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COWPEA PRODUCTION HANDBOOK

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2014

Preface

The idea to write and produce this handbook was conceived when Tony Ngalamu, lecturer in the Department of Agricultural Sciences, College of Natural Resources and Environmental Studies, in University of Juba won a research award C/5425-1 from International Foundation for Science and Syngenta Foundation for Sustainable Agriculture to set off AGRA project to breed cowpea for agriculture in South Sudan.

Cowpea, *Vigna unguiculata*, (L) walp, a multifunctional crop providing food for man and livestock and serving as a valuable dependable revenue generating commodity in many parts of the world, is widely grown by nearly all the small holder subsistence farmers in all ecological zones of South Sudan. Nevertheless, its importance as a major legume in improving the cereal-based diets of the rural population and its role in improving the fertility of the soil remain unknown. Even the word ''Cowpea'' is unfamiliar to people in South Sudan, including many agriculturalists.

This handbook, though may not include all aspects of cowpea, it however describes the various names by which cowpea is called in local languages and varieties of cowpea grown by local farmers in various regions of South Sudan. The importance of cowpea as a crop that cannot be dispensed with in the agriculture of the subsistence farmers in South Sudan and the characteristics of cowpea plant (type of roots, leaves, stem, flower, pods and seeds) are clearly summarised in the handbook so that farmers and students studying agriculture would be able to identify cowpea from other crops, particularly legumes.

The method of propagation, land preparation, planting and seed rate are summarised for farmers who would be interested in growing cowpea as revenue-earning cash crop.

Growing cowpea is a task not devoid of problems. When grown in the field, it is attacked by pests, diseases and weeds, and in storage, it can also be destroyed by pests. All these are well-stated and described mentioning some methods of control that do not involve great financial expenditure by the farmer.

The utilisation of parts of cowpea (leaves and grains) and storage including post-harvest handling in various parts of South Sudan are described in the handbook.

The handbook ends with marketing aspects of cowpea. It is of no national rationale if a crop is grown and ends up eaten by the farmer within his/her household without getting into the major markets of the country. Improvement of cowpea should therefore include strategies for cowpea marketing to accrue income to the farmer so that growing cowpea becomes lucrative. At the present small quantities of cowpea leaves are being sold as vegetable in various forms in markets in South Sudan including the grains.

We believe that the handbook would therefore be of great use to farmers and students studying agriculture in various institutions in South Sudan. It would also be useful to extension agents working with rural farmers.

Acknowledgements

The invaluable contributions of the International Foundation for Sciences and Syngenta Foundation for Sustainable Agriculture, which provided the funds for the study and production of this cowpea publication handbook are greatly acknowledged and appreciated. Thanks to Program for Africa's Seeds System (PASS–AGRA), whose goal is to establish Green Revolution on the continent of Africa, and the College of Natural Resources and Environmental Studies, University of Juba for technical support and providing the working environment for cowpea breeding project in South Sudan.

We also wish to express our sincere appreciation to the members of College of Natural Resources and Environmental Studies for their continual support for the project.

The following individuals are acknowledged for reviewing the manuscript: Mr. Fred Dramani Biga, Dr Silvestro Kaka Meseka, and Dr Michael Baffoka Alexander.

A special word of appreciation goes to Dr Itai Makanda, Professor Aggrey L. Abate and Dr Newton Ochanda for their moral and academic encouragement.

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Abbreviations and Acronyms

AGRA	Alliance For Green Revolution In Africa
BC	Before Christ
CDA	County Department of Agriculture
CES	County Extension Services
FAO	Food and Agriculture Organization
IFS	International Foundation for Science
MAF	Ministry of Agriculture and Forestry
MIS	Market Information System
PICS	Purdue Improved Crops Storage bag
SSA	sub-Saharan Africa
SSCSE	South Sudan Centre for Statistics and Evaluation
WFP	World Food Program
2n	Diploid Chromosome Number
IITA	International Institute of Tropical Agriculture
pH	Potential Hydrogen
UJ	University of Juba

PART I: GENERAL CROP ASPECTS

1.1 Classification

Scientific name: *Vigna unguiculata*

Common names: Cowpea (English), Lubia (Arabic), Neube (French) Koso (Moru), Loputu (Bari), Akuem (Dinka), Ngor (Acholi), Osu (Madi), Amodoro (Latuka), Omodoro (Lokoya), Moro (Dongotono), Anyege (Zande), Namodoro (Lango), Okia (Nuba), and Ngor yamg (Nuer).

Cowpea belongs to the family of Papilionaceae (Leguminosae-Papilionoideae, Fabaceae), with 22 number of chromosomes (2n = 22).

1.2 Origin and Distribution

The precise location of the centre of origin of species of a crop is rather difficult to determine. De Candolle (1886) thought that the origin of a cultivated plant could be found where it grows wild. However, it is not certain to what extent the existing wild varieties and sub-species of *v.unguiculata* have contributed to the origin and diversity of cowpea.

As postulated by Ng (1995) that during the evolution process of *v. unguiculata*, there was a change in its growth life cycle, from perennial to annual. The precise location or region where cowpea was first domesticated is still under speculation. However, the wide geographical distribution of the wild species throughout sub-Saharan Africa (SSA), especially West Africa, indicates that they could have been domesticated in any part of Africa.

Cowpea originated in Africa, where a large genetic diversity of wild types occurs throughout the continent, southern Africa being the richest. The greatest genetic diversity of cultivated cowpea is found in West Africa, in the savanna region of Burkina Faso, Ghana, Togo, Benin, Niger, Nigeria and Cameroon. Cowpea was probably brought to Europe around 300 BC and to India 200 BC. It has been introduced in Madagascar and other Indian Ocean islands, where it is sometimes found as an escape from cultivation. As a result of human selection in China, India and South-East Asia, cowpea underwent further diversification to produce two cultivar-groups, Sesquipedalis Group with long pods used as a vegetable, and Biflora Group grown for the pods, dry seeds and for fodder. Cowpea was probably introduced to tropical America in the 17th century by the Spanish and is widely grown in the United States, the Caribbean region and Brazil.

