains/seeds.

**Post-threshing management**
• Moisture content of the grains must be lower than 11%.
• For seed production, sorting has to be done to remove broken seeds or other debris.
• Dry the cowpea on a clean slab or on protective material, spread on clean floors, to avoid the introduction of stones and other materials.

**Bagging operation for grains**
• Bagging commences as soon as the grains/seeds are certified dry enough and at the right moisture content for storage.
• New bags should be used and these must not be wet to avoid mold.
• The bags must be sealed to prevent the encroachment of rodents and insects.
• Store in a dry, clean rodent-proof place.

**Packaging for seeds**
• Cowpea grown mainly for seeds is further sorted and cleaned before packaging.
• In a well-organized seed production system, the seeds are dressed with seed dressing chemicals prior to packaging.
• Packaging is done based on specified weights, i.e., 3, 5, 10 kg, and properly labeled and sealed.

**Suggestions for further reading**
Postharvest pest management of grains

Rabiu S. Adamu and Hakeem A. Ajeigbe

Department of Crop Protection, IAR. ABU, Zaria, Nigeria

IITA, Kano Station

Introduction

Stored products are attacked by a number of storage pests. The three major ones are insects, molds, (fungi), and rodents (rats and mice).

The major insect pests in stored cereals and pulses are beetles and moths. Damage is done by the larvae which feed and develop inside the grain kernels.

- **Cowpea beetle** *Callosobruchus maculatus* is the most important storage pest of cowpea. Maize weevil *Sitophilus zeamais* is the most important storage pest of maize.
- Damage is caused by the larvae, which bore a thin tunnel on the surface of grain.
- Circular exit holes on the surface of the grain kernel are a typical sign of infestation.
- Infestations usually originate in the field and carried to farm stores. So field crops within about one km downwind of the farm stores are likely to be infested by the adults.
- Cowpea larvae bore into the beans and infested pods are harvested and taken into the farm stores where further development takes place. The female lays eggs on the pods. Each female lays up to 90 eggs. In the stores, the eggs are laid directly on the seeds and hatching takes place in about 6 days.
  - The larvae spend their entire life cycle within the bean.
  - Larval periods are about 14 days.
- The female maize weevil lays white eggs inside the grain by chewing a hole on the surface. Eggs hatch into tiny, soft, white, legless grubs which feed inside the grain.
Each female is capable of laying 300–400 eggs. The adults live up to 7 days and are strong fliers. The whole life cycle takes about 4–5 weeks.

Food prepared from damaged grains has unpleasant flavor and the grains command low prices.

Management methods
1. Harvest the crop as soon as it is mature to avoid field infestation. The earlier the harvest, the less the chance of infestation.
2. Dry grains properly, making maximum use of sun and wind. Low moisture content is crucial for the extended storage life of grains.
3. Choose varieties with a hard seed coat, which acts as a barrier to the larvae. Where available, use bruchid resistant varieties.
4. Select clean and healthy grains to be retained for long-term storage. Broken grains, pieces of straw, and dirt increase the chances of storage problems caused by insects and molds.
5. Clean granaries thoroughly before filling them with new grains.
6. Repair all cracks in the floor and roofs to deny a place to insects and rodents.
7. Inspect grains frequently to detect any infestation early, through sampling and sieving the contents and shaking of the bags.

8. Airtight storage/insect-proof containers, such as oil drums with perfectly fitting lids, can be used. Also, plastic bags or sacks with no holes and dry pumpkin gourds can as well be utilized to store seeds.

9. Triple bagging, using polyethylene bags, has been found to deter bruchid infestation for up to 6 months or more. A simple non-chemical storage method using special polyethylene bags is being popularized in several countries in Africa through the Purdue Improved Cowpea Storage (PICS) project. The project uses polyethylene bags which are 80 microns thick to ensure they are impermeable. The following procedure is used in the packaging:

- Thoroughly dry in sunshine the cowpea to be stored, and then take them to the shade to cool.
- Carefully inspect the plastic bags for any hole, by blowing into each. Hold the mouth tight and press to see if there is any leakage (Do not use bags with holes.) Even extremely small holes will reduce the effectiveness of the storage.
- Fold back the top of the first bag.
- Place the second bag in the first bag, then fold the top of the second bag over the first.
- Place the third bag inside the second bag and fold the top down over the first two bags so that cowpea can be easily poured into the third, innermost bag.
- Slowly fill the innermost bag with cowpea, being careful to shift or rock the bags frequently to eliminate air spaces. Fill the innermost bag nearly to capacity, leaving only enough room for the plastic bags to be tightly drawn together, folded back on themselves, and tied.
- Firmly draw together the top of the innermost bag, squeezing it tightly to press air out.
• Gently rock the bag of cowpea back and forth to help eliminate any air spaces.
• After the cowpea is well settled in place, squeeze the top of the innermost bag again to force out any air and tie the bag closed with string or cord.
• Twist up the remaining plastic above the tie and fold this back on itself.
• Firmly tie the double-folded plastic together.
• Repeat this tying procedure individually for each of the three plastic bags.
• Store the triple bags in an area that is safe from rodents.

