Improved cowpea–cereal cropping systems: cereal–double cowpea system for the northern Guinea savanna zone

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Introduction

Cowpea [Vigna unguiculata (L.) Walp.] is grown throughout West Africa in a variety of crop mixtures, but the importance of cowpea as a component crop is greater in the savannas where rainfall is less and soil fertility is low. Cowpea varieties with higher grain yield, early maturity, and resistance to several diseases and insect pests have been released in several countries. These are being grown over larger areas than before, in different zones (ranging from the arid to the humid zones) and in both dry and wet seasons. Although Africa plants the largest area at 8.9 million of the 9.1 million ha planted worldwide, cultivation is mainly under traditional systems and it therefore has the lowest average yield.

Considering the large differences between yields on-farm (25 to 300 kg/ha) and in experimental stations (1500 to 2500 kg/ha), there is a high potential for yield increases in the region. This potential can be met if suitable agronomic practices and cropping systems that take maximum advantage of the new and improved varieties are deployed to the farmers. The major reason for the low production levels in the developing nations, including Nigeria, is the lack of adequate production practices and inputs.

A combination of improved varieties and improved cropping systems for higher productivity and profitability with a low use of insecticides and fertilizers has been developed for the moist savannas (Guinea savannas) of West Africa (Ajeigbe 2003, Singh et al. 2004, Ajeigbe et al. 2006). These improved varieties and cropping systems (2 cereal: 4 cowpea row-to-row strip cropping) hold great promise for increasing food productivity in West Africa without affecting the environment or degrading the soils. There is a low and selective use of fertilizer and pesticides. Crop residues are fed to small ruminants in permanent enclosures on the home compound and their manure is returned to the field. This system in the northern
Guinea savanna (NGS) zone encourages intensification by double cropping cowpea within the season and also by the judicious use of inorganic fertilizer and manure.

Farmer participatory on-farm validation of the improved cowpea–cereal intercrop systems in the NGS of Nigeria was conducted between 2002 and 2006. Owing to the success of the validation exercise, large-scale dissemination was conducted between 2006 and 2008 to speed up the adoption of the improved system and cowpea varieties, and to improve the productivities of the small-scale farmers in the region. This manual describes the agronomic practices of the maize–double cowpea strip cropping system and presents some of the on-farm results obtained during the validation exercise.

**Traditional cropping systems in the NGS of Nigeria**

In a general survey of cropping systems in West and Central Africa from 1988 to 1990 covering: Nigeria, Benin Republic, Niger Republic, Togo, Cameroon, and Burkina Faso, Singh (1994) identified 15 major cropping systems, in addition to several others which vary from farmer to farmer. In the forest and Guinea savanna zones, cowpea is intercropped primarily with maize (*Zea mays* L.), cassava (*Manihot esculenta* Crantz), yam (*Dioscorea rotundata*), groundnut (*Arachis hypogaea* L.) and soybean (*Glycine max* L.). In the NGS of Nigeria, cowpea is intercropped with maize, sorghum (*Sorghum bicolor* L.) and/or groundnut. The density of cowpea plants is very low (1000–5000 hills/ha) and the cowpea is interspersed among the companion crops. The system varies from alternate rows of maize and sorghum to alternate hills of maize and sorghum or two rows of maize to one row of sorghum or vice versa, depending on the farmers’ food preference and market demand. Soybean or groundnut may replace any of the cereals or cowpea. Within-ridge spacing for cereals ranged from 25 to 100 cm, and from 40 to 100 cm for cowpea. Groundnut and soybean were generally planted closely, at about 20 cm within the ridge. Weeding was done manually with the aid of a short-
handled hoe and sometimes with a bullock-drawn ridger or cultivator. Weeding was done twice or three times, depending on the weed situation and the availability of labor. Harvesting was done when the pods/panicles were dry. A standard assumed by many researchers is given (Fig. 1).

The traditional cropping systems are associated with low yields, lack of inputs (improved seeds, fertilizer, and pesticide) and traditional varieties. The general objective of the farmers is a sustained production at minimal risk to satisfy subsistence needs. Only the surplus is taken to market. The importance of a particular crop is area-specific and could be influenced by food preference, crop rotation, and/or market situation. Fallow and legumes play a vital role 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 cereals have 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. The major constraints include low plant population, diseases and parasitic weeds, low soil fertility, the shading of
legumes by cereals, difficulty in selective input application, and a lack of integration with any livestock component.

With the rapid increase in population, the traditional farming systems are breaking down. Fallow periods are non-existent or too short to be effective. The productivity levels of these systems may be inadequate to meet the demand for food.

