South Sudan Crop Production

Farmer and Extension Guide

CEREALS

Republic of South Sudan
Ministry of Agriculture, Forestry, Cooperative and Rural Development

SORUDEV
South Sudan Rural Development Programme

CONTENTS
Contents

Foreword

Food and nutrition security and poverty reduction are a priority of our government. The Ministry of Agriculture and Food Security, and the Ministry of Livestock and Fisheries are mandated to ensure that the people of South Sudan produce sufficient food to feed themselves and for export. We have developed the National Agriculture Livestock Extension Policy (NALEP) and launched the process of developing the Comprehensive Agriculture Master Plan (CAMP) through which many projects will be implemented.

The Ministries at national and state levels are challenged by limited resources and weak capacity of community based extension workers, particularly at the County and Payam levels yet these are the staff that meet and advise our farmers. Increased production and productivity issues are crucial if we are going to ensure that crop farming and livestock rearing that our smallholder farmers and families depend on is improved.

We highly value and appreciate the support and efforts made by our development partners and the UN agencies, and in particular the support from the European Union to develop thisextension guide to be used by our community based extension workers at both county and payam levels.

The process was rigorous. I am assured that the three guides (crops, livestock and the general guidelines) are written in the language that will be understood by our extensions staff in different agricultural zones of the country.

I am delighted that these guides in the form of booklets will now be used across the country.

Hon. Dr Lam Akol Ajawin

Minister of Agriculture and Food Security

The Republic of South Sudan

Preface

This extension guide for farmers and extension practitioners in South Sudan was compiled over a period of a year. The process brought together staff of both states and national ministries of agriculture and ministry of livestock and Fisheries including technical from the Non-Governmental Organizations and two UN Agencies. The technical information in this booklet is from the experience of South Sudanese farmers, extension staff and development partners implementing food security projects. Additional information was sourced from materials developed by the government, the NGOs, FAO, UNIDO, academic, research and agricultural training institutions across Africa but most especially from the East African sub region. The European Union through the South Sudan Rural Development Programme (SORUDEV) funded and facilitated the process.

The technical information on crop production and animal husbandry techniques that exist in South Sudan were scattered in many documents, places and in the forms that could not be readily accessed or understood by farmers. Above this, there were issues relating to the accuracy of information in them. This booklet therefore provide verified and validated technical information on production techniques that can be used by community based extension workers, County and Payam field extension staff and farmers across agro ecologies of South Sudan. The process of collating the information for the booklet began in June 2014 in the Greater Bahr el Gazal states and was validated twice in the equatorial states of Yei and recently in Juba Juba in May 2016. Throughout this period, the material were pre tested in many communities and at each review stages gaps, clarity, accuracy and relevance were checked and improved on.

Specifically, the guide on crop production covers agronomic and cultural practices for eleven selected crops namely Sorghum, Maize, Rice, Sesame, Cowpeas, Groundnut, Beans, Cassava, Sweet Potatoes, Tomatoes and Kale. In each of the guides you will find information on seed varieties, cropping seasons, land preparation, spacing, pest and diseases management, harvesting techniques and marketing. The second guide on animal production covers husbandry techniques for Cattle, Goats, Sheep and poultry. The guide provides technical information on selection, housing, feed types and feeding, diseases (including disease management) and marketing. The third guide contains a set of guidelines on Ox Ploughing, Agricultural Marketing, Agrodealership, Village Savings and Loans Association, Community Mobilization and Farmer Field School.

'Tayo Alabi

Facilitator

Sorghum Production

(Sorghum bicolor)

Farmer and Extension Guide

SORUDEV
South Sudan Rural Development Programme

Background

In South Sudan, **Sorghum** *(Sorghum bicolorL.)* is commonly called sorghum or *dura*. It belongs to the *family Gramineae* (*Poaceae*) and is believed to have originatedin North-East Africa onthe border betweenSudan and Ethiopia, where it was domesticated some 5,000-8,000 years ago.Wild sorghum plants still grow in this region. Sorghum is widely cultivated in all 10States of South Sudan and is the staple food ofmost communities, which eat the grains and stalks. In agro-pastoral communities the leaves and grains are fed to livestock. Sorghum grain contains 11.3% protein, 3.3% fat and 56-57% starch. It is relatively rich in iron, zinc, phosphorus and B-complex vitamins.

Site selection

Sorghum is described as a resilient crop asit is very well adapted to a wide range of environmental conditions, and is thus an excellent crop for food security. It is particularly adapted to drought and also tolerant of moderate waterlogging,meaning itcan be grown in areas of high rainfall.

The crop does well in most soils, but thrives best in light- to medium-textured soils.While sorghum can tolerate a soil pH of5.0 to8.5, thesoil should preferably be wellaerated and drained.Sorghum is also widely grown in temperate regions and at altitudes of up to 2,300m in the tropics where it is well exposed to sunshine. When selecting a site for cultivation, it is important to choose areas that are safefrom animals and theft and which are suited to animal traction (ox ploughing), especially if there is a desire to expand the area under cultivation.

Land clearance

The common practice is to fell trees and shrubs and to draw fire-linesalong which the land is then burnt. Tools used for land clearance are axes, machetes (panga), hoes (maloda/pur) and slashers. Land clearanceshould begin as early as possible, preferably shortly after the harvest.

Land preparation

Well drained soil is preferable and areas of land that are waterlogged must be avoided. Preparation of land should be done as early as possible at the start of the rains. Traditionally,South Sudanese farmers combine preparation withplanting (sowing). However, farmers are advised to undertake two separate types of land preparation practice (tillage): primary (general) and secondary (fine seedbed) preparation. The tools commonly used by smallholder farmers are hoes (maloda/pur) andthe ox plough (purweng), while tractorsare used for land preparation by large-scale farmers.

Selection of planting materials

Propagation of sorghum is usually through seeding. Types of sorghum seed vary according to the time it takes them to mature (short-, medium- and long-termsorghum varieties). In South Sudan, seeds are mostly selected during the harvest. They should be wholesome (free ofphysical damage, pest infestation and disease) and should be adequately dried before being stored in a clean and well-ventilated area. Farmers are encouraged to procuretheir seeds from the reliable available suppliers and to use certified seeds where available. Seeds should come from a stock kept ingood condition in order to preserve theirviability.

Varieties of sorghum

There are several short-term, medium-term and long-term varieties of sorghum in South Sudan. Examples include:

1. *Short-term*: WeeraborandCam (Aweil),Akuoracot (Jonglei), Nyitiin, Matueel, Nyambor, Ayenawuut, Kamtolo,Maniong, Duor, Anyang, Adhukwongwut, Shuluk (Lakes):
2. *Medium-term*:Nyandok, Malualgot (diil), Chaal, Luwaya;
3. *Long-term*:Kech (yellow) andMabior (known as Mabor in Lakes).

Preparation of sorghum seed

Sorghum is mostly sown through broadcasting. This is common practice in a number of communities in South Sudan. However, row plantingis the preferred method because itensures optimum plant population, higher yields and the development of good-quality grains.

Planting time

The appropriate planting time for sorghum depends on the variety. There are three broad varieties based on their duration (long, medium and short). For long-duration crops, it is recommended to plant immediately the first set of rains begins in April. Short-term seeds are mostly planted in late May. Generally,sorghum production is undertaken in one of three cycles: short-term (45-90 days), medium-term (120-140 days) or long-term (160-180 days).

Plant spacing

For sole cropping the recommended spacing is 45cm between plants by 45cm between rows. Plant population per rowin a single hectare(ha) is about 3,000 when adequate water and soil fertility are available,giving a total plant population of 100,000 to 150,000 plants per hectare.The weight of seedlings produced can varyfrom 3 kg/ha in very dry areas to 10-15 kg/ha in areas under irrigation.

Sowing methods

Seeds are dropped directly by hand into holes in the row or seedbed using the broadcasting, or 'dibbling' method.Since sorghum seeds are small, they are planted or placed at a shallow depth of approximately twice the size of the seed (about 25mm). Sorghum can be intercropped (mixed),most frequently with millet, cowpea, groundnut, sesame (simsim) and maize.

Thinning

For crops grown in dense populations as a result of direct sowing, it is advised to thin to two plants per stand within a period of 2-3weeks after the seeds emerge. This should be doneimmediately following the first substantial rain. The strongest, bestgrown plants should be retained and the weak ones removed.

Fertiliser application

In South Sudan, natural organic manure from cattle is used widely and to various degreestofertilisesorghum fields. For example, in Northern Bahr-el-Ghazal (NBG) and Lakes State, farmers use cow dung to improve soil fertility while in the greater Equatorial region, green manure, goat and poultry droppings are widely used as organic manure. At national level, the Ministry of Agriculture and Forestry (MAF) encourages the use of organic manure such as compost, dung, slurry, liquid manure and crop residue.

For optimum production, inorganic fertilisercan be used (the requirement for which is determined by both soil type and rainfall). A basic dressing ofnitrogen, phosphorus and potassium (NPK)may be required and the crop usually responds well to additional dressings of nitrogen during vegetative growth. A fallowed, loamy soil may not need fertiliser. Rotation with a leguminous crop can give low-cost fertility build-up. Fertiliser requirements can be up to 60-80kg/ha of nitrogen (N), 20-45 kg/ha of phosphorus (P) and 35-80 kg/ha of potassium (K) depending on the crop/soil type. Usually, 5 bags of NPK 15:15:15 should be given to provide this level of nutrients.

Weedcontrol

In practice, weeding is done once in Greater Bahr-el-Ghazal, once in Greater Upper Nile and twice in Equatoria.Weeding is normally done using hand hoes (maloda and jembe).However, in order to best control most common non-parasitic weeds, it is recommended to weed twice (by the third and sixth week).For parasitic weeds such as Striga (dhiac, see the picture below), which can reduce crop yields by as much as 30-50% if not controlled, tolerant and/or resistant varieties of sorghum should be planted. In addition, Striga plants should be pulled by hand and burnt whenever they are seen.

When crops are cultivated in rows, weeding can be done using oxen. Weeding should be done when crops are in their vegetative and booting stages.

Pest and disease control

The most common pests that attack sorghum in South Sudan are birds, livestock, wildlife and insects. These pests can attack at varying stages of sorghum growth and development.Common pests that attack during planting and germination includethe guinea fowl (*wel*), hornbill (*aciil*) andcrow (*gak*).Pests that attack at thevegetative stage include animals such as goats, sheep, cattle, baboons andmonkeys.Atthe seed formation stage, common pests include the Sudan bird (*amour*), dove (*guuk* or*kuur*), alaal andweaver bird (*lual*) while at the storage stage, common pests are weevils, rats, etc.

Diseases

The notable disease that affects sorghum is smut(also known as *tuk, mut*or*thuk*), which attacks at the seed development stage.Grain mould isanother(fungal) diseasethat affects medium-maturing varieties of sorghum(andall varieties when stored). Mould can grow in grain stores due to moist air and limited ventilation. The selection ofvery clean and healthy seeds that are free ofdisease can also help to reduce the incidence of smut.

Stem borer disease is also very common, but can be controlled effectively by ensuring good field hygiene, regular weeding and the destruction of host crops. Other diseases of sorghum include anthracnose and leaf blight.

Harvesting

Harvesting is done manually using sickles, spears (tong) and knives (pal)oncethe crop has reached maturity.

Fresh and dry harvesting

Fresh harvesting is desirable, but not very popular due to the labour required and the inadequate drying facilities available. When the harvest is green, the leaves can be fed to cattle, goats and sheep. The stalks are left in the soilso that new shoots may sprout again from the base of the crop. This is known as ratoon (*abeer*).

