NARO

Republic of Uganda

Adaptation for Smallholder Agriculture Programme
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Investing in rural people

# PRELNOR

## SOYBEAN

### Curriculum and Technical Guide for Farmer Field and Business School Facilitators



2018

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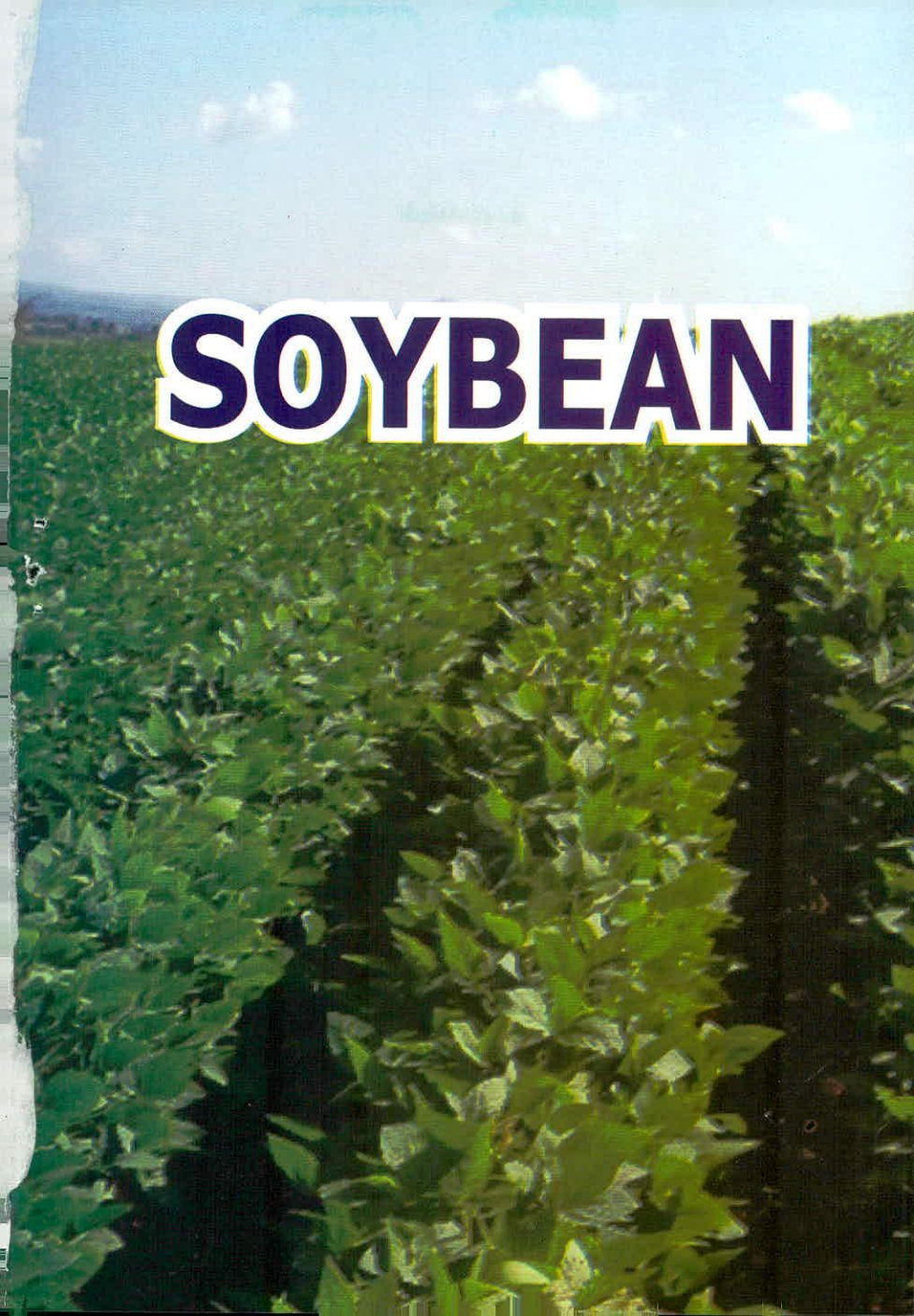