**Livestock in the traditional system**

Livestock are traditionally kept by farmers under extensive management. This system is inefficient because animals are generally allowed to roam around croplands after harvest. The consequence is that animals are under-fed, especially in the dry season, and manure is lost while they roam instead of being accumulated at home under improved management. The livestock and crop enterprises, therefore, are seldom integrated to obtain the advantages of mixed farming. The farmers take manure to the farm but most of the manure is lost while the animals are wandering by roadsides or in the bush in the name of grazing. Also, as farming systems reduce fallow and evolve to continuous cropping, yields of crops and land productivity will decline and sustainability would be threatened. Ultimately, the integration of crop and livestock offers a viable solution because of the complementarities.

**Improved cereal–legume cropping systems**

In Nigeria, several efforts have been made by IITA and its national partners in the development of improved production practices suitable for the cowpea–cereal systems in the Guinea savanna zone. Various row-to-row maize–cowpea planting patterns have been rigorously studied, such as 1:1, 2:2, 1:3, 2:3, 1:4, and 2:4, taking cognizance of the rainfall pattern and the opportunity for intensification. The 2:4 maize–cowpea row-to-row planting pattern was adjudged the most appropriate for the small and medium-scale farmers of the NGS zone. The availability of extra-early maturing varieties of cowpea, adapted to being planted at the beginning of the rains, also allows
double cropping of cowpea in this system. The 2:4 maize–double cowpea system consists of 4 rows of cowpea and 2 rows of maize, all planted on the same day. The second cowpea crop is planted after the first has been harvested (about 60 days after planting). The maize and cowpea are densely planted (Fig. 2). The advantages of this planting pattern include the following.

- High population of cereals and legumes.
- Minimum shading of legumes by cereals.
- Selective inputs are easy to apply on cereals and legumes (fertilizers on cereals and insecticides on cowpea).
- Improved varieties give higher responses to inputs.
- Higher productivity is sustainable over time.
- Farmers’ income is increased (poverty alleviation) through increases in the production of legumes.
- Crop rotation for soil fertility improvement/maintenance.
- Increased legume productivity with less competition from the associated cereals.
- Improved quantity and quality of resulting crop residues.
- Easy management of residues and livestock integration.
- Crop-specific agronomic activities can be practiced on the strips.
Agronomic practices of maize–double cowpea strip cropping system

Site selection and land preparation
The first step in the double cowpea strip cropping system is the selection of a suitable site. The field should not be waterlogged as this will seriously affect the performance of the cowpea component of the system. A well-drained sandy-loam is much preferred.

After a good site has been selected, the land preparation should commence as soon as the rains set in. Depending on the location, the approach to land preparation may vary. In places where the land has been under continuous cropping, harrowing twice before ridging at 75 cm will ensure good growth and development of the crops. Ox-drawn ridgers at 75 cm or manual ridging can also be used (Fig. 3). Depending on available resources, the farmers should choose from the options available to them.

Fertilizer rate and method of application
The cereal–double cowpea strip cropping system requires a low level of external inputs. Manure at an annual rate of 1 t/ha is recommended for this system (Fig. 4a).

Figure. 3. (a) Ox-drawn and manual (b) ridging.
This should be followed by the application of 15 kg/ha each of N, P$_2$O$_5$ and KCl as 100 kg NPK (15:15:15)/ha. The manure and two bags of NPK 15-15-15 should be applied as basal during land preparation before ridging. This basal application will boost the nutrient status of the soil especially the phosphorus content that may be limiting. The maize will need additional N fertilizer as a topdressing (Fig. 4b). This should be provided by the application of urea at about 50 kg/ha at 3–4 weeks after sowing (WAS) (Fig. 4c). The method recommended is spot application; the urea must be covered with adequate soil to avoid evaporation and runoff. A hole is dug about 10 cm from the base of the plant. A bottle cover is used as a measure, the “crown cork” type found on beer bottles. From a half to one full bottle cover of urea is sufficient. The topdressing should be done when the soil is moist.

Figure 4 (a). Manure taken to the field, (b) Maize before topdressing with nitrogen, (c) Maize after topdressing.
Crop variety
Cowpea: Only improved varieties of cowpea should be used, especially for the first planting. The first cowpea crop must be an extra-early maturing variety (60 days) that can dry quickly even under relatively moist conditions. Any of the following varieties: can be used for the first planting: IT93K-452-1, IT81D-1010, IT IT96D-610, IT98K-205-8 IT99K-1245, IT99K-1245 and Achishuru. For the second planting IT89KD-288 or any medium or late maturing photosensitive or dual-purpose variety can be used.