Airtight storage in triple plastic bags is easy to use, effective, and safe. It is recommended that the triple bags remain sealed for minimum of 2 months. When the bags have been opened, it is critical to prevent re-infestation by quickly removing the required quantity of cowpea and re-sealing the bags to prevent entry by bruchids.

10. Cowpea grains can be protected from bruchids by the use of minerals, such as fine sand, ash, limestone, etc.
   • 1 kg of fine sand mixed with 10 kg of cowpea seed
   • 1 kg of wood ash mixed with 40 kg of cowpea seed

11. Vegetable oil provides some degree of protection to cowpea in storage against bruchids for up to 3 months.
   • Groundnut oil – 5 mL/kg of cowpea seeds
   • Neem seed oil – 3 mL/kg cowpea seeds

12. **Use of insecticides:** Only a few insecticides can be used to control storage pests because of the strict regulations concerning safety.
    It is important to note as follows:
    • The use of insecticides is a waste of money and effort when good storage practices are not implemented.
    • No single insecticide is safe. Advertisements proclaiming an insecticide to be safe or non-toxic should be taken with a pinch of salt.
• Use insecticides only on stored products which are clean and dry, and in good storage conditions.
• Find out which insecticide is to be used under specific circumstances or against specific pests.
• Know the quantity and timing of application.
• Never buy or use an insecticide without a label.
• Follow the directions for use strictly; do not use more than the recommended dose.
• Wear protective clothing while applying the insecticide to avoid contact

There are two main ways to apply an insecticide to control storage pests:

1. Mix the insecticide with the grains. The insect is killed when it gets in contact with the poison. This can be applied through several formulations, i.e., dust, wettable powder (WP), and emulsible concentrate (EC), e.g.,
   • Malathion dust mixed with the product provides protection against beetles (bruchids) and borers – 1000 g malathion dust/1000 kg of threshed cowpea grains.
   • Pirimiphos methyl is active against moths, mites, and beetles. It is formulated as dust, WP, and EC, and sold as Actellic, Actellic fog, and Silosan. Apply 200–500 g dust/1000 kg produce.

2. Fumigate. This means that the insecticide is in a gaseous form and so penetrates the stored product. Insects inhale the poisonous gas. Fumigation is especially used in airtight containers using Aluminum phosphide – Phostoxin. This should not come in contact with the produce. Each tablet weighs 3 g. The packaging is a sealed aluminum tube containing 30 tablets.

Mold
• Mold in the stored cowpea and cereal grain is the most difficult infestation to recognize for you cannot see it as easily as you see the damage by insects and rodents.
• Molds feed on stored products; their feeding results in the breakdown of the product’s tissue, which produces gases,
gives a bad taste, and makes produce less nutritious. The germination potential of stored seeds is also reduced.

- Molds develop best in a warm, humid atmosphere. Humidity, in particular, is crucial for the development of molds.
- Mould fungi also produce poisons, such as mycotoxins, that are dangerous to people or animals who eat the produce.
- These poisons can cause problems in the liver, kidney, brain, or skin.
- Signs of mold infection could include discoloration, a change of texture, the presence of green, black, or white fruiting bodies of the fungus on the produce, or an unpleasant smell.

Management of molds

- Timely harvesting prevents infestation of the crop in the field by mold fungi.
- Sun-drying of harvested grains could be carried out by covering the produce with black sheets on a hard surface.
- Proper drying of grains before storage is the best remedy against molds.
- Sun-drying prevents the germination of seeds and growth of moulds.
- Ensure that dry crops do not become wet again through dew or rain.
- Regularly inspect stored product from sacks or containers by sorting with the hand; look for moldy grain early.
- Prevent the absorption of water when the produce is stacked in the store. The product can be placed in plastic sacks. Sacks can be placed on pallets made of wooden laths.
- Stores should be constructed so that there is cross-ventilation and bags should be neatly stacked in such a way that air can pass between and around them.

Rodents

- Rodents damage stored products in three major ways. They consume a quantity of the product. They spoil part of the product with droppings. They gnaw holes in the packing material causing waste.
- Rodents are also carriers of diseases which are harmful to man.
Types of rodents encountered in stored products
- Black rat/roof rat – common
- Brown rat – common, biggest
- House mouse

Management of rodents

Set traps: There are various types.

Use rodenticides:
- Acute rodenticide – fast-acting. Acute rodenticides are extremely poisonous, e.g., Zinc phosphide is used as bait to which fats are added to increase its effect. 10 mg can kill a 200 g rat.
- Chronic rodenticides – slow-acting. Chronic rodenticides are slow-acting poisons (anticoagulants), are used in lower dosages, and have no smell or taste, e.g. Warfarin/Coumafen – chlorophacinone.

Use biological/cultural control: cats and dogs hunt rats and physical barriers can keep rodents out of the stores.

Conclusion

Important considerations
- Timely harvesting.
- Proper drying of grains.
- Careful selection of grains for long-term storage: cleaning, sorting, sifting, and winnowing.
- Regular inspection of stored product, i.e., inspection of grains inside sacks/containers.
- Dry and cool storage.
- Non-chemical control measures.
- Use of pesticides (insecticides and rodenticides), where necessary.
Hygiene: The store and immediate surroundings must be kept clean as possible. Before use, every storage facility should be checked for leaks, cracks, and holes, and these should be repaired to prevent access to rodents. Insect pests are a major problem of postharvest cereals and pulses, especially cowpea and maize. Therefore it is necessary to ensure that incoming grains to be stored are completely free from infestation and that they are not attacked once they are in the store.