SOYBEAN

# INTRODUCTION

Soybean, also known as a miracle crop of many uses has about 20% oil and 40% protein content. Soybean is a source of food in form of sauce, snacks, Soymilk, beverage, baby foods, porridge and soymeat. It is a source of vegetable oil and feeds for livestock and poultry. In addition soybean helps in soil fertility and structure improvement through nitrogen fixation. However its production in Uganda is constrained mainly by pests and diseases, drought, poor soil fertility and use of poor quality seed. The research effort for the past years has been directed to development of soybean varieties that are high yielding, early maturing and resistant to pests and diseases. In the 1990s new soybean varieties namely Namsoy1, 2 and 3 with resistance to rust were first released but later succumbed to soybean rust and thus were phased out and have been replaced with other new resistant varieties namely MAKSoy1N, 2N, 3N, 4N, 5N and 6N. Out of the 6 new varieties MAKSoy1N, 3N, 4N, 5N are expected to do well in the PRELNOR project area.

This manual is thus very key in facilitating promotion of the new varieties through training, seed production and promoting adoption of the new varieties in the project area.

## CONTENTS OF THE CURRICULUM

The curriculum consists of training modules divided into units indicating the topics, objectives, contents, methods of delivery and training materials required. A time schedule is allocated for each topic to enable the facilitator to plan appropriately for each session.

# SoyBean Production Course content

| TIME (HOURS) | | TOPIC | OBJECTIVE | CONTENT | METHOD | MATERIALS |
|---|---|---|---|---|---|---|
| THEORY | PRACTICAL | | | | | |
| 30 min | 30min | Introduction | To enable learners appreciate the economic importance of soybean production | The Economic importance of soybean | ▪ Brainstorming<br>▪ Group discussion<br>▪ Practical<br>▪ Demonstration | ▪ Writing material<br>▪ Visual aid<br>▪ Print out<br>▪ Brochures |
| 30 mins | 45 mins | Record keeping | ▪ To be able to keep proper records | Importance of record keeping | ▪ Brainstorming<br>▪ Group discussion<br>▪ Demonstration | ▪ Samples of records |

| | | | | | | |
|---|---|---|---|---|---|---|
| 15 mins | 45 mins | Constraints in soybean production | To enable learners identify key constraints in soybean production and how to address these limitations. | Constraints in soybean production. | ▪ Brain storming<br>▪ Group discussion | ▪ Writing material<br>▪ Markers<br>▪ Pens<br>▪ Notebooks |
| 15 min | 15 min | Varieties of soybean | To be able to identify different soybean varieties with their attributes | Identification of soybean varieties and their attributes | ▪ Brainstorming<br>▪ Group discussion<br>▪ Practical<br>▪ Demonstration | ▪ Variety samples<br>▪ Variety posters<br>▪ Note books<br>▪ Pens |

| | | | | | | |
|---|---|---|---|---|---|---|
| 15 mins | 20 mins | Seed selection | To be able to select good quality soybean seeds for planting. | Attributes of good soybean seeds for planting<br><br>Clearly differentiate grain from seed; source of seed | ▪ Discovery<br>▪ Group discussion<br>▪ Practical<br>▪ Demonstration | ▪ Demo plot<br>▪ Different varieties of soybean seed samples |
| 20 min | 30 mins | Seed rates | To be able to determine appropriate seed rates and spacing for soybean. | Determining the quantity of soybean per plot size | ▪ Discovery<br>▪ Practical<br>▪ Demonstration | ▪ Demo plot<br>▪ Soybean seeds<br>▪ Flip charts<br>▪ Pens<br>▪ Note books<br>▪ Strings<br>▪ Measuring tape<br>▪ Farm tools |

| | | | | | | |
|---|---|---|---|---|---|---|
| 30 min | 15min | Site selection | To be able to select suitable sites for planting soybean | Selection of suitable sites for soybean production | ▪ Brainstorming<br>▪ Practical<br>▪ Demonstration | ▪ Demo plot<br>▪ Farm tools<br>▪ Note books<br>▪ Pens |
| 30 min | 1hr | Land preparation | To be able to prepare land suitable for planting soybean | Different methods of land preparation for soybean<br>Timing for land preparation | ▪ Brainstorming<br>▪ Practical<br>▪ Group discussion<br>▪ Demonstration<br>▪ Group discussion<br>▪ Sharing | ▪ Hand tools,<br>▪ ox plough<br>▪ Tractors<br>▪ Demo plot<br>▪ Note books<br>▪ Pens |

