Soyabeans Production Guide

ZARI
Zambia Agriculture Research Institute
Researching Soils, Crops and Water In Zambia

Agricultural Productivity Programme for Southern Africa
ZAMBIA

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Agricultural Productivity Program for Southern Africa (APPSA)

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Foreword

Zambia has the potential to produce sufficient food for its citizens and for export.

In order to ensure that good agricultural practices are employed by farmers, crop specific production information should be made available to them.

Due to technological advances and the changing environmental and socio-economic conditions it became necessary to revise the first edition of the Soybean Production Guide, which was published in 2002. This revised edition is meant to provide farmers and other stakeholders crop specific information in order to promote good agricultural practices and enhance productivity and production.

The information contained in this booklet has been generated over a number of years of research and is appropriate for all categories of farmers. The information is meant for extension officers, agricultural training institutions and other development partners.

It is my sincere hope that this information will go along way in stimulating Soybean production in Zambia.

The Zambia Agriculture Research Institute (ZARI) is committed to alleviating poverty and enhancing food security by contributing to increased and sustainable food production.

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1.0 Introduction

Soybean (*Glycine max L.*) belongs to the family Leguminosae. It is a short day crop, which requires short days for flowering. The crop is one of the most important sources of oil and protein and is commonly used in both human and animal diets. Soybeans contain approximately 40% protein and 20% oil on a dry matter basis. Although the oil is used primarily in edible products such as margarine and cooking oil, it is used industrially in such products as high-grade paints and pharmaceuticals. It can also be processed into soybean flour and soybean milk. The soybean meal that remains after the oil is extracted is almost all used as a high protein livestock feed but the meal can be further refined to give various protein extracts for direct human consumption. In Zambia, it is grown by both commercial and small scale farmers.

Besides its uses given above, soybean contributes to improving the fertility of the soil. The crop fixes atmospheric nitrogen into the soil due to the presence of the bacteria Rhizobium in its root nodules. The soybean crop is recommended to be grown in rotation with cereals.

Though Soybean is widely adapted and is grown throughout the country, major production areas are found in agro ecological Region II of Lusaka and Central Provinces and parts of agro ecological Region III of Copperbelt Province. Major production is by commercial farmers.

2.0 Climatic and Soil Requirements

2.1 Climate

Soybeans require medium amounts of rainfall. In Zambia, Region II is the most suitable with a rainfall range of 800-1000 mm annually. The crop does not perform well in areas with high mean maximum temperatures of above 38°C and a rainfall range that is below 800 mm per season.

The optimum temperature range for soybeans growth and development is 22- 35°C. The seed will not germinate at

temperatures below 10°C and temperatures above 40°C will adversely affect growth and flowering. Very low temperatures, especially during flowering, will reduce the oil content and yield.

2.2 Soil Types

Soybean is well adapted to a variety of soils types. However, loose, deep and well-drained soils are ideal for optimum soybean production. But clay soils and compacted soils should be avoided. These soils are prone to waterlogging .Further, a hard crust surface may form when the soil dries affecting emergence.

The soil pH range of 5.5- 7 is ideal for optimal soybean production. If the pH is below 5, then lime could be applied. Application of lime will not only benefit soybean production but subsequent crops.

3.0 Recommended Varieties

One of the most critical decisions in growing soybeans is variety selection. The choice of variety is a key factor in profitable soybean production. Many varietal characteristics, such as maturity, lodging, yield potential, promiscuity and disease resistance, must be considered when selecting varieties.

The table below shows the recommended soybean varieties and their agronomic attributes;

Variety	Days to maturity	Potential yield (t/ha)
Lukanga	115	4
Kaleya	125	3
Magoye	135	2
Hernon 147	135	2
Kafue	110	4
Mwembeshi	125	4

4 Recommended Management Practices

4.1 Land Preparation

Land preparation can be started with winter ploughing which can be done in May-August. Farmers can also practice conservation tillage by making rip lines or digging basins. Farmers with access to appropriate equipment are encouraged to practice minimum or zero tillage.

