

Technology and messaging brief for the bean campaign

Notes for Northern Tanzania

This brief has been developed using the expert guidance of the Selian Agricultural Research Institute (SARI) and N2Africa with technical input from the CABI team including both the Africa Soil Health Consortium (ASHC) and Plantwise. This guidance has helped us to fundamentally rethink the way that ASHC is producing technical briefs in future and how this should impact on messaging.

The brief is now in 2 parts there is the **core brief** – the must haves in the technology for farmers to make the best of improved seeds + fertilizer + good agricultural and land management practices. Second we have a series of additional information – tips - that will improve a farmer’s ability to make decisions and to illustrate the points made.

Current FAO data for Tanzania show common bean is cultivated on approximately 1.25 million hectares of land with 933,000 MT of production each year. The area occupied by common bean is second only to maize, accounting for nearly 11% of the total cultivated land. Three-quarters of the land growing legumes is cultivated by smallholder farmers (especially women) under quite diverse farming systems and agro-climatic conditions; both for household food requirements and income generation.

However SARI findings to date state, the majority of bean farmers understand soils suitable for bean production, control of field and storage insect pests. Research by I-logix for the Legume Alliance appeared to show that farmers are not familiar with plant spacing. Farmers are experiencing weather condition challenges and must adjust planting date accordingly. These challenges for farmers are also challenges for researcher to develop improved technologies and for extension to fill the gaps in farmer’s knowledge.






Communication issues for the campaign: Beans are an important crop. But there are gaps in farmers understanding and these will be explored in this document. The challenge is to package the information so that it is comprehensive and yet concise. Materials must not only be concise but text and images work together so that, even where low levels of literacy persist there is a high level of communication of the meaning. The ISFM message has to be contained within the full sweep of information required by the target audience – which ever member of the smallholder farming family that is!

	Why grow beans?	Communication issues
Core	Nutrition & food security: Common bean is a nutritious grain legume with high protein content (18-30%). It is a rich source of vitamin B, calcium, iron, zinc copper & magnesium and contains 18-30% protein. The young leaves and bean grain are all edible.	<p>Common beans have a number of advantages for smallholder farmers. Messages should be so that the farmer can decide if the technology is right for their situation – but without making the message too complex.</p> <p>The starting point for the campaign should stress the importance of legumes in terms of soil fertility. Growing legumes can add up to the equivalent of 2 bags of nitrogen per hectare. It is important to note however that the benefits to farmers are broad.</p> <p>Different benefits may affect different members of the farming household in different ways and in many ways the soil improvement may be a lower priority than livelihood or food security. Mothers may well be more interested in nutrition – but actually the nutritional benefits may help cash cropping farmers to find new markets – such as boarding schools.</p> <p>The benefits can be packaged to motivate specific members of a smallholder farming family. This will inform the distribution channel.</p>
Core	Livestock: The crop residues are good feed for livestock.	
Core	Livelihood: There is a ready market for common bean in country and neighboring countries. It has been estimated that on average a Tanzanian eats around 20 kg of beans per year. Tanzania is a net importer of common beans and good export markets exist in neighbouring countries.	
Core	<p>Soil fertility benefits: Common bean can be a good nitrogen source for soil because of its ability to fix the freely available nitrogen in the air. Some of the fixed nitrogen is left behind through falling leaves, haulms and roots. It is a good rotation crop and a good cover crop - this means it can help prevent soil erosion.</p> <p>Tip: Crop residues can also form a good basis for compost</p> <p>It has been estimated that growing common beans and leaving behind the roots will result in around 20-60 kg of nitrogen being left in the field available for the next season's crop. This is the equivalent of three quarters to 2 free bags of urea and can give the next crop a very good boost!</p> <p>Tip: The more of the bean leaves, root or haulms that are left behind the more nitrogen will be left in the soil. If you take away all of the root, plant and grain this will limit the soil fertility impact of growing bean.</p>	
Core	Yields: With good agricultural practices, including good preparation of the soil, use of fertilizers if required, use of good seeds of improved varieties and applying good management of the crop during the growing period, (planted at 30-40 kg/ acre, grain yields can be over 800 kg/ acre	

Challenges	Communication issues
<p>Agronomic practices</p> <ul style="list-style-type: none"> • Low awareness of the existing legume technologies • Limited information/knowledge on varieties and seed systems (centralized and decentralized) <p>Diseases and insect pests</p> <ul style="list-style-type: none"> • Prevalence of insect-pests especially whiteflies and bean stem maggot, diseases and parasitic weeds • Diseases including viral (bean common mosaic virus) and bacterial (common bacterial blight) <p>Adverse weather</p> <ul style="list-style-type: none"> • Uncertain weather conditions affected planting calendar (climate change) • Drought <p>Poor soil fertility</p> <ul style="list-style-type: none"> • Low soil fertility <p>Input market problems</p> <ul style="list-style-type: none"> • Inadequate availability of improved seed, Inefficiency in the seed production and lack of diversification of seed sources • Narrow seed market especially for formal sector • Limited client oriented seed marketing (centralized) <p>Output market problems</p> <ul style="list-style-type: none"> • Poor access to external markets - market information • Lack of readily available transport and cold rooms • Lack of commercial facilities to add value to the legumes such as through processing into different products, packaging, etc) <p>Policies</p> <ul style="list-style-type: none"> • Not given priority and therefore less funding • Lack of interest for the private sector to invest in legumes development and promotion 	<p>Challenges are risks – Tanzanian farmers want to minimize risks – but in communications we need to acknowledge them. This brief addresses how to deal with agronomic practices, diseases and pests and soil fertility. Climate uncertainty issues are addressed through variety choices.</p> <p>The Legume Alliance members are working on both issues to address input market failures and to highlight how policies in Tanzania impact on legume growing.</p> <p><i>Review point: Do the communications address these challenges and presenting simple options to smallholder farmers to overcome these challenges?</i></p>

