

# Package 105, Item 1

Type: Issue pack

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**Cowpea post-harvest activities**

1. **Introduction and how to use this issue pack**

This issue pack is designed to give radio broadcasters the information needed to create effective and entertaining radio programs about post-harvest activities in cowpea.

It talks about post-harvest cowpea in northern Ghana, but you can easily adapt the information to other sub-Saharan African countries where cowpeas are grown.

The issue pack begins with this introduction, then **Section 2** presents two true stories of cowpea farmers and traders in northern Ghana.

**Section 3** presents background information on the post-harvest part of the cowpea value chain. (Please see Resource Pack 95, Item 9—[*An introduction to value chains*](http://www.farmradio.org/radio-resource-packs/package-95-researching-and-producing-farmer-focused-programs/an-introduction-to-value-chains/)—for a definition of “value chain,” and for a better understanding of why value chains are important to both broadcasters and farmers.)

Finally, in **section 4**, we list sources for further information on post-harvest activities in cowpea. We include resource organizations, online radio programs, online videos, and online documents.

You could use the information in this issue pack in several ways. For example:

* You could use the stories in **section 2** as a starting point for creating your own local programming on post-harvest activities in cowpeas. You could interview farmers who grow and store, process, or market cowpeas. For example, you might ask them:
	+ What are the most effective and affordable ways to avoid pest damage in stored cowpeas?
	+ What varieties receive the best return in this area?
	+ Are there ways of adding value to cowpea on the farm that will boost farmers’ income?
* You can use the information in **section 3** as background material for any program on post-harvest activities in cowpea.
* You could contact one or more of the organizations listed in **section 4** for further information, or to interview experts.
* You could use the audio and video resources and online documents in **section 4** to help you create programs on post-harvest activities in cowpea.
1. **Stories about post-harvest activities in cowpea**

**Cowpea story #1**

Kwabena Naazie grows cowpea in Bussie, a village in the Lambussie Karni District of Ghana’s Upper West region. One major challenge faced by cowpea producers is crop spoilage, which forces growers to sell their harvest either at reduced prices, or not at all. Mr. Naazie learned about PICS storage bags (see below) on the radio and says that he and most other farmers in his area now use these bags to store their cowpea. He stored about 40% of his last cowpea harvest in PICS bags.

Without the new storage bags, says Mr. Naazie, cowpea spoils within 5-6 months because of insect infestation. But with them, Mr. Naazie learned that he can store his cowpea for more than three years. Currently, he simply stores it until the price is higher and then sells it.

As well as better preserving his harvest, Mr. Naazie realized that the PICS bags represented a business opportunity. He says, “I now buy these sacks from Wa and sell them in my community. Any time I bring them to Bussie, farmers rush in for them.” He made about 2000 Ghana cedis ($515 US) selling PICS bags over about seven months. He says that selling cowpea and PICS bags has enabled him to pay his children’s school fees and do other things.

**Cowpea story #2**

Amama Amadu has been trying to improve her cowpea harvest since she started farming three years ago.

The 30-year old farmer from Nyohindanyili, in the Tolon-Kumbungu District of Ghana’s Northern Region, says: “When I started, I used one bowl of cowpea [as seed] and didn’t even get half as much from my harvest. After that I went to an agro dealer who helped with sprays, but I still didn’t get anything.” Mrs. Amadu was struggling to feed her family.

Things started to improve when she learned how to compost, how to avoid using chemicals, and what prices to expect from the market by listening to the radio. She recalls: “Before, I would go to the market and people would buy at less than what I expected because I didn’t know what price it was going for. Now that I know the prices I can make a profit.”

Now, Mrs. Amadu wants to learn how to properly store her cowpea. Currently, she stores the crop in simple cocoa bags and uses chemicals to keep them from spoiling. But she learned about PICS bags on the radio, and hopes to use them after the next harvest and avoid storage chemicals altogether.

Mrs. Amadu wants to help herself and other women improve their harvest. She says, “I hope to speak on the radio so that I can talk more about the importance of farming and encourage other women to farm.”

1. **Background information on post-harvest activities in cowpea in Ghana**

**Introduction**

The leading cowpea-growing countries in the world are Nigeria, Niger, and Burkina Faso, but there is a lot of land planted with cowpea in many African countries.

In Ghana, farmers grow cowpea on about 180,000 hectares. The crop is the second most cultivated legume after groundnut. Most cowpea in Ghana is grown in the savannah areas of the north, though farmers can grow cowpea anywhere in the country.

