ENHANCING FOOD SECURITY, NUTRITION AND PRODUCTION EFFICIENCY OF HIGH-YIELDING GRAIN LEGUMES IN SELECTED RURAL COMMUNITIES OF LIMPOPO PROVINCE, SOUTH AFRICA

JAN Asiwe, IB Oluwatayo and DN Asiwe

VOLUME 2:
PRODUCTION GUIDE, TRAINING OF FARMERS AND COWPEA PROCESSING, AND CAPACITY BUILDING

WATER RESEARCH COMMISSION

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Report

to the Water Research Commission

by

JAN Asiwe, IB Oluwatayo and DN Asiwe

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Private Bag X03

Gezina, 0031

South Africa

orders@wrc.org.za or download from www.wrc.org.za

EXECUTIVE SUMMARY

Undernutrition can be divided into protein energy malnutrition and micronutrient deficiencies. Globally, the most important micronutrient deficiencies are iron, vitamin A, iodine and zinc. Reports have shown that children living on commercial farms are severely affected, and the prevalence of malnutrition is higher in rural areas than in urban areas. Malnutrition usually results in severe stunting and underweight in children, especially children of the ages one to two years and children under six. It is internationally recognised that malnutrition must be addressed through a multi-sectoral response and a multi- or interdisciplinary research approach. Water use for food production, improved nutrition and health can be achieved by providing a better diversity of foods and more nutritive diets. Furthermore, the lack of information means that it is unclear in most instances to what extent the various and changing environments influence food choices, nutrient intake and the contribution of home garden production to food and nutrition security. This hinders the development of appropriate, sustainable and integrated agricultural, nutritional and social programmes that will improve the nutritional health of rural communities. It is proposed that participatory action research be adopted as an overarching method of understanding the nutrition-related needs of the rural poor.

To enhance and sustain the production of cowpea in South Africa, its production must be matched with consumption or utilisation. Although cowpea is believed to have originated in South Africa, its production, consumption and diversification of products are very poor.

This study focused on one of the ways to enhance sustainable food production and nutrition in the drought-prone communities of Limpopo through the introduction and cultivation of high-yielding, disease- and insect pest-resistant, early-maturing and water use efficient grain legumes (cowpea and pigeonpea).

This project had the following cardinal objectives:

- Introduce and promote high-yielding, pest-resistant, early-maturing and water use efficient grain legumes (cowpea and pigeonpea)
- Promote the transformation of existing cropping practices through the introduction of modern production practices (strip intercropping of legumes with maize)
- Improve the nutritional dietary intake of communities through the introduction of cowpea-based food products (*Akara and Moin-moin*) and the fortification of their maize sole diets with cowpea products
- Identify stakeholders in the cowpea value chain (cowpea production and food processing value addition) and enhance human capital development in the value chain through training and a farmers' school
- Stimulate sustainable development through the improvement of traditional agronomic production practices, the preparation of cowpea diets and cultivation of resource use-efficient legumes

In addition, the project had a capacity-building task to train farmers on agronomic and entrepreneurial skills to empower them to produce these crops, as well as capacitating four MSc degree students.

Results to attain both the first two and the last two objectives were presented in Volume 1 of this project report. Part of the result to attain the third objective was also presented in Volume 1.

Volume 2 presents information on the production of cowpea and pigeonpea or a production guide and atlas of training conducted for farmers on the agro-processing of cowpea and pigeonpea, as well as cultural practices.

One of the outcomes of this project was to produce production guide for cowpea and pigeonpea.

The production guide contains information to guide any farmer on agronomic or cultural practices in cowpea and pigeonpea production, from land preparation, planting varietal selection through harvesting, as well as post-harvest management and utilisation. The document also contains weather and soil requirements for good production.

It contains relevant information generated on the capacity building and skills development of farmers. The findings of the study showed that 125 farmers at Ga-Thaba and Bela-Bela were trained on agronomic skills to empower them to produce cowpea and pigeonpea. Farmers were trained in 11 areas, ranging from land preparation to harvesting and fumigation. In addition, farmers were trained to collect data and keep farm records. The activities of the project included the training of the farmers on the agro-processing of cowpea and pigeonpea for different menus. The atlas of different menus was beautifully presented in the document. This was to empower the farmers with the skills to prepare cowpea and pigeonpea in different menus to enhance dietary intake, nutrition and dietary diversity. The different preparation methods will stimulate intake and nutrition, which, in turn, will steer the consumption and production of the crops. These products (*Akara* or cake, pudding and porridge are innovative and first of their kind on South African menus). The project also captured events such as farmers' days that were organised during the life cycle of the project. Six farmers' days were organised at Ga-Thaba and Bela-Bela to showcase the research findings of the project and cowpea and pigeonpea menus.

The study also produced a wide range of recipes for preparing different menus for cowpea and pigeonpea. The recipes are a preparation guide to aid anybody who wants to prepare assorted cowpea menus.

In conclusion, this study achieved the overall objectives of providing information for a production guide for cowpea and pigeonpea, and empowering the farmers through training and skills development.

The specific key indicators of innovative end-products achieved by the project are as follows:

- A production guide of cowpea and pigeonpea
- The training of 125 farmers on agronomic skills
- The training of 125 farmers on agro-processing and the preparation of different cowpea and pigeonpea menus
- The training of 125 famers on record-keeping and other farm management techniques for profit making and tracking resources used in the production of cowpea and pigeonpea
- The production of recipes for the preparation of different cowpea menus
- The organisation of six farmers' days to showcase and disseminate the research findings of the study

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Reference Group

Dr GR Backeberg	Water Research Commission
Prof N Monde	University of Fort Hare
Ms Moloko Mojapelo	Plant Production Directorate, Department of Agriculture, Forestry and Fisheries
Ms Dephney Marabe	Plant Production Directorate, Department of Agriculture, Forestry and Fisheries
Mr GE Nyoka	Food Security Directorate, Department of Agriculture, Forestry and Fisheries
Prof A Oelofse	University of the Western Cape
Prof W van Averbeke	Tshwane University of Technology
Dr S Mpandeli	Water Research Commission

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Project Team

Prof JAN Asiwe	University of Limpopo
Prof IB Oluwatayo	University of Limpopo
Dr DN Asiwe	University of North-West, Vaal Triangle Campus

The following MSc students from the University of Limpopo participated in the project:

Ms KA Maimela
Ms KS Madimabe
Ms SV Chauke
Ms CM Masegela

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LIST OF ACRONYMS AND ABBREVIATIONS

ARC	Agricultural Research Council
ARC-ISCW	Agricultural Research Council-Institute of Soil Climate and Weather
DAFF	Directorate of Agriculture, Forestry and Fisheries
FAO	Foods and Agricultural Organisation
ICRISAT	International Crops Research Institute for the Semi-arid Tropics
IITA	International Institute of Tropical Agriculture
WRC	Water Research Commission

CHAPTER 1: PRODUCTION GUIDE

1.1 THE ECONOMIC IMPORTANCE OF COWPEA

Cowpea, *Vigna unguiculata unguiculata* (L.) Walp, is an important major staple African food crop. It provides more than half the plant protein in human diets. The seeds are rich in proteins (20-30%), carbohydrates (63.6%), vitamins and other essential mineral nutrients. As a food, it is eaten in the form of dry seeds, green pods, green seeds and tender green leaves. The trading of seeds and processed foods provides both urban and rural opportunities as a regular income earner. The aboveground plant parts of the cowpea, except for the pods, are utilised for animal fodder. It is a source of employment to all involved in its value chain. In addition to its importance as food and feed, the spreading indeterminate or semi-indeterminate bushy cowpea varieties provide ground cover, thus suppressing weeds and providing some protection against soil erosion.

The role of cowpea in the restoration of soil fertility, as well as its compatibility with many crop mixtures, has made it a common component of most cropping systems present in the tropical African savannah zone. The leaf litter and root nodules decay to enrich the soil with nitrogen for the benefit of subsequent crops. As a result of this, cowpea is an important component of most cereal and legume cropping systems.

Another important feature of cowpea is that it fixes atmospheric nitrogen through symbiosis with nodule bacteria (*Bradyrhizobium* spp). In so doing, it provides about 80-90% of its own nitrogen requirements. Many experimental findings indicate that the soil nitrogen levels increase following cowpea cropping. This attribute allows adequate yields in nitrogen-deficient soils where non-nodulating crops (maize and wheat) fail. Maximising nitrogen fixation is an economic way of coping with expensive nitrogenous fertilizers in many tropical and sub-tropical countries.

1.2 THE ORIGIN OF COWPEA

There is significant controversy regarding the origin of cowpea. Some researchers believe that it originates from West Africa, because both wild and cultivated species abound in the region. Other researchers believe that it originated in Southern Africa. However, its production has spread to East and Central Africa, India, Asia, and South and Central America.

1.3 PRODUCTION LEVELS AND LAND AREA UNDER CULTIVATION

In 1981, global cowpea production was estimated at 2.7 million tonnes harvested from 7.7 million hectares. It is difficult to obtain reliable statistics on cowpea land area and production because most

countries do not maintain separate records on cowpea, and cowpea production has not been recorded. Therefore, records on cowpea production offer conservative estimates.

That notwithstanding, and based on the information available from the Food and Agricultural Organisation (FAO), it was estimated that over 3.3 tonnes of cowpea was produced worldwide in 2000 from at least 12.5 million hectares. Cowpea production is widely distributed throughout the tropics, but Central and West Africa account for over 64% of the area with about 8 million hectares, followed by about 2.4 million in Central and South America, 1.3 million in Asia, and 0.8 million in East and Central Africa. Cowpea can be regarded as the fulcrum of sustainable farming in semi-arid lands. This applies to West and Central Africa. In these regions, the area of cowpea production extends westerly from Cameroon through Senegal, lying mainly between 10° N and 15° N, covering the dry savannah (northern Guinea and Sudan savannahs), as well as the Sahel zones. There are also a few additional pockets of production at more southerly latitudes, where the dry savannah agro-ecology penetrates closer to the West African coast, as in Benin and Ghana. The major producing countries in West Africa are Burkina Faso, Ghana, Mali Niger, Nigeria and Senegal. Cowpea production in Nigeria was estimated at about 2.1 million tonnes in 1999. Presently, in Southern Africa, cowpea is planted primarily for fodder, with little production for grain, which is undertaken by smallholder farmers. Yield levels can be as low as 250 kg/ha. This emanates mostly from local farmers. The main cowpea-producing areas in South Africa are KwaZulu-Natal, Limpopo, Mpumalanga and North West.