| | | | | | | |
|---|---|---|---|---|---|---|
| 15 min | 40 mins | Crop rotation | To be able to design a crop rotation program for soybean | Planning crop rotation for soybean | ▪ Discovery<br>▪ Practical<br>▪ Demonstration<br>▪ Group discussion | ▪ Demo plot<br>▪ Note books<br>▪ Pens<br>▪ Markers<br>▪ Flip charts |
| 15 mins | 30mins | Planting soybean | To be able to plant soybean using different methods and recommended depth | Different methods of planting soybean. | ▪ Discovery<br>▪ Practical<br>▪ Demonstration | ▪ Demo plot<br>▪ Soybean seeds<br>▪ Strings<br>▪ Rhizobium<br>▪ Sugar<br>▪ Basin<br>▪ Newspaper<br>▪ Piece of cloth<br>▪ Water |

| | | | | | | |
|---|---|---|---|---|---|---|
| 40 mins | 1 hr<br>15 mins | Soil fertility management and fertilizer requirements for soybean | To be able to manage soil fertility in soybean field<br><br>To be able to identify suitable fertilizers for planting soybean | Soil fertility requirements for soybean<br><br>Importance of soybean in soil fertility improvement<br><br>Types and rates of fertilizers required in soybean production | ▪ Brainstorming<br>▪ Group discussion<br>▪ Practical<br>▪ Demonstration | ▪ Demo plot<br>▪ Soil conditioners<br>▪ AESA sheets<br>▪ Record sheet<br>▪ Organic and inorganic fertilizer samples |

| | | | | | | |
|---|---|---|---|---|---|---|
| 30 mins | 1 hr | Weed management in soybean | To be able to manage weed infestations in soybean. | ▪ Methods of weed management in soybean field | ▪ Brainstorming<br>▪ Practical<br>▪ Demonstration | ▪ Demo plot<br>▪ Weed specimens<br>▪ AESA sheet<br>▪ Record sheet<br>▪ Pens<br>▪ Notebooks<br>▪ Farm tools |
| 20 mins | 1 hr | Disease management in soybean | To be able to manage the different diseases in soybean. | ▪ Methods of disease management in soybean<br>▪ Disease identification | ▪ Brainstorming<br>▪ Practical<br>▪ Demonstration | ▪ Demo plot<br>▪ Diseased samples in the field<br>▪ Spray pump<br>▪ Fungicides<br>▪ Protective gears<br>▪ AESA sheet<br>▪ Pens<br>▪ Notebooks |

| | | | | | | |
|---|---|---|---|---|---|---|
| 20 mins | 1 hr | Pest management in soybean | To be able to identify and control different pests of soybean. | ▪ Identification of different pests of soybean<br>▪ Methods of pest management in soybean | ▪ Brainstorming<br>▪ Practical<br>▪ Demonstration | ▪ Demo plot<br>▪ Insect box<br>▪ Spray pumps<br>▪ Protective gears<br>▪ Samples of chemicals for pest control<br>▪ Pens<br>▪ Note books<br>▪ Flip charts<br>▪ Attendance sheets<br>▪ AESA sheets |

| | | | | | | |
|---|---|---|---|---|---|---|
| 20 mins | 1 hr | Harvesting soybean | To be able to determine time of harvesting soybean. | ▪ Time of harvesting soybean<br>▪ Maturity indicators of soybean<br>▪ Methods of harvesting soybean | ▪ Discovery<br>▪ Sharing<br>▪ Practical<br>▪ Demonstration | ▪ Demo plot<br>▪ Tarpaulin<br>▪ Transport |
| 15 mins | 30 mins | Post-harvest handling | To be able to handle soybean after harvesting. | ▪ Post-harvest handling methods in soybean | ▪ Discussion<br>▪ Practical<br>▪ Demonstration | ▪ Tarpaulins<br>▪ Transport means |

| | | | | | | |
|---|---|---|---|---|---|---|
| 20 mins | 1 hr | Drying soybean | To be able to determine the appropriate moisture content for soybean. | ▪ Methods of drying soybean<br>▪ Determination of the required moisture content of soybean | ▪ Brainstorming<br>▪ Practical<br>▪ Demonstration | ▪ Drying yard<br>▪ Tarpaulins<br>▪ Moisture meter<br>▪ Bags<br>▪ Silos<br>▪ Pallets |
| 30 mins | 1 hr | Threshing and cleaning soybean | To be able to thresh and clean soybean appropriately. | ▪ Methods of threshing and cleaning soybean | ▪ Discussion<br>▪ Practical<br>▪ Demonstration | ▪ Dry soybean<br>▪ Threshing and cleaning machine<br>▪ Winnowers<br>▪ Tarpaulin<br>▪ Mats<br>▪ Packing bags |