4.2 Planting

In Zambia, soybeans should be plated within the month of December. Delayed planting may lead to a reduction in potential yield, while very early planting may lead to poor seedling establishment. In Region II, planting should be done in the first two weeks of December, while in Region III, it should be done in the last two weeks of December

The recommended seed rate i.e. the amount of seed required per unit area, for soybean is 100kg/ha. However, as a safety measure against low germination, a slightly high seed rate is normally recommended i.e. farmers can use a rate of 110kg/ha. The ideal planting depth should be between 2.5 and 3 cm. Avoid planting too deep as some varieties may not emerge because they have short hypocotyls. Deep planting also results in longer exposure of the emerging seedling to soil-borne diseases.

It is recommended that soybean is planted in rows by drilling. The optimum row spacing is 45 or 70cm. If you use 45cm inter-row spacing, then drill 30 seeds per meter while for inter-row spacing of 70cm, drill 40 seeds per meter for farmers using planting basins under conservation farming, 10 to 20 seeds can be placed in each basin and then lightly cover with soil.

4.3 Weed Control

Soybeans are very competitive with weeds once the crop develops a canopy, but early emerging weeds can cause serious problems. In most cases, 2-3 weedings are sufficient as shade from the narrow rows suppresses later weeds. Note that poor weeding can reduce the yield by as much as 30%. Weed control can be achieved through the following methods:

i) Cultural practices- appropriate planting date (too early planting leads to a proliferation of weeds), good seed rate (low seed rates normally leave too much room for weeds to grow, a good seed rate should leave less space for weeds to grow), use of high quality certified seed i.e. seed with little or no weed seed, and following a good crop rotation program.

ii) Mechanical control- this is mainly achieved by inter-row cultivation and is best done when plants are still 5cm tall or less. As plants grow older, mechanical weeding results in damage to both the roots and foliage. Hand hoe, hand pulling, oxen or tractor driven implements can be used to remove weeds from the soybean fields.

iii) Chemical control- this is the use of herbicide and is mainly practiced by farmers that can afford the chemicals.

Herbicides, if used properly, are a safe and effective method to control certain weeds in soybeans. Important factors to consider when choosing a herbicide include:

1) type of weeds present,
2) stage of crop and weed growth,
3) herbicide persistence and crop rotation restrictions,
4) environmental considerations, and
5) herbicide costs.

Farmers are advised to use commercially available herbicides for weed control in soybean and follow the manufacturer's instructions on their use.

4.4 Fertilizer Use

Soybeans take up relatively small amounts of nutrients early in the season, but as they grow and develop, the daily rate of nutrient uptake increases. Soybeans need an adequate supply of nutrients at each developmental stage for optimum growth.

Soybean is sensitive to boron toxicity and therefore the use of boronated fertilizers should be avoided.

Top dressing is not necessary in soybeans because by this time the crop will be fixing its own nitrogen. To enhance nitrogen fixation, it is recommended, especially for non-promiscuous varieties that the seed is dressed with inoculum at planting. Inoculation initiates infection of the roots resulting in nodulation and then nitrogen fixation by the crop.

Promiscuous varieties such as Magoye and Hernon 147 may not require inoculum. On the hand, the non-promiscuous varieties such as Lukanga and Kaleya require to be inoculated. The inoculants can either be in liquid, slurry or peat form.

4.5 Crop Rotation Practices

Soybean is efficient at fixing nitrogen from the air, and when grown under optimum management, it can significantly enrich the soil and therefore crops grown in rotation with soybean benefit from residual nitrogen. It is therefore recommended to rotate soybean with a cereal crop. However, it is important to note that soybean is susceptible to nematodes and therefore should not be grown in rotation with Solanaceous plants or other nematode susceptible crops.

5.0 Crop protection

Soybean is susceptible to a number of insect pests and diseases that reduce the yield and quality of the produce. There are measures that can be taken to minimize the damage.

5.1 Major Diseases and Control Measures

Soybean production in Zambia is affected by a number of fungal, bacterial and viral diseases. The crop is also affected by nematodes. The following are the common soybean diseases.

