

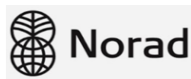


Soybean Production Manual

Good Agronomic Practices for Soybean Production in Northern Ghana

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Introduction

- Soyabean is both a cash and food security crop with demand for grains more than the supply.
- Unfortunately, farmers are unable to utilize this opportunity to increase their incomes due to low grain yields (about 870 kg/ha or 350 kg/acre or less).
- The goal of every soyabean farmer is to increase grain yield for increased income.
- Farmers can increase their yield up to 2,000 kg/ha or 800 kg/acre (= eight 100 kg bags/acre) or more – note that the potential yield for the main varieties ranges from 2,400 – 3,500 kg/ha (1,100 – 1,400 kg/acre).
- It becomes demoralizing for farmers when they are unable to achieve such goals.
- Some farmers only plant the soyabean and do not do anything else in terms of applying improved inputs or management, and still expect to achieve higher yields.

Usually, what most farmers do is just:

- Plough without harrowing or levelling to make the soil ready for best sowing technique.
- Sow without following the recommended time of sowing.
- Sow without following any proper pattern or best available sowing technique.
- Expect higher yields with no certified seeds used for sowing, low plant population, no inoculant or legume fertilizer applied.
- Untimely weeding without any proper plan or no weeding at all.
- Harvest without proper plan or timing of harvest and post-harvest handling.

To increase yields and income, soyabean farmers need to do things differently – embrace new technologies and/or proven or improved agronomic practices.

So, what can farmers do differently to increase yields?
Farmers must consider the following factors/practices:

1. Ensure early planting, **between mid-June to mid-July** depending on the regularization of rainfall.
2. Use non-shattering soyabean varieties to avoid grain loss at harvest.
3. Ensure that the recommended plant population is achieved – 400,000 plants/ha or about 162,000 plants/acre at harvest.
4. Use recommended inputs – certified seeds, inoculant and Yara legume fertilizer at recommended rates.
5. Ensure timely application of inputs and appropriate methods to apply.
6. Manage crop stress adequately – timely and thorough weeding, effective pests, and diseases control.
7. Adequately plan your harvest, do it on time to avoid shattering and grain loss.
8. Do not grow soyabean over multiple seasons on the same field.

9. Soybean can fix up to 40 kg or more of nitrogen per acre (or around 1 bag of nitrogen fertilizer) from the air into the soil to improve the fertility.
10. Therefore, it is best to rotate soyabean with maize or cereals/crops that need more nitrogen to grow well and produce higher yields.
11. Rotating soyabean with maize is also vital to avoid pests and diseases build up or to break their cycles.

- Majority of soyabean farmers, especially the smallholders, need more knowledge on such GAPs/productivity enhancing technologies or proven practices to enable them to achieve their goal of increasing soyabean grain yields for increased income.
- The **purpose of this manual**, therefore, is to provide such knowledge/information or share experiences on proven/emerging technologies and/or agronomic practices that can be adopted by farmers to enable them to increase their soyabean grain yields.
- The manual is structured into **four Modules** based on the productivity enhancing technologies/practices/factors that help to intensify and increase soyabean yields.

Module 1 – Achieving optimum plant population

Module 2 – Harnessing the power of improved inputs

Module 3 – Adequate crop stress management

Module 4 – Proper harvest planning

Module 1

Model 1: Achieving optimum plant population

Learning objective	<ul style="list-style-type: none">▪ Show in a sequential manner, the various factors or proven practices that combine to facilitate achieving optimum or recommended soyabean plant population for increased grain yield.
Learning outcomes	<ul style="list-style-type: none">▪ Key factors/proven practices that can help farmers achieve optimum plant population identified sequentially.▪ Enhanced knowledge of key factors or proven practices that can contribute to achieving optimum soyabean plant population.

Factors or proven practices that can help to achieve the recommended soyabean plant population

When the required plant population is achieved, the soyabean plants can form a closed canopy as seen in the picture. This essentially helps to suppress weeds growth and help to increase yield per unit area and ultimately yield per acre or hectare.



Several factors or proven practices play crucial roles in helping to achieve optimum/recommended soyabean plant population per hectare or acre by enhancing good germination and survival of plants as required, to increase grain yield.

These factors/practices include but not limited to the following:

- Proper site selection
- Adequate land preparation
- Use of improved/certified seeds
- Germination test to determine viability of seeds
- Use of appropriate sowing technique
- Field guarding after sowing

1.1 Site selection

- Land for soyabean production should have a well-drained soil, preferably sandy-loam soil.
- The soil should have no hardpan to enhance water percolation and prevent flooding during heavy downpour as well as to allow easy penetration by the plant roots.

- If possible, use a flat land or a land with a gentle slope to avoid erosion of topsoil.
- If the land selected has a steep slope, then create ridges across the slope (if ridging is a normal practice) to prevent surface runoff.

1.2 Adequate land preparation

Land for soyabean production can be prepared in various ways based on multiple factors including:

- farmer's preference,
- farmer's available resources,
- access to mechanization services,
- site/soil conditions.

1.2.1 Ploughing

- Clear weeds or other vegetation on the land, either manually or using agro chemicals (e.g., total weed killers like glyphosate) at least a week before ploughing.
- **Ploughing can be done 2 to 3 weeks before planting** using a tractor or bullock depending on which one the farmer can access or afford.
- The ploughing depth should be about 20 – 30 cm and should be done when the soil moisture is relatively low to reduce soil compact and formation of a hardpan.
- Do not burn the crop residues left on the field from the previous season. Rather, plough them into the soil to help with moisture retention and organic matter build up.



- If the land has a slope, ploughing should be done across the slope.
- Ploughing is essential as it helps to loosen the soil, bring up nutrients from deeper soil layers and burry weeds. Loosening the soil is important for:
 - enhanced air circulation which is vital for soil micro-organisms that help to decompose organic materials to release nutrients for uptake by soyabean plants,
 - improving water infiltration, and penetration of plant roots into deeper layers to take up nutrients for better growth.
- Please, note that ploughing usually leaves the soil surface uneven (with soil clods/lumps and furrows/trenches/gutters).
- Therefore, it is necessary to harrow/level the soil surface either mechanically or manually before sowing to enhance seed germination.