1.3 Importance of Cowpea

Cowpea is of major importance to livelihoods of relatively poor people in less developed countries of the tropics including South Sudan, especially where animal protein is not easily available for the family. It is an important crop in the agriculture of African countries and South Sudan in particular for the following reasons:

(i) Provision of nutritious food

All the parts of cowpea used for food (fresh leaves, immature pods and the grains) are nutritious, providing protein, carbohydrate, vitamins and minerals. The grain contains 22-23 % protein (as opposed to 2 % in cassava and 10 % in maize) and good quantity of thiamine (vitamin B_1), riboflavin (vitamin B_2) and niacin (vitamin B_3), and richer

than cereals in iron and calcium content. Cowpea leaves are a significant source of β-carotene and ascorbic acid (vitamin C). Cowpeas seed grain used as food, supplement very well the protein deficiency of the predominantly carbohydrate, cereal, root and plantain diet of African communities.

A well-known problem of cowpea grain is its content of tannins, trypsin inhibitors and flatulent sugar, raffinose, which cause bloating of stomach when a meal containing cowpea is consumed. As a result, a meal of cowpea is repulsive to some people. This problem can easily be avoided by grain soaking before dehulling, heat treatment and breeding for cowpea varieties without or with low content of these factors.

(ii) Provision of high quality feed for animals

Cowpea can be grown and above ground plant parts harvested and fed to animals (cattle, sheep and goats), providing proteins, vitamins and minerals.

(iii) Cowpea as cover crop

The spreading indeterminate and semi-determinate bushy growth of cowpea provides ground cover, thus suppressing the growth of weeds and providing protection against soil erosion by running water during heavy rains. A complete ground cover also reduces the temperature of the soil.

(iv) Provision of organic matter to the soil

The root, stem, and haulm residues decay after harvest, providing organic matter and the contained nutrients to the soil.

(v) Fixes atmospheric nitrogen and adds it to the soil

As a legume, cowpea roots fix atmospheric nitrogen thus, increasing or improving the nitrogen content of the soil in which it is growing. Thus, the nitrogen content of the soil increases following cowpea cultivation, a contribution of about 40–80 kg/ha. Growing cowpea in a mixture with cereals (maize, sorghum, or millets) will increase the yield of cereal crops. In rice farming, cowpea can be grown either before or after a crop to increase food production from a land area. It can also be grown in rotation with rice immediately after harvest of rice thereby replenishing the soil fertility for the next crop to be grown on the same piece of land.

(vi) Suppression of growth of striga (ngava (Moru); loliyum (Bari), buda (Arabic)

Some cowpea varieties will stimulate the germination of striga seeds, but the roots of the germinated seedling of the Striga cannot penetrate the roots of the cowpea to obtain nutrients for its subsequent growth. Failing to obtain a host, the striga seedling will starve to death. However, cowpea does not cause suicidal germination in all Striga species. *Striga gesnerioides* and *Alectra vogelii* cause substantial yield reduction in cowpea in the dry savannas of sub-Saharan Africa. It is possible that these two species could be available in South Sudan. Resistant/ tolerant varieties to *S.gesnerioides* and *A.vogelii* have been developed by the International Institute of Tropical Agriculture (IITA) in Nigeria.

(vii) Drought tolerant or drought hardy

Many cowpea varieties can maintain some growth or at least survive and yield under dry conditions where other crop plants cannot grow. Some varieties of cowpea with deep rooting habit can grow under semi-arid conditions.

(viii) Provision of cash (*parata*/money)

Petty trading in fresh cowpea leaves (nyete), fresh produce and processed food provides both rural and urban communities opportunities for earning some money, particularly by women. Trading in cowpea haulms as food for large and small ruminants can be remunerative.

Plate 1: Dry cowpea leaves being sold by a woman in Pajok market, Magwi County, Eastern Equatoria State

(ix) Good growth and yield under irrigation in hot tropical dry season

Cowpea can grow well and attain good yields under irrigation when cultivated during the hot tropical dry season. Some varieties of cowpea can thrive well on the use of residual soil moisture in drier season.

(x) Seeds cook quickly

Dry cowpea seeds take comparatively less time to cook than any other food legumes, an important consideration in most developing countries where cooking fuel is scare.

1.4 Level of Production

(i) Global cowpea production

It is rather difficult to obtain reliable data on cowpea cultivated area and production because it is grown in mixture with other crops. It could be estimated that, the total area under production amounts to about 12.5 million hectares with an annual production of over 3 million tonnes worldwide. Cowpea is widely distributed throughout the tropics, but Central and West Africa amounts to 64 percent of the area with about 8 million hectares followed by about 2.4 million hectares in Central and South America, 1.3 million hectares in Asia and about 0.8 million hectares in East and Southern Africa.

The leading cowpea producing countries are: Nigeria, Niger, Mali, Burkina Faso, Senegal, Ghana, Togo, Benin, Cameroon, and Chad in Central and West Africa; Sudan, South Sudan, Somalia, Kenya, Malawi, Uganda, Tanzania, Zambia, Zimbabwe, Botswana and Mozambique in East and Southern Africa; India, Bangladesh, Nepal, Myanmar, Sri Lanka, Indonesia, China and Philippines in Asia; Cuba, Haiti, and West Indies in Central America; Brazil in South America and USA in North America. Production level in countries like Brazil, Cuba, Ghana, Mozambique, Nigeria, Sri Lanka, Sudan, Zambia and Zimbabwe is increasing due to availability of improved cowpea varieties.