	Land selection and preparation	Communications issues
Core	<p>Moderately fertile to fertile land is good for growing beans. Common bean does not tolerate acidic and alkaline soils</p> <p>Planting the same crop in the same location year after year increases the risks of pests and diseases attacking the crop. So farmers should consider rotating the crops they grow between suitable patches of land.</p> <p>Remove large vegetation from the growing area - small weeds can be ploughed into the soil to improve the soil organic matter. Well-prepared land ensures good germination and reduces weed infestation. A fine tilth is ideal for planting common beans – this means breaking up the big lumps of soil especially along the planting row.</p> <p>Good soil preparation is more likely to result in vigorous early growth, this means plants will be more likely to better withstand pest and disease problems.</p>	<p>The key information to get over is that good land preparation reduces risks – a fine tilth will make the germination of the seed most likely and that vigorous early growth will create healthy plants.</p> <p>If soil is not suitable for beans – it is probably better to grow other crops than to try to change the nature of the soil. Soil test are problematic for smallholders – they are expensive for individuals, but can be possible for groups of farmers.</p>
Tips	<p>Where soil is acidic, add lime to lower the acidity of soil – if this is not possible then farmers should consider growing acid tolerant crops</p> <p>If the land is prone to waterlogging consider making ridges and planting the beans on the ridges.</p>	<p>Smaller pack sizes of seeds mean that farmer experimentation can be encouraged – instead of soil tests.</p> <p><i>Review point: Do the materials suggest a small trial of growing bean?</i></p>

	<h2>Bean variety selection</h2>	<h3>Communications issues</h3>
<p>Core</p>	<p>Beans can be divided into 2 groups - climbing varieties and bush (or non-climbing) varieties. This brief covers only bush varieties.</p> <p>Bush varieties are suitable for lower and mid altitudes</p> <p>Some beans have a relatively short maturity period and are suitable for areas with low rainfall. Late maturing with long maturity periods, varieties are less suitable for drier environments, but often produce higher grain yield and more biomass, fix more nitrogen and therefore make more contribution to soil fertility than early maturing varieties.</p>	<p>The key information is invest in good seed and using improved varieties can help overcome disease problems. When improved seed is boosted with some fertilizer it helps to stop diseases getting hold or allow the plant to bounce back. Short duration varieties can overcome climate uncertainty and water shortage – or when a longer duration crop has failed or been lost.</p> <p>But whatever variety is selected it needs to have a ready market and/or meet the families expectations for taste and cooking. This may require some market research by farmers or farmers groups.</p>
<p>Core</p>	<p>The improved varieties selected in the table above are resistant to common diseases - anthracnose, angular leaf spot, common bacterial blight, halo blight and bean common mosaic virus – so this is a great way to reduce disease risks and loss of income. Careful selection of seed can help farmers satisfy market demand and meet other objectives such as food security or maximising the stover available as fodder for livestock.</p> <p>Choosing the right variety to plant can be difficult because there are sometimes trade-offs: a variety resistant to one disease may be vulnerable to another. Check with seed suppliers on the characteristics of available varieties in order to recommend the most suitable ones for farmers.</p>	<p><i>Review point: Do the materials clearly explain the need to have a trusted market in mind for improved beans and how to get the right variety?</i></p>
<p>Tip</p>	<p>Short maturing varieties can be useful for farmers who have to plant late for example because the rain failed or a crop you planted early in the season is badly affected by pest or diseases.</p>	

Variety & description of seed (suitable for Northern Tanzania)		Local names include	Seed planting rate	Attainable grain yield	Maturity period	Foundation/ certified seed produced
JESCA: Light purple, speckled (bush)		Soya, Iringa, kablankei, combat, Kijivu, punda	40 kg/acre	8-14 bags/acre 800 kg to 1400 kg/ acre	Around 80 days	Basic 960 Certified 1,495
Lyamungu 85: Large light red, mottled (bush)		Rose coco, Farm, Nyayo	40 kg/acre	8-14 bags/acre 800 kg to 1400 kg/ acre	Around 85 days	Basic 4,550 Certified 4,645
Selian 97: Large, red (bush)		Maharagemaku bwamekundu	40 kg/acre	8-14 bags/acre 800 kg to 1400 kg/ acre	Around 85 days	Basic 1,610 Certified 4,310
Lyamungu 90: Large dark red, mottled (bush)		Rose coco, Farm, Nyayo	40 kg/acre	8-14.5 bags/acre 800 kg to 1450 kg/ acre	Around 87 days	Basic Certified 6,470
Selian 94: Pink mottled (bush)		Karanga, njugu	40 kg/acre	8-12 bags/acre 800 kg to 1200 kg/ acre	Around 89 days	Basic 3,895 Certified 1,510
UyoleNjano; Yellow, medium sized (bush)		Njano	30-40 kg/acre	5-9 bags/acre 500 kg to 900 kg/ acre	Around 90 days	Basic Certified