1.2.2 Harrowing

- **Harrowing should be done about one week before planting** to level the soil surface after ploughing, break up lumps of soil and provide a good soil tilth to enhance seed germination.
- It is mostly done mechanically, but if this is not possible, the farmer can use hand hoe to level the soil surface and make it even and ready for sowing.



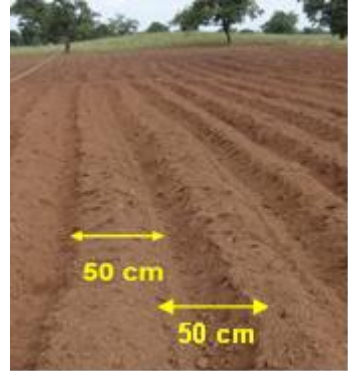
- Please, allow some days (up to a week) after ploughing for the soil to dry before harrowing to obtain a level surface.
- Harrowing/leveling of soil surface for sowing helps to:
 - break soil clods that form on the surface after ploughing and can prevent the seeds from germinating.
 - prevent water from collecting in holes/furrows left after ploughing which can make seeds rot or germinated seeds die for being soaked in water.
 - further destroy weeds and loosen the topsoil for the young roots of seedlings to develop well and the young plants to grow better.

1.2.3 Ridging

- Ridging can be done with tractor, bullocks or using hoes **about one week before sowing**.
- It is vital for shallow soils or soils with a hardpan that could easily get flooded. In such cases, ridging allows water to collect in the furrows between the ridges and helps to improve drainage and keep the plants safe.
- Ridging increases the depth of the topsoil which allows the roots of plants to have more soil room to exploit nutrients and water for better growth.



- Ensure that the distance between the apex (tips) of any two ridges is 50 – 60 cm in accordance with the recommended row spacing.
- If this is not possible, the farmer can sow on both edges of the ridge, in which case the ridges should be made wide with the distance between the edges being 50 cm.



- Ridging with tractor/bullocks does not automatically give the required spacing since the discs are not usually adjustable. So, it is necessary for the farmer to do some adjustments after mechanical ridging to achieve the required row spacing.
- The ridges should be as high as practicable to improve water infiltration.

1.2.4 Minimum/zero tillage

- Some farmers prefer to prepare their lands with minimum or no soil disturbance, especially those that are engaged in conservation agriculture.
- With this tillage practice, the vegetation on the land is not cleared. Instead, planting holes are made, and the seeds are sown directly.
- The farmer then takes care of the vegetation by spraying herbicides (usually a total weed killer) immediately after sowing to kill the weeds and allow the seeds to germinate and grow without competing with weeds.

- This type of land preparation is most suited to land/soil with the following conditions:
 - areas susceptible to drought and high soil temperatures.
 - land with steep slopes and those prone to erosion to prevent water loss through runoff.
- soils with low water holding capacity to allow water conservation.
- Glyphosate is a good example of such non-selective or total weed killing herbicides. Below are some examples of non-selective herbicides with glyphosate as active ingredient and can be used for total weeds control when practicing minimum or zero tillage:

Please, do not spray any of these herbicides after the soybean seeds have germinated to prevent them from being destroyed together with the weeds.

1) GLYKING - Glyphosate 400 g/L SL



A **non-selective** herbicide for the control of grasses/broadleaf weeds and annual and perennial weeds.

Application rate:

- 100-200 ml per 16L knapsack
- 0.4L/acre (about half bottle per acre) and 1L/ha

2) RIDOUT - Glyphosate 400 g/L SL

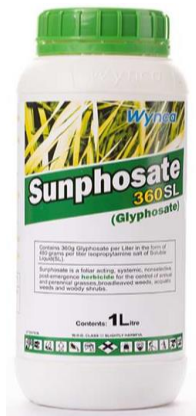


A **non-selective** herbicide for the control of grasses/broadleaf weeds and annual and perennial weeds.

Application rate:

- 100-200 ml per 16L knapsack
- 0.4L/acre (about half bottle per acre) and 1L/ha

3) Sunphosate - Glyphosate 360 g/L SL



A **non-selective** herbicide for the control of annual and perennial grasses and broadleaf weeds.

Application rate:

- 150-200 ml per 16L knapsack
- 1-2L/acre (i.e., 1-2 bottles per acre) and 2.5-5L/ha

4) Ridover - Glyphosate Ammonium 80 g, 75.7% SG



A **non-selective** soluble granular herbicide for the control of annual and perennial grasses and broadleaf weeds.

Application rate:

- 80-100 g per 16L knapsack
- 324-405 g/acre and 800-1,000 g/ha

Herbicides application method

Fill the Knapsack with half the required amount of water. Add the recommended amount of herbicide and mix thoroughly. Top up the tank with water to the required level and shake well to ensure thorough mixture and then spray.

1.3 Seed selection

- Only use certified seeds from certified agro-dealers for sowing.
- If you receive the seeds from a nucleus farmer/aggregator, please verify that they are certified seeds and originally sourced from a certified seeds dealer.
- If required, conduct seed treatment by applying fungicides.
- Clean the seeds by removing damaged/broken seeds, debris, pest or disease infested and irregularly shaped seeds.



1.4 Germination test

Conduct germination test between **10 – 14 days before sowing** to determine if the seeds are good enough for sowing. Germination test can be conducted in a variety of ways. Few examples have been described below:

1) Seedbed method

- Prepare a small seedbed and water it to make it moist but not wet or soaked.
- Make one 100 holes in the seedbed.
- Select one 100 seeds randomly from the seed pack and sow one seed in each hole.
- Count the number of seeds that have emerged by one week time.

2) Bowl method

- Fill a large bowl with soil and moisten the soil.
- Make one 100 holes in the seedbed.
- Select one 100 seeds randomly from the seed pack and sow one seed in each hole.
- Count the number of seeds that have emerged by one week time.

Germination test can be conducted using other methods as well, and the number of seeds to be used for the test can be 100 or 1,000.

Below is a guide on the required number of seeds that should be sown based on the outcome of the germination test.

Germination test result (Number of seeds that emerged)	Number of seeds to be sown per hole or stand
85 or more	2
80 – 84	2–3
70 – 79	3 or more
60 – 70	4 or more
Below 60	Discard. Best to get new seeds for sowing

Irrespective of the sowing method, if birds/rodents may be a problem, and the field cannot be guarded after sowing, then sow at 3 seeds per hole or stand and thin to 2 healthy plants two weeks after sowing.