1.4 SOIL REQUIREMENTS

Cowpea is grown in a wide range of soils, preferably sandy loam soils, which are less restrictive to root growth. This adaptation to lighter soils is coupled with drought tolerance through reduced leaf growth, reduced water loss through stomata, and leaf movement to reduce light and heat load when stressed. Cowpea is much less tolerant to cold soil than the common bean, and it has a low tolerance of waterlogging. Cowpea thrives in well-drained soil and flourishes less in heavy soils. It requires a soil pH level of between 5.6 and 6.0.

1.5 TEMPERATURE AND WATER REQUIREMENTS

Cowpea grows best during the summer season. The optimal temperature range is between 16 and 35 ^{o}C. Cowpea is heat-loving and drought-tolerant and has lower soil fertility requirements than many other crops. Well-distributed rainfall is important for cowpea's normal growth and development. The frequency and unreliability of rainfall poses a problem for cowpea growth in South Africa. In some areas, the frequency of rain is too high, resulting in flooding, while in other areas, the rainfall is so unreliable that moisture conservation remains vitally important for crop production. Cowpea utilises soil moisture efficiently and is more drought tolerant than groundnuts, soybean and sunflower. Cowpea can be produced satisfactorily in regions where the annual rainfall is recorded at between 400 and 750 mm. In some areas of Mpumalanga, where the annual rainfall is high, cowpea could be planted during the period that coincides with the peak rainfall, i.e. the vegetative or flowering stage, so that the pod-drying stage falls in the dry season. Adequate rainfall is important during the flowering or podding stage. Cowpea reacts to serious moisture stress by limiting growth (especially leaf growth) and reducing leaf area by changing leaf orientation and closing the stomata. Flower and pod abscission during severe moisture stress also serve as a growth-restricting mechanism.

1.6 PHOTOPERIOD REQUIREMENTS

Varieties vary in their response to the length of sunlight hours. Some are non-sensitive and can flower between 35-40 days after sowing when grown at a temperature around 30 ^{o}C. The flowering time of photosensitive varieties depends on time, soil moisture level and the location of sowing, and flowering may take longer, depending on the ambient conditions. Even in early flowering varieties, the flowering period can be extended by warm and moist conditions, leading to asynchronous maturity. Day length of between 11 and 12.5 hours is ideal to initiate flowering in cowpea. In South Africa, day lengths are

shorter during the winter and, unfortunately, only very few areas in South Africa can support cowpea production during winter.

1.7 GROWTH HABITS

Cowpea plant types can be grouped into four classes: erect, semi-erect, prostrate and trailing or climbing. There is significant variety within cowpea classes. Growth habits range from indeterminate to fairly determinate, with the non-vining types tending to be more determinate. Generally speaking, farmers classify cowpea into two categories depending on the time taken to reach maturity (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 they spread to yield significant biomass or fodder for farming.

1.8 CONSTRAINTS TO COWPEA PRODUCTION

Cowpea production in Africa and Asia is characterised by low yields ranging from 240 to 300 kg/ha. It is limited by biotic, environmental, edaphic and socioeconomic constraints. Biotic constraints include insect pests, weeds and diseases. Insects constitute a significant threat to cowpea production. In all, insect pests pose the greatest threat in West and East African crops. Cowpea is attacked by a broad spectrum of insect pests from the germination to storage phases. Several of these pests are believed to be indigenous to Africa and may have co-evolved with a complex of wild plant species from different families and genera that may serve as alternate hosts during the off-season. Their effect varies from one agro-ecology to another. Insect pests are known to cause yield losses ranging from 20 to 100%.

Notorious weeds and parasitic weeds influence the cowpea's yield reduction. Yield losses due to weeds and parasitic weeds range from 40-81 and 30-50%, respectively. The prevalence of fungi, viral and bacterial diseases, and nematodes continues to limit cowpea yields in various cowpea-producing areas. Losses due to fungal, bacterial and viral disease organisms are enormous and vary between 18-75 and 20-30% due to nematodes.

Environmental stress caused by weather conditions, especially drought and temperature, reduces the cowpea yield potential in many cowpea-growing areas. Problems arising from soil conditions not only affect lands that are subject to continuous cropping, but also lands that are subject to heavy leaching of soil nutrients, which affect cowpea production in the tropics. These soils have a low pH level (acidic), high aluminium, iron and manganese toxicity, low soil nutrient availability, and especially nitrogen, phosphorus, and calcium (and at times potassium). The symbiont, which is the bacterium that provides legumes capable of fixing nitrogen, is sometimes inefficient due to high soil temperatures. In the West African savannahs where most of the world's cowpea is produced, the temperature of the soil's surface layers often exceeds 40 °C during dry periods, thereby reducing rhizobia activity in the soil. Acid soils, which contain a high concentration of hydrogen ions and free aluminium, are low in calcium and available phosphorus, and can be deficient in molybdenum, with phytotoxic levels of manganese. Cowpea nodulation is generally reduced in acid soils with excess aluminium and manganese, where even tolerant strains fail to infest root hairs. However, liming can be used to correct or ameliorate the problem of soil acidity and aluminium toxicity.

Lastly, the product quality, which must be tailored towards consumer preferences in particular areas, limits the adoption and acceptability of improved cowpea varieties. The dry-seed preferences of West African consumers are well defined. However, elsewhere, consumer tastes are less clearly defined. In many areas, mottled, red and black seeds are preferred for certain purposes.

In South Africa, constraints to cowpea production include diseases such as the viral, bacterial, fungal and insect pests, which include aphids (*aphis craccivora* Koch), pod-sucking bugs, blister beetles and bruchids. Other factors that limit yields include nematodes, extreme temperatures, low soil fertility, lack of good seed and improved varieties, as well as poor cultural practices. Viral diseases seem to dominate in

South Africa. Twelve viral diseases that are known to attack cowpea have been identified. The prevalence of viral diseases in South Africa is attributed to the high incidence of vectors transmitting the virus.

1.9 CULTURAL PRACTICES IN COWPEA PRODUCTION

Farmers utilise several cultural practices in their cowpea production systems. Agronomic practices such as bush-clearing, tillage, weed control, date of planting, manipulation, plant spacing, soil fertility management, pest control and cropping patterns strongly influence cowpea yields. Farmers are known to utilise two or more of these practices in a growing season, depending on the prevailing circumstances to avert pest problems. Cultural practices, such as planting time and plant density, minimise dependence on chemical controls. Other cultural practices that could improve cowpea yield include good land preparation, pest control, fertilizer application, irrigation, timely harvesting and good storage. In addition, an adequate and good distribution of rainfall, especially from planting until mid-podding, is vital for a high cowpea yield.

In order to obtain high cowpea yield, many agronomic practices are employed, which are discussed below.

1.10 LAND PREPARATION

Cowpea requires loose and well-prepared soil for optimum performance. Cowpea may be adversely affected by soil crusting under certain soil and environmental conditions. Soils should be tilled deeply enough to ensure that the tap root is not barred from penetrating the soil, e.g. hardpan.

The land chosen for cowpea production must not be waterlogged, but rather well drained. Waterlogging reduces oxygen availability to plant roots. During land preparation, the existing fallow weeds, trees and shrubs on the site are cut down manually or slashed with a tractor. All fallen tree stumps should be removed. This should be followed by ploughing and harrowing using a disc plough and harrow. Four to six days should be allowed between each operation to enhance good soil tilt for sound seed germination. Subsequent to harrowing, the land may be ridged or left as flat seedbeds. Two rounds of harrowing provide sufficient tilt for good root growth. Ridges can then be made. Cowpea can be planted in flat ground, especially where soils are loose and prone to erosion. In these areas, minimum tillage should be used. Ridging could be achieved by using an animal-drawn ridger or manually with a hand hoe.

1.11 MARKING OR PLOT LAYOUT

After land preparation, the field is marked into blocks of known areas with alleyways between the blocks to enhance material movement and agronomic operations.

1.12 SEED PREPARATION: SEED-SORTING AND TREATMENT

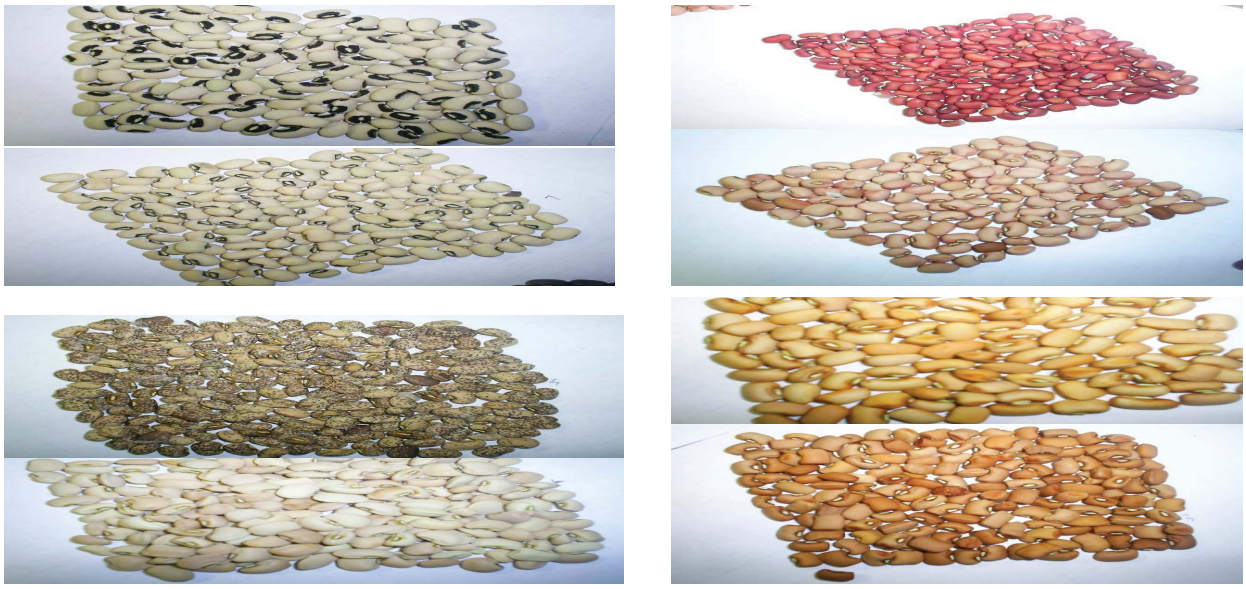
Seeds to be used for planting must be viable and sorted to ensure that they are free from insect damage (without damage holes or wrinkles) or any inert materials. The seeds should be treated with seed-dressing pesticides such as Apron Plus® at a concentration of 10 g per 4 kg of seed or one sachet per 4 kg of seed to enhance good germination and protect the seedlings against insect and fungal infections soon after emergence.