(ii) South Sudan cowpea production

Most small scale farmers in South Sudan do grow a wide range of landraces, and cowpea is a representtative crop whose production is almost exclusively manual, using conventional tools. In addition, areas under cowpea production are determined by family labour and particularly women, and its preferences vary by region for different seed size; colour, texture of seed coat and usage.

In South Sudan, data on the crop is very scarce and if available, it is usually inconsistent and not reliable (FAO/WFP, 2012). This irregularity may be attributed to lack of collaboration between the data soliciting agents and the absence of a functional national cowpea research program. In addition, cowpea is always grown in mixtures with other crops and therefore it is difficult to assess its yield on area bases. For example, in western parts of Central Equatoria and Eastern Equatoria cowpea is grown mainly for leaves as vegetable, in Western Equatoria, it is grown for the seed and in Yei county seeds and leaves are both important.

The Greenbelt ecological zone of South Sudan where cowpea is grown spans through Eastern Equatoria and Western Equatoria states. Cowpea is also grown in other ecological zones of South Sudan (for example, the Ironstone plateau, the Central hills and the Flood plains). Several small scale farmers' in these zones record very low yields and this is attributed to the inherent genetic ceiling expressed in low productivity

among the landraces. A study by El Naim *et al.,* (2012) of the University of Kordofan showed yield levels of 0.8 ton per ha on research stations in Central Sudan. Personal communication with researchers in MAF reveal yield levels of around 0.4 ton per ha registered in farmers' fields in South Sudan. However, without proper documentation repository as a reference point, these figures have to be confirmed and documented in scientific studies.

1.5 Cowpea Preference

Cowpea farmers in South Sudan generally prefer high yielding (both grain and leaf yields), early maturing and tasty varieties of cowpeas (Table.1.1).

Table 1.1: Farmer's cowpea preference in Greater Equatoria

Characteristics	Description	Frequency	Percentage
Early maturity	Yes	44	88
	No	6	12
Leaf and grain, tasty	Yes	41	82
	No	9	18
Leaf texture	Yes	16	32
	No	34	68
Seed colour	Yes	28	56
	No	22	44
Grain size	Yes	33	66
	No	17	34
Grain texture	Yes	16	32
	No	34	68
Cooking ability	Yes	27	54
	No	23	46
Storage ability	Yes	21	42
	No	29	58
Drought resistance	Yes	28	56
	No	22	44
Pest resistance	Yes	28	56
	No	22	44
Disease resistance	Yes	27	54
	No	23	46
High leaf yield	Yes	48	96
	No	2	4
High grain yield	Yes	44	88
	No	6	12

Source: Field survey data (March – April 2014)

1.6 Varieties and Germplasm

Several landraces of cowpea are grown in various agro-ecological zones of South Sudan (Table 1.2). These accessions were collected through organization of several collection expeditions.

Table 1.2: Cowpea accessions collected from various agro-ecological zones of South Sudan

Accessions	Location	Agro-ecology	Planting Date
ACC001: Ladunie & Bamba	Pajok	Greenbelt Zone	April & July
ACC002: Mixture	Pajok	Greenbelt Zone	April & July
ACC003: Aleke & Others	Pajok	Greenbelt Zone	April & July
ACC004: Kenyan Type	Pajok	Greenbelt Zone	April & July
ACC005: Okalanga	Owiny Ki-Bul	Hills & Mts Zone	April & July
ACC006: Nahusiodor	Ikotwo	Greenbelt Zone	April & July
ACC007: Garawa	Ikotwo	Greenbelt Zone	April & July
ACC008: Bahubahu	Ikotwo	Greenbelt Zone	April & July
ACC009: Liliwa	Yei	Hills & Mts Zone	April & August
ACC010: Bubugo	Obasi	Hills & Mts Zone	April & August
ACC011: Liliwa & Mixture	Goja	Hills & Mts Zone	April & August
ACC012: Apagu Lukutu	Yambio	Greenbelt Zone	April & August
ACC013: Apagu Kidigi	Yambio	Greenbelt Zone	April & August
ACC014: Wuzoo	Maridi	Greenbelt Zone	April & Aug
ACC015: Oso jiji	Barwul	Hills & Mts Zone	April & Aug
ACC016: Titinwa	Karika	Hills & Mts Zone	June
ACC017: Ngigiwa	Karika	Hills & Mts Zone	June
ACC018: Biriwa	Wandi	Hills & Mts Zone	June
ACC020: JUB-1	Juba	Hills & Mts Zone	July
ACC021: JUB-2	Juba	Hills & Mts Zone	July
ACC022: MBR I	Bor	Flood Plain	July
ACC023: MBR II	Bor	Flood Plain	July
ACC024: IITA-1	Ibadan	Hills &Mts Zone	July

Plate 2: Farmers cowpea seed (Titinwa and Biriwa varieties from Moru Land) in Mundri East County

1.7 Characteristics of Cowpea Plant

Cultivated cowpea in South Sudan and Africa at large is a single species, but the varietal requirements in terms of plant type, seed type, maturity and usage are extremely diverse from region to region.

Mature plant

Cowpea is an annual herb with determinate and indeterminate growth habits. Varieties may be climbing, bushy, spreading, and semi-upright or erect in growth habit. It is predominantly a crop of drier areas. Most cowpea varieties are, in general, sensitive to photoperiodic induction. They are generally quantitative short day plants with tendency to flower as the day lengths become shorter. The day length influencing/delaying flowering may vary due to differential response of varieties, but it lies close to 13.5 hours.