| | | | | | | |
|---|---|---|---|---|---|---|
| 25 mins | 30 mins | Packaging | To be able to package soybean appropriately. | ▪ Suitable methods of packaging soybean | ▪ Discussion<br>▪ Practical<br>▪ Demonstration | ▪ Samples of packaging materials |
| 30 mins | 1 hr | Storage | To be able to store soybean appropriately. | ▪ Different methods of storing soybean | ▪ Discussion<br>▪ Practical<br>▪ Demonstration | ▪ Stores<br>▪ Silos<br>▪ Soybean seeds<br>▪ Bags<br>▪ Pallets |
| 30 mins | 1 hr | Marketing soybean | To be able to market profitably soybean | ▪ Marketing soybean<br>▪ Profitability analysis for soybean | ▪ Discussion<br>▪ Practical<br>▪ Demonstration | ▪ Flip charts<br>▪ Markers<br>▪ Pens<br>▪ Notebooks |

# SUMMARY INFORMATION ON

# SOYBEANTECHNOLOGIES

## Importance of soybean

- Source of food and food security(oil and protein)
- Household income when sold
- Fodder (cake, hay and silage)
- Green manure and cover crop
- Improves soil fertility and structure through nitrogen fixation

## Constraints in soybean production

- Pests especially leaf miner (webworm) and green stink bug.
- Diseases especially soybean rust, bacterial pustule and red leaf blotch
- Climatic changes (drought)
- Declining soil fertility
- Knowledge gaps in production
- Post -harvest losses
- Accessing quality seeds
- Poor agronomic practices.
- low yielding varieties

## Soybean varieties

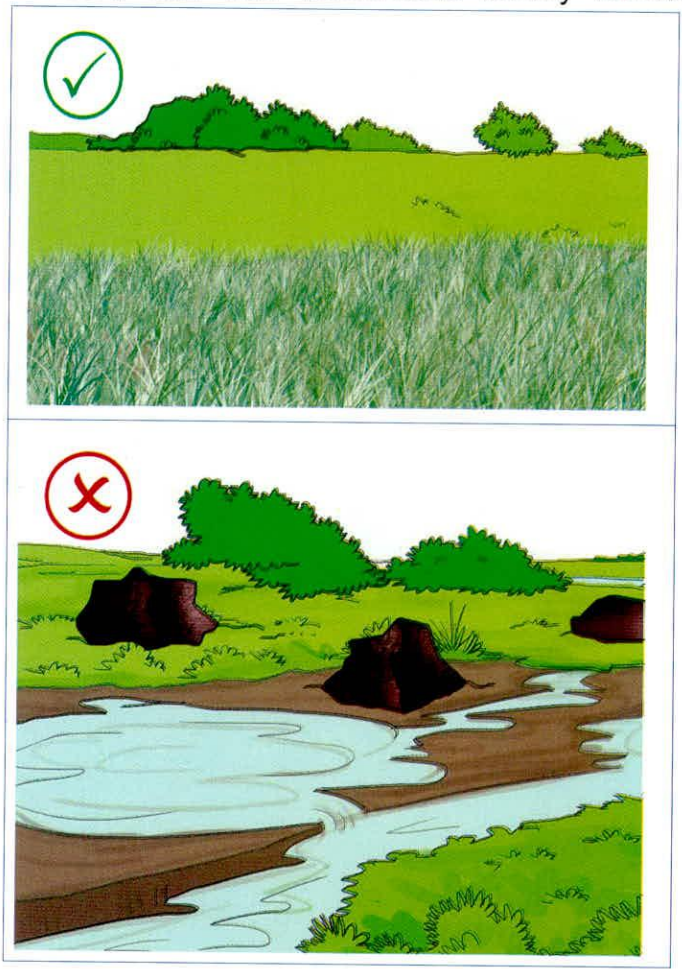
| | Brief Attributes | |
|---|---|---|
| | **MAKSoy2N**  | **MAKSoy3N**  |
| Maturity | 105 days | 100 days |
| Yield | 2-3t/ha) | 2-3.5 tons/ha |
| Others | ▪ Disease & drought tolerant, Resistant to soybean rust and pod shattering, large seeded<br>▪ 38% protein content; 18% oil content; cream helium; turns grey at maturity<br>▪ Rich in zinc & iron, short cooking time | ▪ Disease & drought tolerant ,very resistant to soybean rust and shattering;<br>▪ Has brown pubescence/hair;seeds are large with cream helium and a brown extension above the helium;<br>▪ Rich in zinc & iron, short cooking time |