1.5 Appropriate sowing technique

- Soyabean, being a legume crop rely more on nitrogen in the air for growth.
- Soyabean roots do not spread much widely in the soil like other crops such as maize.
- Therefore, soyabean can be planted close together because close planting does not result in intense competition for nutrients like maize and other crops.
- At an early stage of growth, especially before nodulation, soyabean rely on soil nitrogen. Therefore, if the soil is deficient in nitrogen, it is important that a starter dose (a small amount of nitrogen, about 10 – 15 kg N/ha or 4 – 6 kg N/acre) can be applied to stimulate growth until nodulation.

Do not broadcast your soyabean seeds and **do not practice random planting** as any of these will not help to achieve the recommended plant population.

Practice Row Planting

- This will allow the recommended spacing of **50 cm** between rows (roughly the length of two footprints) and **10 cm** between plants within the rows (roughly the length from the base of your thumb to the top of your index finger) to be applied and to achieve the required plant population.
- Planting in rows makes weeding relatively easier and harvesting and other management practices efficient (as less time is required) compared with random and broadcasting sowing methods.

- Ensure there is good soil moisture prior to sowing, usually after a good rainfall but soil should not be soaked with water as the seeds will rot and not germinate.
- Do not plant too early before the rains are well established as a prolonged dry spell after planting may cause the plants to die.
- The best planting time for soyabean is between **mid-June to mid-July** with the rains likely well established.
- Avoid deeper sowing (**recommended depth = 3 cm; not deeper than 5 cm**) as this may result in loss of seed vigor and poor germination or failure to germinate.

Below are some good examples of row planting techniques

1.5.1 Dibbling (the use of dibber, hoe, cutlass, planter):

- On each row, make 2 adjacent holes about **5 cm** apart and **3 cm** deep as below.
- Each pair of adjacent holes should be **10 cm part** from within the row. Sow **2 seeds in one hole**. The other hole is for fertilizer and will be discussed in later section.



- This sowing technique can be performed mechanically with a multipurpose planter, which can put both the seeds and fertilizer simultaneously.

- Remember, the number of seeds to put in one hole depends on the results of your germination test (***please refer accordingly***).

1.5.2 Drilling:

- On each row, make a furrow using a dibber with a flat edge of about **5 cm width**.
- Sow the seeds at one side of the furrow with 2 seeds per stand and **10 cm between plant stands** within the row and cover after sowing. The opposite side of the furrow is meant for the drilling of the fertilizer at sowing (see details under fertilizer application).
- Do not step on the covered seeds after sowing to allow seeds to emerge.
- Again, remember the number of seeds to put per stand depends on the results of your germination test.
- *This method requires the land to be well prepared – ploughed to properly loosen the topsoil and harrowed/leveled (or double ploughed) to provide an even surface for sowing.*

Do not step on the planting holes after sowing to allow seeds to germinate without obstruction

1.5.3 Intercropping

In areas such as the Upper East Region, some farmers usually intercrop soyabean with maize or other cereals.

The cereal is usually planted as the main crop for household food security with the soyabean added to sell for income.

In such cases, the farmers commonly plant 6 or more soyabean seeds in one hole between two maize plants on the same row.

This practice is called an **additive intercropping** – an intercropping system where the main crop is planted at its recommended sole crop density and the intercrop (second crop) added at a certain proportion of its sole cropping density.

To improve the efficiency and complementary use of growth resources (radiation, soil water, nutrients, etc.) for increased yield of both crops, the following additive intercropping sowing technique shown in the picture can be used:

- The planting rows should be spaced 75 cm apart.
- Use a short duration maize variety.
- Make 4 holes (if maize is spaced 50 cm within the row) or 2 holes (if maize is spaced 25 cm within the row) between 2 maize plants on the same row and sow 2 soyabean seeds per hole. This will mean that the soyabean within-row planting holes are spaced 10 cm apart.
- Make sure the soyabean holes are evenly spaced between the 2 maize plants. Do not put all 8 soyabean seeds in one hole.



With this intercropping method, the taller maize may shade the soyabean to some extent. However, there is more complementary and efficient use of resources. For example, the soyabean fixes its own nitrogen from the air and allow the maize to utilize the nitrogen in the soil for growth – so there is:

- reduced competition for nutrients,
- reduced competition for soil water due to different root systems between soyabean and the cereal, and

- efficient use of radiation because of differing canopy architecture.
- increased efficiency in land use and yield per unit area.

Alternatively, you can intercrop soyabean by planting maize as a monocrop and then between every two maize rows, you plant a row of soyabean. This is also an additive system as the recommended maize population is not reduced and soyabean is integrated as a second crop.

In areas where farmers plant on ridges, as in the Upper East Region, maize can be planted in the middle of the ridges as a monocrop at its recommended population and then soyabean can be integrated as a second crop by planting on the edges or on the sides of the ridges.

1.6 Field guarding after sowing

- There are several animals (e.g., birds, rodents) that usually disturb the germination of seeds.
- Therefore, after sowing, the field should be guarded to protect the seeds and ensure good germination.
- Guarding of the field can be done in multiple ways:
 - The farmer or someone appointed need to watch over the field to scare away birds and rodents and prevent them from digging up the seeds or eating them when they emerge from the soil.
 - The farmer can put up some scare crows to steer away birds and rodents or free roaming livestock from stepping on the seeds sown.
- The field guarding should be done until germination is completed, and the resulting seedlings have attained at least 2 – 4 leaves.

Module 2

Model 2: Harnessing the power of improved inputs

Learning objectives	<ul style="list-style-type: none">▪ Showcase a host of recommended inputs that can help to increase soyabean grain yield.
Learning outcomes	<ul style="list-style-type: none">▪ Increased awareness of some recommended inputs to increase soyabean yield.▪ Full understanding of the application rates, times, and methods of each of the recommended inputs.