Roots: Strong taproot and spreading lateral roots.
Leaves: Compound, with two asymmetrical side leaflets and one symmetrical central terminal leaflet. In other words the leaves are alternating trifoliate with ovate leaflets.

Plate 3: Trifoliate trifoliate leaves of cowpea

Stem: Twining stem varying in erectness and bushiness.

Plate 4: Cowpea climbing & twining stem types

Flower: In axillary racemes on stalks 15 cm to 30 cm long and gives good yield of seeds below about 1,500 m above sea level. Colour variable, their flowers may be purple, pink, white, blue or yellow. They are mostly self-pollinated, but out-crossing may occur only 2 %.

Plate 5: Cowpea flower

Pods & Seeds: The pods of most varieties hang downwards but in most varieties they point sideways or upward. Pods are pendulous, smooth, 10 cm to 23 cm long and cylindrical with a thick decurved beak often containing 10 to 15 seeds. Seeds, 4 to 8 mm broad, variable in size and may be white, brown, mottled brown or black in colour.

Plate 6: Cowpea pods in seed-filling stage

1.8 Environmental Requirements

(a) Climatic needs

Cowpea is adapted to high temperatures in the range, 20℃ - 35℃. It does not withstand flooded conditions. It grows under a wide extreme of moisture, and once established, it is fairly tolerant to drought, and can give good yields under marginal rainfall. It is often grown in the Ironstone Plateau zone and other areas of South Sudan receiving at least 600 mm rainfall per annum and it can be irrigated off-season. Some early and intermediate maturing cowpea varieties can grow and produce seed grain on only 188 mm of annual rainfall. For forage purpose, rainfall of 750 to 1100 mm is preferable. It will tolerate lower rainfall, but in high rainfall areas disease and insect attacks increase. Excessive rainfall also results in the production of too much haulm, delays ripening, and reduces grain yield.

The growth period of cowpea ranges between 90–240 days, depending on the maturity period of the cultivar. The crop can be grown at any time of the year, but best seed grains are produced when the crop is planted in mid-August (zones with heavy rains 800–1500 mm). The minimum terminal rains allows for good flowering and seed-filling, an important window in production cycle of cowpea. Furthermore, the disease pressure and insect attacks seem to be low around this period of year, hence allowing the crop to produce healthy seed grains.

(b) Soil requirements

Cowpea grows well in a wide range of soil textures, from heavy clay if well drained to varying proportions of clay and sand. The crop thrives best in slightly acid to slightly alkaline (pH 5.5–8.3), sandy loam soils. Cowpea can tolerate salinity to some extent, but tolerates soils high in aluminium. The crop is intolerant of water logging and must therefore be grown on free draining soils.

PART II: CULTURAL PRACTICES

2.1 Propagation

Cowpea is propagated by seed, with a seed rate of 25 kg per hectare. Seed rate can be estimated using the following formula:

$$\text{Seed rate} = \frac{\text{Plant population required}}{\text{Number of seeds/kg} \times \text{germination \%} \times \text{establishment \%}}.$$

Optimum soil temperature for rapid germination of cowpea seed is above 18.3 ℃, but the minimum base temperature to initiate germination can be (7℃ - 14℃).

Plate 7: Department of Agric-Science, fifth year students in dual purpose cowpea experimental plots, UJ, 2013

2.2 Land Preparation

The land can be manually prepared using the conventional hand tools (hoes or *torias*). In most settings where cowpea is grown on old plots, field preparations start immediately with cultivation/tilling of the land. However, production on virgin land should start with clearance of bush using axes and

machetes before proceeding to till the land. Trees and shrubs in the site are cut down manually, or grasses slashed and fallen trees removed from the field. Tractors can also be used to plough, and harrow the land before planting. Ridging can be carried out after harrowing if ridge planting is required. At least five to seven days should be allowed between each operation to allow for decay of bushes/ grass and decomposition by micro-organisms, thus enhancing soil fertility for good seed germination and growth. It is important to choose soil from which high production of cowpea may be obtained. A farmer must therefore select a well-drained sandy-loam soil in areas of high rainfall.

Plate 8: Conventional agricultural tools commonly used by the small holder farmers in South Sudan

Plate 9: Modern agricultural implement used by some commercial farmers in South Sudan

Land preparation is carried out before planting for the following reasons:

(i) To prepare a suitable seedbed

- Seedbed should be soft yet compact enough so that soil particles are in close contact with the seed.
- Seedbed must retain sufficient moisture to germinate the seed and support subsequent growth of the seedlings.
- Seedbed must prevent surface run-off and wind erosion.
- Seedbed must not be too compacted; it must allow sufficient entry of oxygen into the soil.

(ii) Elimination of weed competition

- Weeds compete with the crop for water, light and nutrients. They should therefore be destroyed in land preparation.
- Weeds with rhizomes and bulbs should be brought to the surface during land preparation to be dried by the sun.

(iii) To improve the physical conditions of the soil.

The physical condition of the soil is improved in land preparation by:

- Destruction of native vegetation or removal of residues of another crop.
- Removal, burial or incorporation into the soil residues of another crop.
- Loosen (if the soil is too hard), compact (if the soil is too loosen).
- Destruction of hardpan so that water infiltration into the soil is improved.

(iv) Elimination of soil diseases and eggs of insect pests

The hyphae and spores of fungal diseases and eggs of insect pests are brought to the surface of the soil by land preparation so that they may be killed by the intense heat of the tropical sun.

Advantages of planting cowpea on ridges

(a) In places with heavy rainfall and/or impeded drainage, ridges may be beneficial by locally improving drainage and increasing the yield of the cowpea.

(b) Ridges are effective in water and soil conservation by increasing water infiltration in the soil and reducing run-off.