Most farmers harvest their crops afterthey havecompletely dried out in the field. The moisture content of long-term sorghum ranges from30-35% during harvest.Following the harvest, sorghum crops are temporally dried on arack (*jong*) outside the home for about two months prior to being stored. The primary aim is to reduce the moisture contentof the grain to about 15%, which helps to protect the grain from attack by storage pests such as weevils.

When harvesting sorghum to be used as seed, it is advised to pick good, well-formed heads which arefree ofpests and disease.

Yield

Under rain-fed conditions, grain yield can vary from 300 to2,000 kg/ha.

Grain yield under spate irrigation, with little or no rainfall and a total growing period of 90 days, can range fromabout 800 kg/ha to 1,300 kg/ha.A good yield under irrigation is 3.5-5tonnes/hawith a 12-15% moisture content.

Storage

Sorghum seed is stored as either threshed ornon-threshed (panicles). Farmers usually thresh seed during preparation for planting. Threshing includes beating to separate the seeds from the shaft (*ayiel*), cleaning and sorting.

Storage is mostly done using traditional storage facilities such as tins, gourds, pots and*yuk*.

Marketing

Sorghum is the leading staple of the majority of theSouth Sudanese population. As a result,most of the grain produced isconsumed by farmers and their families, However, the bartering of grain in exchange for milkbetween farmers and cattle keepers is also popular. Sorghum is also sold in all local markets as grain and flour.

Rice Production

(Oryza sativa L.)

Farmer and Extension Guide

SORUDEV
South Sudan Rural Development Programme

Background

Rice (Oryza sativa L.) is one of the staple cereal foods and cash crops in South Sudan despite not being widely cultivated. While most of the various agro-ecological zones in South Sudan have high rice-growing potential, at present rice is only widely grown in Aweil (Northern Bahr-el-Ghazal State) where the most intensive effort is led by the Government through the Aweil Rice Scheme. However, some States such as Upper Nile (Renk), Western (Yambio, Nzara) and Central Equatoria (Lanya and Yei) also produce some upland rice.

Site selection

Rice is mostly grown in two types of ecological zone: the lowlands and uplands.

Lowland rice requires fertile, clay loamy soil which retains water in order to grow. For lowland rice cultivation, it is therefore important to select low-lying and swampy areas where water (in the form of either rainfall or floodwater) can stay for 1-4 months on the ground. The water used in the Aweil Rice Scheme is from a mixture of rainfall and river flooding which usually occurs between late July and October of each year.

Land preparation

Proper land preparation is necessary for rice seed production in order to minimise competition with weeds. Seedbeds should be prepared before the onset of the rains in a given location. For new land, all stumps and roots should be removed before ploughing and the land ploughed once and harrowed twice to ensure good fine tilt if the land is flat. A well-levelled field ensures uniform water depth throughout the season and contributes to uniform ripening across the field.

Thorough land preparation can significantly decrease the incidence of weeds in rice paddies and fields. Under the Aweil Rice Scheme, land preparation is done earlier (in February or March) through clearance and ploughing using a tractor or hoe.

Seed and seedbed preparation

Various seed varieties are grown in South Sudan. The Aweil Rice Scheme has more than 20 varieties of which two (BG 400-1 and BR 4) have been developed for use at farm level while the remainder are managed and bulked at the Agronomy Department.

Table 1: Common Rice Varieties tested by the Aweil Rice Scheme

Long-duration varieties	Short-duration varieties
BG 4001	DRS 1
BR 4	ITA 310
Bhavani	BS 370
BG 90-2	IR 2793
B 10	LRO 7
B 15	Nerica 1
IR 47	Nerica 4
V 15	Nerica 11
ITA 123	B solo
R 35-2753	
Geza 128	
Geza 117	

Seedbed preparation starts with the first rains in May and continues throughout June in parallel with sowing. The first decision should be which variety to cultivate. Only viable seeds should be selected and sown.

In most irrigated swamp farming systems, rice seedlings are first nursed and then transplanted into puddled soil.

Under lowland rice, land preparation is done by flooding the field to a depth of 10 cm. Poor or untimely land preparation will cause serious problems with weeds. It is recommended that land be tilled immediately after flooding the farm (at least 15 days before transplanting or direct sowing).

Planting

Rice is planted either by broadcasting the seeds or by first establishing a nursery and subsequently transplanting the seeds.

The depth of planting is about 3 cm. Spacing should be 20 x 10 cm or 20 x 20 cm depending on the tilling ability of the variety. It is advisable to transplant rice seedlings after about 3-4 weeks of germination.

On uplands (which are characteristic of Western, Central and Eastern Equatoria States), rice should be sown on very well prepared land that has been both ploughed and harrowed. Rice is grown in these areas in March/April and in August/September as a relay crop with maize (in this case with a spacing of 45 cm). It can also be grown as a solitary crop. Sowing is done by drilling. In sole cropping the common spacing between stands is 30 cm and thinning is carried out after germination.

Fertiliser application

In most parts of South Sudan (with the exception of Renk), chemical fertiliser is not in use. Crops are therefore entirely dependent on the natural fertility of the soil, particularly in lowland conditions. However, if desired, rice plants do well when they have adequate amounts of Nitrogen, Phosphorus and Potassium (NPK) fertiliser.

Weeds and weed control

Weeds are the most common cause of crop loss of rice. In most irrigated swamp farming systems, rice seedlings are nursed and subsequently transplanted into puddled soil. This practice gives the rice a substantial head start on the weeds and competition is initially minimal. However, competition greatly increases as growth progresses. Common weeds can be controlled by early weeding. It is recommended that weeding be done three times per rice production cycle, with first weeding done within 3 weeks of sowing (or within 1 month if germination is irregular or the rains are delayed).

Common pests and diseases

Pests

Since the resumption of rice production under the Aweil Rice Scheme in 2009, livestock (cattle, goats and other domestic animals that live near rice farms) and birds (crested cranes and ducks) are the most common pests of rice. Theft is also common during harvesting. Gall midge disease was noted by the Rice Scheme following a dry spell of weather. The common insect pests of rice include:

- White stem borers: These make holes in the central stem if the tillers are dry and cause discoloration of the panicle;
- Brown plant-hoppers: These are small winged insects that feed on rice plants and leave circular patches of yellow or brown. They should be visible when the plant is tapped;
- Stalk-eyed flies: The larvae of this insect bore into the rice stem and feed on the plant tissue, causing the death of the plant from the top;
- African rice gall midge: These are insect pests of lowland rice. The larvae attack the growing point of the plant (apex), causing leaf sheath tissue to form a tube-like structure called “silver shoot gall”;
- Rice mealybug: These are immobile plant-sucking insects. The damage is inflicted in patches on the plants since the nymphs do not move;
- Rice weevil: These are a storage pest that bores into the grains and grinds the interior soft content of the grain;
- Termites: These are white ants which affect fields of upland rice by destroying the plant stem at the base in areas of low moisture content;
- Rodents: These are usually rats and can be a major problem. Farmers should set rat traps if available (or get a cat). In all cases farmers should be encouraged to check the rice regularly for signs of spoilage and/or pest infestation.

Pest control methods

There are 3 main types of method that can be used to control pests, namely:

1. Cultural control, or the placing of crop residues in the field at a planting time to divert the pest from the growing crop;
2. Chemical control, or the treating of seeds with insecticide at planting time. The decision to use insecticide should be based on a history of termite damage in the field; and
3. Preventative practices. These include:

a) Flooding

Many species of insect pest begin their resting phase after harvest. Flooding the plots immediately after harvest can thus drown many insects, especially stem borers. Flooding also effectively controls air-breathing insects, such as the mole cricket.

b) Draining

Draining the plots represents an easy, inexpensive and effective means of controlling caseworm. Farmers should be encouraged to drain the affected plot(s) dry for 7-10 days to prevent the spread of caseworm. (It is however important not to drain the water from one plot and into another, since this will only spread the infestation.)

c) Burning

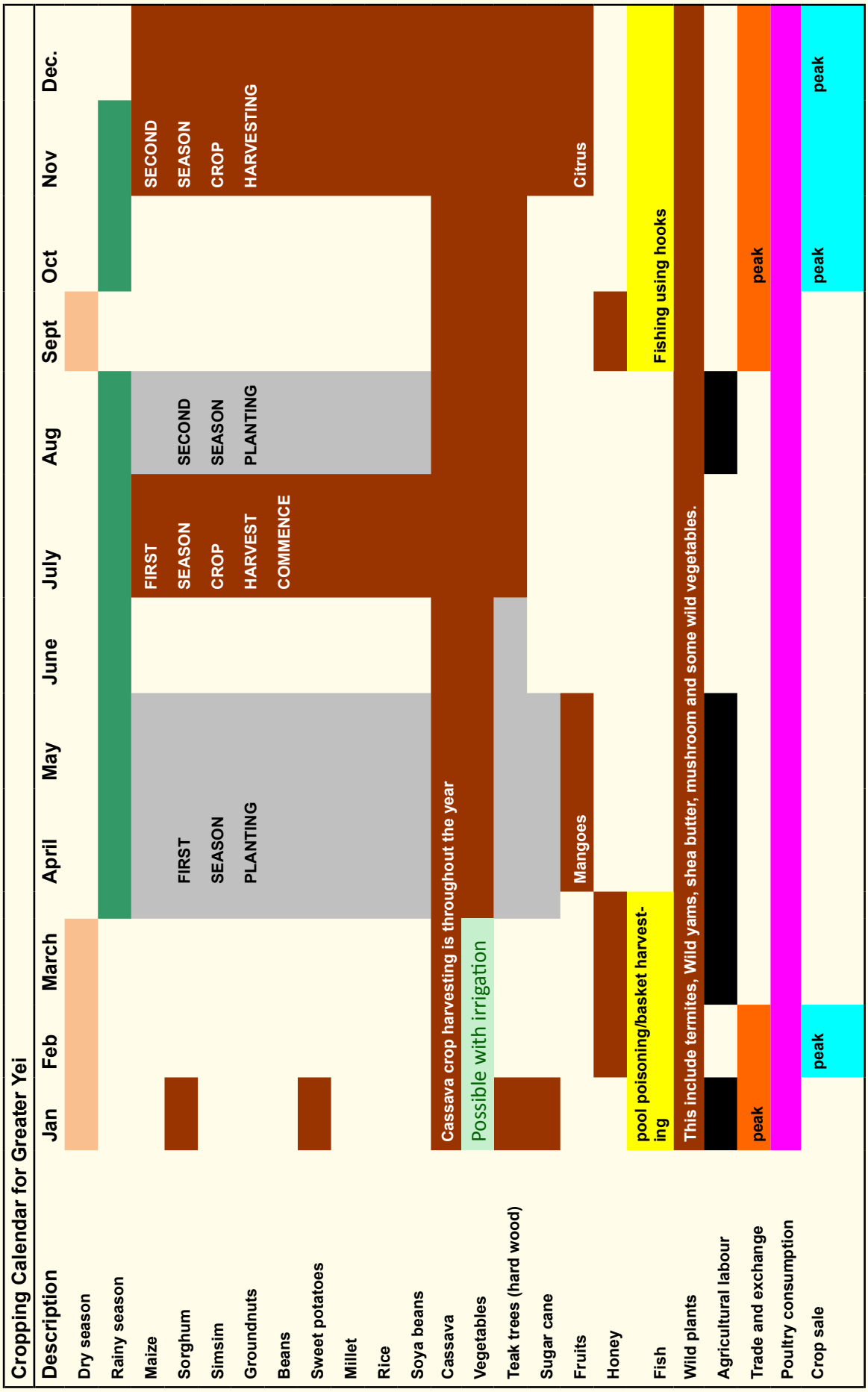
Burning off straw and stubble after the harvest drives away any remaining insects and kills pupating insects in the soil. This also leads to dry conditions that can help control disease.

d) Ploughing

The removal of paddy stubbles and wild grasses after harvest by ploughing them under will minimise the emergence of the next generation of insect pests by killing any larvae hiding in the soil, as well as eliminating a ratoon crop which serves as a host environment for rice-specific pests.

e) Brushing of bunds and peripheries

Many species of insect pest emerge from the plots during certain farming operations (e.g. brushing, burning, and ploughing) and seek refuge in the weeds growing on the bunds and along the edges of the swamp. Brushing the bunds and peripheries deprives many insects of a valuable habitat and can significantly reduce their numbers.