Introduction

- A host of improved inputs are available that farmers can use to assist them increase their soyabean yields.
- Each of these inputs can be used alone or combined to better enhance the prospect of increasing soyabean grain yield.
- These include the following:
 - **Improved variety**
 - **Certified seeds**
 - **Rhizobia inoculant**
 - **Legume fertilizer**
A variety of soyabean yield enhancing fertilizers such as:
 - YaraLegume fertilizer
 - Triple Superphosphate (TSP)
 - YaraVita Croplift Bio (Liquid fertilizer)

2.1 Appropriate variety

- Before buying certified seeds for planting, a farmer should first decide on which variety to use.
- Generally, a farmer must always choose a variety with the following attributes:
 - high yielding,
 - resistant to pod shattering,
 - early – medium maturing to fit into the relatively short duration of the cropping season in northern Ghana,
 - resistant to drought, and tolerant to pests/diseases.
- In addition, a farmer may also consider the type of contract or market he/she is targeting to sell his/her soyabean grains when deciding on which variety to use

for planting – e.g., if the farmer is targeting/has a contract to sell the grains to a processor for oil, then a variety with seeds high in oil should be used. But the variety must conform to the traits indicated above.

Below are some improved varieties recommended by the SSPiNG project

Name of variety	Maturity (days)	Potential yield	Pod shattering	Pest and diseases
Jenguma	110–115	2.8 t/ha 11 bags/acre	Resistant, up to 3% shattering	Tolerant
Afayak	110–115	2.4 t/ha 10 bags/acre	Resistant, up to 8% shattering	Tolerant
Favor	115–120	3.5 t/ha 14 bags/acre	Resistant, up to 5% shattering	Tolerant

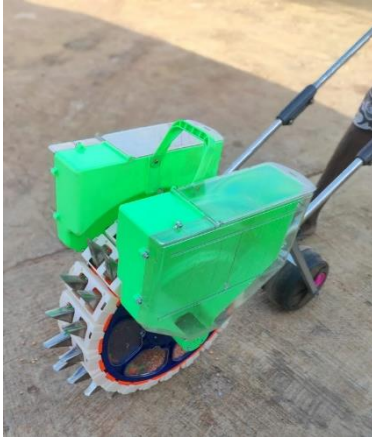
2.2 Certified seeds

- It is important to always use certified seeds from a certified agro-dealer. Such seeds mostly give better germination for high plant population and higher grain yields.
- Always verify that the seeds were from a season prior to the present one or not kept in storage for more than 12



months as such seeds are likely to lose their vigor, not germinate or give low yield.

- In case you cannot have access to certified seeds for planting, you may use the first or second saved seeds from a certified seed for planting. Please do not go beyond the use of the second saved seeds.
- However, we highly recommend the use of certified seeds for planting every season because:
 - soyabean seeds tend to lose their viability and vigor when poorly stored leading to poor germination and low yields.
 - the ability of seeds saved from previous harvest to give higher yields when re-used for planting generally tend to decline season after season.
- **Seed rate:** About 45 – 50 kg of soyabean seeds are required to plant one hectare and **18 – 20 kg** to plant one acre. These are targeted at achieving the optimum population of 400,000 plants or more per hectare and about **162,000 plants or more per acre**.
- Usually, 40 – 45 kg/ha or 16 – 18 kg/acre is adequate with manual or hand sowing. But 50 kg/ha or 20 kg/acre can be targeted when drilling by hand or sowing with manual or mechanical planters. Examples of these planters are shown below.



2.3 Rhizobium inoculant

Introduction (Facts/important notes)

- Rhizobium inoculants are commercially produced rhizobia applied to legume seeds before sowing to enhance nodulation, nitrogen fixation and better yield. There are several quality inoculants available for use on soyabean – e.g., **NoduMax-Plus** and **SariFix**.



- It is important to inoculate soyabean seeds because the rhizobia that normally make soyabean to form nodules and fix nitrogen are naturally found in low amounts in most soils in the savanna areas.



- Most essentially, on newly cleared lands or lands that have not been cultivated to soyabean before, the amount of the right rhizobia for soyabean is more likely to be even less or lacking. Hence, a farmer should always apply inoculant when growing soyabean on such lands/soils.
- To ensure that adequate amounts of the required rhizobia is available in the soil, it is necessary to inoculate soyabean seeds. This will enable the plants to form more nodules, fix more nitrogen, produce more biomass/residues, and give you higher grain yield.
- When the soyabean fixes more nitrogen, it uses part for its own growth and leaves some in the soil to improve the fertility which will then benefit a subsequent crop like maize grown in rotation with the soyabean.
- Always check that the inoculant is the right one for soyabean before buying because some inoculants may not work on soyabean as each legume needs a specific rhizobium to infect its roots to be able to form nodules.
- The inoculant packet always shows the legume types it should be applied to, so always check it.
- Also check the specific rate to be applied because it differs for each inoculant as manufacturers use different formulations and carriers in developing inoculant.
- Ensure that the inoculated seeds do not get in contact with fertilizers when sowing.

Application rate and method

Due to the different formulations/carriers used in developing inoculants, the method and rate of application also differs for each inoculant. Always check the instructions that come with the inoculant for the right method and rate.

Both **NoduMax-Plus** and **SariFix** inoculants have similar application rates and method which is described below.

Application rate:

- 10 g per kg of soyabean seeds **OR** 100 g (one sachet) per 10 kg of seeds.
- This means that for one acre, two (2) of the 100 g sachets of inoculant are needed for inoculation.

Application method (See the pictorial steps below):

1. Measure and place **10 kg** of soyabean seeds in a container large enough to accommodate all the seeds.
2. **For NoduMax-Plus**, dissolve the gum Arabic enclosed with the inoculant packet in 200 ml of warm water (about half of the small mineral water bottle) if preparing it for 10 kg seeds. Add the gum Arabic solution to the seeds, mix until all seeds are uniformly covered.
For Sarifix, moisten the seeds with about 30 ml of clean water (roughly 6 water bottle-cap).
3. Add **100 g** (one sachet) of inoculant to the seeds already covered in gum Arabic solution or moistened and mix thoroughly until all the seeds are uniformly covered and/or coated with the inoculant.
4. Avoid exposure of the inoculated seeds to sunlight by covering with a paper, cloth, etc. Exposure to sunlight will kill the rhizobia bacteria.
5. Place the inoculated seeds under a shade to allow them to **coolly dry for about 15-30 minutes** (note that the time depends on the quantity of seeds inoculated) for sowing.