(c) Ridges are beneficial in increasing yields on light poorly-structured soils in drier areas, although of no advantage on loam soils in high rainfall areas with good drainage.

(d) In slopy land ridges prevent soil erosion by run-off thereby improving water infiltration into the soil.

(e) Ridges retain more moisture from soil depth of 30 cm to 180 cm than flat land. Therefore cowpea roots that penetrate deeper than 30 cm into the soil will yield higher when water stress occurs.

2.3 Field Layout

The length of the field for planting cowpea should follow the contour of the land. Similarly ridges should be constructed following the contour. This is done to minimize soil erosion and conserve moisture.

Plate 10: Department of Agric-Sciences, fifth year students demarcating cowpea experimental plots, UJ, 2013

2.4 Planting

Most cowpeas are intersown with other food crops such as sorghum, maize, millet and cassava. Pure stands are sometimes established near homesteads for their leaves to be eaten as vegetable.

Plate 11: Department of Agric-Science, fifth year students implementing a cowpea experiment UJ 2013

Farmers growing cowpea in South Sudan should be encouraged to grow cowpea as sole crop/ pure stand. The reward is much greater seed yield, especially when early and intermediate maturing varieties are grown, after harvest of maize and rice or ground-nuts planted during the first season (early rains).The seed grain quality is much better and could be saved as seed for planting during the next cropping season.

Early/ intermediate climbing/ bush cowpea varieties can be planted in maize field when the latter attains horticultural maturity (when 60 % of maize leaves senesce). During the harvest of maize crop, the stalk should be cut about 1.5 m tall and left to stand on the field. The maize stalk provides support for the cowpea to grow (climb) and produce good quality seed.

(i) Spacing

Spacing in pure stands is very variable, very often 30 cm× 40 cm in off-season and 40 cm × 50 cm for early and erect varieties. A wider spacing of 50 cm × 75 cm for late or spreading varieties with 2 or 3 seeds per hill are commonly used. In some instances, spacing of 60 cm × 30 cm is also reasonable. Broadcasting is the more common method of sowing amongst rural farmers in Africa and South Sudan in particular where cowpea is sown with other food crops.

(ii) Seeding Depth

2 to 5 cm; however planting at 3 to 4 cm gives good germination hence plant stand.

(iii) Fertilisation

Cowpea grows well without fertilizer in fertile soils. In soils of low fertility, it responds to phosphorus and potash and often to some nitrogen. An amount of about 10 kg/ha of nitrogen applied at the time of sowing and 40 to 70 kg/ha P_2O_5 and K_2O may be applied before sowing. There seems to be response to calcium where the soil pH is low, but this may be a response to molybdenum.

(iv) Irrigation

Supplementary irrigation to cowpea field is important in areas where annual rainfall is less than 400 mm. During off-season, every other day irrigation schedule is necessary so that the plants can withstand the heat and water stress effect of the dry season high evapo-transpiration rate.

Plate 12: A fifth year student, Department of Agricultural Sciences, UJ, irrigating a cowpea experimental plot, 2013

(v) Weed Control

Weeds are serious problem in cowpea production. If not periodically removed they may act as hosts for pests. Thus, they will reduce both yield and quality of the grain. In addition, fodder yield may also be reduced since cowpea is not a strong competitor for resources particularly at the establishment stage. In other words, cowpea should be kept free of weeds after establishment. When left unweeded, cowpea can be completely smothered by weeds resulting in total yield loss. Weeds compete with crop, during growth, for light, water and nutrients. Weeds can cause greater yield reduction than arthropods, bacteria, viruses, fungi and diseases and may lower quality of the produce. Two weed control methods are commonly practiced in cowpea production:

(a) Manual weed control

This is the most common method used by farmers in rural South Sudan. The first weeding using hand

hoes is carried out two weeks after planting followed by a second weeding in six weeks' time. In high rainfall areas such as the Greenbelt, three weedings may be required.

(b) Chemical weed control

Herbicide application is both safe and effective if a farmer can afford. However, its choice and time of application depends on the type of weed and availability of the herbicide to be applied.

Plate 13: Cowpea plants at pod maturation stage at UJ evaluation trial, 2013

(vi) Pests and diseases

Pests

Insect pests are probably the most important factor limiting the yield of seed and quality of leaves used as vegetable. The most important pests of cowpea include:

(a) Bean aphid (*Aphis fabae*)

These aphids are black sucking insects, which cluster around growing points, stems, leaves and flowers. If in large numbers, they can prevent normal growth.

Yellowing and distortion of the leaves is common due to attack of these aphids. Spraying with malathion, menazon or endosulfan can control the spread of the insect pest in the cowpea field.

(b) Blossom beetles (*Coryna spp*), thrips and the pod sucking insect (*Acanthomia horrida*).

(c) Spotted pod borer (*Maruca testulalis*)
This is a pest of drier areas, which can cause damage to seed. The larvae are olive green with rows of dark spots and are hairy. They eat both the flowers and pods causing serious damage to the crop.

If insecticides are to be applied to control pests, they must not be applied before the removal of leaves for vegetable.

(d) Bird damage
The mode of germination of cowpea is epigeal, that is, the cotyledons are carried above the ground. They assume photosynthetic function which supports growth, until the first true leaves are photo-synthetically competent. At this stage, birds especially doves, pigeons, guinea fowls and Double-supped Francolin *Francolinus bicalcaratus 'Kari'* (Moru) cut these cotyledons and eat them; thus destroying the germinated seedling at this early stage. Resowing of the destroyed seedlings can be done immediately. Guinea fowls can be a menace when seeds have been formed in the pods.