1.13 VARIETY SELECTION

The University of Limpopo has developed high-yielding, pest-resistant cowpea varieties with varying maturity periods, different seed colours and varieties that are adapted to various environmental conditions. Some of these varieties have been registered and released in South Africa, and the seed companies are promoting and commercialising them. Choosing an appropriate variety is the most important factor in crop production. Varieties should be planted that are stable and resistant to prevailing biotic and abiotic stresses in the location. Other important considerations in variety selection are growth pattern, maturity, market value, seed size and seed colour. About 20-25 kg of seed is needed to plant one hectare of sole crop land, depending on the seed size. Improved varieties are obtainable from the Agricultural Research Council (ARC), Potchefstroom, or from the Department of Plant Production at the University of Limpopo's School of Agricultural and Environmental Sciences.

Photograph 1.1: Cowpea field, showing fodder-type cowpea

Photograph 1.2: A good grain cowpea type



Photograph 1.3: Variation in cowpea seed coat colours produced for the South African market

1.14 ACQUISITION OF PLANTING MATERIALS

Planting of insect-, pest-, and disease-resistant, as well as high-yielding varieties is one of the ways to reduce over-dependence on pesticides, and falls in the field of host plant resistance.

1.14.1 Host plant resistance

The amount of injury caused by an insect pest to a crop plant depends on the feeding habit of the pest species, the size of its population and the capacity of the plant to withstand the type and amount of feeding injury that results from the species and its population. The ability of plants to withstand attacks and recover from injury are properties associated with the concept of host plant resistance. Insect resistance in plants is defined as the relative amount of heritable qualities the plant possesses, which influences the extent of insect damage. According to Painter (1951), the three mechanisms involved in host plant resistance include preference and non-preference, antibiosis and tolerance. A plant is said to be non-preferred if it possesses some physical or chemical characteristics that render it unsuitable to insect pests for feeding, oviposition or shelter. Resistance is antibiosis if the plant possesses some chemical qualities that can adversely affect the insect's biology. Resistance is tolerance if the plant is capable of producing a good yield under a given insect population, which, under similar conditions, is capable of causing economic damage to a susceptible cowpea variety.

The use of host plant resistance to curb the menace of pests in cowpea crops has been limited by a lack of high-level resistance genes. Of all the cowpea accessions screened for resistance to major pests, only a few have high to moderate levels of resistance to *Aphis craccivora*, *Megalurothrips sjostedti* and *Callosobruchus maculatus*. Notwithstanding this, several varieties with resistance levels higher than in commercial varieties have been identified at the International Crops Research Institute for the Semi-arid Tropics (IITA) in Nigeria. Varieties with low levels of resistance to insect pests could not be used as sole control measures, but could be used in conjunction with other interventions, such as cultural practices, biological control and minimum insecticide application. This integrated approach is necessary to delay pest growth and development, and to enhance the role of natural control factors.

1.15 PLANTING TIME

Cowpea should be planted when there is sufficient moisture in the soil to permit good germination and seedling establishment. Cowpea should be planted after a good rain (above 15 mm). It is not advisable

to plant cowpea in dry soil and planting time must be planned to ensure that harvesting coincides with the dry period that takes place in winter in South Africa (from May to June). This enhances good seed quality and natural seed drying to ensure the low moisture content needed for processing and storage. Planting could commence when rain is stable and reliable in South Africa, starting from the second to third week of December to the first to second week in January. Late-maturing varieties should be planted earlier than early-maturing varieties, preferably during the second week of December. Photosensitive varieties should be planted during the first week of January to reduce their period of vegetative growth.

1.16 PLANT SPACING AND DENSITY

Cowpea spacing depends on the variety and cropping system that are used. The recommended planting for improved varieties is 75 cm between rows and 20 cm within rows for small-scale production. For early-maturing varieties with an erect growth habit, the row-to-row spacing can be reduced to 50 and 10 cm as intra-row spacing (using a mechanical planter). For late-maturing and photosensitive cowpea or pigeonpea varieties, planting on flat soil or ridges is recommended, with row spacing of between 75-150 cm apart and 40-50 cm intra-row spacing. Three seeds per hill are sown and then thinned to two plants per hill about one week after emergence in the case of smallholdings where farmers plant manually. Thinning is optional, as this may increase labour costs. Plant populations could vary from 133,000 plants per hectare for erect or semi-erect varieties to 60,000 plants per hectare (50 x 75 cm) for the spreading types. In experimental stations, the seeding rate ranges from 25-30 kg of good and viable seed per hectare. Commercial seeding rates depend on plant spacing.

1.17 ROUGING

Rouging is the act of removing off-types or volunteer crops from the plant population to avoid contamination during harvesting and out-crossing. Rouging should be carried out during the seedling, flowering and podding stages, as well as before harvesting. Leaf shape, flower colour, pod colour, plant height, plant morphology and maturity can be used to identify off-types. A rouging operation is critical to ensure pure and high-quality seed. The farmer must be conversant with the morphological characteristics of the varieties being grown, and should be able to distinguish them from the off-types and volunteers. Avoiding using the same piece of land season after season will reduce the incidence of volunteer stands from the field.

1.18 WEED CONTROL AT PLANTING

The application of herbicides such as Roundup and Dual at a rate of 2.5-3.0 and 0.5 litres per hectare, respectively, is important immediately after planting to control weeds, especially if planting is carried out two to four weeks after land preparation. It is important to allow for the emergence of weeds in the field for about two to three weeks before planting to enhance efficient weed control. Post-emergence (Roundup) and pre-emergence (Dual) herbicides could be mixed to effect good weed control at planting, depending on the weed situation and planting time. Soil-active herbicides such as Dual should not be applied when soil moisture is excessively low. Subsequent weed control after planting can be achieved through manual weeding or by applying recommended selective post-emergence herbicides such as Bentazone, Fusilade or Scepter.

1.19 WEED CONTROL DURING CROP GROWTH

Weeds, which grow in association with cowpea, differ in flora and intensity from one region to another. Their distribution is affected by factors that include cropping systems, methods of weed control and cropping frequency. Some of the commonly observed weeds in cowpea fields include *Synedrella nodiflora* Gaertn., *Talinum triangulare* (Jacq.) Willd*, Acanthospermum hispidum* DC, *Amaranthus* spp., *Commelina bengahalensis* L., *Brachiaria* spp., *Digitaria* spp., nutsedge (*Cyperus spp*. (L.)), *Cynodon dactylon*, (L.) Pers., *Paspalum* spp. and *Eleusine indica* Gaertn. Although these weeds and many other dryland weeds may occur in cowpea fields, some are known to be more detrimental to cowpea crops,

either because they are difficult to kill or because they seriously interfere with cowpea growth and development. Such weeds include wild poinsettia (*Euphorbia heterophylla* L.), iron weed (*Vernonia galamensis* (Cass) Less.) and *Striga gesnerioides*. In general, weeds reduce cowpea yield due to competition for light, water, nutrients and space.

Weed interference in crops under zero tillage depends on the cropping season, cropping pattern and crop species. Some weeds' interference with cowpea plants is lethal and often leads to the plant dying if the variety is susceptible to them and if no control measures are initiated timeously, as is the case with *Striga* and *Alectra*. Yield losses due to ordinary weeds and parasitic weeds range from 40-81% and 30-50%, respectively.

Weed control methods include cultural, biological and chemical interventions. These methods have been shown to minimise weed competition in cowpea fields. Cultural interventions include methods that farmers use to kill or suppress growing weeds from the crop environment using their bare hands, hand-held implements, and animal or tractor-mounted implements. In many small-scale production operations, the manual weeding method and/or the method using various types of hand-held implements is as old as agriculture itself. The effectiveness of manual weeding is short-lived and requires ongoing weeding. It is recommended that hand weeding be done during the first six weeks after planting cowpea. This period is critical, as it is during this period that the cowpea crop establishes ground cover. Biological control involves the use of biological agents that are known as natural enemies to suppress weed growth and interference. This intervention has significant potential in weed management, but has not been utilised in the control of weeds in South African cowpea fields. However, in Brazil, it has been used successfully to control prickly pear (*Opuntia* spp.) and St. John's wort (*Hypericum perforatum* L.) in maize fields.

Chemical weed control involves the use of herbicides to control weeds. These herbicides can be applied pre- or post-emergence. Several herbicides have been identified to contain weed growth in cowpea crops, however only Trifluralin is registered in South Africa. These chemicals include Metolachlor and Pendimethalin, which should be administered pre-emergence, and Fusilade, which should be administered post-emergence. These herbicides are very effective against grasses, and a formulated mixture of Metabromuron, Metolachlor and Scepter has realised effective control for most annual broad-leaf weeds in cowpea crops when used as pre-emergence herbicides (for example, Scepter, Basagran, Bentazone and Fusilade, which are selective against broad-leaf and grass weeds, respectively).

1.20 INTERCROPPING

Cowpea may be planted as a sole crop, or intercropped with maize, sorghum or millet. There are several intercropping patterns. Farmers in West Africa are known to plant five to seven rows of cowpea between four to five rows of millet, sorghum or maize. This type of intercropping is known as strip intercropping, which is one of the innovations that this project is introducing to farmers. This practice has significant potential for the farmer, fostering cash-earning potential from both crops, distributing labour and spreading the risk in times of crop failure due to pests or abiotic stresses.

The intercropping system where crops are planted in rows is more advantageous than mixed planting (with no definite row arrangement). The advantages include the easier application of farm inputs, movement and farmer operations. Mixed planting should thus be discouraged.

Photograph 1.4: Strip intercropping of maize and pigeonpea

Photograph 1.5: Strip intercropping of cowpea and maize

Photograph 1.6: Mixed intercropping of cowpea and maize characterised by no definite row arrangement and low plant stands

1.21 FERTILIZER APPLICATION

Organic and inorganic fertilizers can be applied when the soil is nutrient deficient. A starter rate of about 15 kg of nitrogen per hectare is sometimes required for early plant development in low-nitrogen soils. Cured animal dung can be applied. Phosphorus is often the most deficient nutrient. Therefore, an optimum application of phosphorus fertilizer is necessary for a sound cowpea yield. Single super phosphate fertilizer should be applied at a rate of 50-100 kg (one to two bags) per hectare, depending on the level of phosphorus deficiency. Nitrogen and potassium fertilizers are only needed when there is obvious proof of deficiencies.

1.22 INSECT CONTROL

Common insect pests that affect cowpea in a South African context include defoliators, aphids, pod borers, pod-sucking bug complex and flower beetle (*Mylabris spp*.) Insects can cause severe damage if they are not controlled. In situations where insect pest pressure exceeds the host plant's tolerance, insect control can be achieved by applying insecticides. Insecticides such as Karate EC, Thiodan and Sherpa Plus at 80 mℓ/20 ℓ of water (i.e. 1 ℓ/ha), or Talstar, Aphox, Pirimor and Cypermethrin can be used, depending on the farmer's insect control objective. To obtain a good yield, it is recommended to spray once at three weeks after planting (seedling stage) if there is an incidence of aphids, foliage beetles and leaf hoppers, and two to three sprays at the flower or bud stage (flowering stage) to full podding stage. The intervals between spraying should be set at between 7 and 10 days. Insecticides can be applied with a tractor (boom sprayer) or a knapsack sprayer, depending on the scale of production. The obtainable yield depends on the effectiveness of pest control measures that are applied and the yield potential of the cowpea variety. A grain yield of 1.5 to 2 kg/ha is possible in a rainfed environment with a low plant population of 100,000 plants per hectare.