Source: YATC Yei What does YATC stand for? It would be a good idea to have a full reference for this information and I can't find a meaning for this abbreviation online.

Maize Production

(Zea mays)

Farmer and Extension Guide

SORUDEV
South Sudan Rural Development Programme

Background

Maize (Zea mays) is the most widely cultivated cereal crop in the world. It is an important source of carbohydrate, one of the most important cereals used for human and animal consumption and is also grown for grain and fodder. Maize is a major source of food for many people in Sub-Saharan Africa where the two largest producers are Nigeria and South Africa. The crop is grown in climates ranging from temperate to tropical during the period when mean daily temperatures are above 15^{0}C. Maize requires between 500-800 mm of water depending on climatic conditions.

Generally, the growth phases of the maize crop depend on the variety being cultivated. The period of growth from germination to maturity ranges from 60-120 days.

Land selection

Maize can be grown in a wide variety of soils, but performs best in well-drained, aerated, deep, warm loam and silt loam that contains adequate organic matter and is well supplied with available nutrients. Maize can be successfully grown in soils with a pH of 5.0-7.0, but a moderately acidic environment of 6.0-7.0 is optimal.

Land preparation

- Land clearance starts with the removal of any vegetation (trees, shrubs and stumps) that may block sunlight, as maize does not tolerate shade. Land preparation is followed by tillage (ploughing and harrowing) of the soil to make it favourable for crop growth. In South Sudan, the following are the common tools used for land preparation:

- Hoes (pur), panga and slashers: These are mainly used by small holder farmers. The method is slow and labour-intensive, but reliable;

- Animal traction: This uses animals such as oxen and donkeys to plough land. This method enables the farmer to open more land and plant more maize than the use of hoes;

Tractors: These are mainly used by large- and medium-scale farmers. Due to high purchasing prices, shortages of spare parts and expensive fuel, most smallholder farmers cannot afford to hire tractors.

Seed selection

Seed in South Sudan is most commonly sourced from farmers' own stock, purchased on the local market, given by family members or supplied by non-Governmental organisations (NGOs) or UN agencies. From farmers' own stock, it is important to select seeds from healthy plants that are free of pests, diseases and weeds. White and yellow varieties are preferred by most people depending on the region.

Local varieties of maize are mostly used. However, NGOs and UN agencies import seeds from either Kenya or Uganda. Seed can be either open-pollinated or hybrid. Open-pollinated varieties commonly found in South Sudan include Longe 1-10 and Katumani composite. Longe 5 is highly adapted to the Equatorial region and is preferred as it grows taller than the Katumani variety.

Planting

Most maize in South Sudan is rain-fed and planting is done in April or at the latest in May, especially in the Equatorial region. In Greater Bahr-el-Ghazal planting is usually done at the onset of the rains. In the Equatorial region, second planting is done in September at the same time as groundnut, sesame and rice. The recommended planting depth is 2-3 cm for moist soils and 5-10 cm for dry planting.

Plant spacing

The recommended spacing of maize is 30 cm between plants and 60-75 cm between rows. In the Equatorial States where varieties with heavy vegetation are grown, 30 by 75 cm is recommended. For approved seeds of optimum health, one seed per hole is recommended; if the farmer is unsure of quality then planting 2 seeds per hole is also a highly recommended and acceptable practice. Plant population ranges from 20,000 to 30,000 plants per ha for large late-maturing varieties and from 50,000 to 80,000 for small early-maturing varieties such as kantumi. When grown for forage (green maize), the plant population is 50% higher. The seed rate is 14-16 kg/ha.

Planting methods

Hand planting is the most commonly used method in South Sudan. It is labour-intensive but can produce excellent results if done properly (including a uniform plant stand). Mechanical planting involves the use of planters pulled by either tractors or animals. This type of planting has the advantage of being quick, and if well supervised can also give excellent results.

Fertiliser requirements

It is important to carry out a soil test to determine the level of soil fertility. In the absence of such a test, a blanket recommendation of 60: 30: 30 NPK kg/ha for Alfisols and of 40: 20: 0 NPK kg/ha for Vertisols should be adopted. The fertility demands of maize are substantial and for high-producing varieties, up to 200 kg/ha N, 50 to 80 kg/ha P and 60 to 100 kg/ha K may be required. In general, the crop can be grown continuously as long as soil fertility is maintained. Where rainfall is low, the crop should be irrigated. Other management practices include crop rotation, weed control, pest and disease management and harvest and post-harvest handling (drying and storage).

Weed control

Weeds are plants that grow where they are not required. Maize plants compete poorly with weeds for water, nutrients, space and light. Maize plants in their early stage (their first 3 weeks) are very sensitive to weed competition. Some weeds are parasitic and poisonous to maize e.g. striga (dhiac).

- Weeds can be controlled by cultural methods (including but not limited to crop protection, proper spacing, timely planting, hoeing and hand-pulling, improved soil fertility and the use of good seeds that are free of weeds. Mechanical methods involve the use of farm tools and implements such as hoes, cultivators and panga, while chemical control makes use of

herbicides (weed-killing chemicals). The use of herbicides is not popular among South Sudanese farmers. Caution must be taken when applying herbicides. The following chemicals are recommended:

- Application of a triazine herbicide at 0.25 kg/ha at the time of pre-emergence (3-5 days after sowing) using a Knapsack sprayer fitted with a flat fan nozzle and 500 litres of water/ha. This should be followed by hand weeding 30-35 days after sowing;
- Application of a triazine herbicide at 0.25 kg/ha at the time of pre-emergence (3-5 days after sowing) followed by 2, 4-D at 1 kg/ha 20-25 days after sowing, using a Backpack, Knapsack or Rocker sprayer fitted with a flat fan nozzle and 500 litres of water/ha;

For line-sown crops, the application of triazine herbicide at 0.25 kg/ha 3-5 days after sowing followed by weeding 30-35 days after sowing.

NB/Herbicide should only be applied when there is sufficient moisture in the soil. The soil should not be disturbed following herbicide application.

Pest and disease control

Maize is mostly affected by pests such as stalk borers, maize aphids, termites, maize seed maggots, maize seed beetles and cutworms. It can also be destroyed by birds, rodents and other animals (both wild and domestic).

The common diseases of maize in South Sudan are maize smut, maize streak, maize rust, stalk rot, maize mosaic and downy mildew.

Cultural methods of managing pests and diseases of maize include crop rotation, proper weeding, optimum spacing, fencing, removal of infected crops and field hygiene. Mechanical methods include scaring the insects away, trapping, picking and crushing them or destroying their habitats. Biological control methods include the use of pest- and disease-resistant varieties of maize, while chemical control uses various chemicals to control both pests and diseases.

Harvesting

Maize is usually harvested by hand on the cob by smallholders. Maize that is to be eaten green is ready for harvest when the grain hardens or when the silky flowering at the top of the maize cob turns black. At full maturity the crop has a moisture content of about 30% (which should be reduced to 14-15% for optimum storage by drying the cobs in the sun).

The average maize yield is 0.8 to 1.26 tonnes per hectare in most of South Sudan. However, in rain-fed conditions, maize yields average 2 to 3 tonnes/ha while under irrigation a good commercial grain yield is 6 to 9 tonnes/ha (10-13% moisture content).

Drying

Immediately after harvest, maize cobs should be properly dried in the sun before being shelled. If the grains are not properly dried, they will attract insect pests and mildew. A practical method of checking the moisture level of the grain is to drop a handful of grains and half a handful of salt into a dry soda bottle. The bottle should then be shaken for 2 or 3 minutes and the grains allowed to settle. If the salt sticks to the walls of the bottle, this means the grains of maize still contain moisture. These grains should be dried again and tested repeatedly (until no salt sticks to the bottle) before they may be stored. Another means of testing the dryness of the grains is to bite them using your teeth.

Threshing/shelling

This is done by hand by small-scale farmers and medium- and large-scale farmers use threshers. The grains should be cleaned by winnowing, then collected and stored appropriately.

South Sudan Crop Production

Farmer and Extension Guide

Legumes

Republic of South Sudan
Ministry of Agriculture, Forestry, Cooperative and Rural Development

SORUDEV
South Sudan Rural Development Programme

Groundnut Production

(Arachis hypogaea)

Farmer and Extension Guide

SORUDEV
South Sudan Rural Development Programme

Background

Groundnut (Arachis hypogaea), also known as Ful Sudan, originated in South America. It has since spread all over the world with production concentrated in Asia (50% of global area and 64% of global production) and Africa (46% of global area and 28% of global production), where the crop is grown mostly by smallholder farmers under rain-fed conditions with limited inputs (ICRISAT data). The seed contains 25-30% protein (average of 25% digestible protein) and 42-52% oil. The crop is an annual herbaceous plant that grows to a maximum height of 60 cm. It is characterised by bearing fruits that develop and mature underground. The fruit forms a pod with 1-4 seeds that develops underground within a needle-like structure called a peg.

Groundnut was introduced to Sudan by the colonial administration. Most of the global production of groundnut is crushed for oil that is used mainly for cooking. The groundnut press cake (made from extracted oil) is a food rich in protein but is also used to produce groundnut flour, which is used in many human foods. The seeds or kernels are eaten raw, boiled or roasted, made into confectionery and snack foods, made into soup or made into sauces to use on meat and rice dishes. The vegetative residues from the crop also provide excellent forage for livestock.

In South Sudan (particularly in Lakes, Central Equatoria and Northern Bahr-el-Ghazal), groundnut is an important cash crop, but the crop is widely cultivated across all regions of the country. Groundnut is a vital ingredient of most household diets in the majority of communities in South Sudan.

Groundnut plants are produced in the tropical and sub-tropical regions of the world, on sandy soils. They are highly practical as they fix nitrogen through their roots, maintain soil fertility and control soil erosion.

- Site selection
- Deep, well drained, light-textured, loose, friable sandy loam or sandy clay loam soils should be selected. Heavy (clay) soils are not suitable for groundnut production;

- Higher altitudes (where the climate is cooler) are not suitable for the crop;
- The area should be open to allow access by sunlight;
- The crop should be grown on new or fallowed land (to avoid pest and disease infestation);

The crop should be grown upland (to avoid flooding).

Land preparation

Land should be prepared early (3-4 weeks before the onset of the rains) so that sowing may take place parallel to the decomposition of organic matter. Crop residues and weeds should be well incorporated into the soil in advance and seedbeds finely tilted. The crop is best adapted to well-drained, loose, friable medium-textured soils. Heavy textures can make it difficult to lift the crop at harvest.

The topsoil should be loose to allow the pegs (on which the fruits are formed) to enter the soil easily. Land should be ploughed and harrowed at a recommended depth. Excessive presence of water in the soil (waterlogging) is harmful and limits the activity of the nitrogen-fixing bacteria.