| | MAKSoy4N | MAKSoy5N | MAKSoy6N | MAKSoy1N |
|---|---|---|---|---|
| |  |  |  |  |

| | **MAKSoy4N** | **MAKSoy5N** | **MAKSoy6N** | MAKSoy1N |
|---|---|---|---|---|
| Maturity | 103 days | 96 days | 93 days | 90days |
| Yield | 2-3.5tons/ha | 2-3.5tons/ha | 2-3.5 tons/ha | 2-3ton/ha |
| Others | ▪ Seeds are large and shinny with grey helium<br>▪ 38% protein<br>▪ 21% oil<br>▪ Resistant to lodging<br>▪ Resistant to pod shattering and soybean rust | ▪ 38% protein<br>▪ 19% oil<br>▪ Seeds are large with black helium with a white slit.<br>▪ Resistant to lodging | ▪ 41% protein<br>▪ 20% oil<br>▪ Resistant to soybean rust and shattering<br>▪ Resistant to lodging | ▪ 41% protein<br>▪ 17% oil<br>▪ Short. small seeded with light brown helium. |

# SITE SELECTION

- The best soil should be well drained loam or sandy loams and moist throughout the growing season, and with reasonable fertility levels.



- Avoid soils in areas that keep standing water for long periods.
- Can survive in a wide range of soils, even acid soils.
- It is very sensitive to soil salinity.
- PH of 6.0-6.5
- Avoid planting soybean in a shaded area.

# LAND PREPARATION

- Prepare a fine seedbed to a moderate depth of 15-20cm.

- First ploughing should be at least 3 weeks before 2nd ploughing. Second ploughing and discing should be at least 1 week before planting.

| | |
|---|---|
|  |  |
| 1st ploughing is rough with big soil particles | 2nd ploughing provides a fine seedbed with de-composed organic matter. |

- In order to control weeds, non-selective herbicide eg. Glyphosate may be sprayed before ploughing is done.



Fresh weeds



Dry weeds after spraying

- Land preparation should be done before the onset of rains.

## ROTATION

- Can be rotated with maize, wheat, sorghum, millet, cotton and rice
- Often intercropped with maize
- If intercropped with maize one should plant 1 row of maize after every 10 rows of soybean to avoid shading

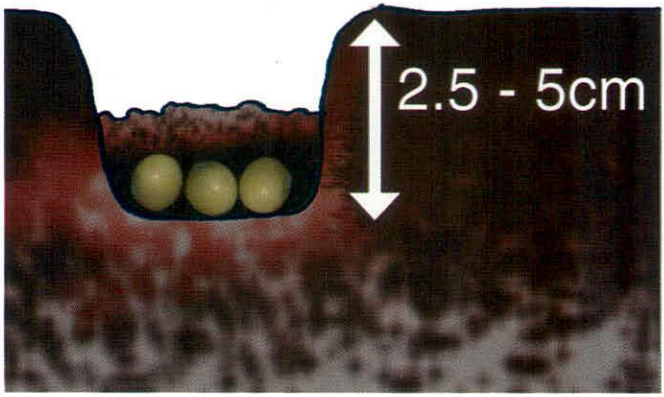
## SEED SELECTION

- Select good quality seed (to avoid storage pests and seed borne diseases).
- Choose disease tolerant varieties such as MAKSoy3N, MAKSoy2N, MAKSoy4N, 5N and 6N
- Select single variety for planting
- The seed must be able to germinate
- Pure/One Variety
- Clean (free from stones, soil, crop residue)
- Free from pests and diseases