1.23 COMMON INSECT PESTS OF COWPEA IN SOUTH AFRICA

*Photograph 1.7: Cowpea aphids (*Aphis craccivora *Koch)*

*Photograph 1.8: Seed damage caused by the cowpea beetle (*Callosobruchus rhodesiasus*). The white specks are the eggs, while the holes are the exit holes through which the adult cowpea beetle emerges*

Photograph 1.9: Blister beetle *(Mylabris spp)*

Photograph 1.10: Pod-sucking bug *(Anoplocnemis curvipis)*

Table 1.1: Some insecticides for cowpea insect pest control

Insecticide/ trade name	Formulation	Rate of application (ℓ/ha)	Rate of application (mℓ/20 ℓ of water)	Target insects
Sherpa Plus	280 EC	1	80	Beetles, thrips, pod bugs
Decis	2.5 EC	0.5	40	Beetles, thrips
Nuvacron	40 EC	0.5-1.0	40-80	Beetles, thrips, pod bugs
Perfekthion	40 EC	0.5-1.0	40-80	Beetles, thrips, pod bugs
Rogor/Dimethiote	40 EC	0.5-1.0	40-80	Beetles, thrips, pod bugs
Thiodan/Thionex	35 EC	1	80	Beetles, aphids, pod bugs
Karate	EC	1	80	All
Cymbush super	Electrodyne formulation	1	-	All
Pirimor, Aphox	50 WP	16/500 g	1 g	Aphids
Talstar		1	60-80	Beetles, thrips, pod bugs, and mites

1.24 HARVESTING

Harvesting should commence when about 90 of the pods have matured and are dry. Prior to harvesting, watering or irrigation should be avoided for two to three weeks from 50% pod maturity. In most cases, cowpea harvesting should coincide with the onset of the dry season, or during a rain-free winter when the dry pods can remain in the ground for about a week before harvesting without spoilage. However, to avoid field weathering or shattering, dry pods should not be left in the field for longer than three weeks after full pod maturity. Harvesting can be carried out manually by using a combine harvester in the case of large-scale production. After harvesting, harvested pods should be packed in sacks and conveyed to an open hall for further drying to enhance threshing.

1.25 SEED PROCESSING

1.25.1 Threshing

Threshing should commence when the pods are dry. Seeds are easily released from the pods with a slight squeezing pressure applied to the pod. The pod can be threshed manually by placing the dry pods in a cloth bag and beating the bag gently with a wooden baton or using a threshing machine, depending on the scale of production. In the case of manual threshing, the threshed content is emptied into a seed tray or bowl for winnowing. For commercial production, a combine harvester can harvest, thresh and winnow simultaneously.

Photograph 1.11: Workers threshing or beating cowpea pods in sacks with wooden batons

1.25.2 Winnowing and drying

Threshed grains are winnowed to remove chaffs and inert substances. Winnowing is carried out 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 or packaged in sacks. Winnowing can be effected mechanically by using an air blower or air compressor. Seeds should be dried to a low moisture content (about 12-14%). If the planting date is well scheduled, crop harvesting can be timed to coincide with a dry period and rain-free winter, where the seeds are dried in the field to about 12-14% moisture content. This ensures that no extra mechanical or natural sun drying is needed. The cowpea's storability depends on its moisture content prior to storage. The lower the moisture content, the better the quality of seeds held in storage.

Photograph 1.12a: Using an air compressor to winnow cowpea mechanically

Photographs 1.12b and 1.12c: The manual threshing and winnowing of cowpea

Photograph 1.13: Clean cowpea seed obtained from manual winnowing

1.26 POST-THRESHING MANAGEMENT

1.26.1 Fumigation

Cowpea seeds should be fumigated to protect them from bruchid damage. The seeds should be fumigated in airtight containers, drums or silos immediately after threshing. Common insecticides available for fumigation include Gastoxin and Aluminum phosphide, using three to four tablets per 50 kg of seed. Fumigation should not take place within human dwelling areas or living rooms.

1.26.2 Seed packaging

- Cowpea grown mainly for seed is further sorted and cleaned before packaging.
- In a well-organised seed production system, the seeds are dressed with seed dressing chemicals prior to packaging. This applies to seeds designated for planting purposes.
- Packaging is carried out according to specified weights, i.e., 1, 5, 10 and 50 kg, and packaging is properly labelled and sealed.

1.27 UTILISATION

In West Africa, where cowpea is a very popular staple food, the incorporation of cowpea into family menus is advanced. For instance, in Ghana, it is used to fortify cassava, plantain, cereal-based meals and yoghurt. In Nigeria, cowpea paste can be boiled or fried to produce a popular meal known as Moin-moin that is served with rice during ceremonies, and Akara, which is served with cereals for breakfast. Part of this project's deliverables was to teach farmers various recipes to include cowpea in menus. These recipes were successfully taught to farmers in the Ga-Thaba and Bela-Bela communities. Details of different recipes that include cowpea are in the utilisation section of this volume.

In comparison to West Africa, South Africa enjoys advanced food technology. However, cowpea utilisation in South African cuisine is poor because production is still in the hands of smallholder farmers. It is envisaged that cowpea meals could complement various popular maize meals, custards, breads, pap and rice dishes in South Africa when production is increased and utilisation awareness has improved. In many localities in Limpopo and Mpumalanga, cowpea leaves are harvested fresh as vegetables for soup preparation, or they are cured for future use during winter when there is no rain to sustain the crop for leaf production. The trading of seeds and processed foods provides both urban and rural opportunities for earning a regular income. The aboveground plant parts of cowpea, except for the pods, are used as animal fodder. Local farmers who cut and store cowpea fodder for subsequent sale at the peak of the dry season have been able to obtain as much as 25% of their annual income from these sales.

Photograph 1.14: Cowpea porridge being served with rice, potato and butternut during the farmers' training programme at Ga-Thaba

CHAPTER 2: TRAINING AND SKILLS DEVELOPMENT OF FARMERS

2.1 INTRODUCTION

Introducing efficient water usage and cultivating low-input grain legumes in rural communities, where erratic rainfall is a major contributory factor to low yield, will ameliorate the problem of food insecurity and malnutrition (Asiwe and Adekunle, 2005; Singh and Ajeigbe, 2007; Asiwe, 2008; Asiwe, 2009a,b; Kutu et al., 2010; Asiwe, 2012; Modi and Mabhaudhi, 2013). This project will not only enhance food security and empower farmers, but also has a high potential for upscaling local and commercial applications, especially among the resource-poor and vulnerable farmers in the study area and South Africa at large.

Modi and Mabhaudhi (2017) reported that reinstating and promoting grain legumes is critical to attaining food crop diversity and nutrition in rural communities. According to them, this diversity will translate to food and nutrition security and improve the dietary intake of rural communities. Alleyne (1977) reported that one of the major concerns in rural communities is protein energy malnutrition. Legumes are generally cheap sources of protein, micronutrients, vitamins and minerals, and complement starchy diets (Khan, 1987). Graeub et al. (2015), McDermott et al. (2015) and Shetty (2015) report that one way of enhancing food and nutrition security is through crop diversity and productivity. Many rural communities in South Africa, and Limpopo in particular, are food insecure and malnourished because of erratic rainfall during the growing season, which impacts negatively on communities as insufficient crops are produced to meet family consumption and income requirements.

One of the ways to enhance sustainable food production and promote food security and nutrition in drought-prone communities in Limpopo is to introduce and cultivate high-yielding, disease-, insect- and pest-resistant, early-maturing varieties, and to use water-efficient grain legumes. Cowpea is a notably versatile crop and is globally known to thrive well under low and erratic rainfall conditions where cereal crops do not thrive. Therefore, cowpea offers an excellent opportunity for cultivation in drought-prone communities in South Africa. The promotion of cowpea in areas with erratic rainfall will increase the productivity of farmers, alleviate poverty and malnutrition, and create employment for all involved in the cowpea production value chain. In order to enhance rural farmers' productivity, they need to be trained in agronomic skills to produce the legumes. The acquisition of agronomic skills will empower them, enabling them to produce the legumes more profitably to create jobs, generate an income and improve their dietary intake. This chapter provides details of training available to farmers in the process of empowering them to acquire production skills

2.2 AGRONOMIC SKILLS

Forty-five farmers in Ga-Thaba and Ga-Chuene, as well as over 50 farmers in Bela-Bela, were instructed in the following cultural practices. Students and extension agents also participated in the training. A total of 125 farmers received training on cowpea and pigeonpea cultural practices in the three selected communities (Ga-Thaba, Ga-Chuene and Bela-Bela) (Photograph 2.1).

Photograph 2.1: Farmers being trained on insecticide spraying techniques at Ga-Thaba

Table 2.1: Training farmers in agronomic skills at Ga-Thaba, Ga-Chuene and Bela-Bela

Training received	**Number of farmers (Ga-Thaba and Ga-Chuene) N = 45**	**Number of farmers (Bela-Bela) N = 80**
Land preparation, layout and planting	45	80
Weed control	45	80
Scouting for insects and insect identification	45	80
Insect control, use of knapsack sprayer and dilution of chemicals	45	80
Calibration and spraying time	45	-
Data collection and record-keeping	45	80
Rouging of off-types and volunteer crops	45	80
Harvesting	45	80
Threshing and winnowing	45	80
Post-harvest management and packaging	45	80
Fumigation	45	80

2.2.1 Land preparation, layout and planting

Cowpea requires well-prepared, loose soil for optimum performance. Cowpea may be adversely affected by soil crusting under certain soil and environmental conditions. Soils should be tilled deeply enough to ensure that the tap root is not barred from soil penetration (hardpan).

The piece of land chosen for cowpea production must not be waterlogged, but well drained. Waterlogging reduces oxygen availability to plant roots. During land preparation, the existing fallow weeds, trees and shrubs in the site are cut down manually or slashed with a tractor. All tree stumps should be removed. This should be followed by ploughing and harrowing using a disc plough and harrow. Four to six days between each operation should be allowed to enhance good soil tilt for good seed germination. The land may be ridged or left as flat seedbeds after harrowing. Two rounds of harrowing provides sufficient tilt for good root growth. Ridges can then be made. Cowpea can be planted on flat ground, especially where the soil is loose and prone to erosion. In these areas, minimum tillage could be used. Ridging could be done by animal-drawn ridger or manually with a hand hoe.