**Warning**
Insecticides are toxic; they should be used with extreme care.
Cowpea varieties for high flour recovery and local dishes

Damian Ihedioha
USAID–MARKETS project
Abuja

Introduction
Cowpea is the most important source of nutritious food and fodder in West Africa. It is drought and shade resistant, with the ability to fix atmospheric nitrogen. Nigeria is the largest producer of cowpea in the world, producing about 2.3 million t/year. Cowpea, as a major source of dietary protein and other nutrients, has a positive impact on the health of human beings, notably women and children. Thus, cowpea is a high-priced and nutritive agricultural commodity used both as a food crop and a cash crop. Trading on dry grains and processed cowpea foods and snacks provides rural and urban women with an opportunity to earn income for their socio-economic activities.

Varietal selection of cowpea for planting is crucial to the continuing productivity of the commodity. The maxim garbage in, garbage out is most apt in this case. The amount of cowpea seeds/grains harvested is a reflection of the quality of the cowpea variety and agronomic practices. The most important consideration in cowpea selection is the quality of the variety. Any mistake or error in varietal selection has implications for productivity, storability, usability, income, employment generation, and food security. It is critical that research institutes, development agents, and extension personnel of Ministries encourage farmers to plant good varieties of cowpea.

Farmers’ considerations in varietal choice
The quality of the seeds and the choice of variety are important factors in cowpea production. The following should be considered in varietal/seed selection by the farmer.
Viability of seeds: Varieties that germinate fast and do not rot when put on the ground should be promoted. For this to have meaning, seeds meant for planting should be stored under good conditions, devoid of insect pests and other contaminants.

Maturity/Duration: Through the results of research, cowpea can be planted more than once a year, because of the availability of early maturing varieties. The desired maturity should also suit the prevailing rainfall patterns and cropping systems. Synchronized flowering and maturity are desirable for the mechanization of cowpea cultivation.

Factors to consider in selecting cowpea for planting include the following:

- Striga resistance
- Insect pest resistance
- High yield potential
- Seed-to-biomass ratio
- Growth pattern/maturity
- Seed color and size
- Market demands

Processors’ consideration in varietal choice
Cowpea farmers are not necessarily producing what they can eat. They are also aiming to catch the market’s share of commodity sales. Interestingly, many processors are emerging in Nigeria who use cowpea grains to make flour and other composite products such as Danwake. Farmers therefore should concern themselves with the requirements of these processors.

Seed size: The processors want seeds of a good size that will pass through the mills completely milled. Small-sized grains can easily pass through the mill without getting milled.

Seed-to-flour ratio: Processors want varieties that have a thin seed coat and more cotyledon. Such varieties have a better flour-to-seed ratio.
Easily de-hullable varieties: De-hulling of cowpea is an important unit operation in processing. Processors favor varieties that are easily de-hulled with little abrasion by or contact with the machine.

Cooking quality: Processors and home users of cowpea require varieties that take a short time to cook, thus saving costs on energy and fuel. They also favor varieties that do not foam much when they are boiled. Other considerations are as follows:

- Storability
- Nutrient composition
- Special considerations
- Color of seeds
- Milling characteristics, testa-to-endosperm ratio

Farmers must therefore take these into consideration, if they are to remain in business to satisfy processors’ needs.

Cowpea processing
Cowpea undergoes one form of processing or another before it is consumed and the level of processing it undergoes is determined by several factors, including but not limited to:

- moisture content
- method of harvesting
• amount of harvest stalk on the cowpea
• rate of infestation by insects
• conditions under which grains were stored
• intended final use of the product
• commercialization processes involved

The most common type of processing involves cleaning cowpea by removing the plant’s stalk. Cooking is also another form of processing. However, if not done under controlled conditions, cooking leads to a decrease in the nutritional value of the product. Cooking cowpea using pressure cookers and other modern cooking equipment under pressure (121 °C) decreases trypsin inhibitors and enhances the digestibility of protein.

**Industrial processing**
The value chain shows that cowpea has limited industrial processing, for the following reasons.

- limited industrial end-products.
- difficulty in de-hulling.
- limited market for products.
- problems of machinery.
- limited resources to take on varied products.
- storage problems associated with industrial products.

**Concept of value addition**
The cowpea we produce may have stalks and contain stones. Several varieties may be mixed together. It could be infested by insects and above the normal moisture content. There could be other impurities that cause off-odor and a bad color.

As a consequence, any deliberate effort made to improve the quality, marketability, wholesomeness, and general value of the product is called value addition.

**Processed products**
Cowpea is prepared for consumption mostly in the whole grain and split forms. The ground form (flour), even though it does not have sufficient industrial processing, is gaining prominence
in Nigeria but is susceptible to post-processing deterioration. However, this product can be used in many different forms, thus enhancing food security and better livelihoods.