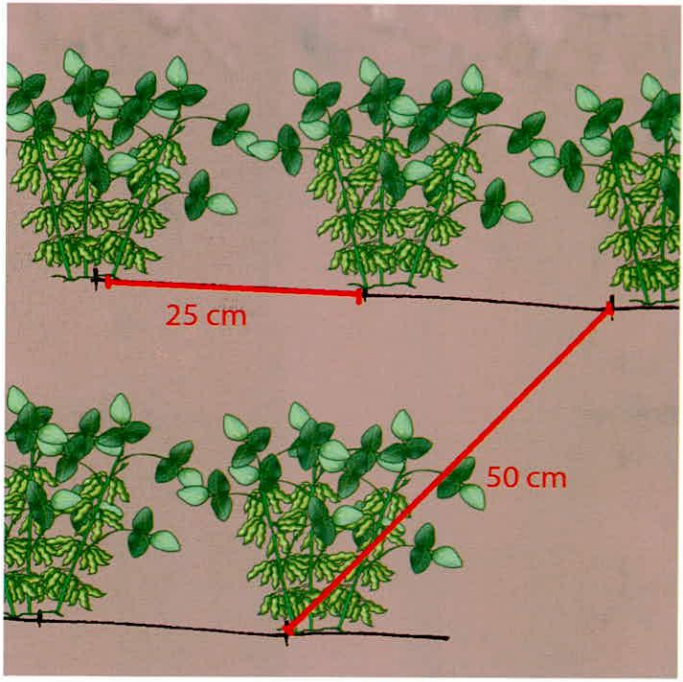

IMPROVED SEED

## PLANTING/SPACING

- Pre-test seed for germination to avoid poor germination. Germination percentage should be at least 85% and above
- Plant the soybean seed only when the soil is moist
- Place seeds at a depth of 2.5-5cm and cover lightly with soil.




- Plant at a spacing of ( 50× 25)cm 3 seeds per hole in the dibble method and (60x5) cm 1 seed in the drill method in pure stand

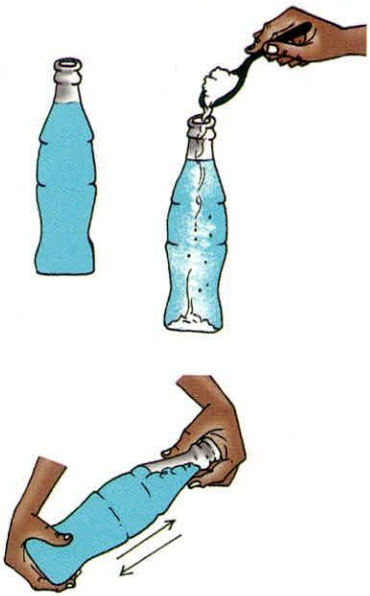



- Use seed rate of (20 to 25 kg/acre).
- Inoculation of soybean: it's recommended that the farmer dresses/ mixes the soybean seed with an inoculum Rhizobium Japonicum, a nitrogen fixing bacteria that improves on nodulation capacity and subsequently yield of soybean.

## How to inoculate the seed with rhizobium

**Step 1:**

Take clean water in soda bottle, add one table spoonful of sugar and shake well to dissolve. You have made an inoculum sticker.



**Step 2:**

Take a debe (15kg) of clean soybean seeds or any big sized seeds.



**Step 3:**

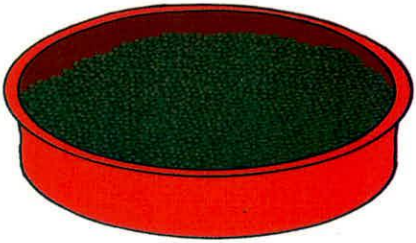
Empty the seeds into clean basin

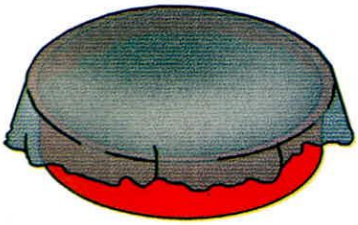


**Step 4:**

Pour the prepared inoculum sticker into the seeds.



| | |
|---|---|
| **Step 5:**<br>Mix the seeds well with sticker so that they are wetted. |  |
| **Step 6:**<br>Empty the MAK BIO-N-FIXER inoculant onto the wetted seeds. |  |

| | |
|---|---|
| **Step 7:**<br><br>Mix the seeds thoroughly so that each seed is uniformly coated with the inoculant. |  |
| **Step 8:**<br><br>Cover the inoculated seeds with,cloth or sack to protect from direct sunlight. Sow the seeds immediately in moist well prepared field. | |

**Note:** Mix the inoculant only in the seed that is going to be planted on the same day.

- After germination has taken place, ensure that the field is protected from birds (doves) and other rodents.
- In case of drill method, thinning should be done during the first weeding if the plant population is very high.

# WEED MANAGEMENT

- Early weeding suppresses later weeds.