Given the above, farmers were trained on steps in site selection and land preparation, ensuring that the site for cowpea or pigeonpea crops is well drained and not waterlogged, since legumes are unlikely to thrive in waterlogged soil. Farmers were advised to prepare their land in November, a month before planting, to allow weeds and volunteer crops to emerge before planting, so that weed control could be effective at the planting stage. The next step was to remove any tree stumps in fields before using a tractor to plough and harrow to prepare suitable seed beds. Cowpea can be planted on flat ground or on ridges. Farmers were trained on how to mark the field into planting plots to ensure they knew how to plant in the field and to familiarise themselves with planting density. Farmers were trained on how to mark out the plots in rows according to plant-spacing methods using ropes and T-markers (see photographs 2.2, 2.3, 2.4 and 2.5). The instructor demonstrated how to plant cowpea at 0.75 x 20 cm at suitable inter-row and intra-row spacing measurements, while pigeonpea should be planted at a spacing of 0.75 x 50 cm. The farmers were advised that cowpea should be planted between the first and second weeks of January so that maturity coincides with the period of the rain-free onset of winter. Pigeonpea should be planted between the first and second weeks of December.

Photographs 2.2a and 2.2b: Farmers' participation during training to mark plots, and on spacing and planting at Ga-Thaba (top and bottom), the University of Limpopo Research Farm (top), Bela-Bela (bottom left) and Ga-Chuene

Photograph 2.3: Farmers' participation during training to mark plots, and spacing and planting at Ga-Chuene

Photograph 2.4: Farmers marking plots, spacing and planting at the University of Limpopo Research Farm

Photograph 2.5: Farmers' participation during training to mark plots, and spacing and planting at Bela-Bela

2.2.2 Weed control

Farmers in the three communities (Ga-Thaba, Ga-Chuene and Bela-Bela) were trained to apply herbicides.

Types of herbicides

Two types of herbicide can be used: pre-emergence herbicides (e.g. Dual, which is applied when the soil is moist to kill ungerminated weeds) and post-emergence herbicides (e.g. Gramoxone and Roundup, which are non-selective). Gramaxone is a contact herbicide, which kills any part of the plant on which it is sprayed. Roundup is a systemic herbicide that can kill a plant to its root, irrespective of which part of the plant is the contact point. Selective herbicides (e.g. Bentazone or Scepter) only kill broad-leaf weeds and not grass weeds. They are systemic in action and farmers were advised not to apply them to mixed intercrops where legumes and cereals are planted together. Fusilade is recommended for grass weeds. Farmers were advised not to apply it where maize or other cereals are planted. Instead, they were advised to apply selective herbicides when the weeds are younger than three weeks for maximum effectiveness.

Application rates

Dual herbicides should be applied at 0.5 ℓ per hectare or 30 mℓ per 15 ℓ of water in a knapsack. Post-emergence herbicides should be applied at 3 ℓ per hectare or 180 mℓ per 15 ℓ of water in a knapsack.

Time of application

Farmers were advised to apply Roundup and Dual together at their respective recommended rates one day after planting on a rain-free day. However, selective herbicides should be applied about three to four weeks after planting to suppress weeds before the cowpea canopy cover stage.

Use of the knapsack

Farmers were trained on how to load and mix the insecticides, and how to apply the mixture safely by following safety precautions, as well as how to maintain the knapsack.

Calibration of spraying time and volume

Farmers were trained on how to calibrate the spraying time and volume per unit area of land (Figure 2.1 and Photograph 2.7). In the demonstration trial, time spent spraying insecticide on the same plot area of monocrop, strip intercrop and mixed intercrop plots were established, and farmers found that it took three times longer (22 minutes) to spray mixed intercrops as opposed to strip intercrops (seven minutes) or monocrops (six minutes), because plants in the mixed intercropping plot were scattered as opposed to being planted in defined rows (Figure 2.1). The farmers concluded that spraying or applying farm inputs was more challenging in mixed intercrop plots than in strip intercrop plots.

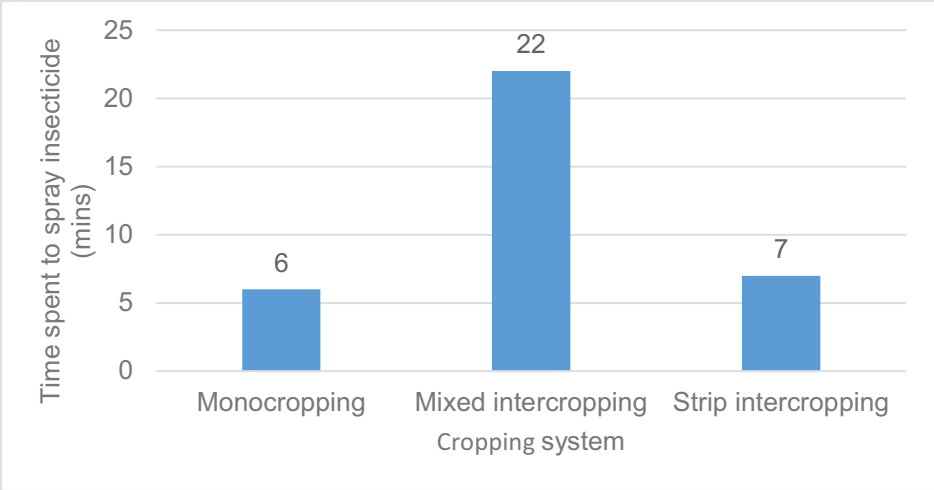


Figure 2.1: Comparative spraying times farmers spent on cropping systems

2.2.3 Scouting for insects and insect control

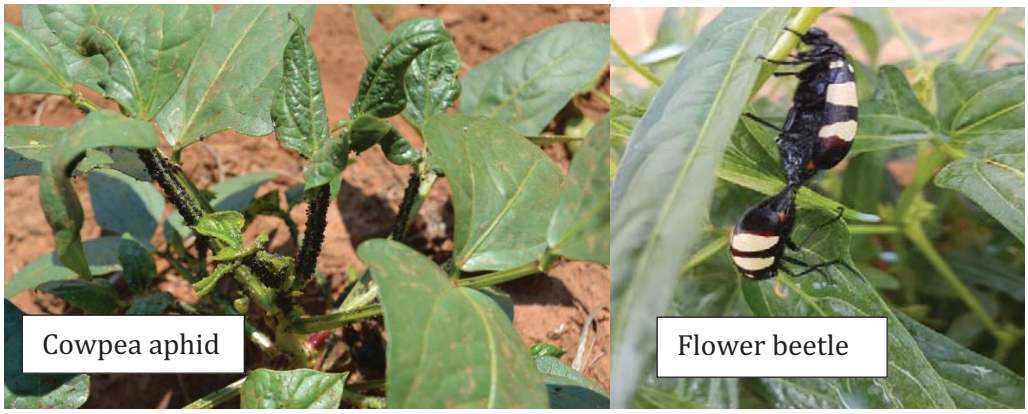
Farmers were advised of the menace caused by insects and were taught how to manage and reduce insect damage. Farmers were trained to scout for and identify insect pests present during the various growth and reproductive stages of cowpea and pigeonpea. Common cowpea and pigeonpea insect pests in South Africa include defoliators, aphids, pod-borers, pod-sucking bug complex, flower beetle (*Mylabris spp*.) and bruchids (photographs 2.9, 2.10 and 2.11). Farmers were given a photographic demonstration of plots showing photographs of the different insect pests or specimens that are present at the seedling or vegetative stages and during the reproductive (flowering and podding) stages of cowpea and pigeonpea, so that they would be able to identify common insect pests and their feeding damage. During the training sessions and farmers' interaction sessions, farmers were educated on damage and control tactics, as insects can cause severe damage if not appropriately controlled.

Farmers were taught to control insect pests by using insecticides and were introduced to and advised on the range of available commercial insecticides. Knapsacks and insecticides were provided to the farmers at Ga-Thaba and Ga-Chuene during the training programmes (Photograph 2.6). Training included how to mix and apply insecticides at the appropriate recommended application rates. Insect control can be achieved by applying insecticides (Photo 2.8). Insecticides such as Karate EC, Thiodan, and Sherpa Plus should be applied at 80 mℓ per 20 ℓ of water (i.e. 1 ℓ/ha). Talstar, Aphox, Pirimor and Cypermethrin can also be used depending on the farmer's insect control objective. To obtain a good yield, it is recommended to spray cowpea once at three weeks after planting (seedling stage) if there is an incidence of aphids, foliage beetles and/or leaf hoppers, and two to three sprays during the flower or bud stage (flowering stage) to full podding stage. The spraying interval should be between seven and 10 days. Insecticides can be applied with a boom sprayer attached to a tractor or with a knapsack sprayer, depending on the scale of production.


Photograph 2.6: Prof Asiwe presenting two knapsack sprayers to the Ga-Thaba farmers

Photograph 2.7: Prof Asiwe demonstrating how to mix insecticides and apply the insecticide safely


Photographs 2.8a and 2.8b: Farmers' participation during a practical demonstration of insecticide spraying at the Ga-Thaba demonstration plot



Photograph 2.9: Cowpea aphids (left) and flower beetles (Mylabris spp)

Photograph 2.10: Cowpea bruchid damage on a susceptible cowpea variety

*Photograph 2.11: Pod-sucking bug (*Anoplocnemis curvipis*)*

2.2.4 Data collection and record-keeping

Farmers were trained on data-capturing skills. They were also trained on record-keeping and other farm management techniques to turn a profit. They were trained to consider agriculture as they would any other business venture. Information was provided in terms of the different types of records to keep, the advantages of record-keeping, and what the farmers stood to gain by keeping good records. For example, record-keeping is important to support farmers to apply for loans, as such records can be presented to showcase their business's performance. Farmers were also taught how to keep records on the farm areas cultivated, date of planting and data related to peak flowering or 50% flowering and the maturity of the different crop varieties they grow. Recording this information was important to determine how many days it takes each variety crop to flower and reach maturity, enabling the farmer to adjust when each variety should be planted to ensure that the plant's maturity coincides with the rain-free winter period.

2.2.5 Rouging

Farmers were trained to differentiate between off-type and volunteer crops, and cowpea or pigeonpea plots. Rouging is the act of removing off-types or volunteer crops from the plant population to avoid contamination during harvesting and out-crossing. Farmers were advised to rogue their plots during the seedling, flowering and podding stages, as well as before harvesting. Leaf shape, flower colour, pod colour, plant height, plant morphology and maturity can be used to identify off-types.