+ 1 bag is 100 kilograms

	Seed quality	Communications
Core	<p>Only high quality seed should be used for planting. It is important to ensure that the seeds are free from insects, disease infestation and weed seeds. Damaged or wrinkled seeds, or seeds with holes should not be used. Seed from diseased plants should never be saved because these seeds are also infected.</p> <p>Bean seed can be saved from season to season – but for the best results new seed should be purchased every 3 seasons (also see note below on storing seed)</p>	<p>The key message is use good seed that is free from disease. New seed should be purchased every 3 seasons to keep up the quality of crop and yields.</p> <p>Do a germination test on saved seed to check it is viable and to get the planting density right. In reality poor farmers may struggle to get new seed but they can adjust the planting density when planting if the seed did not germinate well.</p> <p>Review point: Is the need for high quality seed stressed?</p>
Tip	<p>Quality and viability of saved seed: Do a germination test 10 days before planting. Plant 50 seeds and if 40 emerge it is good for planting, if 30-40 grow, plant more seeds than recommended. Try to get new seeds if less than 30 seeds emerge. If this is not possible you will need to plant more seed and/or expect to do more gap filling to get a good coverage.</p>	
Tip	<p>Quality and viability new seed: When you buy new seed: At planting retain 20-30 seeds, the receipt and package in case you have problems later on and need to complain.</p>	

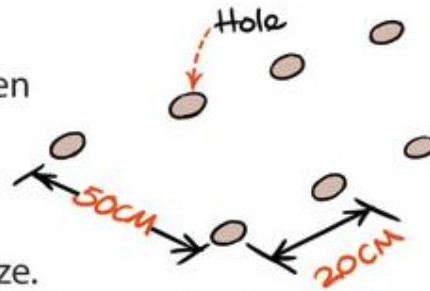
Fertilizer application at planting		Communications																
Tip	It is advisable to get a soil test before application of any fertilizer. Soil testing services are available at ARI-Selian and ARI-Mlingano and they supply both results and recommendations.	Key message is soil tests are useful as some areas in Tanzania are naturally high in phosphorus and these don't need P fertilizer.																
Core	<p>If a soil test is not possible there are useful principles to remember. Beans fix nitrogen but cannot fix other nutrients so it is a good idea to apply phosphorous containing fertilizers at planting – such as TSP, SSP, DAP, NPK or Minjingu phosphate.</p> <p>Common bean can fix its own nitrogen, but in degraded soils some nitrogen may be required to get the bean growth started. In such cases farmer can use either DAP, MinjinguMazao or Yara legume at planting. No top dressing is required.</p> <p>When the pH of the soil is below 5.6 - SSP and TSP are good phosphorus fertilizers – but they are not readily available in Tanzania. NPK 10:20:20 supplies both phosphorus and potassium and is more readily available from agrodealers.</p> <p>The following table will help farmers to apply phosphorus at a rate of 20 kg / hectare:</p> <table border="1"> <thead> <tr> <th>Fertilizer type</th> <th>Rate (kg/ha)</th> <th>In the furrow, spread 1 Teaspoon evenly</th> <th>In the furrow, spread 1 Soda bottle-cap evenly</th> </tr> </thead> <tbody> <tr> <td>DAP</td> <td>100</td> <td>every 1 meter</td> <td>every 60 cm</td> </tr> <tr> <td>NPK (10:20:20)</td> <td>230</td> <td>every 50 cm</td> <td>every 30 cm</td> </tr> <tr> <td>MinjinguMazao</td> <td>230</td> <td>every 40 cm</td> <td>every 25 cm</td> </tr> </tbody> </table>	Fertilizer type	Rate (kg/ha)	In the furrow, spread 1 Teaspoon evenly	In the furrow, spread 1 Soda bottle-cap evenly	DAP	100	every 1 meter	every 60 cm	NPK (10:20:20)	230	every 50 cm	every 30 cm	MinjinguMazao	230	every 40 cm	every 25 cm	<p>Currently ery few farmers add fertilizer to beans - but some beans have the advantage of fertilizer added to the intercropped varieties.</p> <p>Small amounts of nitrogen help get beans off to a good start - too much will create foliage and not grain.</p> <p>When P fertilizer is added the campaign is recommending a rate of 20 kg / hectare. P levels vary in different products and the density of the products vary too - so it is important to get across how much of a product needs to be applied.</p>
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Tips	<p>Some fertilizer specially blended for the legumes are available in limited amounts in Tanzania, for example, Yara Mila Legumes and SYMPAL (by MEA ltd) – other products will be released that do similar jobs</p> <p>Farmyard manure can help boost bean production. Between 4-8 tones per hectare (depending on availability) applied at planting supplemented with either DAP, NPK or Minjingumazao will give a good response</p> <p>Small amounts of nitrogen at planting can help kick start beans – before they start to fix nitrogen. Nitrogen promotes foliage growth so too much will result in large plants – but grain yields will suffer. Some nitrogen can be supplied when NPK is applied to maize that is intercropped with beans. Too much nitrogen will create good foliage growth at the expense of the beans.</p>	<p>Farmers lack basic measuring equipment so proxies for weights and distances need to be produced.</p> <p>Review point: is a clear business case made for applying P fertilizer?</p>																