6. Ensure that you sow the inoculated seeds as soon as possible, particularly about 30 – 60 minutes after inoculation.
7. In an extreme case where you cannot sow immediately, ensure that you sow the seeds on the same day they are inoculated.
8. Inoculant application rate can be adjusted accordingly based on the quantity of seeds to be inoculated.

Handling and storage of inoculant

- Keep the inoculant package sealed until you are ready to use.
- Store the inoculant in a cool, dark, and dry place away from heat, direct sunlight, and moisture.
- Do not store the inoculant in a freezer as this will kill the rhizobium bacteria. However, you can store the inoculant in a fridge.
- Always follow the recommended storage instructions included in the inoculant package.

NoduMax-Plus Legume Inoculant



Materials Needed for Seed Inoculation

- A container large enough to contain 10 kg of seeds
- 200 ml of warm water
- "Wooden" stirrer/ Spatula
- 10 kg of certified seeds
- Gum Arabic packet
- NoduMax-Plus Inoculant

Practical Steps to Inoculant Application



1
Pour 10 kg of certified seeds into the container large enough to contain 10 kg of seeds.



2
Add the dissolved gum Arabic sticker onto the seeds



3
Gently stir to ensure uniform mixing of the seeds and sticker.



4
Add 100g Nodumax-Plus inoculant to the seeds and mix until seeds are uniformly coated with the inoculant



5
Cover the plastic container with the lid.



6
Swirl gently to ensure proper adhesion of inoculant to seeds. Occasionally remove the lid and check for proper mixing. Seeds turn black when properly coated with the inoculant.



7
Well coated inoculated seeds will appear as shown.



8
Air dry coated seeds under a shade for 15 to 20 minutes.

2.4 Legume fertilizer

Harnessing the power of improved inputs to increase soyabean yield

The general perception is that soyabean does not require any fertilizer. This is not entirely correct.

- Soyabean does not require a nitrogen fertilizer because as a legume plant, it is able to fix nitrogen from the air into its root/soil through a process called 'biological nitrogen fixation'.
- When the soyabean fixes the nitrogen, it uses some for its own growth to produce higher yield and leaves some of the nitrogen in the soil to improve the fertility.
- However, if the soil is deficient of nitrogen, that is it has a very low amount of nitrogen, then a small amount of nitrogen is needed at the infant or early stage of the crop before it begins to fix its own nitrogen. This is called a starter nitrogen.
- The starter nitrogen amount should normally be a maximum of 15 kg N/ha or 6 kg N/acre.

Apart from nitrogen, requires phosphorus, potassium and other nutrients for better growth and yield. However:

- Soyabean require more phosphorus than the other soil nutrients.
- These nutrients including the phosphorus cannot be fixed by soyabean, so they have to be supplied through application of recommended fertilizers.
- Some recommended fertilizers, also recommended by the SSPiNG project include the following:
 - YaraLegume fertilizer
 - Triple Superphosphate (TSP)
 - YaraVita Croplift Bio (Liquid fertilizer)

Benefits of applying legume fertilizers

- Rapid growth and development of the soyabean plants.
- Reduction in flower abortion or loss of flowers.
- Increased number of pods per plant and pod filling (3-4 seeds per pod).
- Larger grain or seed size and increased grain weight.
- Increased grain yield.
- Improved grain quality.
- Increased economic returns.

2.4.1 YaraLegume



- This is a legume fertilizer produced and marketed by Yara Ghana.
- There are two types:

1) **YaraLegume (YL):**

(0:18:13 + 6CaO + 2S + 3MgO + 0.075B)

This fertilizer blend has phosphorus (18% P₂O₅) and potassium (13% K₂O) as the main active ingredients. It also contains 6% calcium, 2% sulphur, 3% magnesium and some boron to further support the growth of soyabean plants.

2) New YaraLegume (NYL):

(4:18:13 + 6CaO + 2S + 3MgO + 0.075B)

The New YaraLegume has the same active ingredients as the YaraLegume described above. However, this new blend also has a 4% nitrogen as a starter dose to trigger rapid growth of the young soyabean plants until they can form nodules and fix their own nitrogen.

2.4.2 Triple Superphosphate (TSP)

(0:46:0 + 15Ca)

- This is a phosphate-based fertilizer with a high concentration of phosphorus and suitable for soyabean for enhanced growth and yield.
- It also has a 15 % calcium to provide additional nutrition for the soyabean crop.



Application rate (YaraLegume and TSP)

Legume fertilizer	Rate (kg/ha)	Rate (kg/acre)	Applying with water bottle cap
YaraLegume	250	100 (2 bags)	1 cap for every 4 holes or stands
TSP	100	40 (1 bag)	1 cap for every 10 holes or stands

Application time:

- Whether YaraLegume or TSP, the fertilizer should be applied at sowing (**recommended**).

- If for any reason the fertilizer cannot be applied at sowing, ensure that it is applied **within two weeks** after sowing and **NOT** later than that.

Application methods

a) Drilling method:

- With this method, the fertilizer is applied at sowing.
- The method requires the land to be well prepared – ploughed to properly loosen the topsoil and harrowed/leveled to provide an even surface.
- At planting, make a furrow using a dibber with a flat edge of about **5 cm width**.
- Sow the seeds at one side of the furrow and cover seeds (*please refer to sowing techniques*) and then drill the fertilizer at the other side of the furrow opposite the side where the seeds were sown.
- Cover the fertilizer after application to avoid nutrient losses.

b) Band placement method:

- This method also requires the land to be well prepared – ploughed and harrowed/leveled.
- The method can be used to apply fertilizer both at sowing and after the seeds have germinated.
- If applying at sowing,
 - make 2 adjacent holes about **5 cm** apart and **3 cm** deep (*refer to the picture under sowing technique*).

- Sow the seeds in one hole and place the fertilizer in the other hole and cover after application to avoid nutrient losses.
- If applying after germination, place the fertilizer **5 cm away** from the base of the plant in a **3-5 cm deep trench** and cover after application to avoid nutrient losses.