However, the growth in the share of processed cowpea in the diet has not received sufficient attention, especially in Nigeria. Thus, for industrial purposes, cowpea presents processing difficulties. No wonder people often say that cowpea is a difficult product to promote for industrial use. The difficulties are caused by the heavy labor and time requirements for preparation, and undesirable product characteristics. A more important problem is the inability of industries to take on the processing of the product. Experts have in the last decade been working on increasing the consumption of processed cowpea through a reduction in postharvest losses to insect pests, using solar disinfection, improved grain quality, more efficient nutrient extraction, and new cowpea-based food products.

The following are processed products from cowpea:

- whole cleaned cowpea
- de-hulled cowpea
- flour
- composite flour
- cowpea-based animal formulae
- extruded cowpea protein, etc.

When cowpea products are reconstituted in water, with the addition of other condiments, the following derived products can be made: *moin-moin* (steamed cowpea paste), *akara, kose* (fried cowpea paste), and cowpea cake.

Derivatives of processed cowpea products include cowpea soup and *danwakè*. 

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Prospect of cowpea marketing and industrial demand

Bello Abba Yakasai
Manager, Northern Nigeria Business Promotion Office
USAID–MARKETS Project, Kano

Introduction
Nigeria occupies the number one position in cowpea production. But regardless of this enviable position, Nigeria is not listed among the nations exporting cowpea. Here are some of the reasons for this situation.
- Large domestic consumption – Cowpea is regularly consumed by almost every Nigerian household as part or the whole of meals.
- Inability to compete in the export markets – Poor production technology and high cost of production do not favor competition with other producing nations.
- Dominance of small-scale and subsistence producers.

In 2005, Nigeria’s production was estimated to be over 2.3 million t valued at about ₦88 billion. This figure was expected to rise steadily over the years. With the new focus of stimulating industrial processing, consumption is expected to rise and there are growing possibilities of stimulating the export of processed cowpea products. Cowpea remains the main source of protein for rural Nigerians. The use of cowpea cuts across the country for breakfast, lunch, and dinner.

Prospects of cowpea marketing
Expanding domestic use of cowpea across the country is bound to increase the value of cowpea in the markets. In addition, there has recently been an increase in the industrial processing of cowpea which will further stimulate its use in the home.
Industrially processed cowpea comes with the advantage of presenting fewer domestic processing rigors which presently reduce the level of consumption by many families.

Expanding export potentials as a result of improved productivity and processing will certainly increase cowpea production and further affirm its position in the economy of the rural poor. By increasing the productivity of cowpea to a competitive level, Nigerians could be exporting cowpea into the world markets. Increasing value-added activities will certainly increase commercial production and specialization. The introduction of disease resistant varieties and the improvement of the types will raise production and certainly enhance Nigeria’s position for cowpea in the market place.

The continued use of cowpea hay, a major source of fodder, especially for small ruminants, is expanding in households that keep a few animals for subsistence needs.

Potential of value-added products
The demand for cowpea for industrial processing is currently minimal. However, it is expected to rise with the current quest to introduce industrially processed cowpea for various processed and semi-processed foods and food items. Value-added processing into flour and other form of semi-processed cowpea meals, such as Danwake, a common food among the Hausa; Akara (Kosai) a common breakfast dish across the country; Moimoi (Alala), a common national snack, and many more, will raise consumption and surely increase the income for all actors in the value chain in the cowpea subsector. It has also been observed that there is increasing use of cowpea in many local domestic foods, either as a part or the whole meal. Cowpea cake, porridge, and other new emerging foods and drinks are becoming common in the urban areas. In the rural areas, there is increasing awareness of the use of cowpea as a substitute for animal protein.
Within the last couple of years, a number of cowpea processing industries started to emerge in Nigeria, with a few in Lagos and Minna, with a focus on the export of their processed products. However, with the coming of the USAID–MARKETS project, about five new industries are being established in Kano. Some of them will specialize in the production of pure cowpea flour while others will specialize in other cowpea-based semi-processed foods. A few of the industries are profiled below.

**Dantata Foods**
- Located at Dawanau Market in Kano.
- Product will be pure cowpea flour.
- Status–machinery being installed.
- Production at 10 t/day *200 annual work days = 2000 t/ annum.
- Value of raw products @ ₦32,000/t = ₦128,000,000
- Estimates of value-added products @ ₦150/kg/processed flour (recovery 70%) ₦420,000,000.
- Possible employment generation – factory workers, transporters, traders, food vendors, etc.

**Modern Universal Foods and Beverages**
- Located at Sharada Industrial Estate, Kano.
- Pure cowpea flour.
- Installation completed.
- 10 t/day @ 200 annual work days = 2000 t.
Value of raw products @ ₦32,000/t = ₦128,000,000.
Value of value-added products @ ₦150/kg/processed flour (recovery 70%) ₦420,000,000.
Possible employment generation – factory workers, transporters, traders, food vendors etc.

Convenient Foods and Beverages
Located at Sharada Industrial Estate, Kano.
Danwake flour (cowpea flour mixed with sorghum flour, milled dried baobab leaves, potash, and ground chili pepper).
Installation completed.
5 t/day @ 200 annual work days = 1000 t.
Value of raw products @₦32,000/t = ₦64,000,000.
Possible employment generation – factory workers, transporters, traders, food vendors etc.