2.2.6 Harvesting

Farmers were taught when to harvest using the Maturity Index of pod colour, when 90% of the pods in the plant population turn a brown or tan colour (Photograph 2.12). Harvesting should commence when about 90 pods have matured and dried. Prior to harvesting, watering or irrigation should be avoided for two to three weeks from 50% pod maturity. In most cases, the harvesting of cowpea should coincide with the onset of the dry season or during a rain-free winter when the dry pods can remain for about a week awaiting harvesting without spoilage. However, to avoid field weathering or shattering, dry pods should not be left in the field for longer than three weeks after full pod maturity. Harvesting can be carried out manually using a hand harvester or by using a combine harvester in the case of large-scale production. After harvesting, harvested pods should be packed in sacks and conveyed to an open hall for further drying to enhance threshing.

Photograph 2.12: Cowpea demonstration plot ready for harvesting

2.2.7 Threshing

During the training programme, farmers were advised to commence threshing when the pods are dry. Materials required include 50 kg capacity synthetic sacks, wooden sticks for beating the pods in the bags, bowls for winnowing and an air blower if it is affordable. Seeds are easily ejected from the pods when slight pressure is exerted on the pods. The pods can be threshed manually by placing dry pods in cloth or synthetic bags and beating the bag gently with a wooden baton (Photograph 1.11) or using a threshing machine, depending on the scale of production.

2.2.8 Post-harvest management

2.2.8.1 Fumigation

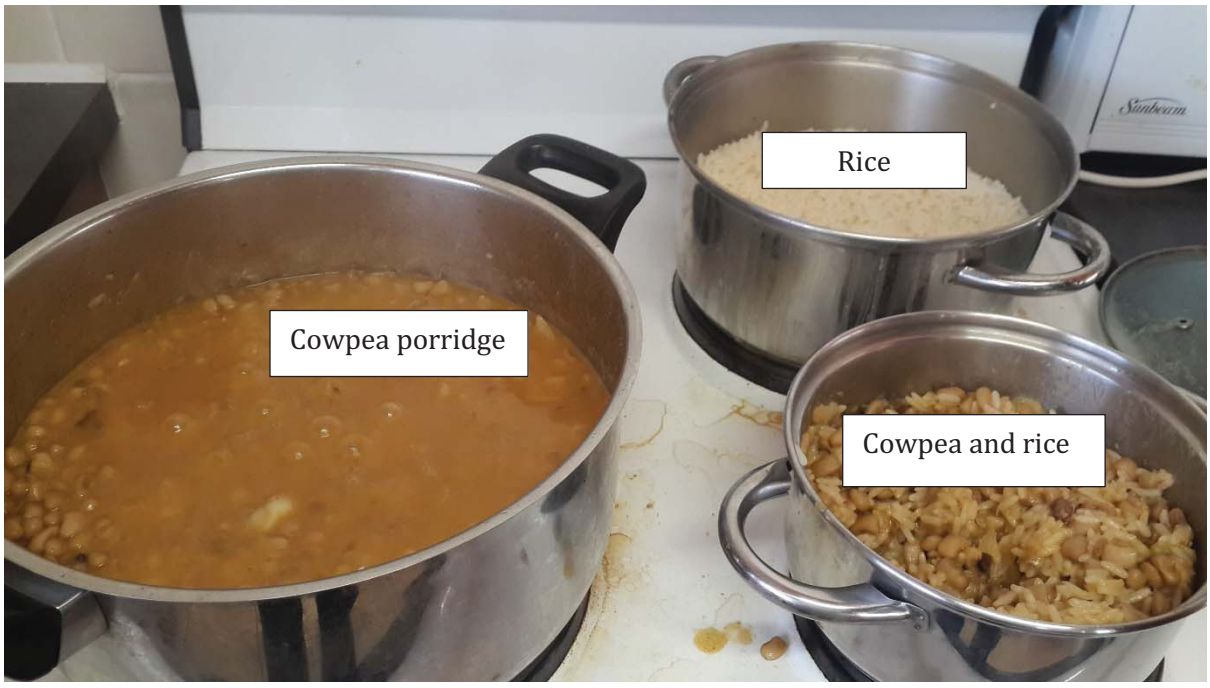
The rationale for fumigation is to protect cowpea and pigeonpea seeds from bruchid damage during storage. Farmers were advised to fumigate seeds in air-tight containers, drums or silos immediately after threshing. Common insecticides available for fumigation include Gastoxin or Aluminium phosphide, using three to four tablets per 50 kg of seed. Fumigation should not take place within human dwelling areas or living rooms.

2.2.9 Training farmers on cowpea recipes

To equip the farmers with the skill of improving their dietary intake and diversity, farmers were trained to prepare different cowpea and pigeonpea recipes and the recipes were provided. A total of 125 farmers received training on cowpea menu preparation in three selected communities (Ga-Thaba, Ga-Chuene and Bela-Bela) (photographs 2.13, 2.14 and 2.15).

Table 2.2: Training received by farmers on cowpea and pigeonpea menu preparation at Ga-Thaba, Ga-Chuene and Bela-Bela

Training received	Number of farmers (Ga-Thaba and Ga-Chuene) N = 45	Number of farmers (Bela-Bela) N = 80
Cowpea or pigeonpea cake (Akara)	45	80
Bean pudding (Moin-moin)	45	80
Cowpea or pigeonpea soup	45	80
Cowpea or pigeonpea porridge and bread	45	80
Bean and rice	45	80
Cowpea and potato	45	80
Cowpea and butternut	45	80
Cowpea or pigeonpea and pap	45	80
Cowpea or pigeonpea and custard	45	80
Processing of cowpea or pigeonpea seed for menu preparation	45	80



Photograph 2.13: Farmers' food preparation: cowpea porridge, and cowpea and rice

Photograph 2.14: Farmers' food preparation: fried bean cake 'Akara'

Photograph 2.15: Farmers' food preparation: Cowpea served with rice, butternut and potato

2.2.9.1 Farmers' days

Several farmers' days were organised to showcase the project's research findings, to prepare food made from cowpea and pigeonpea, and to respond to farmers' questions and feedback. Photographs 2.16 and 2.17 show various farmers' day events conducted between 2016 and 2018 at Ga-Thaba and Bela-Bela.

Photograph 2.16: Farmers' days at Ga-Thaba

Photograph 2.17: Farmers' days at Bela-Bela

2.2.9.2 Packaging

Cowpea is one of the major menus consumed in different parts of African countries and packaging remains one of the key ways to make the products attractive to consumers. Farmers were trained on how to make cowpea products marketable either as raw (uncooked) cowpea or as processed or packaged cowpea products. One of the ways to do this was by putting the raw cowpea in transparent nylon (polythene) bags of different weights (1 kg, 2 kg, 5 kg, 10 kg, etc.). The same can be done for processed cowpea, especially cowpea or bean cake and *Moin-moin*. The essence of packaging into different weights is to accommodate people of different income categories. Other products can also be processed into very attractive and sellable menus for profit making, depending on the location, the needs of the consumers and their preferences.

CHAPTER 3: COWPEA USE: RECIPES AND MENUS

3.1 INTRODUCTION AND IMPORTANCE OF COWPEA

Cowpea (*Vigna unguiculata*), also known as black-eyed beans and black-eyed peas in America, is indigenous to West Africa. It is a subsistence crop (Gomez, 2004) and one of the most valuable grain legume crops grown in the tropical and subtropical regions of the world (Carvalho et al., 2012; Khalid and Elhardallou, 2016). One major advantage of cowpea is that it is more drought tolerant (Fatokun et al., 2004; Asiwe, 2006; Modi and Mabhaudhi, 2013) and, in comparison to other bean species such as soybean, produces crops with as little as 300 mm of rainfall due to its propensity to form a deep tap root (Gomez, 2004). It also not only thrives in sandy soil (Gomez, 2004), but also in different types of soils and climate regions (Onyenekwe et al., 2000). Cowpea is one of the most economically important indigenous African legumes (Langyintuo et al., 2003), and are of utmost significance to the livelihood of a large percentage of people living in West and Central Africa, not only as a source of food, but also for animal feed and as a source of income (Singh, 2014). It is also believed that farmers cultivating cowpea and pigeonpea varieties in rural communities will provide the same benefits to their South African counterparts.

One of the ways to enhance sustainable food production, thereby improving food security and nutrition in drought-prone communities in Limpopo, is by introducing and cultivating high-yielding, disease-, insect-, and pest-resistant, early-maturing, and water-use efficient grain legumes such as cowpea, pigeonpea and Bambara groundnut. Cowpea and early-maturing pigeonpea are notable versatile crops that are globally accepted as thriving well, even under low and erratic rainfall conditions where cereal crops cannot thrive (Asiwe, 2007; Asiwe, 2009a; Asiwe, 2009b).

Cowpea (*Vigna unguiculata* L. Walp) and pigeonpea (*Cajanus cajan*) are nutritious multipurpose grain legumes with tremendous potential, especially in South African rural areas. These legumes are drought tolerant (Fatokun et al., 2004; Asiwe, 2006) and can thrive well during low water stress and soil fertility. Cowpea is an important grain legume with significant potential for production and dietary intake in South Africa. The seeds are rich in protein (24.8%), carbohydrates (63.6%), vitamins and other essential nutrients (Bressani, 1985; Prinyawiwatkul et al., 1996; Fadupin, 2011; Masenya et al., 2014, Asiwe, 2017). It is eaten as dry seeds, green pods and leafy vegetables. In many African countries, cowpea is a major food security crop (a versatile candidate crop for the ongoing food security initiative in South Africa) (Whitebread et al., 2009), AATF, 2012). The processing and trading of cowpea seeds provide a dependable source of livelihood for impoverished communities in both rural and urban areas, thereby creating opportunities to earn a regular income (Giami et al., 2003; Giami, 2005; IITA, 2011).

Cowpea snacks are important traditional plant protein-rich foods prepared and sold on the streets in many African places, and this can help improve the dietary intake of South Africa's impoverished communities. According to Omenna et al. (2016), a proximate composition of boiled cowpea contains the following nutrients: crude protein (18%), fat (3.6%), fibre (1.81%), ash (3.6%), moisture (15.10%), carbohydrates (58.10%) and caloric value (163.80%). These researchers also established that raw uncooked cowpea seeds contain crude protein (22%), fat (3.71%), fibre (1.95%), ash (3.80%), moisture (9.25%), carbohydrates (59.69%) and caloric value (156%).

A comparison between the nutrient content of cooked and raw cowpea determined that raw seed contains slightly higher nutrients, except for moisture and caloric value. Given the above, it can be assumed that the nutrient content of cooked cowpea and the meals demonstrated in this project are likely to provide nutrients within this range, and can supply consumers' daily dietary nutrition intake.