5.1.1 Asian Soybean Rust *(Phakopsora pachyrizhi)*

Asian Soybean Rust is a devastating disease capable of causing defoliation and significant yield loss ranging from 15-80 %.. Common symptoms of the disease include formation of lesions on lower leaf surfaces, starting as small, grey spots and changing to tan or reddish-brown. The mature lesions form small pustules that usually occur on lower leaf surfaces. On a windless day, if soybean rust infected leaf is gently tapped, the spore dust will fall off. Severe rust infections result in premature defoliation and early maturity.

Asian Soybean Rust in the field

Control Measures

Currently there is no effective resistance to Asian Soybean Rust in commercial soybean varieties grown in Zambia. Asian Soybean Rust management depends on scouting, early detection, and destruction of weed hosts and the use of appropriate foliar fungicides.

5.1.2 Bacterial Blight *(Pseudomonas syringae)*

Bacterial blight is a very common foliar disease of soybean throughout Zambia, but it seldom causes serious yield loss. The disease is seed borne and usually infects the crop in the early stages of crop development. Common symptoms appear on young leaves as lesions that are small, angular and reddish-brown with water-soaked margins surrounded by a yellow halo. As the disease progresses, lesions merge to produce large, irregularly shaped dead areas. Centers of older lesions frequently fall out, causing leaves to appear tattered. On stems and petioles, lesions are large and black. Symptoms often disappear under dry, hot conditions. Infected seed often has a water-soaked discolouration, starting at

the hilum, which can reduce seed viability and reduce germination.

Early signs of Bacterial blight. Bacterial blight with leaf tattering.

Control Measures

Control measures include use of cultural practices and use of tolerant varieties. The following cultural control practices should be employed:

i) Crop rotation with crops such as maize and wheat.
ii) Tillage to reduce the survival of pathogen.
iii) Removal of crop residues.

Where, resistant varieties are available, it is recommended that these are used as a strategy to prevent disease occurrence.

5.1.3 Sclerotinia Stem Rot *(Sclerotinia sclerotiorum)*

This disease is relatively new in Zambia. Outbreaks of this disease usually cause serious wilting which lead to crop losses varying from 0 - 100 % depending upon factors such as crop varieties, locations and environmental conditions. The common symptoms include wilting and eventual death of upper leaves of infected plants in the reproductive stage. Leaves become greyish-green, necrotic and turn brown, remaining attached to the stem. Diagnostic symptoms develop at first above the soil level and up to 50 cm above it. Water-soaked lesions develop at the nodes and change from tan to white and later become covered with whitish substances (mycelial growth).

Sclerotinia on a soybean stem

Control Measures

The following control measures should be used:

i) To minimize disease incidence, use disease free seed.
ii) Sow at low densities to reduce disease transmission.
iii) Burying crop debris bearing sclerotia at a depth of 15 – 25 cm with a mouldboard plough reduces inoculum carry-over and delay disease development.
iv) Where there is a serious threat of the disease. keep the field free of weeds as many broadleaf weeds may harbour the disease pathogen.
v) Employ crop rotation practices. At least two or three years of a non-host crop such as maize can reduce the presence of the disease pathogen in the soil. Crops that should not be in rotation with soybean are beans, peas and sunflower.
vi) Chemical control with an appropriate fungicide will reduce disease incidence.

5.1.4 Frogeye Leaf Spot *(Cercospora sojina)*

This disease is prevalent in fields which are grown with soybean continuously. The common symptoms of the disease appear on leaves as lesions that are small, irregular to circular and grey with reddish-brown borders that most commonly occur on the upper leaf surface. Lesions start as dark, water-soaked spots that vary in size, and as lesions age, the central area becomes grey to light brown with dark, red-brown margins. In severe cases, the disease can cause premature leaf drop and will spread to stems and pods.

The symptoms on stems are not as common or distinctive as foliar symptoms and appear as narrow, reddish brown lesions that turn

light grey with dark margins as they mature. The lesions on pods are circular or oval shaped and are initially red-brown and turn to light grey with a dark brown margin. Infected seeds have light to dark grey discoloured blotches that vary in size and cover the entire seed in severe cases and often leads to seed coat cracking.

Frogeye Leaf Spot in the field.