Response to market demand
Among the major weaknesses for producers is their inability to source specific markets for their products and to build business relations that guarantee repeat orders from the buyers. On the other hand, most of the development programs’ assistance is targeted at enhancing productivity. Little was done to develop systems of market relations that would ensure the profitable disposal of products by the farmers at the end of the season. A recent study showed that the cowpea value chain includes many actors—of which the most important are producers, farm workers (including family labor), grain merchants, grain retailers, processors, commercial food preparation businesses (formal and informal), and consumers. Most actors in the cowpea value chain are poor, with the exception of grain wholesalers in Kano. Producers (farmers) and informal vendors particularly cluster in the lower income groups. Cowpea marketing in Nigeria, and in Kano in particular, is highly competitive. The cowpea merchants support a well-developed collection system throughout northern Nigeria and
southern Niger. These merchants provide credit to buyers in local markets, who buy small quantities (often in 10 to 20 kg lots) until they accumulate 100 kg bags, which are stored until a truck transports them to the city or main market in Dawanu, Kano. Most merchants try to purchase cowpea within the market area where they operate, but some purchase directly from farmers with the help of sales agents. Prices are established by negotiation after physical inspection of the grain. Qualities are sometimes compromised along the value chain between producers and consumers through adulteration, re-bagging, etc.

Use of best practices in both production and postharvest activities is minimal in the smallholder farms. This reduces the chances of the farmers to specialize and serve specific markets’ needs. To take advantage of the industrialized markets, producers need to understand the needs of the markets in terms of desired product types, product quality, and quantities of orders. Farmers need to organize themselves both as groups or individually to be able to satisfy these demands in a timely way and on a continual basis. This will assist in building reputation and confidence, which will lead to the repetition of orders by the buyers.

To achieve such objectives, producers must understand the strength in generating volume through bulking and use that strength for collective bargaining. They must understand that those days are gone when producers cultivated their lands because “they felt like it”. In the present day, production is for commercial purposes and producers must produce to serve the needs of the markets.

**Profit-driven production**
Major crop producers in the world operate like any other business ventures; they succeed because, right from the onset, they make profit their primary motive. They understand that their survival in the business depends on how profitable it is, or
better, how profitable they make it to be. They have learnt the rules, memorized them, and actually live by them. These rules are known to every reputable commercial producer. But for the sake of our clients, they are to ensure that they do the following:

- Make *profit* the motive for their investment
- *Calculate* before commitment
- Keep *records*
- Get *the market* first
- Are committed to *specialization*
- Maintain *integrity*
Formation and management of farmers’ cooperative societies

Isa Malami
KNARDA, Kano

Introduction
What is today regarded as the modern type of cooperative movement owes its beginning to the activities of the Rochdale Equitable Pioneers of Toad Lane, Rochdale, England, in 1844. However, contrary to popular belief, the cooperative ideas that evolved into the Rochdale Equitable Pioneers Society had originated to some extent in past historical periods. In short, the cooperative method of doing business has a very long, enviable history. From the beginning of recorded history, the cooperative method has evolved from a religious oriented institution to a formalized business oriented organization, serving economic rather than spiritual needs. The cooperative idea was there in the Babylonian period, the Greek era, the ancient Chinese era, the Roman era, the early Christian period, during the rise of Islam, in the Middle Ages, and finally through the industrial revolution of nineteenth century Europe.

In the African subregion, some efforts at developing African indigenous cooperative theories, though without much success, were made by such personalities as Leopold Senghor of Senegal and Julius Nyerere of Tanzania.

Cooperatives in Nigeria
From our knowledge of communities in various parts of Nigeria, cooperation is the essence of successful social, economic, cultural, and political life. Cooperation has existed from ancient times amongst different communities, both inside and outside Nigeria. For example, amongst the various numerous traditional communities, Hausa, Igbo, Yoruba, Edo, Ijaw, Tiv,
etc., especially amongst the Igbo, the survival and continued existence of the village were based on cooperation. This was made manifest in religious rites, the communal clearing of sources of water supply, road construction, farm work, hunting, etc. Other existing examples of cooperation are in situations where urban dwellers get together to protect themselves against criminals and night marauders.

The Federal and State agencies cooperate to deal with problems of general economic and social concern, for example, health care delivery, education, epidemics, the battle against crime, etc. Members of the business community, even gari and yam traders in various markets, cooperate to achieve common goals through their various trade and professional organizations. Generally, in striving for various goals, cooperation has become an in-word for everyone from professionals to business people and amongst educators at all levels. Both the Federal and State governments encourage the populace to cooperate with them to further advance whatever objectives they have enunciated as their policy position. In fact, even Nigerian politicians of diverse convictions join the chorus of appeals to the electorate to cooperate with them in their bid to get elected into parliament. In or around 1935, a modern cooperative business enterprise was introduced by the then colonial administration into Nigeria through the enactment of the Cooperative Society’s Ordinance No. 6 of 1935.

**Meaning and scope of cooperatives**

In the Nigerian mixed economy system there are three types of business enterprises which have developed over the years. These are individual proprietorship, the partnership, and the corporation. Within the corporation subgroup, there are the cooperatives and other corporation profit and non-profit types.