Do not Broadcast your Fertilizer as this will Encourage Weed Growth to Compete with the Soyabean Plants

2.4.3 Croplift Bio (Liquid fertilizer)

This is produced and marketed by Yara Ghana. The product contains:

- sticking agents to adhere it to the leaves,
- wetting agents to spread the product over the leaf surface,
- uptake agents to enhance nutrient uptake by the soyabean plants.
- The product can be mixed with other chemicals (insecticides, herbicides, weedicides, etc) in one tank when applying.



Application rate:

- 2 liters per acre and 5 liters per hectare

Application time:

- Apply 1 liter/acre (1 bottle) or 2.5 liters/ha when the soyabean plants attain 4-6 leaves (about 3-4 weeks after sowing). Repeat this application 10 – 14 days after the first application.

Application method

- Measure 1 standard milk tin of product into a half filled 16-liters volume of Knapsack.
- Top up the already filled Knapsack with water up to the 16-liter mark to uniformly mix and shake thoroughly.
- Proceed to spray the leaves of your soyabean plants.



YaraLegume
fertilizer



TSP

YARA
Knowledge grows

NOT	8.5%
Urea	8.5%
B	0.02%
Mn	0.003%
Zn	0.6%
P ₂ O ₅	3.4%
K ₂ O	6%
Cu	0.1%
Mo	1%

YaraVita
CropLift Bio

CropLift Bio

Module 3

Module 3: Adequate crop stress management

Learning objectives	<ul style="list-style-type: none">▪ Know when soyabean plants are stressed.▪ Identify the major sources or factors that cause stress in soyabean.▪ Understand damages caused by each source/factor of crop stress.▪ Understand the management measures for the various crop stress factors.
Learning outcomes	<ul style="list-style-type: none">▪ Enhanced understanding of weeds management practices.▪ Enhanced ability to identify the major pests and diseases of soyabean and their control/management measures.

When is a crop stressed?

A crop is stressed when an external factor/condition causes it to suffer and grow poorly and ultimately decreases the yield. Crop stress can result in low yields or even a total crop failure.

Impact of crop stress

If crop stress is not sufficiently managed, it can lead to:

- Reduced number of soyabean plants per acre or hectare as it could affect the survival of the plants. In the end, optimum plant population cannot be achieved.
- Stunted plant growth.
- Limited production of biomass.
- Poor nodulation and nitrogen fixation.
- Low number of pods per plant.
- Poor pod filling leading to low number of seeds or grains per pod.
- Small seed or grain weight/size.

3.1 Sources of crop stress

Crop stress emanates from multiple external factors or conditions, which can be living organisms or non-living things. Prominent among these include:



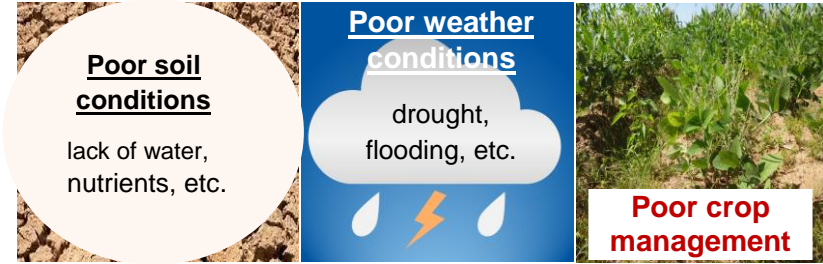
Pests



Diseases



Weeds



3.1.1 Weeds

- Weeds compete with the soyabean plants for nutrients, water and light, depriving the plants of these essential growth elements and decreasing the yield.
- Weeds serve as host for some diseases and pests that attack soyabean plants.
- Weed seeds/residues can be mixed with soyabean grains and reduce the quality.
- Timely and thorough weeding is important for better growth, canopy closure, better weed suppression and higher yield.
- The number of weeding depends on the time and severity of weed infestation.

Manual weed control

- Hand weeding (with hoe) is preferred though labor intensive.
- Generally, 2–3 weeding should be done for better growth of soyabean.
- First weeding should be done at 2–3 weeks after planting and second weeding at 4–6 weeks after planting based on level of weed infestation.

- If a pre-emergence chemical is applied to control weeds, then one hand weeding at 5–6 weeks after planting should be done.
- The second weeding must be done before flowering to prevent loss of flowers.
- Avoid weeding immediately after rainfall to prevent weed seeds transport in the field.

Chemical weed control

- Weeds can also be controlled with herbicides / weedicides.
- The choice of herbicide depends on the predominant weed species in the field and the availability of herbicides.
- Chemical weed control can be performed at pre-emergence stage (before the soyabean seeds germinate, usually, same or next day after sowing) or at post-emergence stage.
- A post-emergence herbicide can be applied when the soyabean plants are at about 4–6 leaf growth stage or as early as weed infestation warrants it.

Recommended herbicides that can be used for chemical weed management in soyabean

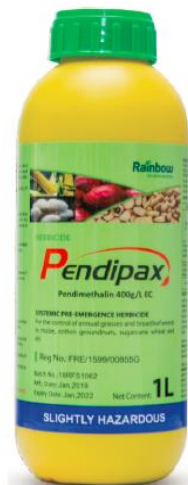
1) PENDIPAX -

Pendimethalin 400g/L EC

A selective **pre-emergence** herbicide for the control of both **grasses and broadleaf weeds**.

Application rate:

- 120-200 ml per 16L knapsack
- 810 ml-1.2L/acre and 2-3L/ha



2) STOMP -

Pendimethalin 445g/L CS

A **pre-emergence** herbicide for the control of both **grasses and broadleaf weeds**.

Application rate:

- 100-200 ml per 16L knapsack
- 810 ml-1.2L/acre and 2-3L/ha



3) AGRISTOMP -

Pendimethalin 456g/L CS

A **pre-emergence** herbicide for the control of both **grasses and broadleaf weeds**.

Application rate:

- 100-200 ml per 16L knapsack
- 810 ml-1.2L/acre and 2-3L/ha



4) TARGET -

Imazethapyr 240g/L SL

A selective **pre- and early post-emergence** (around 25 days after planting) herbicide for control of **grasses and broadleaf weeds**.

Application rate:

- 30-60 ml per 16L knapsack
- 140-300 ml/acre and 350-730 ml/ha



5) AGIL 100 EC

A **post-emergence** herbicide for control of **grasses/narrow leaf weeds**.