Selection of planting materials

Seed should always be purchased from reliable and certified seed dealers who are legally recognised by the Ministry of Agriculture, Forestry, Cooperatives and Rural Development (MAFCRD). Farmers should also use their own saved seeds from previous seasons. Healthy and good-quality groundnut seeds should be sorted after shelling at harvest time.Varieties

South Sudan grows two major varieties of groundnut: the creeping (runner) type (a long-maturing type of 120-150 days) and the upright (bunch) type (short-maturing type of about 90 days). Varieties should be selected according to their suitability to the farmer's ecological zone. Other criteria to be considered when choosing a variety include yield, resistance to drought and disease, market demand and local preferences.

1. Common groundnut varieties grown by many farmers in South Sudan include:
2. The erect (Virginia) type, known as "Mr. Lake" in Lakes State and as "Atomthii" (in Dinka) in the other three States of Greater Bahr-el-Ghazal;
3. The bunch type, known as "Jang/ Tongpiny Jang" in Lakes State and as "Atomdit" in the other three States;

The runner type, known as "Maborgok" in Lakes State, "Atomdit" in the other three States of Greater Bahr-el-Ghazal and "Bongotwan/ Bombom" in Central Equatoria State.

- Improved groundnut varieties that have been tested in the Greater Bahr-el-Ghazal region include:
- Igola I, II and III (100 days to mature)
- Serenuti II, III and IV (100 days to mature)
- Red Beauty (75 days to mature)
- Serenuti 5R (red-seeded Uganda Serere, 100-110 days to mature)
- SERENUT 6T (tan-seeded Uganda Serere, 90-100 days to mature) Sodari (Sudan, 100 days to mature).

Planting

Before planting, farmers should conduct a simple germination test by pouring water into a cup containing sample seeds. The seeds should be left to stand for about 5 minutes and then observed. Seeds found to be floating should be collected and discarded.

In South Sudan, planting of groundnuts is normally done by opening holes with hand hoes. The seeds are dropped singly into each hole or into furrows along a row. Seeds selected for planting should be clean, viable and without blemish.

Planting depth is about 5-8 cm depending on the size of the seeds, but in most parts of South Sudan planting depth is only estimated visually when digging holes. Conventionally, groundnut is spaced at between 40 x 20 cm and 30 x 20 cm. Groundnut crops are commonly intercropped with sorghum, cowpea, sesame and bulrush millet in South Sudan.

- The quantity of groundnut seeds planted per feddan is about 30-32 kg depending on the variety.
- Planting is done by opening holes with a hand hoe (at least 5-8cm deep);
- If the farmer is sure of the viability of the seeds being planted, there is only need to place 1 seed. If in doubt, 2 seeds may be sown per hole to account for failure to germinate;

The seeds should be covered with a thin layer of soil to protect them from birds and insects. This layer should be pressed gently and firmly onto the seed so as to ensure contact with soil moisture.

Planting time

Planting is done immediately at the onset of the rains (mostly, between April and May). However, planting should be based on planting calendar of the agro-ecological zone. The groundnut plant is most sensitive to water deficit during the flowering period, followed by the pod formation period if not planted at an appropriate time. In general, water deficits during the vegetative period lead to delayed flowering and harvest and can reduce growth and yield.

Seed rate

30- 35 kg per feddan is recommended depending on the variety.

Spacing

- Depending on the variety planted and fertility of the soil, the following spacing is recommended:
  - Virginia type (Mr. Lake): 25 cm x 40 cm, i.e. 25 cm between plants and 40 cm between rows;
  - Bunch type (Jang or Atomdit): 30cm x 60cm, i.e. 30 cm between plants and 60 cm between rows;

    Improved varieties: 45 cm x 15 cm for bunch types and 50 cm x 15 cm for creeping types.

Harvesting

Under rain-fed conditions, good average yields vary from 2-3 tonnes/ha of unshelled nuts under intensive management. Yields respond well to ox-plough cultivation. Under irrigation and intensive management, yields can reach 3.5 to 4.5 tonnes/ha of unshelled nuts. Harvesting starts in August or September but varies according to the variety and time of planting. Generally, harvesting is carried out 90-120 days after planting.

Soil fertility and maintenance

Groundnut belongs to the legume group of plants, which have the ability to generate their own nitrogen through the nodules of their roots. However, groundnut thrives best with the application of optimum quantities of plant nutrients via organic manure such as cow dung and crop residues, which improve soil fertility.

Being a legume, groundnut can fix nitrogen from the air, but a pre-plant nitrogen application of 10- 20 kg/ha is recommended to ensure good crop establishment. Phosphorus requirements are 15-40 kg/ha and potassium requirements 25-40 kg/ha. For proper kernel formation and pod-filling, 300- 600 kg/ha of calcium (Ca) is required at the onset of pod (fruit) formation in the topsoil. Limestone is used when soil acidity needs to be corrected and gypsum when only the Ca level needs increasing. At a pH lower than 6, liming may be necessary to avoid aluminium and manganese toxicity.

Weeds and weed control

In order to achieve maximum economic yield, weeds must be eliminated. Groundnuts are very poor competitors with weeds during the early stages of their growth. Weeding should be done early while at the same time "earthing" up the ridges to encourage "pegging", i.e. the penetration of young nuts through the soil. Weeding is done using hand hoes (small maloda) or jembe, but late weeding is only done by hand through the picking of weeds (in order to avoid damaging the pegs and tender pods that are developing).

- The most common weeds that affect groundnut are grasses. Striga does not severely affect ground or bulrush millet; therefore, farmers are advised to plant bulrush millet around groundnut to starve the weed by denying it food.
- Weeding should be carried out at least twice per season depending on soil fertility levels;
- First weeding should be done after 2-3 weeks once the seedlings are 10-15 cm high;
- Second weeding should be done after 4-6 weeks;
- Earthing up is necessary during weeding in order to allow peg penetration into the soil and proper root development;

Mulch should be applied to the base of the plant during weeding to help conserve moisture.

- Other important agronomic/routine practices
- Crop rotation: Groundnut should be rotated with cereal after 2-3 seasons to avoid the build-up of pests and diseases;
- Intercropping: Groundnut should be intercropped with cereals or cassava so that available land space is well utilised. Intercropping also fosters symbiotic relations between cereals and pulses;

Row planting: Planting in rows reduces plant competition with weeds for sunlight, water and nutrients from the soil, hence maximising crop yield.

Groundnut maturity and harvesting

Groundnut matures after 100-120 days depending on variety, soil fertility and ecological conditions. If planting is done in May or June, harvesting is usually in September or October.

Maturity

- Groundnut is visibly mature when the leaves turn yellow and begin to fall from the plant. To check for maturity, the farmer should uproot at least 2-3 plants at random from different parts of the field and at the following signs:
- The pod should be completely full and hard;
- A fully mature pod should be light brown to tan in colour and well textured when examined;

The kernel of mature seed should appear dark when opened.

Harvesting

Groundnut is ready for harvest when the leaves turn yellow and begin to wilt. Harvesting should be done by hand while making sure the pods sticks to the pegs. If the pods are trapped in the soil, hoes can be used to lift them. Farmers should avoid causing mechanical damage to the pods to avoid infection during storage.

Harvesting can be done either by direct lifting (pulling out the plant by hand) when the soil is wet or by digging it out using a hand hoe when the soil is dry.

Pests, diseases and their control

Pests

Groundnut pests mostly include white grubs, termites, millipedes, aphids, groundnut

hoppers, thrips and ground leaf-miners, among others.

White grub

White grubs are the larvae of scarab "chafer" beetles. Many species of white grub are associated with groundnut damage in parts of sub-Saharan Africa and can attack groundnut plants at all stages of growth. They both eat the roots and damage the pods of groundnut plants. White grubs feed mainly on the taproots and/or peripheral roots, leading to stunting (reduced growth) or death.

- Control:
- Farmers should allow enough time between manure application and groundnut planting. Excessive use of organic manure in groundnut farms increases the incidence of white grubs, especially when manure is applied during the cropping season;

Deep ploughing or hand hoe tillage exposes soil pests to desiccation and predators, thus helping to reduce their numbers and minimise the damage they cause.

Termites

Termites are serious groundnut pests throughout Southern African and West Africa. Termites attack and invade growing groundnut plants through the roots and stem at ground level, hollowing them out and causing the plants to wilt and die with a consequent reduction in crop stand.

Scarification of pods is by far the most common type of termite damage at plant maturity, a factor often aggravated by late harvesting.

- Control:
- Farmers should remove residues of previous cereal crops (sorghum, millet and maize). Plant residues left in the field serve as food for termites, which may infest the new crop;
- Planting should be carried out early enough to avoid periods of drought. Moisture deficiency may put a crop under stress and lead to attacks by termites due to compromised resistance;
- Harvesting should be done promptly. The drought and high temperatures that come during the late growing season are conditions that favour termite infestation as well as fungus (A. flavus) infection of pods, leading to aflatoxin formation in seeds;

The complete destruction of mounds and removal of queen termites are effective control measures against mound-building species **(Macrotermes spp.).**

Millipedes

Millipedes are among the most economically damaging of groundnut soil pests. They are brown to blackish in colour and curl when disturbed. They attack groundnut seedlings during the first 20 days after planting, feeding on the emerging cotyledons before moving to the root system at the collar region.

Millipedes also attack maturing groundnut plants during pod formation, i.e. when the pods are still soft. Immature pods from severed pegs are often perforated and thus suffer secondary infection or invasion by rot-causing organisms such as Aspergillus flavus.

- Control:
- Early planting and dense, close spacing are effective cultural practices;
- The build-up of aphids and of their natural enemies should be monitored and the latter conserved. Ladybirds are reported to be important natural predators of groundnut pests;
- Neem seed or leaf extracts should be used if necessary;
- Groundnuts (and other legumes) should not be cultivated continuously on the same ground;

Where possible, varieties that are tolerant of or resistant to pests should be used.

Diseases

Groundnut diseases include rosette, leaf-spot and Aspergillus flavus (A. Flavus), the latter of which causes aflatoxins. Aflotoxins and leaf-spot pathogens are poisonous to humans.

Leaf-spot is induced by fungus. The symptoms are dark spots on the leaves, followed by yellowing and eventual death of the leaves. Rosette is a viral disease spread by aphids. Infected plants will become stunted and bunched and eventually, will die.

- Control:
- Early planting;
- Resistant varieties;
- Close spacing;
- Crop rotation;
- Burying of crop debris;

Removal of affected parts of the plant.

Harvesting and storage

Harvesting should begin when a good number of pods have fully developed and are fairly intact. Maturity of pods is normally achieved when the veins begin to turn yellow and leaf shedding begins.

The method of harvesting groundnuts depends on the specific type grown. Harvesting by hand is more suitable for erect (bunch) groundnut varieties, while runners are usually pulled out using a hoe (maloda). When using a hoe to harvest groundnut, care must be taken to avoid damaging the pods and seeds.

After harvesting, groundnuts are dried to the required moisture content (7-8%), after which they are sorted, bagged and stored or sold in their shells. Traditional and local storage facilities vary from one community to another and include gunny bags, gourd, pots, tins, baskets and woven leaves.

- For safe storage, farmers are recommended to:
- Properly dry groundnuts to a moisture content of less than 13%;
- Place groundnuts in packaging that maintains a suitable environment and prevents/restricts moisture

accumulation and insect/rodent infestation;

- Use new/clean gunny or polybags to store the groundnuts;
- Put only clean sorted kernels into the bags;
- Avoid placing the bags directly on the floor;
- Avoid heaping groundnuts in their shells or pods on the floor of the storage structure;
- Maintain good storage facilities (which are well-ventilated, dry and of low relative humidity) and take care not to expose produce to moisture during transport and marketing;
- Monitor and control insect and rodent activity during storage;

Avoid mixing new and old stock produce.