In 2010, the average consumption of cowpea in Ghana was about five kilos per person per year. The demand for cowpea in the country is increasing because of high population growth.

Most households in West Africa eats cowpea. Cowpea has been called "the poor man's meat" because it contains so much protein. Although cowpea is two or three times as expensive as maize, rice, and other cereals, it is relatively cheap compared to other sources of protein such as milk, meat, or eggs. Unlike other commodities, cowpea can be stored without refrigeration. Because of this, it is an important source of protein for people who do not have access to refrigeration.

Cowpea is both a food security and a cash crop. Because it is quick to mature, farmers can grow and harvest the crop in two months, and get break-even yields even when there is little rain. Cowpea is called a "hungry season crop” because it is the first crop to be harvested before the cereal crops are ready. Households can store and eat cowpea when they run out of other foods.

The potential yield of cowpea is up to 2.5 tonnes per hectare. In 2010, the average cowpea yield in Ghana was about 1.3 tonnes per hectare.

Households can earn a good income by producing two or three crops of cowpeas per year. Until several years ago, most Ghanaian farmers sold their cowpeas shortly after harvest, mainly because of pest problems during storage. But in the last few years, they have been storing their cowpeas for a longer period, typically four to five months, because of the availability of good storage methods and storage insecticides..

Consumers in different countries have varying preferences for seed size, colour, and the texture of the seed coat. For example, Ghanaians might pay more for black-eyed peas, while Cameroonians would lower their prices for them.

Cowpea also helps the environment. Its deep roots help stabilize the soil, and the plant’s shade and dense cover help protect the ground from erosion and preserve moisture. These qualities are particularly important in dry areas. Like other legumes, cowpea fixes atmospheric nitrogen, increasing the nitrogen content of the soil. It is often intercropped with sorghum, millet, or maize, as much to foster their good health as for its own harvest.

#### **Food and feed uses**

Unlike other legumes, cowpea can be eaten at different stages of its development: as fresh green leaves, dry leaves, green pods, green beans, or dry seed. The most common form of cowpea eaten is the dry seed.

West African households use cowpea seeds in a variety of ways. Most cowpea is cooked with vegetables, spices, and palm oil to make a thick soup that accompanies the basic staple cassava, yam, or plantain. Households also grind cowpea seeds into flour, mixed with chopped onion and spices, and pressed into cakes that are either deep-fried (*akara* balls) or steamed (*moin-moin*). Some seeds are ground or crushed into meal that is used in buns, fritters, and sauces. Seeds are commonly boiled with maize, eaten as porridge, or even boiled in their pods. They can also be steamed or fried to make a paste or sauce eaten with *ugali* or other staples. Immature seeds are also boiled and eaten as a vegetable.

Cowpea flour is a traditional favourite in rural households in northern Ghana because cowpea flour is less susceptible to post-harvest pest damage and can be used in many different dishes. Thus, cowpea flour helps maintain food security between harvests.

The stems, leaves, and vines are used as animal feed and often stored for later use during the dry season.

**Nutrition**

Cowpea seed is very nutritious, containing about 20-30% protein and 2% oil, with the remainder being carbohydrate, minerals, and other nutrients. Cowpea is rich in vitamins B1 and B3, as well as dietary fibre, iron, and potassium, and low in fat and calories.

**Post-harvest activities for cowpea**

After harvest, pods should be sun-dried immediately, and then threshed. Before storage, clean seeds and separate them from chaff or haulms through winnowing. Only well-dried and properly cleaned seeds should be stored. It is important to dry cowpea before storage to reduce the moisture content of grains in order to avoid seeds getting moldy. A well-dried cowpea seed should have less than 10% moisture content. Such seeds make a cracking sound when crushed between the teeth.

*Threshing and winnowing*: Cowpea can be threshed manually by beating the plants on a cement floor, or beating bagged pods with sticks once they are dry enough. Various types of threshing machines are available in different sizes, powered by petrol, diesel, or electricity, for small-, medium-, and large-scale threshing of cowpea. Whatever the method used, cowpea seed can be easily damaged if threshed too roughly or when too dry. When planted, damaged seed will produce weak, stunted plants and other abnormalities.