	Planting and spacing	
Core	<p>Planting in rows with the correct spacing makes it easier and quicker to weed and harvest the crop.</p> <p>Planting bush beans in a mono-crop Plant in rows – 50 cm apart 2 seeds every 20 cm Or preferably plant 1 seed every 10 cm to minimize competition.</p> <p>Fill gaps when the seeds have emerged.</p> <p>Intercropping bush bean Bush beans can be intercropped with cereal – to avoid them being adversely affected by shade, plant 2 rows of cereal and 1 row of beans</p> <hr/> <p>The spacing in maize/bean intercropping should be: Maize planted at 75 cm between rows with one line of bean in between maize rows. In improved spacing (also known as mbili system) the crops are sowed at 50 cm between two maize rows and 1m between the maize and the intercropped 2 bean rows. Both systems result to maize population of 44,444 plant /ha.</p>	<p>Key information planting in rows takes longer at planting – but saves time in weeding and harvesting.</p> <p>Spacing and quality of the seed are related but for new seed 1 seed/ hole every 10 cm is a clear recommendation – which minimizes competition. Challenge is making sense of these distances without tape measures. Clipping soda tops on a string can give a good tool to use for spacing rows.</p> <p>Review point: have spacing options been spelt out?</p>

Note: -Planting in rows makes it easier to weed

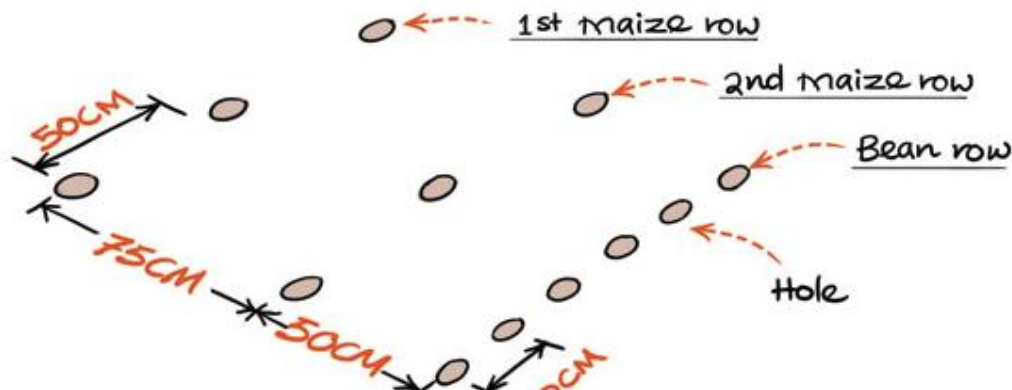
Planting bush beans

- plant in rows 50cm apart
- Plant 2 seed every 20 cm if using oxen



Intercropping bush beans

- Beans can be intercropped with maize.
- Maize seeds should be planted 50cm from each other with rows 75cm apart
- Plant beans row 50cm apart from the maize row.
- Beans seed should be planted 20cm apart



Plant 1-2 weeks earlier in cropping season to escape heavy infestation of bean flies./bean stem maggot

	Weeding	Communications
Core	<p>Weeds should be controlled to minimize competition for nutrients, water, sunlight and space. Weeds are also a host for some common pests. Weeds can be controlled manually or chemically, or using a combination of the two approaches.</p> <p>Manual weed control Plant the beans in a weed free soil that has been ploughed or hoed to a fine tilth, Weed about 2 weeks after planting Second weeding (5-6 weeks after planting).</p> <p>Chemical weed control: (for medium to large scale farmers) Herbicides, if used properly, are safe and effective in controlling weeds. There are different types of herbicides. The type to use depends on the predominant weed species and the availability of the herbicide. Herbicides are available for pre-emergence (land preparation) or post-emergence weed control (after the beans have sprouted). If pre-emergence herbicide is applied at planting, one weeding may be required at 5-6 weeks after planting. Only chemicals registered by Tropical Pesticides Research Institute (TPRI) should be recommended. This will be clearly marked on the product.</p>	<p>Regular weeding will create healthier bean plants – better able to access available nutrients and some pest and diseases find it more difficult to take hold without weeds. Herbicides are a viable option to hand weeding.</p> <p>Review point: has importance of getting rid of weeds been stressed?</p>
Tip	Seek advice from your extension officer or agrodealer before purchasing or using herbicide.	
Tip	Available herbicides in Tanzania are <i>Stomp 500EC</i> , <i>Galex 500EC</i> , Pursuit plus or <i>Fusilade</i> . Follow the instructions from the manufacturer or seek advice from an extension agent.	

Control measures for field insect pests

Core

Check the field regularly for insects that damage your plants. The most likely pests in common beans in Tanzania are likely to be aphids, bean stem maggot, bean foliage beetle, pod borers, pod sucking bugs and white fly.

Rotating bean with other non-legume crops helps to prevent a build up of pests and intercropping can help by creating breaks in the crops where pests cannot flourish. Planting beans in well prepared, fertile land to promote generally healthy plants that are better able to fight back if pests attach.

Core

Field insects: Aphids

Key signs: Direct feeding damage results in loss of sap/juice and injury to plant tissues. Young plants are particularly vulnerable. Plants may be small/stunted and may die under heavy attack. Leaves may appear wilted. If aphids are not controlled they can multiply very quickly in just a week. Aphids live mainly underneath the leaves, in groups of a few to several hundreds. Yields are reduced and indirect damage occurs through virus spread. Aphid numbers can recover quickly after control measures have been taken

Prevention: Good agricultural practices including maintaining high soil fertility improves plant vigour and increases the crops ability to tolerate aphids.