- Soybean does not tolerate weeds at all because this greatly affects its yield
- 1st weeding: 2 weeks after germination
- 2nd weeding: 3 weeks after first weeding.

**Note:** Number of weedings may differ depending on the weed density of a given field.

## SOIL NUTRIENT MANAGEMENT

- Plant in soils with adequate levels of fertility. Do soil testing to know the status of the soil fertility
- In soils with low fertility, apply organic manure or inorganic fertilizer TSP/SSP at a rate of 50kg/acre for phosphorus deficiency.
- In cases of Potassium deficiency, apply 10 Kg/acre of muriate of potash (MOP).
- The crop is capable of fixing up to 110 kg nitrogen per acre and does not respond to N fertilizers.

**Note:** Incorporate the fertilisers during 2nd ploughing.

- Rotate and intercrop with cereals and root crops.
- Clean/disease free husks can be ploughed into the soil to improve fertility.

# PEST AND DISEASE MANAGEMENT

Major disease; Soybean rust

Others: Red leaf blotch, bacterial pustule, root rots

| Disease | Control |
|---|---|
| Soybean rust symptoms  | ▪ Rotate and intercrop with cereals and root crops.<br>▪ Plant resistant/ tolerant varieties such as MAKSoy1N and 6N, MAKSoy2N , MAKSoy3N, MAKSoy4N and MAKSoy5N to reduce yield losses.<br>▪ Scouting, early detection and the use of recommended foliar fungicides. |
| Leaf blotch  | |
| Bacterial pustul  | |

Major pests of soybean

- Leaf miner (webworm), green stinkbug.

Picture of leaf miner damage (webworm)



## Control of the webworm

- Use of resistant varieties. Unfortunately all the current soybean varieties are not resistant to this pest. The pest can be managed by use of a contact liquid insecticide Cypercal P720 EC® ( a.i. 120 g/l cypermethrin and 600 g/l profenofos), applied at 2 and 4 weeks after emergence. Alternatively, Dimethoate (Rogor 40L EC (a.i. 400 g/l perfekthion) starting from 20 days after emergence and repeating 4 times at 10 days interval.
- Plant tolerant varieties such as, MAKSoy1N and 6N ,MAKSoy2N , MAKSoy3N, MAKSoy4N and MAKSoy5N to reduce yield losses from angular leaf spot, anthracnose, soybean rust and soybean mosaic disease
- Rotate and intercrop with cereals and root crops

# HARVESTING

- Uproot the whole plant when mature and spread on a clean surface or tarpaulins until all the pods are dry and crisp.



- Harvest early to avoid weevil infestation, shuttering and termites damages,

## Signs of soybean maturity;

- Leaves and pods will turn from green to golden yellow
- Pods further turn from yellow to coffee brown, mahogany brown or tan depending on variety; when dry.
- All leaves will drop off
- Maturity ranges between 90-105 days depending on variety and environment

### Soybean is ready for harvesting only when:

- All stems and pods are thoroughly dry
- Pods give a rattling sound when the plant is shaken

## Method of harvesting:

- Hand pulling.
- Avoid delayed harvesting to control reduced seed viability, pod shattering, rotting of seed and termite damage

**Note:** Harvesting should be done in the cool hours of the morning

# POST- HARVEST

- Thresh, winnow and sort by hand. the disease stained, off-types or damaged seeds
- Thresh on a clean surface/ tarpaulin
- Continue drying seeds for 2-3 more days in good sunshine to ensure seed is at the right storage moisture content of 10-12%
- Avoid long storage of soybean because this affects viability for example if seed is harvested in season A, it should be used in season B of the same cropping year
- Pack in bags of up to 100kg and place on dry wooden racks in a well-ventilated, vermin and water proof store, portable silos.



# STORAGE

- Dry the soybeans adequately to about 10% moisture content: should not be possible to dent with your teeth.
- Pack the seed in bags and store it in a well ventilated, cool and dry store.
- Keep the bags on raised pallets or benches.
- Never ever put the bags on bare ground/floor. It affects food and seed quality.