Marketing

Groundnut is locally marketed in the 10 States of South Sudan, where it is mostly processed into paste or butter for local consumption. Some groundnuts are taken to Juba, Malaka, Bentiu, Jonglei, Western Equatoria and Wau by traders.

Cowpea Production

(Vigna unguiculata (L.) Walp)

Farmer and Extension Guide

SORUDEV
South Sudan Rural Development Programme

Background

Sources indicate that cowpea (Vigna unguiculata L. Walp) originates from Southern and West Africa. In South Sudan, cowpea is grown for its leaves and seeds and consumed as a green vegetable. The land must be well drained in order to avoid waterlogging. Growth habits of cowpea can be climbing, creeping or erect. Cowpea is important in areas of marginal rainfall as it is well adapted to dry climates and suitable for a variety of intercropping systems. Cowpea is a quick-maturing crop and farmers can start consuming it after 21 days. Cowpea is also an important nitrogen-fixing crop. In South Sudan, the local name of cowpea is Lubia and the young green leaves are plucked and eaten as Korofo N gette in the Equatorial region.

Site selection

Cowpea is grown in a wide range of soils, but shows a preference for well-drained and friable sandy loam soils (which tend to be less restrictive to root growth). The crop is tolerant of dry and shady conditions, but is highly susceptible to a variety of pests and diseases and does not do well in poorly drained or cool areas.

Land preparation

During land preparation, existing fallow weeds, trees and shrubs are cut down manually or slashed. This should be followed by ploughing and harrowing. Land preparation should be done at least 3-4 weeks before planting.

Selection of planting materials

Farmers should select clean seed that is free of pests, diseases and weeds (and preferably drought-tolerant). Planting materials can be sourced from own stock, market or family and friends.

Varieties of cowpea

The main varieties of cowpea cultivated in South Sudan are Secow 2W and Secow IT (short-maturing variety that is ready for consumption in 3 weeks). A seed rate of 2.5-3.0 kg/feddan is recommended depending on the variety planted.

Planting

Cowpea can be planted immediately at the onset of the rainy season or irrigated. The seed should be planted at a depth of 3-4 cm. Crops sown earlier tend to have elongated internodes and to be less erect, more vegetative and lower-yielding than those sown at the best time. It is

recommended to plant one seed per hole at 7-15 cm apart or two seeds per hill of 60 cm x 30 cm. If the seed has not come from a certified dealer, a simple germination test can be performed before planting to achieve optimum plant population.

Soil fertility requirements and maintenance

Cowpea can benefit from organic and chemical fertiliser in depleted and marginal soils, although in South Sudan the need for fertiliser is limited.

Intercropping

Crops that can be intercropped with cowpea include sorghum, maize and other non-nitrogen-fixing crops.

Weed control

Weeds are best controlled by good seedbed preparation or the use of no-till, timely and thorough manual weeding. This should be done 2-3 weeks after germination. After 6-8 weeks (at which point the canopy closes), weeds should no longer cause a problem for cowpea.

Pest and disease control

- Common pests of cowpea are:
- Aphids;
- Pod-sucking bugs;
- Blister beetles;

Pod borers.

- Pest control methods include:
- Planting of resistant varieties;
- Used of clean planting materials;
- Pulling out and burning of diseased plants;

Field hygiene and weeding.

- Common diseases of cowpea are:
- Cowpea mosaic (cowpea mosaic comovirus, black-eyed cowpea mosaic virus, cowpea severe mosaic virus and cowpea aphid-borne mosaic potyvirus);
- Damping-off disease;
- Bacterial blight;

Anthracnose.

- Disease control methods include:
- Pulling out and burning of diseased plants;
- Use of resistant varieties;
- Field hygiene;
- Crop rotation;

Use of chemicals (pesticides etc.)

Harvesting, drying and shelling

- Farmers should:
- Harvest on time when the leaves are dry to avoid loss due to shattering, mould and rot;
- Dry the crop on a clean patio or tarpaulin and thresh (manually) when sufficiently dry;

Further dry the seed to about 10-12% moisture content for storage.

Treatment and storage

- Farmers should:
- Treat seed with a recommended chemical;
- Package and store them in a cool, dry and clean environment;
- Use durable and moisture-proof packaging material to avoid re-absorption of the moisture (which can cause pre-germination);

Conduct a periodic test to revalidate seed quality.

The growth habits vary according to whether erect or semi-erect types are being cultivated. At time of maturity, leaves will wilt but may

not drop off completely. Cowpea needs to be harvested when the seed moisture content is low. When grown for consumption as vegetables, cowpea leaves are picked 4 weeks after planting and this continues until the plants start to flower.

Marketing

For the cowpea seed market, seed quality is vital, so care during harvest and post-harvest handling is crucial to avoid cracking or splitting the seed. Cowpea leaves are also sold in South Sudan.

Sesame Production

(Sesamum indicum)

Farmer and Extension Guide

SORUDEV
South Sudan Rural Development Programme

Background

Sesame (Sesamum indicum) is a very important crop in South Sudan and is grown in all regions of the country. Mostly referred to and traded as Simsim, Benne or Nyim, sesame is believed to originate in East Africa and is one of the oldest commercial oil seeds in the world. The oil is clear and edible, with a pleasant taste and a very long shelf-life if properly refined. Sesame has an oil content of 48-55% and a protein content of 44-48%. The crop matures in 120-140 days. Common varieties of sesame colours are black, white and brown.

1. The economic advantages of sesame include:
2. High nutritional value;
3. Brewing;
4. Good sauce;
5. Use of cakes for animal feeds;

Stalks can be burnt to ashes and used as a tenderiser.

Site selection

Sesame should be grown in well-drained, fertile, sandy loam soil that is protected from animals.

Land preparation

Land clearance starts with the removal of shrubs and stumps from the sesame farm. Commonly used tools are hand hoes (jembe, pangas, rakes and axes), while for large-scale production ox ploughs and tractors are used. The crop requires very fine tilt because of its small seeds, so secondary tillage is vital.

Selection of planting materials

Only viable and certified sesame seeds are recommended for planting.

Types of seed in South Sudan

There are two types of sesame native to South Sudan: Black/Grey and White. The most widely grown imported variety is "Morada", identified by its purple stems and leaves. Morada originated in the Congo and produces higher yields, while also being more resistant to aphid attacks.

The varieties of sesame indigenous to Bahr-el-Ghazal are Aniu and Mala. These have green branches and foliage with small pods and are drought-resistant, but produce low yields and are susceptible to most diseases.

Preparation of planting materials

Planting requires the availability of seeds and tools. The recommended seed rate is 5 kg/ha where planting is done by broadcasting, 4 kg/ha when planting is done by drilling on flat land and 3.5 kg/ha when drilling is done in ridges.

Planting

Sesame is often cultivated as the first crop in a rotation, as it requires fertile soil. In this case grasses must be eradicated as sesame is a poor competitor with weeds. Planting must be done as early in the rainy season as possible. A seedbed of relatively fine-textured soil is required for the small seeds to grow properly. A seedbed with a fine tilt is more likely to form a hard cap if disturbed by heavy rain, thus preventing germination.

- There are several cultivation methods:
- Direct sowing in holes, using sticks for support;
- Sowing after narrow strips have been prepared;
- Drilling in rows about 45 cm apart that are later thinned (at a height of about 5-10 cm) to a distance of 15-20 cm within the row;

Mixed broadcasting with other crops.

The optimum depth at which to sow sesame is around 1.5-2.5 cm. It is important to sow at an even depth to ensure simultaneous and uniform growth of the crop. Smallholder farmers will often sow by hand. Mixing the seed with sand, dry soil, ash or dried, sieved manure or compost can help make seed distribution more uniform. In order to achieve an optimum crop density, unbranched varieties should be spaced ideally at 6-10 cm, and at least at 15 cm within rows once they reach a height of 5-10 cm, while branched varieties should be drilled in rows about 45 cm apart and later thinned (at a height of about 5-10 cm) to a distance of 15-20 cm within the row.

Sesame is often sown at the onset of the rains (April-May) along with other crops such as pigeon pea, maize or sorghum. It grows to a height of 1-2 metres. When not being intercropped, it can also be planted in July.

Fertiliser requirements

Organic manure from cow dung, goat and chicken droppings and crop residues can be applied to improve the fertility of the soil. Inorganic fertilisers are not commonly used in South Sudan, but it has been found in the region that sesame does well in environments where good quantities of NPK fertiliser are readily available.

Cultivation of sesame in the South Sudan savannah does not require excessive fertiliser unless the soil quality is very poor. NPK fertiliser is required where soil fertility is low. Two bags of NPK fertiliser (15:15:15) should be sufficient to fertilise one hectare.

Weed control

Weeding should be done once or twice a year to enhance maximum sesame yields. Common weeds of sesame are grasses and other vegetative plants. Traditionally, weeding is done by hand using hoes (maloda) or simply by hand-picking the weeds from the sesame fields. Herbicides are not generally used to control weeds since commercial farming has not yet taken off in the country.

Pests and diseases and their control

Pests

The commonest pests of sesame are the silverleaf fly, cotton aphid, beet army worm, green peach aphid, fire ant, cutworm, bollworm, grasshopper and yellow-striped blister beetle, among others.

Good cultural practices are essential to pest control. Sesame is an excellent rotation crop of cotton, maize, groundnut, wheat and sorghum. It restricts nematodes that attack cotton and groundnut plants and is also an excellent soil builder, as it improves both texture and moisture retention and alleviates soil erosion. Sesame is resistant to drought, tolerant of insect pests and diseases and is generally a low-cost crop, making it one of the best alternative speciality crops.

Diseases

- Diseases which affect sesame include cotton root rot, bacterial leaf spot, bacterial blight and sesame root rot. Methods of disease control include:
- Treating seeds in hot water (for 10 minutes at 52°C);
- Cultivating at low humidity and temperature (changing the sowing date if necessary);
- Destroying crop residues;

Using clean seed of known origin.

Harvesting

- Sesame is ready for harvest when the plant has completely dried out. The plants are cut to a height of 10-15 cm, or uprooted before the capsules are fully ripened. The optimum time for harvesting is when:
- The first, lowest capsules turn brown and begin to pop open;
- The stem turns yellow;
- The leaves turn yellow and begin to fall off;

Blossoming has finished.

Sesame should be harvested when about 50% of the capsules have turned from green to yellow. Harvesting should be done without delay (in order to prevent seed loss through shattering) and should be done by cutting the stems of the plants with sickles. Harvesting by pulling the plants from the root should be avoided in order to prevent contamination of the seed by sand. After harvesting, the plants should be tied with rope into bundles and stood on a mat or a sheet of tarpaulin until the capsules are fully dried. This prevents wastage of seeds and contamination by impurities compared to simply leaving the capsules on bare ground (where they may shatter).

Threshing

Threshing is normally carried out after the sesame has completely dried. The stalks are beaten to open the capsules and release the seeds. Winnowing is done after threshing to separate the seeds from any foreign bodies and residues.

Storage

Sesame is mostly stored in jute and polyethylene bags. Traditionally, it can also be stored in pots, granaries and plastic containers that are tightly closed to suffocate any pests.

Marketing

Sesame is found on all markets in South Sudan. Though mostly produced in small quantities, sesame is traded very actively in all States and exported in small quantities to Uganda and Kenya.