Control: Look for aphids under the leaves. Look at 20 to 30 plants in different parts of the field. If two or three of those plants have at least two groups of aphids then you must act. If you see many aphid mummies, chemical sprays may not be the best option as these kill natural enemies of aphids.

Spraying with soap is a cheap, safe and effective control because it washes away the protective coat on the aphid's skin. Fill a bucket with water and dissolve half a finger length of a bar of soap (about an inch, or 10-15 tablespoons of liquid soap). Stir well until bar is gone. Put the soapy water in a sprayer and spray both sides of the leaves, particularly the undersides, entirely covering all plants in field. The spray must contact aphids to kill them. Spray in early morning or in evening so the spray does not dry quickly. Spraying when it is cool also keeps the sun from burning the leaves.

Inspect your field at least once a week and spray as and when needed. Stop spraying two weeks before harvest to let the soap disappear. If the soap does not control the aphids enough, seek further advice.

Field insects: Bean stem maggot or bean fly

Key signs of investment: May see small cream coloured maggots on the stalk of the bean plant. Look for yellowing and stunting of plants at 2-3 leaf stage and dead seedlings. Larvae feeding inside the stem will cause a noticeable thickening and cracking at soil level. When damage is seen check regularly for 2 mm small blackish bean flies on bean leaves from plant emergence up to 2- leaf-stage of plants. Also search for punctures holes made on leaves caused by bean flies in the egg laying process. If you find 3-4 adult bean flies on plants/square meter consider direct control

Prevention: Buy seeds pre-coated in pesticide [Imidacloprid (such as Gaucho, and others) or with Diazinon]. Plant 1-2 weeks earlier in cropping season to escape heavy infestation of bean flies.

If the soil condition is poor strengthening the plants will make them better able to tolerate bean flies. Apply chemical and organic fertilisers (about 30 kg diammonium phosphate (P_2O_5 +30 kg N) + 5 tonnes farm manure per ha,)

Frequently irrigate to reduce water stress and strengthen plant to better tolerate bean flies.

Crop rotation can reduce fly populations.

Controls: Earth up soil around the plant stem to cover damaged and encourage root growth. Use Thiamethoxam products (e.g. Actara and Sotiva). In case of heavy infestation, remove and destroy crop residues after harvest to kill the larvae and pupae of bean flies that live and remain in the bean stems. This means that ploughing in or long-term storage of the crop residues as feed would not be possible.

Field insects: Bean foliage beetle

Key signs: The adult beetles (6-8 cm) usually emerge with the early rains and attack the young plants. The beetles chew small round holes in the leaves. When already few feeding holes are observed on half of the leaves per plant, or 1-4 adult beetles per square meter are observed, consider control action. Chemical control may be considered if many holes are seen on many plants. The larvae feed on the roots leading to the plant yellowing and shrivelling. To be sure it is larval damage and not another pest or disease, sample soil around several of these bean plants. Search at a depth of 5 – 15 cm for small whitish larvae.

Prevention: Post-harvest tillage to destroy larvae (when 3-8 larvae per square meter) and adults that are dormant in the soil. Delay sowing for 1 - 2 weeks during cropping season (e.g. mid-March instead of early March for Kilimanjaro & Arusha region). Note that in case of bean fly infestation, a contrary 1-2 week earlier planting is advised. Rotation or intercropping with non-leguminous crops helps to reduce pest population.

Control: Spray with Neem seed extract or Neem seed cake powders at a rate of 25g/ litre of water, to repel adult beetles from feeding on bean leaves. Apply a maximum of two times at 7 to 10 day intervals. Post-harvest tillage to expose larvae to the sun and kill them, reducing the pest populations' carryover to the next cropping season.

Field insects: Bean pod borers or moth

How to identify the pest: The adult moth has brown forewings with 3 white spots. The larvae, or caterpillars, can grow up to 17-20 mm long.



Left: Adult moth has brown forewings with white markings. *Right:* Caterpillars are whitish to pale green in colour with irregular brown-black spots and the head is dark brown

Key signs:

Look for round holes on the flowers and also folded leaves that are stuck together. Open the flowers to look for larvae. The pods will have a distinct hole where the larva entered. Yellowish-brown balls can be found on the outside of the pods; these are the droppings (faecal matter) left behind by the larvae as they bore into the pod.

The Bean pod borer feeds on the flowers and foliage however the most damage occurs from feeding on, and boring into, the pods and eating the developing beans. Once mature the larva drops from the plant to the soil where it pupates beneath plant litter. Legume pod borers can cause yield losses of up to 80%.

Prevention: Plant early to avoid the period of heavy infestation. Use resistant/tolerant varieties and/or early maturing varieties if they are available in your area. Do not grow common beans in the same field every year but rotate the common bean with other crops such as maize, but remember the borer can survive in other leguminous plants, kudzu, lima beans, green gram.

Intercropping beans with sorghum or maize reduces the populations of the pod boring pests and decreases yield losses.

Control: Hand pick eggs and larvae from the plants and crush them. Prune leaves with white silk threads that stick together and also remove older leaves to allow more sunlight to reach the leaves and stems of the plants.

Pod borers are difficult to control with insecticides because they remain hidden in the pod/bean. *Bacillus thuringiensis* (Bt) is also effective against the larva.