Control Measures

Control measures include the use of resistant varieties, practicing crop rotation with non-hosts crops such as maize and wheat and use of recommended foliar fungicides applied during late flowering and early pod set to pod-filling stages to reduce the incidence of the disease.

5.2 Major Pests and Control Measures

A number of different insects occur in soybean fields, but few are of economic importance and therefore do not warrant control measures. Some of the common pests are; termites, cutworms, stink bugs and leaf eating caterpillars.

Control Measures

In epidemic situations, chemicals are available to control most of these pests.

6.0 Harvesting

Soybeans should be harvested as soon as it matures to avoid loss of yield through shattering. When fully mature, most varieties will change colour of the pods from green to golden yellow, and when shaken, the seeds should rattle, and .at least 50% of the leaves should have fallen to the ground. Additionally, the moisture content

of .the grain, is between 12- 14%.
To minimise the risk of shattering, farmers should plant areas that they can manage to harvest before shattering starts as this may lead to yield loss. Varieties such as Magoye and Hernon 147 should be harvested early as they take 7 and 10 days respectively to start shattering after maturity.

The harvesting of soybeans is usually done by hand under small scale and by combine harvesters under commercial production.

Ideally harvesting should be done in the morning because the presence of dew prevents shattering and should be stopped as soon as it gets hot. The harvesting can also be done in the late hours of the afternoon when it is cool.

7.0 Post Harvest Handling and Processing

7.1 Threshing and Cleaning

After harvesting and drying, threshing is done in order to remove the grain from the pods. This is done by pilling the plants on a concrete floor or tarpaulin and then beating lightly.
After threshing, the soybeans grains are normally contaminated with debris such as soil, plant, small stones, weed seeds, or broken soybean seeds. The broken seeds and other impurities hinder drying operations, make post-harvest processing longer and more costly, lower the end-product quality, and serve as targets for post-harvest disease.

7.2 Storage

Clean threshed soybeans grain should be stored when the grain moisture content is between 10% and 12%. Before storage, soybean grain should be packed in bags made of either polyethylene or cotton fibers. Ideally, bags should be stacked on wooden platforms in order to prevent direct contact of bags with the floor. The free space between the top layer of the stacks and the top of the storehouse should be at least 1 meter. The period of storage will depend on the intended use of the stored grain. If the stored grain is meant to be used as seed for next season planting, the

storage room should be well ventilated to ensure low and stable temperature and humidity so as to minimise loss in seed viability. For grain meant to be sold at a later date, ensure that the storage conditions prevent grain deterioration through damage by pests.

7.3 Processing Soybean

Most of the soybean grain produced is commercially processed into various products such as edible oil which include cooking oil, margarine and mayonnaise. However, small extraction machines are available for small scale processing for oil, milk and flour.

Benefits of Modern Soy Products include the following:

- Soy concentrates and isolates are easily digested by humans
- Soy protein is equal to the quality of cow milk, meat and egg protein
- Soy proteins are acceptable in almost all diets
- Soy protein contain virtually no cholesterol and it is lactose-free
- Soy proteins are lower in fat
- Soy milk is high in protein and contains about the same amount of protein as cow milk
- Soy milk has potential to reduce cholesterol
- Soy milk is rich in calcium
- Soy milk is ideal for all categories of consumers – children, youths, middle-age and old people
- Soy milk is tasty

Make soya milk following these steps:

- Let 1-2 cups of beans soak overnight with 3-5 cups of water.
- The next day, rinse the beans with clean water.
- Boil them for about 10 minutes then drain off the water.
- Pound (pulverize) the beans mixed with same amount of boiling water.
- Pour the blended mixture through a clean cloth (T-shirt) - or a very fine sieve - to separate the milk from the rest of the soya.

How to make Full fat- Soy flour:

- Dry-clean soybeans by removing stones, chaff, dirt and other foreign matter.

- Roast in a pan on fire or in an oven for 10-25 min
- Dehull the roasted soybean.
- Grind the dehulled roasted/toasted soybean to flour in a mechanized mill or a manual grinder and sieve
- Pack in a polythene bag and store in a cool dry place

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