South Sudan Crop Production

Farmer and Extension Guide

Tubers

Republic of South Sudan
Ministry of Agriculture, Forestry, Cooperative and Rural Development

SORUDEV
South Sudan Rural Development Programme

Cassava Production

(Manihot esculenta)

Farmer and Extension Guide

SORUDEV
South Sudan Rural Development Programme

Background

Cassava (Manihot esculenta) originated in South America. It was first introduced to Africa by the Portuguese and grown in the Congo Basin. Cassava is a perennial shrub of the family Euphorbiaceae which is grown primarily for its storage roots but also for its leaves, which are eaten as a vegetable. Some of its local names are Banda and Bafra. There are two main types of cassava: bitter and sweet. The bitter types contain hydrogen cyanide (prussic acid) which is highly poisonous; hence the need to process bitter cassava before it is eaten. The cassava plant is a woody plant with erect stems and spirally arranged, simple-lobed leaves with petioles (leaf stems) of up to 30 cm in length. The edible roots of the plant are usually cylindrical, tapered and may be white, brown or reddish in colour.

Cassava plants can reach 4 metres in height and are usually harvested 6-12 months after planting depending on the variety cultivated. In South Sudan, cassava is traditionally grown in the Equatorial States but has since spread into all other parts of the country.

Site selection

Cassava prefers light soils or deep, well-drained loam soils. It is drought-resistant and can grow in poor soils, but it cannot withstand waterlogging as this causes the tubers to rot.

Planting materials

Cassava is normally planted from stem cuttings taken from a plant which is at least 10 months old. The stem should be healthy and without bruises. A good stem should be at least 30- 40 cm in length, with a minimum of 5-7 nodes.

Varieties

The popular varieties of cassava that are grown in South Sudan are Baworoworo, Abbey Ife, S S4, T ME-5, T ME-12, T ME-14, MM95/0414, Tiara, Karangba, Nasse-1 and Nasse-2. Cassava is primarily grown for its carbohydrate, but protein-rich varieties are now being developed to improve nutrition when consumed. These varieties can currently be sourced from research institutions.

Planting

Cassava stem cuttings can be planted at any time of the year provided there is enough moisture for germination. In the Equatorial States where cassava is very popular, the best time for planting is between April and September as this is when the rains are most regular. The orientation of

the stem in the soil depends on the maturity of the stem and the soil type. Cuttings are placed according to the direction of the wind and the nodes should be in an upright position.

Horizontal planting is suited to mature cuttings in loam soils with sufficient moisture. It is common for farmers in South Sudan to place cassava stem cuttings flat in the soil; however, the International Institute for Tropical Agriculture (IITA) recommends that cuttings be pushed into harrowed soil at an angle of 45^0. In this position, the arrangement of the stem tubers should ensure balanced depth and spread.

Planting time

Early planting at the onset of the rains is recommended in Greater Bahr-el-Ghazal and in most States of South Sudan. This enables the cuttings to receive sufficient moisture to sprout and become well established, thus making them more tolerant of pests and diseases. In the Equatorial States, planting may be done at any time of the year and it is normal to intercrop cassava with maize, groundnut and millet (as well as with upland rice as a relay crop).

Spacing

The recommended spacing is 1 metre between plant and 1-1.5 metres between rows (1 x 1.5 m). For seed multiplication, the recommended spacing is 1 metre between rows and 50 cm between plants. Most communities plant on flat, well-ploughed and harrowed land.

Planting depth

Planting depth varies according to the type and condition of the soil. Shallow planting in soil whose moisture content is low will result in poor establishment and low yields, while deep planting can make sprouting difficult. Deep planting is advisable in areas prone to attacks by termites.

Table 1: Planting depth in different soils under different environmental conditions

Conditions	Dry	Wet
Sandy	6 inches (15 cm)	4 inches (10 cm)
Loamy	4 inches (10 cm)	2-3 inches (5-7.5 cm)

Gap filling

Any plants that have died must be replaced within the first month after planting. Plants replaced later than this may fail to catch up due to shading by taller, healthier plants.

Fertiliser

Cassava can do reasonably well without the use of organic fertiliser, but responds particularly well to fertiliser application. Application of NPK 10:10:20 at 260 kg per hectare should be done 3 months after planting. Potassium (K) is essential to the development of the root.

Weed control

Cassava is a slow-growing crop and is thus susceptible to weed competition, especially in the first 1-4 months of growth before the canopies are formed. When cassava is a solitary crop, it is best to weed the cassava farm 3-4 times per season (starting 3-4 weeks after planting).

Cultural control (which is the most commonly used method among small-scale producers) includes hand weeding using small hoes (maloda and jembe). Care must be taken not to disturb the root or to cause bruises (through which the crop may become infected by disease).

Chemical control (i.e. the use of herbicides) on cassava farms is not very common in South Sudan as only small areas are currently cultivated. Herbicides are only effective if applied on time and in the appropriate amount; therefore, the use of herbicides is recommended only when the cassava field is too large to be weeded culturally. Diuron,

Alachlor and Floumetron have been found to be effective as pre-emergent herbicides. For information on quantities, farmers should contact their extension agent or refer to the instructions issued by the manufacturer.

Common pests

Cassava is often affected by termites, green mites, whitefly, variegated grasshoppers, porcupines, rats and bush rats, wild pigs, monkeys, moles, domestic animals and human theft.

Common diseases and disease control

Common diseases of cassava include cassava mosaic, brown streak, bacteria blight and root rot. The common disease control measures practised by farmers in South Sudan are crop rotation, roughing, timely weeding, field hygiene and the use of resistant or tolerant varieties. For cassava mosaic, the most effective measure is to plant improved varieties that are resistant to the disease.

The most common methods of pest control include the use of traps or nets, fencing, scaring off pests or destroying their natural habitats. Pesticides are used only as a last resort when the need overwhelms the farming community.

Harvesting

Cassava is usually ready for harvesting about a year after planting depending on the variety grown. Some early-maturing varieties may be ready for harvesting within 9 months. On most smallholder farms, cassava tubers are harvested by hand-pulling or digging. The roots should be dug up carefully to prevent damage.

Cassava roots are highly perishable and quick to rot. Therefore, they are usually sold on the market as soon as they are harvested. It is a common practice to keep the tubers in the soil until the farmer is ready to take them to market. The life of the root tuber can also be extended by processing it into other forms. Cassava can yield up to 12.5-15 tonnes per hectare without the application of fertiliser. When fertiliser of adequate potassium (K) content is supplied, cassava can yield up to 20-35 tonnes per hectare depending on the variety planted.

Cassava is an important crop for the following reasons:

- Cassava leaves are nutritious and add vitamins and minerals to the diet;
- The stalks can be dried and used as sources of energy;
- Cassava peel can be used for animal feed and mulching;
- Cassava acts as a tenderiser if burnt to ashes;
- The starch can be extracted as an ironing agent;
- Cassava can also be used to brew alcoholic drinks.

Marketing

Cassava is sold locally as fresh tubers and leaves in most markets in South Sudan. Sweet varieties are eaten fresh, boiled or roasted, while bitter varieties are cut into chips, soaked in water over a period for 3-5 days (which is vital to reduce the poisonous cyanide) and dried and milled into flour, which is then sold in bags across the country. If properly packed and kept in a dry environment, cassava may be stored for a long time. Cassava cuttings are also sold on the local market to generate income for smallholder farmers. Cutting multiplication, bulking and selling, particularly of improved varieties, is becoming an area of specialisation of some producer groups.

Sweet Potato Production

(Ipomoea batatas)

Farmer and Extension Guide

SORUDEV
South Sudan Rural Development Programme

Background

Sweet potato (Ipomoea batatas) is native to Central and South America, but is cultivated throughout the world. It is highly suited to many of the local growing conditions in East Africa. In South Sudan, sweet potato (Bambe or Kayata) is commonly grown in the Greater Equatorial region and on a very limited scale in the Greater Bahr-el-Ghazal region. Development partners are currently introducing the yellow-fleshed sweet potato variety, which is rich in beta carotene and is an excellent source of essential vitamins.

Site selection

Well-drained, sandy loam soil is preferred and heavy clay soils should be avoided as they can restrict root development, resulting in cracks and poor root shaping.

Plating material

Disease-free planting materials (usually fresh vine cuttings or sprouts from tubers) can be purchased from research stations (or farmers' own stock can be used if known to be disease-free). Crops are bulked in a nursery bed to provide enough cuttings for commercial planting. Vine cuttings should be about 30-40 cm in length with approximately 8 nodes and should only be taken from crops that are mature enough to provide this material. The recommended plant spacing is 330 cuttings for every 100 metres of row.

Seedbed formation

Sweet potato is grown on raised beds or mounds. This provides developing roots with loose, friable soil to expand to their potential size and shape without restriction, while also allowing for adequate drainage. Mounds should be about 30 cm high and 40 cm wide at the base. The main requirement is that the developing roots remain below the soil within the hill.

Planting of cuttings

Cuttings should be inserted into the mound at an angle of about 45^0 as this promotes uniform root development. The cutting should be inserted about halfway (3-4 nodes visible) at a spacing of 30 cm between plants. Cuttings must be watered during or immediately after planting.

Varieties

The popular types of sweet potato grown in South Sudan are:

- Osukut (early-maturing, high-yielding, sweet and highly marketable);
- Araka red (early-maturing, high-yielding and tolerant of cylas spp.);
- Araka white (early-maturing, high-yielding);
- Yellow-fleshed sweet potato.

Weeds and weed control

Weeds are only likely to cause a problem early in crop growth (before vigorous vine growth covers the beds as plants become established). Potato is a very active creeping plant that usually interlocks and covers the soil surface quickly. Since weeds compete with crops for nutrients, light, water and space and may also host insect pests, farmers must ensure that weeds (including their root systems) are either removed or deeply buried during land preparation. Unwanted plants should be removed wherever found. Weeding should be done before the sweet potato vines cover the soil, with hand weeding done twice at 3 and 6 weeks after planting.

Pests

Sweet potato is commonly affected by a range of pests including termites, aphids, beet army worms, sweet potato weevils (Cylas puncticollis), caterpillars of the sweet potato butterfly (Acraea acerata), millipedes, porcupines, rats and bush rats, wild pigs, monkeys, moles, domestic animals and human theft.

Harvesting

Sweet potato roots are ready for harvesting 3-8 months after planting, depending on the variety. If the crop is harvested too early the roots will not be fully developed. If left for too long in the soil, the roots may become fibrous, thus reducing yield and increasing rot.

Most farmers conduct piecemeal harvesting. This involves moving around the field looking for cracks in the mounds and ridges, which farmers perceive to be indicative of a sizeable root, and removing a selection of larger roots after which the earth is heaped up over the remaining smaller roots to allow continued bulking. The practice involves harvesting small quantities and normally starts as early as 2 months after planting for some varieties. Longer-maturing varieties are usually more suited to the piecemeal method than early-maturing varieties, all of whose storage roots mature at more or less the same time.

Storage

During storage of sweet potato, rot-causing organisms such as Rhizopus fungi can infect damaged roots and spread to other roots on contact. The best method of control is prevention, i.e. avoiding skin damage and discarding damaged roots. Roots should also be dried before packing.

Optimum storage conditions are 14-16°C in a high-humidity cool store. Storing sweet potato below 10°C may cause damage due to chilling, while storing above 16°C can lead to excess weight loss and sprouting.

Sweet potatoes can be preserved by slicing and drying the chips, which can then be pounded into flour if desired. Some varieties can also be eaten and/or used to feed animals such as rabbits, guinea pigs and shoats.

Marketing

Sweet potatoes are sold locally as fresh tubers or dry chips (muterere) in some markets. The sweet potato vines can also be sold as planting materials to other farmers as a source of income.