Inadequate nutrition is an ongoing problem in rural South Africa and among some ethnic groups. About 15% of children in South Africa are reportedly born with a low birth weight as a result of maternal malnutrition (Labadarios et al., 2011). Other problems associated with insufficient nutrition include stunting or low height for age. Studies have shown that 26.5% of children in South African rural areas were stunted in comparison to 16.7% in urban areas. Additionally, being underweight is a problem among Coloured, black and Indian men (Voster, 2010). This implies that there is significant potential in rural communities and households where this project is being primed to benefit from protein-rich diets to improve their nutrition and dietary intake.

Foods consumed in most African countries comprise mainly carbohydrate crops such as cassava, yam, maize, rice and millet. Although they have a high nutritional value, grain legumes are a minor component of the diet (Gomez, 2004). Legume seeds are an important source of cheap plant protein, supplementing cereals with protein, minerals and vitamin B complex. Legumes also provide additional nicotinic acid and minerals, and are rich in dietary fibre and carbohydrates (Rochfort and Panozzo, 2007).

There has been a worldwide upsurge in the demand for an affordable source of protein with equally good nutritional properties. This is especially true in developed and underdeveloped nations, where animal protein is either limited or not within the affordability range of poor people (Cheftel et al., 1985). Legumes grown in these nations could potentially replace animal protein for the financially underprivileged, since they are rich sources of protein (20-30%), vitamins and minerals (Kay, 1979; Quass, 1995; Tharanathan and Mahadevamma, 2003; Asiwe, 2017). Cowpea is also a rich source of dietary fibre and phytochemicals, which include phenolic antioxidant compounds that are known to prevent heart disease and cancer (Granito et al., 2005). Cowpea dishes, which this project provided, in combination with other dishes (especially cereal-based dishes), will meet consumers' dietary needs. This will enhance their protein fortification value, making them invaluable for both children and adults. Cowpea is also a useful feed ingredient in manufacturing feed for pigs and poultry. This could improve feed security for poultry and pork farmers.

Studies have shown that factors such as thermal treatment, dehulling, soaking and cooking may affect the cowpea seeds' nutritional compounds (Frias et al., 1995; Kozlowska et al., 1996; Omenna et al., 2016). However, cowpea is generally a very good source of nutrients, especially protein and carbohydrates (Langyintuo et al., 2005). Another factor that might affect variation in the nutritional composition of cowpea is the variety of cowpea. However, a study of Carvalho et al. (2012) used 30 varieties of cowpea and established that cowpea is rich in nutrients, irrespective of the variety.

According to these researchers, the proximate composition varies among genotypes in crude protein (20-30%), dietary fibre content (20-35%), in protease inhibitors (2-4 UI/mg protein), lectin (40,000-640,000 UH/kg meal), essential amino acid levels, in vitro protein digestibility (30-40%), and in the apparent concentration of expressed proteins. The antioxidant capacity varied from EC50 of 9.54-38.7 mg seed extract/mℓ DPPH and the highest values of alpha- and delta-tocopherol were detected, which were 0.38 and 1.88 mg/g, respectively (Carvalho et al., 2012). This project had the potential of testing different cowpea varieties, which could provide rural consumers with varied protein content.

To enhance and sustain the production of cowpea in South Africa, its production must be matched with its consumption or utilisation. Although cowpea is believed to have originated in South Africa, its consumption and diversification is very poor. The only common recipe uses cowpea seed for soup or to boil. In many parts of West Africa, cowpea can be utilised and consumed in many different ways. This has enhanced the diversification of cowpea produce and its associated value chain. The essence of this manual is to promote cowpea recipes in South Africa. A few of the communities that produce cowpea are being trained to prepare different cowpea dishes, not only to improve the communities' dietary intake and uptake, but also to increase the employment and income status of all in the value chain.

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3.3 COWPEA AND PIGEONPEA RECIPES

Cowpea can be used in a number of ways, such as in simple cooking (e.g. soups or stews) or in more exotic menus (e.g. boiled, steamed, fried or baked dishes). The recipes presented in this volume emanate from different parts of Africa, especially West Africa. This is because cowpea is mainly consumed in South Africa as a soup and porridge, or as "boil and eat". The dishes and recipes presented below are usually served as family meals and during business meetings, social events or gatherings.

3.3.1 Cowpea cake (*Akara*)

Ingredients

- 750 g cowpea
- Vegetable oil for frying
- 1 raw chilli pepper or according to preference (optional)
- ½ medium or 1 small onion
- 1 Knorr chicken cube
- About 200 ml water
- Salt to taste

Method

- Soak the cowpea in warm water for about three hours to soften the cowpea.
- Remove the cowpea coat.
- Blend the cowpea together with the onion, Knorr cube and pepper (add just enough water to ensure the blade of the blender rotates easily). Blend the mixture into a good smooth paste.
- Pour the paste into a bowl and whisk for about five minutes to incorporate air into the paste.
- Add salt to taste.
- Pour vegetable oil into a frying pan (about 1.5 ℓ, just enough to float the paste) and allow to heat up for about five to eight minutes on medium heat level (test the readiness/hotness of the oil by adding a pinch of salt in the heated oil and you will observe a sizzling sound that indicates that the oil is hot enough).

Photograph 3.1: Sorted cowpea seeds (righted) prior to cooking

Photograph 3.2: Rubbing soaked cowpea seeds in the palms to remove the cowpea coats

- Start scooping the paste into the heated oil by using a spoon.
- Deep fry until golden brown (turning regularly to avoid burning and for even cooking and colouring).
- Remove the bean cake balls with a spoon and place in a bowl or sieve lined with kitchen paper towels to absorb excess oil.

Photograph 3.3: Frying cowpea cake (above) and fried cake "Akara"

3.3.2 Cowpea pudding (Moin-Moin)

Ingredients

- 750 g cowpeas
- 100 g prawns (optional)
- 3 Knorr chicken stock cubes
- Fresh red chillies (the number depends on preference)
- 2 big onions
- 120 g tomato puree
- 20 cl vegetable oil
- Boiled eggs which are sliced into small pieces and 170 g shredded tuna
- 2 teaspoons ground nutmeg
- 2 litres of water
- Salt to taste

Method

- Soak the cowpea in warm water for about three hours to soften the seeds.
- Remove the cowpea coat.

- Place the processed seeds into a bowl and add water to completely cover the seeds and then leave for about an hour to soften the seeds further to get a good consistency when you blend the seeds.
- Blend the cowpea seeds together with the onion, Knorr cube, red chillies, nutmeg and tomato puree with about 200-300 ml water.
- Add the vegetable oil (about 30 ml).
- Slowly add the remaining water, prawns and shredded tuna, and stir until all the ingredients are properly mixed.
- Add salt to taste and stir properly.
- Cover the base of a big pot or steamer using aluminium foil or plastic. Pour some water (about an inch deep) into the pot and place the pot on the stove.
- Pour the mixture into preferred containers (plastics or nylon sachet or aluminium foil) and then insert the egg into the cowpea paste of each container. Seal with aluminium foil or cover the container and place in a pot or steamer.
- Cook for about an hour. You can check if the cowpea pudding is cooked by inserting a table knife into it; if cooked, the knife will have a slight non-sticky smear of the paste, but if smeared with the paste, this may indicate that the pudding is not yet cooked. When you cut through the pudding, the insides will be set rather than watery.

Note: you can also steam the cowpea pudding using a steamer, or use a microwave oven, intermittently checking to see whether it is cooked as instructed above.

Cowpea pudding can be eaten in a number of ways. It could be eaten as a snack, as part of a meal, or cut up into pieces as an appetiser. It could be served with fruit juice or as a side meal with jollof rice, fried rice or maize meal and milk.

3.3.3 Cowpea porridge

Ingredients

- 750 g cowpeas
- Vegetable oil
- 2 large onions
- Chillies and salt (to taste)
- 2 big Knorr chicken stock cubes

Prior to cooking

- Wash the cowpeas in cold water and set aside.
- Chop two large onions and chillies.

Method

- Place the cowpea in a pot (large enough to accommodate the rise in volume of the cooked cowpea and to prevent spillage onto the stove) and add water to about the same level of the cowpea and set the pot on the stove to cook. Alternatively use a pressure cooker if you have one to reduce the cooking time.

- Cook until soft, adding more water intermittently when necessary. When the porridge is soft, or about an hour from the start, add the Knorr cubes, chillies and salt to taste. Add the chopped onions and vegetable oil about 30 minutes prior to turning off the stove.
- Stir the porridge while cooking regularly with a spoon to avoid burning.
- Serve with custard, bread or maize meal with milk. It could also be served with fried sweet potatoes or potatoes.

3.3.4 Rice and cowpea

Ingredients

- 500 g long grain parboiled rice
- 250 g cowpeas
- Salt (to taste)
- 2 Knorr chicken stock cubes
- 1 teaspoon thyme

Prior to cooking

- Wash the cowpea in cold water.
- Place the cowpea in a pot, add some water and bring to the boil.
- Wash the rice and set aside.

Method

- Place the cowpeas in a pot (big enough to accommodate the rise in the cowpea volume and rice when cooked, and to prevent spillage onto the stove) and add water to about the same level of the cowpeas, and set on the stove to cook.
- Add the washed rice and the boiled chicken stock about an hour after you have started cooking the cowpeas. Add salt, thyme and Knorr cubes to taste.
- Cover the pot and cook at a low to medium heat until the water is completely dry (check regularly to prevent burning).
- Turn off the heat when the cooking mixture is soft enough as this indicates that the cowpeas are cooked. Cooking time is about two hours on an electric stove but with gas, it could take an hour and a half.
- Serve with a sauce of your choice (preferably tomato stew), along with the fried chicken or fish.

Photograph 3.4: Different cowpea preparations with rice

3.3.5 Cowpea and potato porridge

Ingredients

- 250 g cowpeas
- 200 g potatoes
- 1,500 mℓ water for cooking
- 50 mℓ vegetable oil
- 20 g grated or ground onion (ground)
- 15 g ground pepper or to taste
- 2 Knorr cubes
- Salt to taste

Method

- Wash the cowpea and cook until soft (approximately an hour and a half). Add Knorr cubes and salt to taste at the commencement of cooking.
- Cut the potatoes into uniform sizes, add to cowpeas one hour later, and cook the mixture for about 45 minutes to an hour.
- Add the remaining ingredients (sliced onion, pepper and oil) and cook until the mixture is soft and tasty, and has a good aroma.
- Serve alone, or with custard and maize meal or bread.

3.3.6 Cowpea and coconut custard

Ingredients

- 250 g brown cowpeas
- 140 g dry coconut
- 3-4 cloves
- 1 ℓ of water

Method

- Wash the cowpeas and cook until mushy.
- Mash the cowpea into a smooth paste using a wooden spoon or blender.
- Break the coconut open, remove the nut, and grate the copra into the water.
- Filter to get coconut milk.
- Add the coconut milk to the mashed cowpeas and strain.
- Add cloves.
- Boil in an uncovered saucepan until the mixture thickens (about an hour and a half).
- Add salt to taste.