Thresh the dry pods on a clean surface such as a tarpaulin. Dry the threshed grains on a clean surface for two sunny days. Test the grain to see if it is dry enough for storage or market by biting or pinching grain with your finger nails. When dry enough, grain should break or crack rather than bend or stick between teeth or fingernails. Afterwards, winnow against the airflow so that materials such as chaff and broken seeds are blown away, then collect the grains in a clean container,

*Sorting and grading*: Careful harvesting and post-harvest handling are needed to avoid cracked or split seeds. Sorting should separate broken seeds from full seeds, and remove foreign matter, discoloured or diseased or rotten grain, pest-damaged grain, and immature or shrivelled grain. These characteristics are the basis for grading the grains.

Farmers harvest the youngest leaves or tender shoots. These are usually higher in protein, and, without insect damage, often look more appealing. Older leaves accumulate dust or get spattered with mud from raindrops, while younger leaves do not need as much washing.

*Drying:* The lower the moisture content, the better the quality of seeds in storage. Cowpea seeds and pods are often sun-dried for several days before storage to reduce pest infestations in storage. This strongly reduces infestation from the main weevil storage pest, the cowpea weevil.

Dry the pods in the sun and protect from rain. Dry them on a clean surface such as a mat, plastic sheet, or tarpaulin, or on a raised platform. Do not dry the pods directly on the soil.

Research has found that drying cowpea in a simple, low-cost solar dryer, built from local materials, reduces weevil damage, though seed viability also drops. Solar-treating seeds may reduce post-harvest weevil injury but may not be effective at preserving seeds meant to be planted.

Leaves can be dried and then stored for the dry season. Leaves should be sun-dried for 1-3 days, and can then be stored for up to a year after cooking, as dried cooked leaves are not damaged by insects as much as dried seeds. Sun-dried leaves may lose nutrients, but losses can be reduced by minimal cooking and by drying in the shade.

*Cleaning and packaging*

Sun-drying and storage in polythene bags is effective, and appears to be better at controlling mould and insect infestation. Clean the grains, then winnow to remove chaff, dust and other rubbish. Remove shrivelled, diseased, or broken grains and grains of other varieties.

Place the grain in clean bags. If re-using bags which previously contained grain, wash the bags and then disinfect by boiling them in water for five minutes before placing the grain inside. Bags must be sealed to keep out insects and rodents. Grain can be treated before storage to control storage pests.

Some buyers want seed cleaned and bagged, while others will accept dry seeds in bulk and clean it themselves.

*Storage*

Clean out the store thoroughly before a new crop is loaded. Old residues should be burned. Only well-dried and properly cleaned seeds should be stored. As mentioned above, a well-dried cowpea seed should have less than 10% moisture content.

Stack bags on a raised platform or wooden pallet away from the wall. Avoid direct contact of storage bags with the ground. Inspect and remove infested or rotting grains regularly.

Cowpeas are often stored in drums, sometimes with added insecticide. There are also a variety of traditional storage structures.

*Managing storage pests*

The major pest of stored cowpea is the cowpea weevil, *Callosobruchus maculatus* (F.), though other similar beetle pests cause losses. In some African countries, many weevil generations thrive and reproduce during storage and cause losses of 90-100%.

Damage is restricted to eating quality only. It is not possible to eat (or sell) cowpea grains when they are riddled with weevil holes. Germination of cowpea seed is also affected because the seed depends on the food inside the seed coat until it develops roots.

Cowpea that are not stored with either chemicals or effective non-chemical methods are often completely consumed by storage pests within 10 to 12 months of storage. Storage losses in West Africa are substantial in spite of the use of storage insecticides. Few Ghanaian farmers keep their cowpea in storage over the entire storage season. Most farmers sell cowpea shortly after harvest, partly because they have difficulty dealing with storage problems. Other reasons are a lack of capital to invest in storing cowpea, and the need for immediate cash to pay off debts.

Because West African consumers pay substantially less for pest-damaged cowpea, this is a big economic loss. Farmers also lose money when selling early in the storage season because prices rise as cowpeas become increasingly scarce.

Storing cowpea in dry pods protects the grains in the pods from further attack by insect pests. As the pods dry, the pest's ability to infest them decreases. Thus, dry seeds stored in their pods are quite resistant to attack, whereas threshed seeds are susceptible to attack throughout storage. However, storing threshed seeds with airtight storage methods such as PICS bags (see below), or using recommended insecticides on threshed seeds in storage makes them even more resistant to pest attack than cowpeas stored in pods.