Application rate:

- 60-80 ml per 16L knapsack
- 200-490 ml/acre and 500 ml - 1.2L/ha



6) SUPREMO - Imazethapyr 240g/L SL

A **post-emergence** herbicide for control of **grasses and broadleaf weeds**.

Application rate:

- 30-60 ml per 16L knapsack
- 140-300 ml/acre and 350-750 ml/ha



7) WEEDBLOCK - Imazethapyr 37.5g/L ME

An early **post-emergence** herbicide for control of **grasses and broadleaf weeds** (2-4 leaf stage).

Application rate:

- 150 ml per 16L knapsack
- 800 ml/acre and 2L/ha



Herbicides application method

Fill the Knapsack with half the required amount of water. Add the recommended amount of chemical and mix thoroughly. Top up the tank with water to the required level, shake well to ensure thorough and even mixture and then proceed to spray.

3.1.2 Pests

- Pests attack plants at different stages of growth – seeds, young plants, flowering, podding and pod-filling stages. Control should be targeted at these stages.
- Most importantly, pests and diseases must be controlled between flowering, podding and pod-filling stages for better grain yield.
- Pay more attention to the pod-sucking bugs/insects as those directly reduce soyabean grain yield and quality.
- Leaf eating pests should be controlled but they do not need much attention as pod-sucking ones since they do not directly reduce grain yield and quality.

Identification of some common soyabean pests

1) Soyabean



- These pests feed on the soyabean seeds in the pods when they are still developing.
- They penetrate the pods, suck nutrients and fluids and eventually cause the seeds to be shriveled.

2) Soyabean aphids



- These pests are normally found on the undersides of soyabean leaves and stems.
- They suck fluids and nutrients, and cause the plants to be stunted, abort flowers and ultimately reduce pod and grain yield.

3) Silverleaf whitefly



- This is one of the most common pests of soyabean that reproduces faster under hot and dry weather conditions.
- They suck fluids and nutrients from soyabean plants and cause serious yield reduction.

5) Pod bug



These pests suck the pods of soybean, causing poor pod filling and reduced grain yield.

6) Bean leaf beetle



- These pests vary in color ranging from yellow, green, tan or red with a small triangle behind the head.
- They cause much damage on young soyabean plants by causing defoliation.

7) Ants



- Ants do not directly attack soyabean plants like the other pests.
- However, in the process of building their nests or mounds, soils brought to the surface by colonies of ants can:

- bury smaller soyabean plants.

- affect the roots of soyabean plants, cause loss of soil moisture around the root zone and deprive the plants of the needed water and eventually negatively impact on the survival of soyabean plants.
- These can lead to low plant population and contribute to yield reduction.
- These ant colonies can be controlled with chemicals such as **Furadan and Dursban**.

Pest management measures

- Use clean or certified seeds for sowing.
- Use soyabean varieties resistant to pests.
- Practice adequate land preparation – ploughing and harrowing to kill weeds that could serve as hosts for pests.
- Practice crop rotation to break pest cycles.
- Use recommended insecticides to control pests.
 - Usually, one or two sprayings of these insecticides is adequate to control pests.
 - However, the level of pest infestation will determine the number of sprayings that will be needed.
 - When to first spray soyabean plants depends on the time pest infestation is noticed and the level of infestation – but usually first at flowering and then another spraying may be enough based on pest incidence – normally 21 days after the first spraying.
 - Spraying should be done early in the morning or late in the afternoon.

Below are some recommended insecticides that can be used to control pests in soyabean.

1) Dimeking

Dimethoate 400g/L EC



- 70-80 ml/16L knapsack
- 700 ml/ha
- 280 ml/acre

Target pests:
Aphids, Thrips,
Grasshoppers

2) Lambdaking

Lambda Cyhalothrin



- 50-70 ml/16L knapsack
- 600-700 ml/ha
- 240-280 ml/acre

Target pests:
Aphids, Beetles,
Thrips, etc.

3) Colam

Lambda-Cyhalothrin
+Thiamethoxam 141G/L ZC



- 15-30 ml/16L knapsack
- 200 ml/ha
- 80 ml/acre

Target pests:
Sucking and
chewing insects

4) K-OPTIMAL

Lambda Cyhalothrin 15 g/L
+Acetamipride 20 g/L EC



- 40 ml/16L knapsack
- 1L/ha
- 0.40L/acre

Target pests:
Aphids, Bugs,
Whiteflies, etc.

Ema Star

Emamectin Benzoate 48 g/Lt
+ Acetamiprid 64 g/Lt

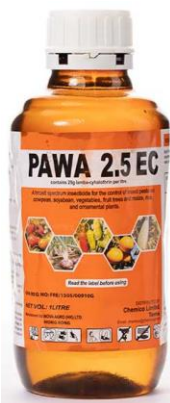


- 20-30 ml/16L knapsack
- 250-500 ml/ha
- 100-200 ml/acre

Target pests
Aphids,
Whiteflies, etc.

PAWA

25 g Lambda-cyhalothrin/L



- 35-50 ml/16L knapsack
- 500-800 ml/ha
- 200-324 ml/acre

Target pests
Aphids, Whiteflies,
Bugs, Stem borers

3.1.3 Diseases

Identification of soybean diseases

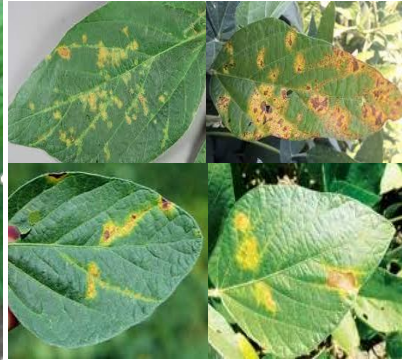
There are several diseases that can affect soybean plants at different stages of growth and reduce the yield. These may either be caused by viruses, bacteria or fungi.