Core

Field insects: White flies

Key signs: Look out for whitish-brown eggs and /or whitish adults on the underside of young leaves. Look for a cloud of over to 3-5 white insects that resettle soon after the plant is shaken. Look for yellowing on the lower leaves of the plant.

Start control measures as soon as the pests are observed on the crop.

Prevention: Plant during or shortly after the rains to have less whitefly damage. Keep the field free of weeds throughout the cropping season as they can act as alternate hosts for whiteflies. Plant repellent crops like coriander and Mexican marigold around the edge of the field to repel the white flies. Conserve natural enemies e.g. parasitic wasps by avoiding to spray during flowering

Control: Mount yellow sticky traps to trap adults- 4 traps/300m² at 50cm above the ground

If spraying is needed, please spray in the morning, targeting the underside of the leaves when symptoms appear.

Choices of chemical sprays include :

- *Beauveria bassiana* Strain GHA products e.g. Biobassiana)
- *Bacillus thuringiensis* products e.g. BN3 WP and Ascopel WP)
- Azadirachtin 0.03% (50 ml/20L water)
- Imidacloprid based products e.g. Confidor 200SL, Imax 200SL, and Tata Mida 200SL at a rate of 10mls in 20 litres of water
- Neonicotinoid, IRAC 4A.
- Systemic insecticide with translaminar activity and with contact and stomach action
- Lambda-cyhalothrin based products e.g. Karate 2.5WG at 20gms/20L of water and Duduthrin 1.7EC at 60ml/20L of water
- Alpha-cypermethrin based products e.g. Bastox 100EC at 6ml/20L of water Tata Alpha 10EC at a rate of 6ml per 20 litres of water

Pepper spray:

- Add 30 chopped peppers to a 1 litre warm water. Soak for 1 day then dilute in 10 litres of water and spray on to plants targeting the underside of leaves.

Only chemicals registered by Tropical Pesticides Research Institute (TPRI) should be recommended. This will be clearly marked on the product.

Core

Storage pest: Bean bruchid

Key signs: While the bean bruchid is primarily known as a storage pest of grain legumes, it starts attacking the pod while the crop is still in the field. However, it is during storage that it causes the most damage and can multiply. Signs include internal feeding of the bean, holes in the bean and adults on the stored crop.

The larvae of bean bruchids are white and can be found in tunnels inside the bean. The adults are 3-4.5 mm in length and grey and reddish-brown. Adults lay eggs on the outside of ripening pods and the larvae bore into the seeds and feed. Before pupating, the larvae cut a hole to exit through but remain inside the bean. When they reach the adult stage, the adults push their way out leaving a hole about 2 mm in diameter. When threatened, adults will pretend to be dead and fall from the plant.

Prevention: Use clean certified seed. Consider intercropping maize with beans to reduce the pressure of pest in the field. Harvest beans as soon as they are mature to reduce the risk of heavy infestation. Remove and destroy all infested crop residues immediately after harvest. Air-dry the beans to a moisture level of 12% or lower before storage.

Clean the storage facility prior to storing the harvest is one of the most important practices. Using a disinfectant for cleaning. Do not store old beans with newly harvested beans. Store beans in air-tight containers if possible, such as in plastic sealable bags, drums, or clay pots. Mixing beans with vegetable oils, neem seed powder, wood ash or *Beauveria bassiana* (a fungus) can protect the stored beans and reduce losses. Add 1g of *Beauveria bassiana* or wood ash to 1 kg of the stored beans.

The most effective prevention method is to store the grain in airtight bags where the bruchids cannot survive. PICS (Purdue Improved Cowpea Storage) triple bags store grain under air-tight conditions and keep away insects from the grain. The grain is placed in a bag with an air-tight fastening. This process is repeated until three bags surround the grain. When all the bags are tied, any insects in the grain die from lack of oxygen. It is not necessary to chemically treat seed against storage pests when using PICS bags.

Control: The insecticide phosphine is also an effective fumigant for storage facilities, but is toxic, expensive and not widely available. For smallholders, the use of insecticides is not recommended since the beans are usually stored for short periods of time and intended for consumption. This is an area where extension agents and agrodealers should be able to offer advice. Also see references to triple bag storage (PICS bags) in the post-harvest section, which is a chemical free preventative approach. Only chemicals registered by Tropical Pesticides Research Institute (TPRI) should be recommended. This will be clearly marked on the product.

Core	<p>General measures to control diseases</p> <p>Fungal and bacterial diseases survive in seed or in plant residues. The use of clean seed, crop rotation, proper weeding and post-harvest tillage helps to control the disease. Do not use seed from diseased plants because these seeds are also infected. For viral diseases uprooting and burning infected plant is recommended. Fungal diseases include anthracnose, leafrust, white mold, angular leaf spot, powdery mildew</p> <p>Bacterial diseases include common bacterial blight and halo blight.</p>
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Field diseases: Common bacterial blight