*Using ash*

For small quantities of seed, storage with wood ash is effective. Farmers should use an equal amount of wood ash and cowpea seed, mix them thoroughly, and store in a container. The ash and seed mixture should be covered with up to three centimetres of ash and the container must be closed tightly. Fine sand can be used instead of wood ash.

*Solar treatment*

For large amounts of cowpea, it is more effective to expose the seeds to high temperatures in order to kill cowpea weevils, larvae, and eggs. Solar treatment is an effective, low-cost, non-toxic pest control process, which does not alter the physical, cooking, nutritional, and other desirable properties of cowpea. Use the following steps:

1)      Spread straw or dry grass on level ground.

2)      Spread a black polyethylene sheet over the straw. (A polyethylene sheet measuring 3 metres x 3 metres allows 50 kg of seed to be dis-infested in one treatment.)

3)      Spread the cowpea grain uniformly on the polyethylene sheet.

4)      Cover the grain with transparent plastic material with a similar size as the first polythene sheet.

5)      Fold the edges of the two plastic sheets under and secure them with stones.

6)      Leave in the sun for at least two hours.

*Triple bagging/PICS bags*

You can also use PICS (Purdue Improved Cowpea Storage) triple bags to reduce insect damage during storage. Place grain in the innermost of the three bags and tie it tightly. Then tie the middle bag, and finally tie the outermost bag. When all three bags are tied tightly, any insects in the grain die from lack of oxygen. It is *not* necessary to treat seed with insecticide against storage pests when using PICS bags.

*Drums*

Drum storage offers the greatest economic advantage for storage periods of more than three months. It requires less labour than solar treatment or insecticides because the grain is handled only to fill and empty the drum. In Senegal, drum storage is economical because of the large supply and modest cost of steel drums. In other regions, drums are often sold at higher prices and drum storage may be less economical than triple bagging, solar treatment, or other storage technologies.

*Resistant varieties*

The following varieties were developed in Ghana are moderately resistant to storage weevils and other pests and diseases:

* Padi-tuya
* Songotra
* Bawutawuta
* Zaayura
* Hewale

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| *Botanical methods of preventing storage losses** One environmentally friendly and inexpensive way to reduce fungal contamination of stored cowpeas is with the essential oil of *Lantana camara*. Tests show that, at a concentration of 20 micrograms (thousandth of a gram) per millimetre, the essential oil was effective at managing fungal contamination.
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* In the DRC, powdered leaves of *Tephrosia vogelii* (*Bubawu tshiluba* in the local language) were effective at protecting stored cowpea seeds for five months when used at 45 grams per kilogram of cowpea seeds.
* Applying essential oils of four eucalyptus species (*Eucalyptus lehmannii, E. astringens*, *E. maidenii,* and *E. cinerea)* controlled cowpea weevils without harming seed germination.

*Processing*

Primary processing yields storable products that can be used as and when required, and include soaking, de-hulling, grinding or milling, germination. and fermentation. Secondary processing is involved in preparing final consumer products and includes various forms of heat treatment, including boiling, steaming, cooking, alkaline treatment, roasting, and frying in deep fat.

*Soaking* at room temperature reduces cooking time and the need for fuel, though long soaking times may lead to nutrient loss and bacterial infection.

*De-hulling* or removing the seed coat reduces cooking time and increases digestibility, but reduces the dry matter (the part of a food that would remain if all water were removed). Farmers can de-hull manually by rubbing or stirring wetted beans in a mortar and floating off the seed coats in water. This is laborious and time-consuming, and de-hulling machines are available to make the process more efficient. In Nigeria, cowpea is not usually de-hulled unless making cowpea flour. Also, cowpea may need to be de-hulled to be digestible for infants.

*Grinding or milling:* Cowpea canbe partially milled into dry split legumes, sometimes called *dhal*. Dhal is a good storable form of cowpea, not easily attacked by insects. Alternatively, whole or de-husked split cowpea can be ground into dry flour or ground wet into a batter for use in a number of sweet and savory dishes, either alone or in combination with cereals. Flours are winnowed toremove the husk and then sieved to obtain fine flour.

*Germination (sprouting)*: Use of germinated cowpeas is becoming popular in Nigeria and other West African countries. Germination or sprouting improves the overall nutritional value of legumes and gives a characteristic, agreeable flavor to cowpea. Germinated cowpeas can be dried and cooked later into sweet savory dishes with good nutritional qualities.