South Sudan Crop Production

Farmer and Extension Guide

Vegetables



Republic of South Sudan
Ministry of Agriculture, Forestry, Cooperative and Rural Development

SORUDEV
South Sudan Rural Development Programme

Tomato Production

(Solanum lycopersicum)

Farmer and Extension Guide

SORUDEV
South Sudan Rural Development Programme

Background

Tomato (Solanum lycopersicum) originated in South America and has since spread all over the world where it is cultivated on homesteads, in small gardens and on large-scale industrial farms. Global production exceeds 70 million metric tonnes annually. The tomato is a member of the botanical family Solanaceae, which includes edible plants (potato, pepper, tobacco, Irish potato and aubergine). In South Sudan, tomato is produced on both a small and medium scale (particularly in northern regions) for both consumption and income generation.

Tomatoes are an important source of vitamins and an important cash crop for both smallholders and medium-scale commercial farmers. Tomatoes are used in cooking both as flavour enhancers and as a thickener in food. They are always in high demand for both fresh consumption and processing.

Tomatoes will do very well under a wide range of agro-ecological conditions. They can be grown under irrigation, in greenhouses or in hydroponic conditions and some varieties also do well under rain-fed agriculture. Tomatoes grow best in temperatures of 20-27°C. Fruit development will be poor when average temperatures exceed 30°C or fall below 10°C. Tomatoes prefer well-drained soils (as they are sensitive to waterlogging) and do best with 7-19 hours of sunlight per day.

Broadly, depending on the variety and technology used the growing phases of tomatoes are:

- 7-10 days for germination;
- 4-6 weeks from emergence to transplanting (plants should be transplanted when they are approximately 10-12 cm tall);
- 4-6 weeks from transplanting to first flowering;
- 4-6 weeks from first flowering to first ripening of fruit;
- 10-15 weeks for the harvesting period.

Site selection

Tomato gives good results when grown in well-managed sandy loam soils and heavy clay loam soils that are free of hardpan. However, the best results are obtained from deep, well-drained loams. The soil should be rich in organic matter and plant nutrients, with an optimum soil pH value of 6-7.

It is good practice for farmers to avoid planting tomatoes in a field that has previously been planted with tomato or other solanaceous crops such as pepper, tobacco or aubergine.

These crops share common insect pests and diseases; as such, it is important to rotate crops within the field.

Land preparation

Proper land preparation is necessary to loosen soil and break any hardpan or compaction. Farmers should ensure deep digging and the preparation of soil to a medium tilt. Land preparation should include the incorporation of a reasonable quantity of farmyard manure (such as cattle or poultry dung) into the soil in order to improve its structure, fertility, texture, aeration and capacity for water retention.

The soil should be sterilised to expose pests and weeds to sunlight. This can be done by burning dry stalks inside the soil or piling them on top of the seedbed before planting. This should reduce the population of nematodes and other soil-borne diseases of tomato. In soils whose pH is low, lime can be applied to increase the pH. For alkaline soils, gypsum can be used to reduce soil pH (as well as levels of sodium).

Nursery practices

When cultivating solanaceous crops such as tomato, it is recommended to start with a nursery. Here, crops are provided with the care and attention that will prepare them for life in the field. A nursery seedbed will be of one of two types depending on the season. In the dry season (during which most tomatoes are grown in South Sudan), seedbeds should be slightly sunken to increase water retention during watering. During the rainy season, the beds should be raised and flat and shelter provided from heavy downpours.

Nursery soils should be free of stones or stumps and should be prepared to a fine tilt using hoes and garden forks. The nursery beds should be shaded and lightly covered with mulch to further reduce moisture loss and keep weeds in check. It is important to keep the beds clean and free of weeds.

Nursery beds of tomato should measure approximately 1 metre x 1.5-3 metres. The length of the bed may vary as necessary and convenient. If the soil is prone to nematodes, it may be sterilised in the nursery by heating it in bags or by burning dry plant residues on top of the nursery bed.

During their latter time in the nursery, seedlings need to be hardened off in order to acquaint them with the conditions they will later face in the field. This is done by gradually reducing the amount of water and shade provided to the seedlings. This should be done 6-9 days before transplanting.

Seed rate

About 250 g of seed (approximately 70,000 seeds) is required to produce enough seedlings to plant one hectare of an indeterminate variety. 125 g of seed is required for one hectare of a determinate variety. Seeds should be sown at a depth of 0.5 cm.

Planting/transplanting

Seedlings raised in nurseries are transplanted to the field. They are usually ready to be transplanted 3-4 weeks after sowing (by which time they should have developed 3 true leaves) and should be transplanted into moist soil. The seedbeds should be irrigated after sowing and this should be done regularly until the seedlings reach a height of 5-7 cm or are about 1 month old. Transplanting is best done in the evening or very early in the morning to avoid strong sunlight.

Varieties

Most tomato seeds planted in South Sudan are imported. Common varieties grown by farmers, especially in the dry season, are Roma VF, Ronita, Roma VFN, Piacenza and Tengeru 97. All of these are plum-shaped, fleshy, of an intense red colour, excellent for processing and with the capacity for long storage and travel. The Roma VF and Roma VFN varieties are also tolerant of some pests and diseases (Veticillium and Fusarium and Veticillium, Fusarium and root knot Nematode respectively).

Spacing

Tomato spacing is determined by variety, soil fertility and the availability of soil moisture. Tomatoes usually thrive best when spaced at 60 cm x 45 cm. Yields of 75-100 tonnes/ha are possible.

Staking

This is the practice of supporting the tomato plant to protect it from breaking due to strong winds and/or the weight of the fruit. Staking is done when the plant has completely established itself and is almost flowering. Stakes approximately 4 feet long and 0.75 to 1 inches square are placed between every one or two plants depending on the tying system that is employed. Stakes are usually driven about 12 inches into the ground. An additional stake can be supplied at the end of each section to strengthen the trellis. Stakes should be inserted immediately after transplanting to minimise damage to the root system. It is thus important to have the support ready when needed.

Plants are usually tied initially when they are about 12-15 inches tall and should be tied prior to any of them lodging. The first string is usually placed about 10 inches above the ground, with subsequent strings placed about 6 inches above the previous one. Some varieties may be tied as many as three or four times.

Pruning

Side shoots, laterals, old or diseased leaves and branches and overshadowed lower leaves should be removed by hand. Following formation of the first fruit cluster of mature green tomatoes, all lower older leaves should be removed to enable ventilation and the dispersion of food to the fruit. Flowers should be pruned to 5-6 per cluster for medium- to large-sized fruits.

Fertiliser application

Tomato is a heavy feeder of plant nutrients, including nitrogen, phosphorus and potassium (NPK) and as such responds well to organic fertiliser. The amount of fertiliser applied is influenced by the fertility of the soil, the season and the cultivar. Besides using organic fertiliser, farmers are advised to use compost, farmyard manure, green manure and liquid manure (slurry and plant tea).

Irrigation

Irrigation is critical to tomato production, especially in the dry season. Most farmers in South Sudan will move their farm closer to a river or stream during this period. It is important to supply sufficient water at critical times, such as immediately after sowing or transplanting. Care should however be taken, as irrigation after a long dry spell without prior light irrigation results in cracking of the fruit.

Weeds

The crop stand should be kept free of weeds at all times. Weeds compete for soil nutrients, space, water and sunlight and are also vectors of disease. Hand weeding of tomato fields is recommended. Mechanical cultivation should be shallow and should not be done too close to the plants to prevent damage. Hand-hoeing is also practised, especially with tomato production under protection.

Common pests and diseases

Pests

Tomato is often affected by whitefly, leaf-miner, red spider mite, cutworm, aphid, thrip, American bollworm and birds, among others.

Diseases

Common diseases of tomato are blight (early and late), damping-off disease, bacterial wilt, bacterial canker, bacterial speck, leaf spot, powdery mildew, end rot and anthracnose.

Control methods

Cultural methods include crop rotation, appropriate weeding, optimum spacing,

fencing, removal of infected crops and field hygiene. Mechanical methods include scaring the insects away, trapping, picking or crushing them and destroying their habitats. Biological methods are the use of resistant varieties and the preservation of natural predators of pests such as birds, wasps, ladybirds, praying mantises etc., while chemical control involves the use of various chemicals to limit both pests and disease.

Harvesting

Most smallholder farmers use a combination of field packing of "pinks" (tomatoes that have begun to change colour) and bulk harvesting of mature green tomatoes. Generally, the time and method of harvesting depends on the distance to the market and the storage capacity of the variety cultivated.

The end-use of the product and the distance to the market will determine when to start harvesting. Tomatoes intended for processing are harvested once they are fully mature. Fruit to be shipped over a long distance is harvested before this stage, while crops for local markets are picked later.

There are four distinct stages of picking depending on the intended market:

- Pale yellow blossom end (often greener): the fruit will last a week or more before ripening depending on the cultivar;
- Pink blossom end: at this stage the fruit will ripen in 4 days or more;
- Pink: at this stage the fruit will ripen in one or two days;
- Ripe: The fruit will be ripe or firm and should be marketed or used immediately.

Tomatoes for the fresh market are harvested by hand while those intended for processing purposes are harvested mechanically, especially in developed countries. It is recommended that picking be done early in the morning.

Grading

Tomatoes are graded according to size, colour and quality. Fruit of good quality must be succulent, well-shaped and uniform in size and colour and should be free of diseases, cracks, blemishes, foreign matter or spray residue.

Packing

Tomato fruits (especially high-grade fruits and/or those intended for specialised markets) are packed in trays, wooden boxes or cartons. Lower-grade fruits are packed separately.

Storage

Storage conditions are dictated by the stage of ripeness of the fruit. Generally, tomatoes should be stored in a cool, dry place.

Marketing

Tomatoes are sold fresh to communities and on local markets. Most of the tomatoes purchased are eaten as a salad ingredient by households and at hotels. There is a large demand for tomatoes in the major cities of South Sudan where markets are numerous and the human population is higher.

Okra Production

(Abelmoschus esculentus)

Farmer and Extension Guide

SORUDEV
South Sudan Rural Development Programme

Background

Okra (Abelmoschus esculentus) is a vegetable crop of the genus Abelmoschus and family Malvaceae. It is a stout, erect annual herb that may grow up to 4 metres tall depending on the variety and has spirally arranged leaves with leaf blades up to 50 cm in diameter and 3-7 lobes. It originated in Africa (most likely East Africa) and today is widely distributed across the tropics, sub-tropics and warmer portions of the temperate region (ECHO, 2003). The economic importance of okra cannot be over-emphasised. It is a good source of vitamins C and A, B-complex vitamins, iron and calcium. It is also low in calories and a good source of dietary fibre.

Site selection

Okra will grow well in a variety of soil types, but thrives particularly well in well-drained sandy and clay loam soils. The plant is best adapted to a climate with a long, warm growing season and grows best at a maximum average temperature of 35°C with a minimum average of 18°C.

Varieties

The common varieties of okra that are cultivated in South Sudan are:

- Pusa sawani: This is a high-yielding variety that is tolerant of vein mosaic. It grows to 2-2.5 metres tall and has long pods (18-20 cm) that are dark green, smooth and have 5 ridges. This variety is mainly imported;
- Clemson spineless: This grows to 1.2-1.5 metres in height and has pods that are about 15 cm in length, green and moderately ridged. It is also known as ladies' fingers. It is an improved variety and seeds are mainly imported;
- White velvet: This is a medium-height variety that can grow to 1.5-1.8 metres. Pods are 15- 18 cm in length, slender, tapered, smooth and creamy white;
- Local varieties: These include Turang per, Thou amaal and Amilaak baar. They are known by a number of different names depending on the ethnic group that cultivates them.

Land preparation

Soil is prepared 2-3 months before planting and it is recommended to allow any crop residues and organic matter in the soil to decompose before okra is planted. Early land preparation also permits weed seeds to germinate, thereby allowing early cultivation to destroy young weeds before planting. Soils should be tilled to a minimum tilt.