This dish can be served as savoury custard as well as a sweet dessert. As a savoury, it can be served as a sauce to accompany fish and maize meal. For a dessert, sugar to taste is added, and it is chilled to thicken.

3.3.7 Cowpea flour soup

Ingredients

- 115 g cowpea flour
- 120 g small piece of fish or shredded tuna
- 50 ml cooking oil
- 1 or 2 Knorr cubes
- 115 g tomatoes or 1 large tomato
- 30 g onions or 1 small onion
- 10 g or ½ teaspoon ground pepper
- 20 g or 1 teaspoon salt
- 1.5 ℓ water for cooking

Method

- Make a sauce using the oil, ground tomatoes, onion, pepper, Knorr cubes and salt.
- Add water to make stock.
- Blend the cowpea flour with some water and add to the stock, quickly and gently stirring as you do so.
- Cook until the bean flavour disappears.
- Prepare the fish and add to the mixture, continue to cook for 10-15 minutes.
- Season well and serve.

Boiled spinach may be chopped up and added to the soup. It may be served as a soup for an appetiser or as a sauce accompaniment to pap.

3.3.8 Cowpea stew with fried sweet potato

Ingredients

- 340 g cowpeas
- 215 g fish
- 15 g ground shrimp or shredded tuna
- 60 g or 1 medium onion
- 215 g or 2 large tomatoes
- 200 ml palm or vegetable oil
- 7 g or 1 teaspoon ground pepper
- 15 g or 1 teaspoon salt
- 200 ml water for cooking

Method

- Wash the cowpeas and cook until they are soft.
- Prepare the fish and cut into pieces.
- Make a sauce using the oil, sliced onion, tomatoes, pepper, salt and the ground shrimp or shredded tuna.
- Add the cooked cowpeas and simmer for 5-10 minutes.
- Serve with fried sweet potato.

3.3.9 Cowpea with pumpkin and butternut

Ingredients

- 500 g washed cowpeas
- 500 mℓ water
- 500 g pumpkin cut into one-inch thick cubes
- 1 teaspoon seasoning (salt and pepper)
- 2 Knorr cubes

Method

- Wash cowpea and boil for an hour.
- Add the pumpkin and stir carefully to mix.
- Add seasoning and Knorr cubes to taste.
- Cook until soft and water reduces.
- Serve hot or cold with stew.

Photograph 3.5: Serving cowpea with potato, rice and butternut

3.3.10 Cowpea and corn

Ingredients

- 180 g soft coated cowpea
- 300 g fresh green corn
- 20 g ground pepper
- 40 mℓ vegetable oil
- 15 g dried fish or shrimps
- 2.5 ℓ water

Method

- Remove the husk from corn cobs and cook in water for about 50 minutes.
- If dried corn is used, soak in water for about two hours prior to cooking. Strain when ready to cook.
- Prepare cowpeas, wash and add to corn.
- Cook until soft (approximately 90 minutes).
- Add other seasoning ingredients and cook until the mixture is soft and tasty
- Serve as a dish on its own or with stew.

Processed broken dry maize can be used in place of green corn.

3.3.11 Cowpea with maize flour

Ingredients

- 340 g cowpeas
- 140 g maize flour
- 5 g ground pepper
- 50 mℓ vegetable oil
- Salt
- 2 Knorr cubes
- 850 ml water

Method

- Cook cowpea with pepper, salt and Knorr until soft but not squashy (approximately 60 minutes).
- Leave some water in the cowpeas to steam the maize flour.
- Mix maize flour with water until you achieve a crumbly consistency.
- Make a hole in the middle of the cowpea mixture and add the oil and the maize flour to it.
- Reduce the heat and simmer until the maize flour is cooked (approximately 20 minutes).
- Remove from heat, stir the mixture, and allow to cool before serving.
- Serve as a main dish.

3.3.12 Cowpea flour soup with spinach

Ingredients

- 85 g cowpea flour (homemade)
- 130 g dried fish or chicken
- 2 Knorr cubes
- 40 g steamed spinach leaves
- 500 ml water to start off soup
- Salt to taste
- 5-10 g ground pepper (according to taste)
- 170 ml oil

Method

- Add Knorr cubes and oil to water and place on fire.
- Soak fish, wash removing bones and add to mixture (or use chicken).
- Add dry pepper.
- Add cowpea flour to an additional 140 ml water and stir with a stirring fork or whisk.
- Stir very quickly to avoid lumps.
- Stir for three minutes, and then add more water (170 ml) for the cowpea to absorb and to lighten the soup.
- Add steamed spinach after the cowpea flour flavour has cooked out, and cook for an additional two minutes.
- Serve immediately with mashed potato or pap.

3.3.13 Cowpeas, corn and groundnuts

Ingredients

- 170 g cowpeas
- 170 g corn
- 140 g fresh groundnuts
- 1 small coconut
- 15 g salt
- 400 mℓ water

Method

- If dried corn is used, soak in warm water for about 2 hours.
- Cook the corn until a bit soft, then wash the cowpeas and add them to the partly cooked corn.
- Add groundnut to the mixture of corn and cowpeas after about 45 minutes.
- Cook until the corn, cowpea and groundnut are done, but it must remain whole (allow about two and a half hours in total).

- Add salt to taste.
- Break, wash and slice the coconut to garnish the dish.
- Serve as a refreshment or snack.

3.3.14 Roasted cowpea

Ingredients

- 340 g cowpeas
- 15 g salt or to taste
- Cold water as required

Method

- Wash cowpeas and soak them for five minutes in salty water (enough to cover the cowpeas).
- Drain and place in a pot with a little water.
- Cook until the water evaporates, stirring constantly.
- Continue stirring the cowpeas over an even heat to avoid burning or uneven browning.
- Keep roasting until the skins rub off (about one hour).
- Serve at parties as a snack.

3.3.15 Cowpea puree baby food

Ingredients

- 340 g cowpeas (with coats removed)
- 15 g salt
- 1.4 ℓ water

Method

- Soak cowpeas in warm water for about three hours and remove the seed coats.
- Boil until soft and mushy.
- Add a little salt.
- Use a wooden spoon and press against the side of the pan to obtain a smooth paste or puree.

It may be served with fried tomato sauce. Margarine or vegetable oil may be added. It is a suitable dish for infants and toddlers.

3.3.16 Cowpea pie

Ingredients

- 340 g cowpeas (brown type)
- 150 g rice
- 90 g herrings (ground) or shredded tuna
- 30 g or 1 medium onion
- 1 large tomato
- 10 g pepper
- 20 g salt (or to taste)
- 50 mℓ cooking oil
- 2 ℓ water for cooking
- 60 g margarine (for pastry)
- 120 g wheat flour (for pastry)

Method

- Cook cowpeas and rice until very soft, then mash together.
- Prepare a gravy using oil, ground tomatoes, onion, pepper, ground herring and salt.
- Add half of the gravy to the mashed rice and cowpeas.
- Make pastry and line a greased pie dish.
- Pour the mixture into the pie dish and bake in a moderately hot oven (20 minutes).
- When baked, pour over the remaining gravy and serve.

3.3.17 Cowpea tea cake

Ingredients

- 70 g or ½ cup or 4 tablespoons of cowpea flour
- 120 g or 2 medium eggs
- 100 g or 4 tablespoons of margarine
- 80 g or 4 tablespoons of sugar
- 5 g or ½ teaspoon grated nutmeg (flavouring)
- 5 g or ½ teaspoon salt
- 5 g or 1 teaspoon baking powder
- 50 ml or 4 tablespoons water for mixing

Method

- Cream the margarine, sugar and salt until frothy.
- Break the eggs into the mixture and beat well.
- Add the nutmeg.
- Mix the dry ingredients and fold into the cream mixture.
- Fill cake tins or small cake cups and bake (one hour).

Serve for afternoon tea.

3.3.18 Cowpea sandwich spread

Ingredients

- 250 g cowpeas
- 10 g grated onion
- 15 mℓ lemon juice
- 10 g margarine
- Pinch of nutmeg
- 5 g salt
- 1.4 ℓ water for cooking

Method

- Boil the cowpeas until very soft, and then press them through a sieve to make a smooth paste.
- Add seasoning ingredients and mix well.
- Serve as a sandwich spread on bread with slices of tomato.

It makes an excellent lunch.

3.3.19 How to remove the cowpea coat

There are three different ways of removing cowpea coat:

Rubbing between the palms

Method

- Soak the cowpea in warm water for about three hours to soften the cowpea.
- Rub the soaked cowpea seeds between your palms until all the coats have come away from the seeds.
- Repeat the above step for all the cowpea seeds.
- Place the cowpea seeds in a large bowl and pour a substantial quantity of water into the bowl so that the cowpea coats float in the water.
- Drain off the floating cowpea coats. Continue pouring more water and remove floating coats until all have been removed.

Photograph 3.6: Trainees processing cowpea cake and pudding: removing the cowpea coat

Using a blender or food processor

Method

- Soak the cowpea in enough warm water to cover it for three hours.
- In small batches, place the soaked cowpea seeds into the blender or food processor and add enough water to cover (avoid overloading the blender with too much cowpea mixture).
- Using the pulse button, pulse about three to five times or until you see that the majority of the coat has come away. If your blender has no pulse button, simply put the blender on for a few seconds at a time.
- Repeat the above step for all the cowpea seeds.
- Place the cowpea seeds in a large bowl and pour a substantial quantity of water into the bowl so that the cowpea coats are floating on top of the water.
- Remove the floating cowpea coats. Continue adding more water and removing the floating coats until all the coats have been removed.
- Hand-pick any seeds still attached to the coats and repeat Step 2 above or rub between the palms if the quantity is too small to place in a blender.

Using a pestle and mortar or a wooden cutting slab and a pebble, stone or rolling pin

The pebble, stone or rolling pin must be big enough to apply enough pressure to remove the cowpea coat.

Method

- Soak the cowpeas in warm water for about three hours to soften them.
- Drain the water from the cowpea so that the seeds will not soak up more water.
- Scoop a small quantity of the cowpea seeds into a mortar or wooden chopping board.
- Use a pestle or pebble pin to rub the cowpea seeds against the inside wall of the mortar or the chopping board to remove the coats from the seeds.
- Repeat this process for all the cowpea seeds.
- Place the cowpea seeds in a large bowl and pour a substantial quantity of water into the bowl so that the cowpea coats are floating on top of the water.
- Pour out the floating cowpea coats. Continue adding water and removing floating coats until all the coats are removed. Hand-pick any seeds that are still attached to their coats and repeat Step 4 above or rub between your palms if the quantity is too small.

3.3.20 Making cowpea flour

Steps

- Remove the coats from the required quantity of cowpeas by any of the methods indicated above.
- Dry the cowpea thoroughly.
- Grind the dried cowpea into a powder.