*Heat treatment:* Heat treatments for preparing cowpea include boiling to an *eating-soft* condition, pressure cooking, steaming, frying, and roasting. Cooking under pressure appears to be the best method of reducing cowpea cooking time, but pressure cookers are expensive. After the seed coat is removed, cowpeas can be ground into a dry flour or wet paste with a mortar and pestle, grinding stone, or village hammer mill. The paste or rehydrated flour canbe deep fat-fried into bean balls or steamed into *moin-moin*. Heat treatment for specific periods the digestibility of cowpea protein, and retains acceptable flavor and colour. But extended cooking at higher temperatures and pressures lowers nutritional quality.

*Alkaline treatment:* Boiling cowpeas cantake a long time, consuming a lot of fuel. Consequently, especially in Nigeria and Ghana, you can shorten the cooking time by adding an alkaline rock salt known in West Africa as *kanwa* or *trona*. Adding kanwa raises the pH of the cooking solution, which reduces cooking time. Kanwa is sometimes misnamed “potash” in Nigeria. It is mined from several deposits in West Africa. Using these alkaline salts during cooking increases water uptake and cowpea tenderization, thereby reducing cooking time. The level of *kanwa* used in cooking cowpea should be reduced to an optimum level——about one teaspoon per regular household meal of cowpea—to prevent reduction in protein quality while still saving cooking fuel. Sodium bicarbonate and wood ash are sometimes substituted for kanwa.

**Gender and post-harvest activities in cowpea**

In West and Central Africa, cowpeas are grown by both men and women, but women dominate post-harvest processing and marketing.

Cowpea provides a source of cash for women farmers who make and sell snack foods made from cowpeas. In many African countries, women harvest and sell direct to consumers on roadsides because pod prices are higher than dry seed prices. In general, women retailers buy the seeds from wholesalers and commission agents to sell smaller quantities in local markets.

In Nigeria, men particularly value the income and food benefits, while women emphasize home cooking and consumption and the feeding of small livestock such as sheep and goats.

**The cowpea value chain**

The cowpea value chain is highly commercialized in Ghana. Most cowpeas enter commercial trade from the surplus-producing areas in the north to southern urban centres through the Techiman and Tamale markets.

There are four main channels in the value chain for grain legumes, also known as pulses, such as cowpea in Ghana:

1. subsistence production and consumption (about one-third of the cowpea produced by households is eaten by the household itself);
2. dried unprocessed cowpea sold to local and long-distance markets for direct household consumption; and
3. dried cowpeas sold for industrial processing; and
4. manufacture of edible vegetable oil, food, and feed products.

In West and Central Africa, the majority of cowpea is sold in bulk. Vendors display large bowls of cowpeas that consumers can inspect before making their purchase. As noted above, the preferred visual characteristics of cowpea varies from place to place.

In West Africa, consumers eat cowpeas all year round, but almost all cowpea production occurs between August and December. Typically, prices are lowest during harvest. Prices rise steadily thereafter to a peak in June, July, and August.

Farmers sell cowpea to local traders in village markets. Local traders assemble small lots into larger volumes, then transport them to central, urban markets, and sell to stores and grain merchants. These merchants then sell wholesale to long-distance trade and local retailers. Wholesalers in large urban markets also travel to surplus regions to buy grain directly from farmers in village markets on market days.

Specialization is increasing, and farmers are increasingly selling to aggregators and commission agents rather than local traders. Aggregators and commission agents finance farmers and supply services such as tillage, threshing, shelling, assembling, cleaning, sorting and grading, repacking, and storing. Then they sell to long distance traders, poultry farms, and industrial processing companies. Aggregators are increasingly becoming dominated by farmers’ groups. There is also cross-border trade with several countries.

In 2004 in Ghana, the Savanna Farmers Marketing Company was established by a non-governmental organization to improve production by small-scale farmers. The organization started marketing in 2008. It improves the capacity of farmers to negotiate, aggregate produce, and sell through structured channels. In 2010, the company had 9,500 farmer-members who marketed over 12,000 tonnes of grains. The company links farmers to value chains by increasing marketed surplus and improving quality. It operates by establishing close business relationship with farmers through regular meetings, and organizes farmers into farmer-based organizations and helps them get registered as co-operatives, establishing links to rural banks for credit.