Below are some of the common diseases that can affect soybean:

Viral diseases



Soyabean mosaic



Soyabean vein necrosis



Bean pod mottle

Bacterial diseases



Bacterial pustule



Bacterial blight



Soyabean leaf rust



Soyabean tan spot

Fungal diseases



Frog eye leaf spot



Soyabean rust



Soyabean stem rot



Fusarium root

Control measures for soyabean diseases

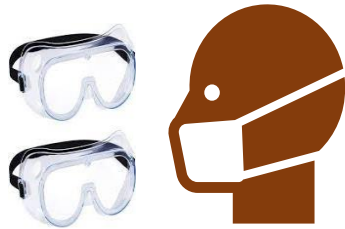
- Use clean or quality/certified seeds for sowing.
- Treat seeds with fungicide (**e.g., Captan, Apron Plus or Thiram**) at the rate of one sachet per 8 kg seeds to control soil-borne pathogens or fungal diseases before planting.
- Use soyabean varieties resistant to diseases.
- For viral diseases, uproot and bury the infected plants.
- Practice adequate land preparation – ploughing and harrowing or double ploughing or apply fungicide to contaminated soils to destroy pathogens.
- Practice crop rotation to break the cycles of diseases



3.1.4 Protective equipment for chemical usage

Face protection

- For eyes, wear goggles and protective glasses
- Wear mask for nose and lungs protection



Hands and arm protection

Wear arm guards and gloves



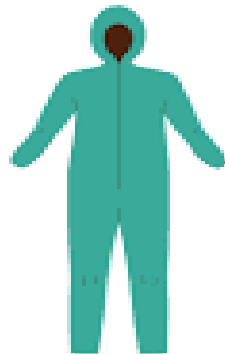
Feet and legs

Wear boots with protective soles such as Wellington boots



Whole body

Wear the above PPEs including a protective clothing to cover whole body.



Safe use of chemicals

- Seek advice from an Agricultural Extension Agent if you are not sure of what chemical to use.
- Always read the instructions on the chemical container to fully understand the precautionary or safety measures before use.
- Always keep record of the type, date and name of chemical used.
- Do not taste or smell pesticides as they are toxic and avoid contact while spraying.
- Do not mix different chemicals together to spray.
- Do not drink or eat while mixing or when spraying any chemical.
- Always use a stick to stir when mixing chemicals. Do not use your hand to stir.
- Do not use knapsack sprayers that leak.
- Use high pressure nozzles to apply pesticides (this ensures release of smaller droplets targeted at pests) and low-pressure nozzles to apply herbicides (for release of larger droplets targeted at weeds).
- Always spray along the direction of the wind to avoid droplets of the chemical drifting towards you.
- Safely dispose of any empty chemical containers by piercing and then burying them.

Module 4

Module 4: Proper harvest planning

Learning objectives	<ul style="list-style-type: none">▪ Identify the best time for harvesting of soyabean to avoid yield loss.▪ Understand the different harvesting methods and benefits.
Learning outcomes	<ul style="list-style-type: none">▪ Enhanced understanding of the best time to harvest soyabean to avoid shattering and yield losses.▪ Increased awareness of the different harvesting methods and the associated benefits.

4.1 Harvest timing

- Most of the recommended soyabean varieties are medium maturing, taking between 110 – 120 days (i.e., 3-4 months) after planting to mature.
- Harvesting must be properly timed to avoid pod shattering and yield losses.
- Do not harvest too early. This may lead to immature and poor-quality grain, reduced yield and increased possibility of pest/disease attack during storage.
- Do not harvest too late as well to avoid problems of pests and diseases, too dry and cracked grains, etc.
- Soyabean pods are ready for harvest when about 85% or more of the pods have turned brown for a non-shattering variety. This is about when 9 out of 10 pods turn brown.
- For a shattering variety, harvest when 80% of the pods (that is 8 out of 10 pods) have turned brown.
- It is best to harvest when the grains contain between 13 – 15% moisture.

You can test the readiness of the pods for harvest by shaking them. If you hear the seeds / grains making rattling noise within the pods, then they are ready for harvest. At this stage, any further delay in harvesting may result in pod shattering.

4.2 Harvesting methods

- Always harvest soyabean under dry weather conditions for better grain quality.
- **Soyabean should be harvested by using hoes, sickle or machete**, etc. to cut the plants at soil level. This method allows the roots of the soyabean plants to be left in the soil so that they can decompose and add

nitrogen and organic matter to the soil to improve its fertility. **Recommended.**

- It is **not advisable to harvest soyabean by uprooting** the whole plants. This harvesting method removes the roots from the soil and decrease the amount of residual nitrogen that can be added to the soil to improve fertility. It also decreases the organic matter build up in the soil.
- Harvest either early in the morning or in the late afternoon to avoid yield losses through pod shattering.

4.3 Post-harvest handling

- After harvesting, heap the soyabean plants on a tarpaulin to dry in the sun for up to 10 days before threshing. It is important to turn over the heap at a regular interval for faster, proper, and uniform drying.
- Always protect the pods being dried from possible rainfall, dust, and other contaminants.
- Thresh mechanically using a thresher or manually by beating the dry pods with sticks.
- After threshing, clean the grains by removing weed seeds, debris, and other foreign materials. This helps to ensure quality grains to meet recommended quality standards and for better grain price.
- Dry the grains to a commercial moisture content of 12–13% for storage lasting up to one year. If you intend to store for more than a year, dry the grains to a moisture content of around 10%.
- U can test the grains to determine if they are adequately dry for storage by biting. If the grain breaks or cracks, it is dry enough but if it bends or sticks between your teeth, the grains are not dry enough.

- Store the well dried grains in clean and uncontaminated bags.
- Do not use recycled fertilizer or chemical bags to store soyabean grains.
- Store the soybean grains in a cool, dry and ventilated room or hut.
- Place the bagged soyabean grains on a wooden board such that the bags do not lie or touch the ground.
- Jute bags are usually preferable because they do not conserve heat and allow soyabean grains to be stored for a longer time.
- Ensure that the storage room is well ventilated.

4.4 Residue management

- **Do not burn** the soyabean residues after harvesting.
- Leave all the residues (including falling leaves, stover after threshing, roots, etc.) in the field.
- Make sure to spread the residues uniformly across the field. These will decompose and add nitrogen to the soil to improve the fertility to enhance the yield of crops like maize that will succeed the soyabean in rotation.
- Retaining the residues in the field is also important for organic matter build up for moisture retention and longer-term soil fertility maintenance – especially nitrogen and carbon stocks.
- Residues of plants that were infected with diseases and pests should be removed from the field and either deeply buried or burned.