Plate 14: Guinea Fowl on University Campus, waiting to land in a near-by crop of cowpea planted in the dry season

(e) African Red Monkeys

Both the grey and brown African monkeys can eat the pods of the cowpea. They start eating the pods at the pod filling stage and if left unchecked, they can completely devour the crop with total yield loss. The only control is to keep watch over the crop from the time pods are being formed until harvest.

Plate 15: African Red Monkey within UJ campus, one of the destructive cowpea pests

(f) Bruchids (Callosobruchus)

This is the main storage pest of cowpea. There are two major species: ***Callosobruchus masculatus*** and ***Callosobruchus chinensis***. The adult beetles often lay their eggs in the field on the developing pods. The larvae bore through the pod walls and into the seeds. They are so small that their entry holes are almost invisible and as the seeds grow, the holes disappear. The larvae feed inside the seeds and each makes a tunnel almost to the surface. Only the seed coat is left intact, forming a window at the end of the tunnel. After pupation, the adult beetle emerges by pushing out the flap of seed coat, leaving a circular hole.

Although some eggs are laid in the field, most are laid by adults emerging in the stores. They lay their eggs loosely amongst the seeds and can cause a rapid increase in the number of infected seeds.

In some settings in South Sudan, farmers often mix cowpea seeds with ash; this is the mostly used control measure.

Plate 16: Garawa variety of cowpea pods infested by bruchids in storage in Ikotwo

Cowpea grains in storage are susceptible to bruchid destruction. In storage they can completely destroy the grains into powder if the seeds are removed from the pods.

Diseases

Diseases of cowpeas are more prevalent and serious in humid areas but they can also attack the plants in drier areas. The most common diseases that affect cowpea are:

(a) Zonate leaf spots

These are various spots on the leaves caused by *Ascochyta phaseolorum* and *Dactuli phoratarii* and pseudo rust (*Synchytrium dolichi*). Their control is mainly by growing resistant varieties of cowpea to these fungal diseases. Septoria leaf spot, Cercospora leaf spot and brown blotch are some of the common cowpea leaf spots.

(b) Viral diseases

Cowpea is susceptible to more than 20 viral diseases, some of which include: cowpea aphid-borne mosaic, cowpea banding mosaic disease, cowpea chlorotic mottle virus, cowpea golden mottle virus, cowpea yellow mosaic and cowpea severe mosaic virus. Some are passed from one generation of plants to the next through the seed, and as a result, they can spread to other cowpea production areas through seed transfer. Seed borne diseases are spread within cowpea fields by insect pests such as aphids and beetles.

Viral diseases are difficult to control using chemicals. The only possible control is the use of improved cowpea varieties with resistance to viral infection.

Plate 17: Cowpea mosaic virus observed at UJ off-season cowpea experiment in 2013

(c) Bacterial diseases

Bacterial blight is a common cowpea disease of the humid tropical areas.

Plate 18: A fifth year student, Department of Agricultural Sciences, spraying aphids with malathione on cowpea experiment UJ, 2013

2.5 Harvesting

To make a good vegetable or spinach, the leaves of the cowpea plant must be young and tender; the best leaves are about the third and fourth from the apical end of the shoots. Removing all the tender leaves three times at weekly intervals, starting four or six weeks after sowing (planting) have no adverse effect on grain yields although flowering may be delayed. In crops grown for the seed, 10–20 % of the leaves are harvested before the start of flowering with little detrimental effect on the seed yield. Stronger defoliation (>40 %) increasingly reduces flowering, fruiting and seed yield.

Mature seeds are usually harvested by hand. Green pods are harvested when the seed is still immature, 12–15 days after flowering. Harvest of matured pods for dry seeds are usually done by removing matured pods individually as they ripen and are spread on the ground in the homestead to dry. In indeterminate maturing varieties, harvesting of matured pods is complicated by prolonged and uneven ripening; for some landraces harvesting may require up to seven rounds with three to four days intervals. The duration of the crop from sowing to harvesting depends largely on the growth habit, the rainfall and local husbandry practice but is seldom not more than five or six months.

2.6 Utilisation

The tender leaves are usually picked, crushed and fried and then boiled with meat or sesame or groundnut paste and eaten with *'ugali/asida or kisra'*.

Sometimes the leaves are dried and ground into powder, which can be stored for later consumption in the dry season when fresh leaves are not available.

Cooking before drying of cowpea leaves is a widespread method of preservation in many parts of Africa; boiled cowpea leaves are kneaded to a pulp and then squeezed into golf-ball size pallets that are dried and stored.

The seeds may be boiled with maize or sorghum and eaten as "*balila"* or mixed with sesame or groundnut paste and eaten. In some communities, the boiled seeds mixed with sesame or groundnut paste is eaten with *"ugali/asida".* The seed coat may be removed, after which they are boiled or fried and sesame or

groundnut paste is added to make a sauce (*pirinda*), which can be eaten with "*ugali/asida or kisra*".

2.7 Cowpea Production Limitations

- Cowpea yields are normally low, as a result of insect damage, poor management and the use of unimproved varieties.
- The pods shatter quite readily when mature, losing seed and sometimes causing problems with volunteer plants in the following crop.
- Harvesting of indeterminate types can be a problem since the pods may be removed every few days over a period of several weeks.
- Storage losses can be high, often as a result of attack by bruchid insects.

PART III: POST-HARVEST HANDLING

3.1 Threshing

The pods of cowpea can be manually threshed by beating with a stick when harvested pods spread in the sun are well-dried. The seeds are breakable as such the threshing should be light, just to break the pods. The pods can also be broken by fingers to remove the seeds, if the quantity is little.