**Common names** **for cowpea**

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Arabic: lupia (in Sudan)

Botswana: dinawa, nyeru or dinawa (in Setswana)

English: cowpea, black-eyed pea, black-eyed bean, marble pea

Ethiopia: adanguari, nori

French: niébé

Kenya: boo (in Luo); kunde (in Swahili); thoroko (in Kikuyu)

Lesotho: linaoa (in Sesotho)

Malawi: nkunde (in Tumbuka); khobwe (in Chewa)

Mauritius: voehme (in Mauritian Creole)

Namibia: omakunde, olunya (white with black eye), omandume or ongoli (mixed black, brown, purple) (in Oshiwambo, Ovambo tribe)

Nigeria: agwa, akidiani

Portuguese: ervihia de vaca

Seychelles: brenm (in Seychellois Creole)

South Africa: dinawa (in Northern Sotho)

Spanish: chicharo de vaca

Swaziland: tinhlumayi (in Siswati)

Tanzania: kunde (in Swahili); nkunde (in Nyiha)

Uganda: amuli, boo-ngor, omugobe, boo (in Acholi and Luo)

Zambia: ilanda, nyabo (in Tonga)

Zimbabwe: nyemba (Shona); ndlubu (in Ndebele and Zulu)

1. **Further resources on the cowpea value chain in Ghana and sub-Saharan Africa**

***Resource organizations***

1. Savanna Agricultural Research Institute (SARI), Dr. I.D.K. Atopkle. Phone: 0208164898. Email: idkatopkle@yahoo.com
2. N2 Africa Project under International Institute of Tropical Agriculture (IITA), Prof. Samuel Adjei–Nsiah. Phone: 0208676166/0245395251. Email: s.adjei-nsiah@cgiar.org
3. Nu Image–PICS Bag, David Baba Yara. Phone: 0206618556. Email: nuimage2009@yahoo.com

***Videos***

# Purdue Agriculture, 2012. *Cowpea Storage Saves African Farmers Millions.*

[*https://www.youtube.com/watch?v=WRR9pS7B0W8&feature=youtu.be*](https://www.youtube.com/watch?v=WRR9pS7B0W8&feature=youtu.be)Scientific Animation Without Borders (SAWBO), undated. *Solar Treating of Cowpea Seeds.* <https://www.youtube.com/watch?v=epGFvCUrUJs>

***Documents***

1. Food and Agriculture Organization of the United Nations (FAO), 2004. *INPhO Post-Harvest Compendium: Cowpea*. <http://www.fao.org/fileadmin/user_upload/inpho/docs/Post_Harvest_Compendium_-_Cowpeas.pdf> (1,912 KB) (in English only)
2. Ishikawa, H., I. Drabo, S. Muranaka, and O. Boukar. 2013. *Cowpea field guide for Burkina Faso*. IITA, Ibadan, Nigeria. 30 pp. <http://biblio.iita.org/documents/S13ManIshikawaCowpeaNothomNodev.pdf-93056c479264da9365a7771527da53f5.pdf> (3,221 KB) (English only)
3. Mulei, W.M., Ibumi, M. and Woomer, P.L. 2011. *Grain Legume Processing Handbook: Value Addition to Bean, Cowpea, Groundnut and Soybean by SmallScale African Farmers*. Tropical Soil Biology and Fertility Institute of the International Centre for Tropical Agriculture. Nairobi. 42 pp. <https://www.n2africa.org/sites/n2africa.org/files/images/Handbook%20Grain%20Legume%20Processing%20S.pdf> (1,069 KB) (in English only)
4. N2Africa and ASHC (Africa Soil Health Consortium), 2014. *Better cowpea through good agricultural practices: For farmers in Zimbabwe.* <http://africasoilhealth.cabi.org/wpcms/wp-content/uploads/2014/12/290-N2Africa-Zimbabwe-cowpea-booklet.pdf> (1,862 KB) (in English only)
5. National Academies Press, 2006. *Lost Crops of Africa, Volume II: Vegetables*, chapter 5, pages 104-117. <http://www.nap.edu/read/11763/chapter/7#107>
6. Republic of South Africa Department of Agriculture, Forestry, and Fisheries, 2011. *Production guidelines for cowpeas*. <http://www.arc.agric.za/arc-gci/Fact%20Sheets%20Library/Cowpea%20-%20Production%20guidelines%20for%20cowpea.pdf> (3,485 KB)(in English only)
7. Savanna Agricultural Research Institute, 2012. *Production Guide on Cowpea*. <https://csirsavannah.wordpress.com/2012/12/04/production-guide-on-cowpea-vigna-unguiculata-l-walp/>(65 KB) (in English only)

## Acknowledgements

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