Core	<p>Key signs: Common bacterial blight is a serious disease that attacks the foliage and pods of various kinds of beans. Plants grown from infected seed develop spots on the first leaves (the cotyledons) that then produce spores to infect other leaves. The first symptom is small angular spots that look water-soaked, expanding as large brown dead areas. The spots often have bright yellow haloes. In very susceptible varieties the spots continue to expand and the leaves appear burnt and become torn. Dark streaks occur on the stems, becoming lighter as they age.</p> <p>On pods, the spots are water-soaked at first, becoming red-brown and sunken, mostly circular. A yellow liquid containing bacteria seeps out of the spots when plants are wet and humidity is high. In severe cases, the pods shrivel and die.</p> <p>Start checking two weeks after seedling emergence and weekly until pods form. Check for signs of small water-soaked dark spots on underside of leaves and pods shortly after seedling emergence. Check for narrow lemon-yellow ring around small necrotic lesion on both leaves and pods. Act when more than 4 rings on 5 to 10 out of 50 plants are found.</p> <p>Prevention: Use seed that is certified free from bacterial infection, or purchase from an approved source. All varieties listed in the seed section above claim to be resistant to this disease.</p> <p>Do not save and re-use seeds from previously infected fields as they carry over the disease. For smallholders who save their own seed:</p> <ul style="list-style-type: none"> • Carefully select plants for seed that do not show symptoms of disease. Choose only those seeds without marks on the leaves or pods • If most plants show symptoms, do not use them as a source of seed; obtain seeds from a reliable retailer <p>Remove weeds, volunteer (those that have grown without being planted) beans and other legume crops from the field before planting. Do not plant new crops next to those that have the disease.</p> <p>Avoid movement through the field when plants are wet to prevent blight spread. Remove re-grown beans after harvest because they are potential sources for</p>
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the bacterial disease. Plough after harvest to burry debris and encourage decomposition (note that, once the field is infected, the disease also survives in the soil) Rotate with non-leguminous crops for at least 2-3 years to break the cycle of the disease.

Use maize as an intercrop; it reduces spread of the bacterium between bean plants.

Remove weeds as they develop after the beans have been planted. Weeding is important, not only to eliminate potential sources of the bacterium, but also to improve aeration so that the leaves dry out as rapidly as possible after rains or heavy dews.

Remove re-grown beans after harvest because they are potential sources for the bacterial disease. Plough after harvest to burry debris and encourage decomposition (note that, once the field is infected, the disease also survives in the soil) Rotate with non-leguminous crops for at least 2-3 years to break the cycle of the disease.

Control: Use a 2-3-year rotation between crops of beans on the same land if bean blight is established in the field, e.g. use rotations with maize.

Avoid workers and machinery passing through diseased crops and then those that are disease-free, particularly in wet weather.

After harvest, collect and burn or plough back the diseased crop. It is likely that the bacterium survives only a few months in soil in the absence of a host.

Spray with copper-based compounds such as copper oxychloride (COPPER OXYCHLORIDE 850g/ litre; CUPROZIN 35 WP; and others). This can help to some extent to manage bacterial blight, but it cannot completely control the disease. It is a multi-site action bactericide. Usually applied at 40 – 80 mg per 20 litre knapsack sprayer (2.4kg/ha), but double-check product label. Never spray more than 6 kg copper per hectare per year.

To obtain maximum benefit from the use of fungicide, cultural control methods should also be applied.

Field diseases: Halo blight

Key signs: Symptoms of halo blight of beans are most clearly seen on leaves. Monitor for symptoms especially during favourable conditions, i.e. cool (16-23 °C) and moist weather. The first symptoms are water-soaked spots, little bigger than a pin-prick, scattered on the leaf blade. The bacteria produce a toxic chemical which results in a yellow area (the 'halo') spreading outwards from the spots, which then go red and dry up. The yellow areas from adjacent spots often join up. Water-soaked areas or lesions also develop on pods, stems and leaf stalks, and sometimes produce a whitish ooze which contains bacteria.

Seedlings that develop from diseased seed are systemically infected and lesions (small wounds) develop around the stem. The nodes rot and plants are stunted and distorted, with an overall lime-green colour. Common blight has similar symptoms to halo blight. Other fungal diseases that attack the leaves produce different shaped spots that are not water-soaked and lack the characteristic halo associated with halo blight.

Prevention: Cultural approaches: The most important measure is to use certified seed. An alternative is to sow seed saved from plants that are healthy and occur in areas free from halo blight. All of the varieties listed in the seed section above claim to be resistant to halo blight and they should always be used in areas of high rainfall, where the risk of halo blight is greatest.

Other steps to take include deep-ploughing or removal of the remains of bean plants after harvest. This may be impractical for smallholders because of labour and cost constraints. Intercropping maize and beans may reduce the risk of halo blight as this creates barriers to the spread of disease.

Prevent spread of the disease by not enter the bean field when plants are wet to avoid spreading the disease to unaffected areas. Clean and disinfect equipment used in infected fields before moving to disease free fields. Practice crop rotation with cereals such as wheat, barley, oat and maize for 3 or more years.

There are no preventive chemical options.

Control: Remove and deep plough disease plants. Deep plough infested plant debris into soil shortly after harvest and thoroughly cover to allow quick decomposition. Practice a 3-year crop rotation without legumes. Hand removal of infected plants, particularly at the early stage of disease development, will limit spread of the disease.

Chemical treatment with copper-containing pesticides, applied at the first signs of the disease, can reduce the rate of spread of halo blight. This is, however, costly for smallholders to apply and gives only marginal gains. It is not effective against common blight.