3.2 Sorting

Seed quality is a determinant of good crop establishment, growth and development. Thus, care at all levels of operations; from harvesting, threshing and post-harvest handling to keep the seeds free of infection by pests and diseases is necessary. Sorting is crucial to remove defective and broken grains, stones, waste and infected seeds from healthy ones. It is in the interest of the seed dealers to get clean seed from seed farmers so that they get better pay. The seeds found in South Sudan markets are not clean; they contain stones, various foreign wastes, broken and defective grains; infected grains with diseases, weevils and bruchids.

3.3 Grading

The highly nutritious cowpea seed is grown for fresh, processed, and dried uses. Thus, healthy leaf and high quality seed is required for consumption and marketing. Grading can be done by removing infested, diseased and broken seeds and leaves. Shrivelled seeds are also eliminated.

3.4 Packaging

Cowpea seeds sold in South Sudan markets are not packaged as it is done in other countries. They are sold in open containers and in open air exposed to both high temperature and humidity. Thus, small holder farmers need the technical know-how of packing seeds to keep them safe and viable. The seeds should be packaged in bags and placed into an electrical dryer or spread on a slab under the sun to ensure that the moisture content of the seed is reduced to the desired level of 12 % or less. Thus:

- Cowpeas should be packed in suitable packages which must be clean, sound, and free from insect, fungal infestation and the packing material shall be of good grade and quality.
- Cowpeas can be packed in containers which will safeguard the hygienic, nutritional, technological and organoleptic qualities of the products.
- The containers, including packaging material, should be made of substances which are safe and suitable for their intended use. They shall not impart any toxic substance or undesirable odour or flavour to the product.
- Each package shall contain cowpeas of the same type and of the same grade designation.
- If cowpeas are presented in bags, the bags shall also be free of pests and contaminants.
- Each package shall be securely closed and sealed.
- For long period storage of cowpea, the Purdue Improved Crops Storage (PICS) bags should be introduced in South Sudan for use to cowpea farmers. The bag reduces loss of cowpea grain to insect infestation.

3.5 Storage

In South Sudan, agricultural communities store their cowpea grains in diverse ways, depending on whether the grains are for consumption during the year or the grains are for seed for planting next season. Cowpea grains for consumption remain in pods and stored in granaries, structured as shown in plate 15. For seed, many farmers prefer storing the seed grain within the dry pod. The dried pods are tied in small bundles and hung over the cooking spot in the house/ kitchen so that whenever food is being cooked the smoke from the fire would drive away invading insects.

In some places, for example Yei County, in Central Equatoria State, dried chillies are ground into powder and sprinkled in a bag in which pods are kept. The hot chillies (*piper nigrum*) are reported by farmers to scare and repel away invading storage pests. Dried cowpea leaves as vegetable can also be stored in water proof containers to be eaten in the dry season when green vegetables are scarce.

Plate 19: Farmers traditional grain store at Pajok, Magwi County, Eastern Equatoria State

PART IV: COWPEA MARKETING IN SOUTH SUDAN

4.1 Marketing

The marketing of cowpea is of great interest to the farmer, the consumer and the middleman. To the farmer, it provides a channel of communication between him and the society and gives him continuous information about the demand for his product. The consumer views it as a means of supplying his needs since marketing helps in raising the standard of living of people by satisfying a multitude of needs and desires of the consumer. The middleman depends upon it for his livelihood. These diverse interests lead the farmer to seek a high priced market for his products, the consumer a low priced market and the middleman, a margin between the farm price and consumer's price that will amply reward him for his service.

From a marketing perspective, a potential market consists of a group of people with similar needs for a particular good or service, possessing sufficient resources to make a purchase, and have the willingness and ability to buy. Essentially, buyers and sellers need not come together. However, it has been observed that most African markets for Agricultural goods involve physical contact between buyers and sellers; hence, the markets have a clearly defined geographic location. Most villages have small markets where traders regularly gather to market their produce. These markets are named as road side markets, rural markets/village markets, assembly markets and direct selling to traders. The same types of market play an important role in cowpea marketing in South Sudan (Bibagambah, 2002).

According to Samuelson and Nordhau (1995), the critical characteristic of a market is that it brings buyers and sellers

together to set prices and quantities of good; thus, leading to the definition of a market as a mechanism by which buyers and sellers interact to determine the price and quantity of a good or service.

Cowpeas are mainly produced by small-scale farmers for family consumption with some little surplus for sale. The area planted with cowpea accounts for 1.3 per cent of the world's total planted with other crops, but may be subject to wide variations. These variations occur mainly due to cowpea price changes and climatic conditions. Difficulties in getting improved varieties and pesticides, as well as their high costs are also constraints that inhibit expansion of cowpea production in South Sudan to reach its full potential and hence attain market values.

Given the growing importance of cowpeas as a means to improve the livelihoods of people in South Sudan, coupled with the little information available on the marketing of cowpeas and its associated problems, the focus of this section of the handbook is to highlight key aspects for the successful marketing of cowpeas in South Sudan.

4.2 Cowpea Market Opportunities

Cowpea is one of the most important indigenous legumes of the tropics and sub tropics. In Africa, information on cowpea marketing and trade is lacking and data on cowpea production and consumption economics scattered, yet the urban population are undergoing a nutritional transition characterized by decline in consumption of traditional food crops, and increasing consumption of refined and processed foods (fats; sugars and animal foods). There is need for a shift in philosophy of here's what we produce to a situation where farmers take note of food products the consumer wants in order for their products to have

a place in the market. The availability of market for cowpea both domestically and regionally makes it a potential income and food security crop for the rural poor and so the need to understand its consumers, hence defining the market.

In South Sudan, very little is known about the willingness of consumers to pay for preference characteristics of cowpea. This state of affairs puts producers, middlemen and other role players in the marketing chain at a disadvantage based on the economic principle, which postulates that a product's demand stems from the utility provided as a function of its quality characteristics.