The organization of rural production cooperatives has in recent years become one of the most important preconditions for the efficient mobilization of production resources and accelerated rural progress. Even though the family farm may be considered
efficient within the stated demands of modern times of enterprise self-sufficiency, the dynamic demands of modern times are such that, a framework has to be subjected to drastic structural changes. One of the most effective vehicles for organizing modernized rural production is the cooperative.

What are cooperatives?
These are an almost universal form of organization found in practically all countries and used by people with very small means to improve their levels of living. Improvement of the levels of living implies that there is no end to the ways that the cooperative idea can be made to benefit people in the everyday needs of life. To place the meaning of cooperatives in the proper perspective, certain essentially discernible features of brotherhood must be recognized. Four of these features are relevant. First, the association consists of groups of people who join together to perform functions which they cannot very well undertake as individuals. Secondly, the association seeks to provide some services that are crucial or very desirable in the lives of the people concerned. Thirdly, it operates on the basis of self-help, whereby those involved look towards themselves as a group for the solution of the problems. Fourthly, it does business from motives of service and not for the purpose of making a profit.
Specific objectives of cooperatives
Such objectives appear universal. The first is the objective of providing goods and services at cost. The second is the aim of eliminating the unnecessary profits of middlemen in trade and commerce. The third is to prevent the exploitation of the weaker members of the society. The fourth is the aim of protecting the rights of people, both as producers and consumers. The fifth is the objective of promoting mutual understanding and the education of members and, in the long run, among people in general. With these objectives as a framework, cooperation can be defined as a system of social organization based on the principles of unity, economy, democracy, equity, and liberty.

Classification of cooperatives
Cooperative business enterprises or activities can be organized for any legal purpose in any field of human endeavor. As a result, it is natural to expect to find many different types in operation. The classification of cooperative societies is certainly not an easy matter. This is because, especially in this era of the emergence of multipurpose cooperative societies, a cooperative may have one major area of operation for which it is known, in addition to other minor or subsidiary activities which have been listed in its Certificate of Incorporation. In spite of this, cooperatives may be classified according to groups served, size, areas covered, functions performed, type of membership, legal status, and financial structure. Cooperative classification could be attempted as follows:

1. Based on the group served or function performed, cooperatives can be classified as Agricultural Societies or Auxiliary Societies.

In these two classes could be found cooperatives in various activities, such as purchasing societies, marketing societies, production/supply societies, civic societies, credit societies, consumer societies, health societies, workers’ societies,
agricultural workers’ societies, social service societies:—
transport, architectural, housing, entertainment, repair/
maintenance, etc.

2. Based on the area or level of operation:
Under this category may be classified four types of cooperative enterprises.

a. Rural/local, primary, urban
b. Regional—secondary
c. National/federal
d. International

3. Based on legal status:
When cooperatives are classified based on their legal status, two types are recognized.

a. Unregistered societies
b. Registered societies

The latter could be subdivided into those registered with unlimited liability, multiple liability, limited liability, etc.

4. Based on the economic status of members:
Under this category, three types of cooperatives may be recognized.

a. Producers: farmers, traders, craftsmen
b. Consumers
c. Workers

5. Based on types of membership
Here, three types are prominent, which are applied to large cooperatives that usually operate on a regional basis.

a. Federated cooperatives
b. Centralized cooperatives
c. Mixed cooperatives
6. Based on the sectors of the economy where the societies are engaged.
   a. Agriculture
   b. Small industries
   c. Retail, wholesale, trade
   d. Service trade – Banking, Insurance, Transport, Hotel and Tourism, etc.

7. Based on the size of the cooperative.
This may be measured by the volume of businesses, the number of members, or the monetary value of assets in naira.

8. By type of financial structure
Cooperative enterprises can be classified according to the financial structures. Usually two types are identifiable:
   a. Stock Cooperatives Societies: Here equality is represented by the ownership of shares of common or preferred stock by stock holders who are the owners, with related provisions for the ready transfer of stock ownership. Stock cooperatives usually have restrictions on the transferability of stock by members and on the withdrawal from the society by members.
   b. Non-stock Cooperative Societies: In this case, ownership is represented by membership certificates; often providing evidence of the payment of a membership fee.

**Membership of farmers’ cooperatives**
The purpose of coming together to form a cooperative is to enable the farmers to intensify all-year-round farming. Members must be 18 years old and above, and membership is constructive, regardless of class and religion. Every member is a practicing farmer and in addition is resident in the association’s area of operation. The cooperative is a business organization. Members always strive to promote their economic interests and insist on undertaking profitable ventures. A successful cooperative is one that can manage, control, and self-finance its activities.
Essential steps in the formation of viable cooperatives

- Choice of name
- Collection and completion of membership application forms
- Registration of members
- Collection of registration fees and share capital
- Selection/Election of leaders (Chairman, Second, Secretary, and Treasurer)
- Registration with State and local Agricultural Departments
- Development institutions
- Opening bank accounts
- Opening association’s documents
- Arranging business meetings to discuss production inputs, training, levies, savings, deposits, and the adoption of by-laws

If a problem exists, the type and extent of the problem are determined clearly and concisely. Leading members meet to discuss the problem. ADP field office and contact farmers are consulted.

Quality of good cooperative officials
People likely to promote the success of the association as officials should be elected according to the following criteria.