Maize: Medium to long-duration maize varieties including hybrids can be used.

Planting pattern, planting date of component crop, and spacing
The planting arrangement should follow the pattern: 2 rows of maize to 4 rows of cowpea. It is better to start with maize rows. In the following year, start with cowpea rows.

Maize and the first cowpea crop should be planted on same day or as nearly as possible if maize was planted first. Planting should be done only when the rains have become established. In the NGS zone this is at the end of May or in early June. It is important to plant as early as possible because of the second cowpea crop that would be planted after the harvest of the first one. Plant the cowpea at an intra-spacing of 20 cm with 3 seeds/hole, thinned (optional) to 2 plants/hill at 2 WAS. In high soil fertility conditions, plant maize 25 cm apart, sowing 3 seeds/hole and thin to 2 plants/hill at 2 WAS, or 2 seeds/hole without thinning, especially with high quality seeds. In low soil fertility conditions, plant maize 20 cm apart, 2 seeds/ hole, and thin to 1 plant/hill at 2 WAS.
The second cowpea crop should be planted after the harvest of the first one; this should normally be from the end of July to the first week of August. After the harvest of the first cowpea crop (Fig. 5), the land is ridged up for the second cowpea crop to be planted on both the old cowpea ridges and between the maize stands on the maize ridges. The field can also be sprayed with paraquat (a non-selective contact herbicide) to kill the weeds and cowpea plants. Thereafter, the second cowpea crop can be planted. The dead weeds and first crop of cowpea therefore serve as mulch. The herbicide has limited damage on the companion maize. Plant 3 seeds/hole dug 20 cm apart in the middle of two previous cowpea hills. The second cowpea crop should also be planted in the maize rows in between two maize hills.

**Weeding**

Weeding is crucial in any crop production. About 2–3 weedings will see the crops through to harvest. Depending on how well the land preparation was conducted, the first weeding should

![Figure 5. Harvesting of the first cowpea crop in August.](image)
commence at 3–4 WAS. The weeding should coincide with top dressing urea on maize. This will ensure the proper utilization of the fertilizer by the cereal crop components. The second weeding will be done 3 weeks after the first and the extra-early maturing cowpea crop is harvested 2 weeks later. The second cowpea crop may require one weeding at 4 WAS. If herbicide was used, the mulch tends to prevent weed growth and the second cowpea crop may not need weeding.

**Crop protection**
The improved cowpea varieties are relatively resistant to most of the common pests and diseases. However, two sprays of insecticide at flowering and podding are still necessary to ensure a good cowpea harvest. Cypermethrin or a commercial formulation of Cypermethrin and Dimethoate is recommended. Imidichroprid may also be used as the first spray and Cypermethrin, or the combination of Cypermethrin and Dimethoate, should be used as the second spray. The insecticides recommended (Cypermethrin, or the combination of Cypermethrin and Dimethoate) are fairly popular with farmers and are available in the markets under various brand names. One liter/spray of the chemical is recommended for 1 ha of a sole cowpea crop. In the improved strip cropping system 700 ml/ha is enough because cowpea occupies only 66% of the cropped area.

The first spray is at about 3-4 WAS or at budding, to control aphids and thrips; the second spray should be applied 10–14 days afterwards or at podding to control thrips, *Maruca* pod borers, and pod sucking bugs. Occasionally a third spray may be needed, especially with the second cowpea crop, to control *Maruca* pod borers and if there is a pod sucking bug attack. In the use of insecticide, safety issues (Fig. 6) must be considered.
Harvesting, threshing, and winnowing

Harvesting of maize should be timely to avoid losses to pests (rodents) and bad weather. Maize can be harvested green or as dry grain when the crop is fully mature. For dry grain, the cobs should be harvested when the color changes to brown. Maize stalks can be cut and packed standing in heaps on the field to continue drying until when labor is available for threshing the cobs and the grain has fully dried. The cobs could be removed from the stems and dehusked or the stems could be cut and heaped at a specific location for dehusking later. Husks should be allowed to dry to a content of about 14% for easy shelling. After shelling, the grain can be further dried before bagging and storage in a weevil-free store until it is needed for consumption or for sale.

Harvesting of cowpea should commence as soon as the crop is mature and the pods show signs of drying. Since the first cowpea crop usually matures during the rains, care must be taken to ensure proper drying. However, pods of IT93K-452-1 dry fast, even under shade. Depending on the variety grown,
two to three 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 grain, are not easily threshed. The harvested pods should be spread out and not piled up. Wet pods could lead to mold damage (Fig. 7).