Subsistence farmers in South Sudan are the major producers and consumers of cowpeas. These farmers not only grow cowpeas for dry seed for human consumption and fodder for animal feed, but also utilize the green leaves and tender pods as vegetable. The amount of the leafy cowpea parts consumed annually in Africa and Asia is equivalent to 5 million tons of dry cowpea seeds representing as much as 30 % of the total food legume produced in the lowland tropics (Fery, 2002).

The marketing of cowpeas, like other crops, is mainly confined to local markets and farm gate. This is attributed largely to lack of access to urban markets by farmers partly due to poor road network and poor modes of transportation. However, considerable local trade in cowpea therefore exists within the local communities. Inter-regional trade in cowpea too exists. It is a profitable crop to produce according to Sabiti (1995) and a lot of the crop could find its way to the East African Markets in Kenyan and Uganda markets.

Availability of land to farmers may not to be an issue with regard to size of cowpea fields. However, lack of capital and inadequate labour seems to be the main factor restricting cultivation of larger acreage (Isubikalu, 1998).

4.3 Quality of Cowpea Product

Storage plays a significant role in product quality and thus grain prices. However, quality-price relationships are less significant during the dry season when poor quality product may sell at a higher price than good quality grain at harvest. Prices tend to be positively correlated over time with damage because damage levels increase with grain scarcity (Langyintuo *et al.,* 1999).

However, acceptance and intention to purchase food products are linked to consumption and the purchase process and can be used as an indirect way to obtain data to understand consumers' behaviour (Iop *et al.*, 2006). Acceptance and preference, for a long time, have been taken into account in consumer's food studies (Schutz, 1999). Food acceptability, choice and consumption are complex processes influenced by many intrinsic factors, such as colour, aroma, flavour, and texture, as well as factors extrinsic to the product.

4.4 Key Aspects for the Successful Cowpea Marketing

The lack of a proper Market Information System (MIS) is severely constraining the efficient marketing of cowpeas. Such information would allow role-players to make better production and marketing decisions that will increase efficiency and hence profitability. Therefore, the implementation of a MIS focusing on cowpea specifically should receive serious consideration. What follows are broad recommendations to establish a cowpea MIS.

(i) Information on local prices, demand and supply, and buyers' preferences should be collected and registered, in collaboration with the cowpea forum, by the South Sudan Centre for Statistics and Evaluation (SSCSE) which has representatives in all the South Sudanese states. In addition, the SSCSE already has gained invaluable experience in collecting and processing of market data. The SSCSE could be assisted by the National Ministry of Agriculture which has personnel in all states that also interact with rural communities. Food and Agricultural Organization (FAO) of the United Nations is another important source of information on cowpea in South Sudan. The reports of crop assessment being carried out annually by FAO will help in building a formidable data on cowpea production and marketing.

(ii) Both SSCSE and FAO have links to the East African Market Information System Network and could use this opportunity to source information on cowpea demand and prices from other East African countries and beyond.

(iii) Aggregated statistics on cowpea area and production should be collected by each County Department of Agriculture (CDA) on a yearly basis, and such information could be used to forecast supply. CDA is assisted in its field data collection by the County Extension Services (CES). Hence the CES could also assist in gathering up-to-date, reliable and relevant information and pass it on to the SSCSE for collation.

(iv) Data on cowpea should be centralized and processed by SSCSE personal. Price data should be collected from rural and urban markets. It should be processed and

disseminated on a daily basis. This may require regional information hubs.

(v) Information on foreign prices and demand could be disseminated on a monthly basis and supply forecast on a yearly basis. Information could be disseminated through national radio, as well as through FM radio stations which are very popular in South Sudan. Information should be broadcasted in Juba Arabic and the local language of the specific County.

4.5 Strategies for Cowpea Market Development in South Sudan

The introduction of a sustainable and viable credit system to provide financial support to market actors would be an important way of promoting cowpea marketing since no formal credit system exists in the cowpea sector.

Institutions dealing with market information systems need to know what information is needed by market actors and what would be the most appropriate form of disseminating such information. To communicate cowpea related market information, different modes could be used depending on their accessibility. These options include the use of radio broadcasting, telephone calls, television, e-mail exchanges and webpages specialized in cowpea or other agricultural products, reports and daily newspapers. Radio could be the best way of communicating market information to its users if the appropriate language is used. Phones also appear to be a popular way of receiving information. Television could also be the most favoured way to receive information.

Awareness campaigns should be launched that focus on the different uses of cowpeas as source of nutritious meal. In this regard, the different characteristics of cowpea should be promoted. Promotion could also make use of television spots and recipe brochures on the different uses of cowpea.

Producers (as a collective group), wholesalers and exporters should attend events and trade fairs, such as the Agricultural Fair held in Juba in 2011. The goal of the agricultural fair is to provide international exposure to small-scale farmers and to showcase agricultural products. Processors, for example, attending this event with value added cowpea based products are still doing it in a non-organized manner. More specifically, an agricultural forum should be established as overarching body where issues such as cowpea marketing, research, exports, consumer trends and the like could be critically discussed. Such a forum should be inclusive and act as a lobbying institution for cowpea role-players. Furthermore, it could provide the necessary impetus for the establishment of sub-organizations that represent role-player groups, such as, a cowpea producer organization.

Collectors and retailers appear to be ignorant of what their clients need. This is probably due to a poor communication and the fact that they don't have enough or any information, which could be used to promote the characteristics of cowpeas as a nutritious food. Therefore, it is vitally important to inform collectors and retailers about buyers' preferences, and the opportunity that conveying such information could actually increase their sales. This could be done through the information channels described, as well as with brochures. The suggested agricultural forum is crucial and could play an important role in promoting cowpea production and marketing in South Sudan.

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