- Are respectable, decent in manner, and have an impeccable character.
- Have a strong ability to learn and utilize experiences gained.
- Are resourceful, able to take calculated risks and search for new and improved ways or methods of operation.
- Are dynamic and enterprising.
- Are willing to learn and handle basic accounting and record keeping.

Do not elect a person who:

1. Claims to be a foundation member but does not attend meetings or pay his dues.
2. Likes to hold office but won’t do the work and will not delegate responsibility.
3. Does not make sacrifices for the success of the association but donates large sums of money at public launchings.
4. Collects the association’s loans but will not pay back.

Reward cooperative officials for good management but periodically evaluate them so that they may not feel they are indispensable.

**Cooperative principles**

A successful cooperative is one that has the ability to manage, control, and self-finance its activities.

At the formative stages, ADPs assist farmers to mobilize human, financial, and productive resources.

After registration and take-off, cooperatives must try to generate their own funds for replacing wells and pumps, for farm operations, and for sustaining their associations.

Self-help is the basis of forming cooperatives. Therefore, every cooperative must strive to raise its own internal revenue continuously and not rely on government, or other external loans. Members should become self-reliant.

**Raising internal funds**

Some ways by which the internal funds could be raised:

- Share capital: Share price is fixed and members can purchase what they can afford.
- Thrift saving: These are mandatory contributions, usually of fixed amounts paid at each meeting.
- Levies: Levies are announced, based on the association’s needs.
- Registration fees: Pre-determined by associations.
- Deposits: These are voluntary savings by members, raised according to the individual’s capital and convenience.
- Members’ personal donations.
- Profit from the association’s investments.
External sources of funds for cooperatives
Cooperatives can obtain financial support from external institutions, agencies, and individuals. This can be in form of loans, grants, or donations.
- Commercial Banks
- Nigerian Agricultural, Cooperative, and Rural Development Bank
- International agencies: bilateral/multinational.
- FAO
- The World Bank
- UNDP, etc.
- International/local NGOs.
- Other cooperatives
- Government subsidies and grants
- Community Banks
- People’s Bank

Standard books and records
a. Most important are the Books of Accounts
1. Receipt Book cash
2. Cash Book
3. Payment Voucher
4. General Ledger
5. Members’ personal ledgers
6. Members’ personal passbooks

b. Other books and record
1. Loans register
2. Bank books – (Check books, tellers, passbooks)
3. Minutes book
4. Store book
5. Files for loan bonds and correspondence.

Fund utilization
The cooperative funds may be used only for objectives in accordance with the bye-laws. The cooperative funds can be applied to the following:
1. Registered members of the society can borrow from them at an interest predetermined by the association.
2. The funds can be applied in support of the cooperative when in need of an urgent bulk purchase of fertilizer, agro-chemicals, fuel and lubricants, and other farm inputs.
3. Others can also borrow from the funds on agreed administrative charges.
4. The cooperative can use the funds to do other business.

Elements of effective loan administration and recovery
Keep a true account of the assets and liabilities of the cooperative. Ensure that all the association’s funds are kept in a reputable bank account, except for a small amount of cash set aside for immediate commitments. With the consent of the members, the executive management committee shall carry on the business of the society and set an example of keenness and the cooperative spirit to other members. At any point in time, the committee should be able to explain to members, with facts and figures, the association’s affairs and accounts.

Loans are to be granted only to members who are dedicated, have paid their fees and dues and have savings with the organization.

Effective loan administration entails:
1. Regular inspection and assessment of farm performance by all members
2. Periodic meetings of members to solve problems
3. Collective investigation of default cases
4. Enforcement of recovery measures (by locking wells, recalling pumps, and applying government measures)

Monitoring, supervision, and evaluation of cooperatives
1. Training on the process of obtaining loans
2. Filling of forms
3. Opening and operating individual bank accounts
4. Use of loans in cash or kind
5. Decisions on types of projects
6. Lectures on farm records and accounts
7. Regular inspection and assignment of farm performances
8. Periodic meetings with farmers on problems
9. Servicing and applying solutions through contact with relevant institutions/agencies
10. Evaluation reports

Members’ liability
A member’s total liability to the society should not be more than 10% of the total liability of the society.

Termination of membership
Membership shall be terminated by:
a. Death.
b. Ceasing to hold a qualifying number of shares in accordance with the bye-laws.
c. Migrating from or ceasing to conduct business in the area of operation of the society.
d. Ceasing to be a bona fide trade/artisan/farmer/worker.
e. Any member, who wishes to withdraw his membership voluntarily, shall give three months notice in writing to the secretary, provided that the member withdrawing is not indebted to the society.
f. Permanent insanity.
g. Expulsion, due to the incessant violation of the bye-laws.
h. Failure to conduct business in accordance with the objectives of the society.
i. A member on termination shall be paid back within three months the amount of share capital actually paid by him together with any money (except any entrance fee) or goods due to him from the society after deducting from them any money or goods due to the society from him.