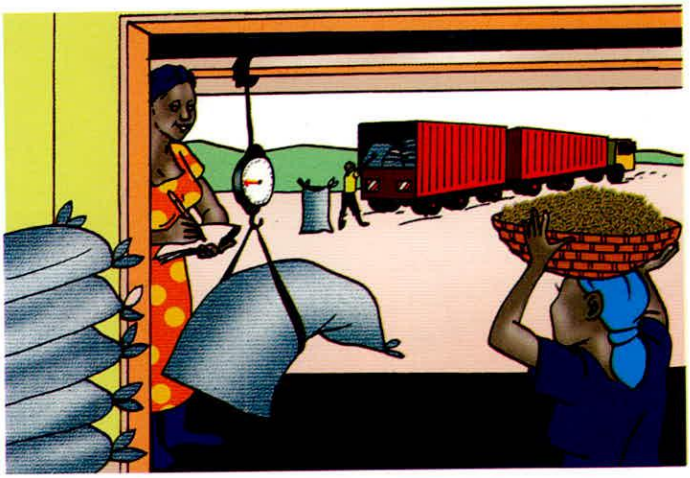


# VALUE ADDED PRODUCTS FOR SOYBEAN

| | |
|---|---|
|  |  |
| Soymilk powder | Tinned Soytea beverage |
|  |  |
| Sachet Soytea beverage | Soymummies |
|  |  |
| Soymeat | SoySip |

# MARKETING

- Conduct market survey to establish the market requirements in terms of quality, quantity, seasonality, price.



- Provide market information and linkages.
- Promote bulk marketing to increase bargaining power.
- Encourage contract farming.
- Promote local seed business.

# PROFITABILITY ANALYSIS OF SOYBEAN

## Gross –margin analysis per acre of soybean (Gross margin varies with cost of production and expected market price)

**Example :** Assumptions ; yield per acre = 800 kg and market price=1,200 sh per kg

| Item | Unit | Quantity | Unit cost | Total |
|---|---|---|---|---|
| Cost of input | | | | |
| Rhizobium | Packets | 2 | 2500 | 5000 |
| Seeds | Kg | 25 | 3,000 | 90,000 |
| Tools (hoes) | Pieces | 5 | 8,000 | 40,000 |
| Tools (pangas) | Pieces | 2 | 3,000 | 6,000 |
| Pesticides | Litres | 2 | 20,000 | 40,000 |
| **Total input cost** | | | | **184,000** |
| Labour costs | | | | |
| Land preparation x 2 | Man-day | 2 × 10 | 5,000 | 100,000 |
| Planting | Man-day | 4 | 6,000 | 24,000 |
| Weeding | Man-day | 2 × 10 | 5,000 | 100,000 |
| Harvesting | Man -day | 2 × 5 | 5,000 | 50,000 |

| | | | | |
|---|---|---|---|---|
| Drying | Man-day | 8 | 5,000 | 40,000 |
| Threshing | Man-day | 4 | 5,000 | 20,000 |
| Packing bags | Pieces | 8 | 2,000 | 16,000 |
| **Total labour cost** | | | | **350,000** |
| Cost of labour and input | | | | 534,000 |
| Gross Margin | | | | 426,000 |

**Note:** production cost per unit (kg)

$$= \frac{\text{Total cost}}{\text{Total output (yield)}}$$

$$= \frac{240{,}000}{800}$$

$$= 667.5/-$$

Profit margin per kg = sale price per unit – production cost per unit

$$= 1{,}200.00 - 667.50 = 532.5/-$$

**Implication :** A farmer is getting a profit of shs 532.5/- per kg produced

# RISK AND SENSITIVITY ANALYSIS

## Risk analysis for soybean Enterprise

**Scenario 1**:A decrease in yield of soybean to 700 kg/acre and a rise in market price to shs 1,300 kg/kg

| Parameter | Product | Qty (kg) | Marketing Price (Sh.) | Total (Sh.) |
|---|---|---|---|---|
| Expected Revenue | Soybean | 1 acre × 750 | 1,300 | 910,000 |
| Total Cost | | | | 534,000 |
| **Gross Margin** | | | | **376,000** |

**Scenario 2:** An increase in yield of soybean to 900 kg/acre and a fall in price to shs 1,000/kg

| Parameter | Product | Qty (kg) | Marketing Price (Sh.) | Total (Sh.) |
|---|---|---|---|---|
| Expected Revenue | Soybean | 1 acre × 900 | 1,000 | 900,000 |
| Total Cost | | | | 534,000 |
| **Gross Margin** | | | | **366,000** |

Note : a) In scenario 1 above, the decrease in yield accompanied by a rise in price will not significantly affect profitability of the enterprise

b) Under scenario 2: A fall in market price will drastically reduce profitability of the enterprise.

A fall in market price has a far reaching effect on gross margin than a fall in yield.

# REFERENCES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