Planting

In South Sudan, okra is established by direct sowing in the field. To facilitate speedy germination, okra seed should be soaked in water overnight before planting. About 3 kg of seed is required per feddan. The seed rate should be 8-9 kg per hectare and the planting depth about 1.5 cm.

Spacing

This should be 45 x 45 cm, 50 x 30 cm or 60 x 15 cm within and between rows depending on variety, soil moisture content and soil fertility.

Fertilisation

Inorganic fertiliser and natural sources of plant nutrients such as compost, manure tea and plant tea (e.g. tithonia for foliar feed) are commonly used. Well-composted manure should be applied at time of planting at a rate of 20 g/plant. Additional compost or manure is needed during the vegetative period. Manure and plant tea can be fed to the plants via a drip irrigation system to avoid excessive use of labour.

Weeds and weed control

Common weed species that affect okra in many parts of South Sudan include annual grasses such as crabgrass and goose grass, perennial grasses such as mupaith grass, broad-leaf weeds such as sickle pod, annual morning glory and common cocklebur, and nut sedge.

When the okra and weeds are small, tilling with a rolling cultivator (on medium-sized farms) will kill most small weeds. Where weeding is done manually (as is the case among most smallholder farmers in South Sudan), local tools such as hoes and maloda should be used. Farmers should avoid throwing too much soil directly against the okra stems as doing so can increase the incidence of stem rot. First weeding should be carried out 2-3 weeks after planting.

Pests and diseases

Common pests of okra include cutworm, cotton seed bug, African bollworm, spiny bollworm, spider mites, thrip, tobacco whitefly, root node nematode, aphid, flea beetle, grasshopper, leaf-miner, flower beetle, cotton stainer and stink bug. Common diseases include damping-off disease, early blight, powdery mildew, bacteria blight, black mould and Fusarium wilt, among others. The common disease control measures practised by farmers include crop rotation, roughing, timely weeding, field hygiene and the use of resistant varieties. The most common methods of pest control include the use of traps or nets, fencing, scaring off pests or destroying their natural habitats. Chemicals are sometimes used as a last resort.

Harvesting

Most varieties of okra grown in South Sudan are ready for picking 45-55 days after planting. Bud-like pods begin to form about 4-6 days after flowering. Pods are harvested when still tender and once they have attained a length of 7-15 cm, depending on the variety and market requirements.

The crop will bear pods for several months under ideal conditions, especially when mature pods are picked regularly. Pods must be picked about 4-5 days after flowering when about 4 inches in length, before they mature and toughen. Under South Sudanese conditions, harvesting normally continues for 45 days after the first harvest. Regular picking every 1-2 days is essential to ensure pods comply with the size prescribed by the market. Okra should not be harvested when it is raining or when the soil is excessively wet since excess moisture can induce mould development on the pods and the cut petioles. Okra pods decay quickly; therefore they should be marketed within a day of harvesting.

Storage

Okra deteriorates rapidly after harvesting and is normally stored only briefly before being marketed or processed. Large quantities are canned, frozen or brined. Okra has a very high rate of respiration at warm temperatures and must be promptly cooled in order to reduce field heat and subsequent deterioration.

Okra that is in good condition can be stored satisfactorily for up to 10 days at 7-10° C. At higher temperatures toughening, yellowing and decay are rapid. A relative humidity of 90-95% is desirable to prevent shrivelling.

Kale Production

(Brassica oleracea L. var. Cephala)

Farmer and Extension Guide

SORUDEV
South Sudan Rural Development Programme

Background

Kale (Brassica oleracea L. var. Cephala) is mainly grown for consumption and sale on local markets. It is a popular vegetable crop in South Sudan commonly known as Sukuma wiki. It is grown mostly in small quantities for home consumption and local market sale and is known to be a valuable source of vitamins and minerals as well as a source of cash for small-scale farmers in rural and peri-urban areas. The crop can be either rain-fed or irrigated. It requires an optimum mean temperature of 15-18°C for growth and leaf development and a maximum temperature of 24-28°C. It grows well in a wide range of soils of adequate moisture and fertility. To maintain growth, kale requires a constant supply of moisture and should as a general rule receive a minimum of 2.5 cm of water per week.

Site selection

The land should be located near a water source and should be raised off the ground in order to avoid waterlogging. Kale thrives in well-drained, light-textured loam or sandy clay soil. The recommended seed rate is 2 kg per acre.

Land preparation

Nurseries

Kale seedlings are first raised in a nursery bed before transplanting. The nursery bed should measure 1 metre x 1.5-3 metres to allow for easy nursery management. A furrow should be dug using a stick and the seed drilled into the furrows. The furrows should be covered with light soil and grass and then watered.

Seedbeds

Land should be prepared well in advance of transplanting. Field operations should be avoided when the land is wet. This will help to prevent the spread of disease from plant to plant and the movement of infested soils within and outside the field. The field should be free of weeds as the brassica family are potential alternative hosts of insect pests and diseases.

Transplanting

Seedlings should be transplanted when they have grown to about 5-10 cm in length and have 2 or 3 leaves. Transplanting should be done early in the morning or late in the evening when the sun is low. The seedlings should be planted at a depth of 2-3 cm with a spacing of 45 x 45 cm between

plants and rows. After transplanting, other management practices such as watering, application of organic manure and weeding should be carried out.

Weeding

Weeding should first be done within 1-2 weeks of planting and then repeated as necessary to avoid competition for nutrients, water and space. Weeding is also done to reduce the incidence of pests and disease.

Pest and diseases

The most common pests of kale include aphid, sawfly, cutworm, diamondback moth, leaf miner and thrip (Tabaci frankliniella spp.).

Summary of husbandry practices for the cultivation of all vegetables

- Select a suitable site
- Use recommended varieties
- Follow approved nursery practices
- Ensure proper land preparation
- Apply the correct amount and type of fertiliser
- Transplant at the correct time and spacing
- Control weeds by cultivation
- Use recommended pest control measures
- Harvest regularly and on time

Source of illustration: African Organic Agriculture M2 Soil Fertility Management

Bibliography

Lambert Delimini 2012. Seed Production and Training Manual by FAO

A Training Manual and Field Guide to Small-Farm Irrigated Rice Production Developed by Peace Corps/Sierra Leone Edited by Michael L. Morris. 1980

Guideline on Production of Cowpea published by Ministry of Agriculture, Forestry and Fisheries South Africa 2011

Jean du Plessis 2008. Sorghum Production Department of Agriculture in cooperation with the ARC-Grain Crops Institute South Africa.

Alabi Tayo 2014. Agricultural Extension Packages for South Sudan. SORUDEV Programme(Draft)

IITA: Southern Sudan, equatorial region, cassava baseline survey technical report

IITA: Disease Control in Cassava Farms

Norwegian Peoples Aid 2012, A Participatory Farmer Training Manual (Crop Production)

Martin Prowse and AdmosChimhowu 2007.Making agriculture work for the poor. ODI Natural Resource Perspectives 111

Ekanayake I.J 1997: IITA. Guide to husbandry requirements and crop management practices for cassava

IITA 2000.International Institute of Tropical Agriculture.Starting a Cassava Farm.

Adekunle,A.A et al 2012. Growing Cassava Commercially in Nigeria, An illustrated guide. A cassava Hand Book for Practice and information Exchange

UGA Extension Commercial Tomato Production Handbook.Bullentin 1312 University of Georgia. Reviewed January 2014

SESACO 1982, Sesame Production Guide. Sesaco Sesame Coordinators
Derek et al 1979: A Tropical Agriculture Handbook

Moreno.A.R 1995. Recent Developments in cassava agronomy

Acknowledgment

The commitment of the following organizations and individuals made this work possible. They contributed time and technical knowledge during the writing and collation process: Food and Agriculture Organization, Concern Worldwide, Norwegian Peoples Aid, Norwegian Refugee Council, Marial Lau Livestock Training Centre, National Ministry of Livestock and Fisheries, Yei Agricultural Training Centre, Crop Training Centre Yei, State Ministry of Agriculture and Animal Resources Northern Bahr el Gazal/ Western Bahr el Gazal/ Warrap and Lakes States, National Ministry of Agriculture and Food Security, University of Bahr El Gazal, State Ministry of Agriculture and Rural Development Central Equatorial State, Catholic University, Ministry of Agriculture and Rural Development Western Equatorial State, Ministry of Agriculture and Rural Development Eastern Equatorial State, Welthungerhilfe, Hope Agency for Rural Development, Veterinaires Sans Frontiere Germany, World Vision International, Yei Agricultural Training Centre, Cardno UK, People in Need, Danish Refugee Council, Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH, OxPlough Farmers Association, Inter-Governmental Authority on Development.

The writing and compilation of this booklet took place in various locations and many people made technical input some of whom we may not be able to acknowledge here. We particularly thank the following people for their direct contribution: Carlos Hagalla Lino, Dominic Albino, James Thiop Kuei, John Chol Akot, Daniel Mabil Magai, Daniel Nondi, Akena Ceaser Poul, Dilla Iyu Cyrus, Angok Akoy Garang, Anei Azik Arop, Lita Jackson, Lewis Karienyeh, Aker Ayoump, Berhanu Wolde, Taban Kaps Robert, Longo Awic, Rose Dawa, Mary Khozomba, Paul Thon Akech, Peter Madut Amet, Maror Woi Major, Agustino Uger, Phillip Dirichi, Susan Kilobia, Isaac Bazugba, Favaro Michele, Peter Deng, Joseph Ogayo, Charles Stephen, Samuel Ajuijig, Bida Emmanuel, Ustaz Ajang, Makur Buong, William Simon Bol, Jeremiah Omondi, Joseph Kawac, Simon Akok, Evans Owino, Pio Aport, Paul Angelo, Abbas Ibrahim, James Mathiang, Fathi Rahman, John Makur Garang, Makur James, Abraham Andrew, Larriase Esserhinh, Samuel Deng, David Okot, Julius Lonyong, Edwin Adenya, Dilla Iyu Cyrus, Rizig Elisama, Loius Kayanga, Aboubakar Abdullah, David Bala, Emmanuel Samuel, Augustino Atillio, Mary Gordon, Annafelix H. Baigo, Joseph Akim Gordon, Aggrey Lokolo, Dr. Charles E. Wani, George Kamillo, Dr. Pio Kour, Dr. Erneo Balasio, Edward Barnabe , Donato Apari, Kenyi Robert Kennedy, Santino Agany Chan, Caroline Maua, Dr. George Leju, Michal Waui, William Atiki, John Fox, Tayo Alabi, Bongomin Cricket, Paulo Girlando, Sebit Peter, Anthony Raymond, Mary Karanja, Juohn Maruti, Betty Koiti and also to Luisa for editing the booklet. The following organizations supported the printing of this booklet.

"This publication has been produced with the assistance of the European Union. The contents of this publication are the sole responsibility of Ministry of Agriculture and of Ministry of Livestock and Fisheries South Sudan and can in no way be taken to reflect the views of the European Union."

EUROPEAN UNION

The guide on crop production covers crop agronomic and cultural practices for eleven selected crops namely Sorghum, Maize, Rice, Sesame, Cowpeas, Groundnut, Beans, Cassava, Sweet Potatoes, Tomatoes and Kale. In each of the guides you will find information on seed varieties, cropping seasons, land preparation, spacing, pest and diseases management, harvesting techniques and marketing. The second guide on animal production covers husbandry techniques for Cattle, Goats, Sheep and poultry. The guide provides technical information onselection, housing, feed types and feeding, diseases (including disease management) and marketing. The third guide contains a set of guidelines on Ox Ploughing, Agricultural Marketing, Agrodealership, Village Savings and Loans Association, Community Mobilization and Farmer Field School.