Group dynamics
1. Characteristics of a good cooperative
It is an association of persons with variable but voluntary membership, based on self-help, for the promotion of the economic interests of the members operating a jointly owned business.
2. **Process of cooperative formation and registration**
   - Basic guidelines
   - Essential steps
   - Bye-laws
   - Roll of members and key officials

3. **Management of groups**
   - Relations and linkage with national and regional institutions.
   - Groups are business organizations with social responsibilities.
   - Meeting procedures.
   - Group conflict and conflict resolution.
   - Disciplinary procedures (fines, reprimands, termination, etc.)
   - Enforcement of rules and regulations.
   - Strategies for expanding and managing participation.
   - Constraints to effective cooperative development.

In conclusion, cooperative formations are very important for the resource-poor farmers in Nigeria as these will ensure their access to inputs and enhance their bargaining power for the marketing of their produce.
Annex 1

Opening remarks by Mohammed Umaru
Director
National Agricultural Extension and Research Liaison Services,
Ahmadu Bello University, Zaria.
Opening ceremony of the pre-season training for extension agents in the cowpea-based crop–livestock systems project in Kaduna State, held at NAERLS Conference Hall, 8 May 2007

Protocols
It is my privilege and honor to welcome you to NAERLS, Ahmadu Bello University, Zaria, at this official opening ceremony of the 2-day pre-season training for extension agents in the Gatsby cowpea-based crop–livestock systems project in Kaduna State.

I consider this training workshop to be crucial. Pre-season training has been one of our regular activities in this institute for decades. The benefits of pre-season training are enormous and include updating the knowledge of the participants on improved production practices to ensure increased productivity for more income.

The Gatsby cowpea-based crop–livestock system project has had an impact on the lives of farmers in Kaduna State with an initial takeoff at Giwa LGA in 2002 and now there is full determination to cover the entire State in 2007. The easy-to-adopt technology and enormous benefits accruing from it might have been responsible for the wider acceptance of the system. It is hoped that this pre-season training will include an evaluation of the performance of the system with a view to improving and further refining the technology.

The task of the extension agents who will be responsible for conveying the knowledge gained in this training to the farmers is enormous. Often the inability of the extension agents to convey adequate information and supervise the established trials undermines the success of such trials. It is important therefore that this should be well conceived during this training so that, as change agents, you have the responsibility of ensuring that each farmer complies with the recommendations of the technology.
I wish to commend the IITA Kano Station for organizing this pre-season training. It is encouraging to see your organization collaborating with the three Research Institutes (NAERLS, NAPRI, and IAR) based at Ahmadu Bello University. This collaboration should be strengthened further to guarantee the future mutual relationship. The recent launching of the Presidential Initiative on doubling maize production (which coincidentally is being coordinated by IITA) is a welcome development. I hope the Gatsby project will take advantage of this development to expand its scope of operation.

The NAERLS as you know is saddled with responsibility of extending proven technologies to farmers in the whole country and this we have been pursuing vigorously. You will recall our interest in this project since it started in 2002. We have been involved with some of the LGAs and staff of ADPs in carrying out this project in some States with outstanding results. The secret behind the success which has been mentioned in many fora is purely adequate supervision. I will therefore wish to suggest that adequate machinery be put in place for effective supervision this year and beyond.

The issue of improved seeds should be addressed adequately. Already many requests have been pouring in from our farmers. With the anticipated rapid expansion of this project, it will be necessary to secure seeds, possibly through community-based seed production systems. This will guarantee a sustainable seed supply to meet the farmers’ need.

Finally, let me thank every one of you, especially the resource persons who will be leading discussions in this training. I hope the deliberations of this training will be put together to serve as a guide for the activities of the project this year.

I wish you all every success in this very important training and hope that you will find the time during the course of the training to see some of the facilities in NAERLS.

Thank you all.
Annex 2

Opening remarks by Alhaji Tijani Auwal
Director, Agricultural Services
Kano State Ministry for Local Government.

Opening ceremony of the postharvest training for extension agents in the cowpea-based crop–livestock systems project in Kano State, 5–6 November 2007, International Institute of Tropical Agriculture, Kano Station, Kano, Nigeria

Let me start by thanking IITA, particularly the personnel that coordinate this project, the Gatsby cowpea crop–livestock project, for organizing this very important training workshop on improved cowpea–cereal crop–livestock systems. It is not only the subject of the training or the project itself that that impressed me, but also the apparent change of attitude or approach by the institute, IITA. In the past, as we could all testify, research institutes generally confined themselves within their experimental environments without bothering to come out to the field to supervise their final work, the research outcome, and also without involving major stakeholders in contributing their views on an important research project that might have a direct bearing on them. However, with the introduction of this project, we are beginning to witness a positive change of attitude, where the coordinators go out to the fields themselves, listen to views, and seek relevant contributions from stakeholders with a view to making the project achieve its mission. This is a very welcome development, and I am optimistic that the project will achieve its ultimate goals if this kind of collaboration continues.

Commenting on the project itself, I will want to suggest that more and more communities be enrolled to participate in the project. This has become necessary to enable a greater number of farmers to benefit from the technological and economic realities. Before I close my remarks, it is pertinent to inform this august gathering that my Ministry, the Ministry for Local Government, which is one of the stakeholders in this project,
is always willing to cooperate and contribute in whatever way it can. It is truly agriculture-friendly. The active participation in this project of the Local Government in the State is testimony to this claim.

Finally, I wish to thank all those that contributed towards making this occasion a reality and I hope its outcome will add more to the success of the project.

Thank you and God bless.