Field diseases: Bean common mosaic virus

Core

Key signs: The most common viral diseases is Bean Common Mosaic Virus. This disease is spread in infected seed and also by aphids. Plants grown from infected seed are stunted; leaves are distorted and show dark green areas along the main veins and light green-yellow between. This light and dark green pattern is called a 'mosaic'. Often the green areas have a bubble-like (or blister-like) appearance. The leaves may also curl downwards with rolling of the leaf blade. Plants with these symptoms rarely produce pods.

It is advisable to monitor the field from 2 weeks after planting to flowering. Observe the leaves for symptoms which include: mosaic, necrosis (leaves dying), curling on leaves ∪ Monitor especially during flowering. Take action if you find one plant infected. Monitor for the presence of aphids on shoots, stem and leaves. And effect a control measure when 20 aphids are observed on 2.5 cm of shoot

Prevention: Use seed that is certified free from virus infection, or from an approved source. Plant tolerant varieties (all of the varieties listed above) are good preventions methods. Smallholders who save their own seed should:

- Carefully select plants for seed that do not show symptoms of disease, i.e. they look healthy.
- If most plants show symptoms, do not use them as a source of seed, but obtain them from reliable sources, such as a commercial company or from other growers whose plants have been monitored for the disease.

Interplant with maize to reduce aphid infestation and virus infection.

Plant mixtures of bean varieties – a strategy used in parts of Africa.

Using fertilisers will make the plant more vigorous and help it stave off/ recover from an attack. If there is an outbreak, cleaning field tools (hoe, etc.) after use and avoiding movement in the field / touching from infected to non-infected plants will contain the spread. Avoid saving seeds from infected fields. Control aphids in the field and other fields around (see control)

Control: Uproot infected plants and burn as soon as spotted. Do not plant new crops next to those that have the disease. During early crop growth the most practical recommendation is to learn to identify plants with symptoms of seed-borne infection (see Key signs, above) and remove them as soon as they are seen. After harvest, collect and burn or plough back the diseased crop to destroy the aphids.

Control aphids using soapy water on plants and under leaves. Mix 8 gram of soap in 10 litres of water and spray on plants.

<p>Core</p>	<p>Harvesting</p> <p>Timing: Delaying harvesting can cause crop losses. Start harvesting when the leaves and pods are dry and yellow-brown. Harvesting early in the day will reduce shattering of pods.</p> <p>Threshing and drying: Dry the threshed grains on a clean surface in the sun until the grains have a moisture content of 10-12%. Test the grain to see if it is dry enough by biting or pinching grain between fingernails –the grain should break or crack, not bend or stick between the teeth or fingernails.</p> <p>Winnowing: Remove chaff, dust and other rubbish by winnowing. Also remove shriveled, diseased, broken grains and grains of other varieties to achieve high quality, high value grain.</p>	<p>Key message: Delays to harvesting can cause huge losses and getting the grain dry and clean increase the value of the grain. Traders will pay less for grain they have to clean.</p>
<p>Core</p>	<p>Storage</p> <p>To store grain other containers can be used including plastic and metal drums. PICS (Purdue Improved Cowpea Storage) triple bags store grain under air-tight conditions and keep away insects from the grain. The grain in the place in a bag with an air-tight fastening. This process is repeated until three bags surround the grain. When all the bags are tied, any insects in the grain die from lack of oxygen. It is not necessary to chemically treat seed against storage pests when using PICS bags.</p> <p>Clean the storage room. Stack the grain bags on a raised platform or wooden pallet away from the wall. Avoid direct contact of storage bags with the ground. Inspect and remove infested or rotting grains on a regular basis.</p> <p>When chemicals are applied to grain before storage, do not eat or sell the grain until it is safe for consumption</p> <p>Storing: Fungal and bacterial diseases survive in seed or in plant residues, so only store seed that is known to be disease free. To store seed use bags and treat seed with recommended pesticide, see storage pest section above. This is something extension agents and agrodealers should help with. Do not use seed from diseased plants because these seeds are also infected.</p>	<p>Key message: Purdue Improved Cowpea Bags – offer air tight storage through triple bagging, these bags are good for 3 seasons so are a similar price to chemical treatment over that period and they are much safer. Saved seed can be treated with pesticide – but new seed should be purchased every 3 seasons.</p>

	<p>Post harvest</p> <p>Post-harvest tillage to expose bean foliage beetle larvae to the sun and kill them, reducing the pest populations' carryover to the next cropping season.</p> <p>Whilst generally it is good to plough back into the soil organic matter, such as bean leaves, pods or stover – pest damaged or diseased plants should be removed if beans are to be grown on the same ground next season. Some pests and diseases stay in the soil – or seed.</p>	
Core	<p>Safe use of chemicals</p> <p>Only chemicals registered by Tropical Pesticides Research Institute (TPRI) should be recommended and only post-emergence herbicides and insecticide and fungicides that are recommended for common bean to avoid damage to the plant. Where possible it is good to advise farmers to use alternate active ingredients to prevent development of resistance</p> <p>Chemicals can be toxic, so remind farmers to follow instructions on the product package or from the agro-dealer for safe use. Also follow the instructions about the time needed between spraying and safe consumption of fresh pods. Chemicals should not be stored in the same place as food. Retain chemicals in the original containers – if not original container clearly label and keep out of reach of children</p> <p>Remind farmers to wear protective clothing. And spraying early morning or late evening to avoid harming bees. Remind farmers to read and follow instructions on the label and to dispose of containers properly to avoid aquatic contamination.</p>	<p>Key review point: Has the safe use of chemicals been addressed?</p>