The second cowpea crop is harvested at the end of the season and there are fewer difficulties in timing and drying than for the first cowpea crop. One or two harvests may also be required, depending on the weather conditions. If the crop is planted early or if the rains stop late, two pickings may be required. However, for late planting or when the rains stop early, farmers should usually allow 80–90% of the pods to dry and harvest all of them, including those partially dry. Alternatively, the whole dry plants can be cut and heaped, dried, and beaten to thresh the pods. These are then winnowed to get the grain. This is a good practice, since it encourages improved utilization by livestock of the cowpea residues (pod wall, leaves, and stems mixed together and beaten to small pieces).

Figure 7. Spreading out pods of IT93K-452-1 in Kaduna State, Nigeria.
It is essential that the cowpea pods are 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 commences as soon as the pods are well dried. The level of dryness can be tested by rubbing a few pods on palms. If the pods are well dried, some of the seeds will be released as a result.

The advantages of proper drying before threshing are as follows:

- It reduces the labor requirement.
- It reduces the risk of grain damage.
- It reduces the risk of mold.
- It enhances the quality of the grain/seeds.

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

Whichever threshing method is employed, care must be taken to avoid damaging the grain. Broken seeds reduce the quality and market value of cowpea.

Winnowing is the separation of the seeds from the chaff, other immature seeds and debris. Winnowing should be done against the air drift so that the inert materials, such as chaff and broken seeds, are blown away by the wind and the grain is collected in a clean container.

**Bagging and storage**

Bagging commences as soon as the grain/seeds are certified dry enough and are at a good moisture content for storage. Moisture content of the grain must be low and not more than 11% before storage. Dry on a clean slab or on protective material, spread on clean floors to avoid the introduction of
stones and other materials. New bags should be used and must not be wet, to avoid mold. The bags must be sealed to prevent encroachment by rodents and other animals. Grain should be stored in cool, dry places, mostly using the triple bagging system for cowpea.

**Results of the on-farm validation of maize–double cowpea strip cropping system**
The maize–double cowpea strip cropping system has been tested at a large scale in a farmer participatory evaluation. Farmers adopting this system produce over 3 t/ha of grain with cowpea contributing about 60% of the grain yield obtained (Table 1). However, the traditional system, even with some application of insecticides on cowpea, produced a total of less than 1.5 t/ha of grain. Results from the crop seasons 2003–2005 indicated that the
Figure 8. Stages of the improved maize–double cowpea strip cropping system. (a). Maize–first cowpea crop at flowering, (b). Maize–first cowpea crop at full podding, (c). Maize at maturity, second cowpea crop at vegetative stage, and (d). Maize cut and stalked while second cowpea crop is maturing.
value of grain produced ranged from ₦113,589 to ₦145,823 in the improved systems compared to ₦26,579–₦54,100 in the traditional systems. The total cash inputs for improved seeds, fertilizers, and chemicals in the improved systems ranged from ₦8000 to ₦11,000. Thus, farmers are deriving major benefits, ranging from 300 to 400% superiority, from the improved system. The most attractive part of this system is the availability of cowpea grain in August which is normally the off-season for cowpea and prices are high. The benefits from the maize–double cowpea strip cropping system, therefore, include an increase in household food supply as well as more cash and high quality crop residues.

Summary

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

- **Plant early:** First planting in May/June.
- **Specific needs of component crops must be met to guarantee a high yield.** Maize needs adequate fertilization: 1 t/ha manure plus 100 kg NPK 15 15 15. Top-dress maize with 50 kg urea/ha. Cowpea needs two insecticide sprays.
- **Choice of variety: improved versus local:** First cowpea crop must be extra-early, 60 day, cowpea. Medium to late-maturing maize varieties including hybrids can be used. The second cowpea crop should be a dual-purpose variety.
- **Choice of planting geometry/pattern (row arrangements).**
  - 1 cereal: 1 legume—traditional system, too harsh on legumes.
  - 2 cereal: 2 legume—improved system but still harsh on legumes.
  - 1 cereal: 4 legume—improved system, however, the cereal production is minimal.
  - 2 cereal: 4 legume—improved system, allows for component crop agronomic activities, maximization of limited inputs, and is the best in enhancing the socioeconomics of farmers.
- **Harvesting depends on the component crop.** Harvest when crops are fully mature, dry well, and store properly.
Suggestions for further reading


