KP19
Knowledge Product 19

CCARDESA
Centre for Coordination of Agricultural Research and Development for Southern Africa

DECISION TOOL:

Climate Smart Pest and Disease Control Options for Sorghum & Maize

CLIMATE SMART AGRICULTURE
KNOWLEDGE PRODUCTS FOR EXTENSION WORKERS
Customised Information Tools for Agricultural Professionals

Audience: Local Level Extension Staff (Government, NGO/Civil Society, Private Sector)

Maize | Sorghum | Decision Point | Gender | Youth | Climate Smart | Practice

german cooperation
DEUTSCHE ZUSAMMENARBEIT

Implemented by:
giz

WHAT IS CLIMATE SMART AGRICULTURE (CSA)?

CSA comprises three interlinked pillars, which need to be addressed to achieve the overall goals of food security and sustainable development:

1. **Productivity:** Sustainably increase productivity and incomes from agriculture, without negative impacts on the environment
2. **Adaptation:** Reduce exposure of farmers to short-term risks, while building capacity to adapt and prosper in the face of shocks and longer-term stresses (resilience). Attention is given to protecting ecosystem services, maintaining productivity and our ability to adapt to climate changes
3. **Mitigation:** Wherever and whenever possible, CSA should help to reduce and/or remove greenhouse gas (GHG) emissions. This implies that we reduce emissions for each unit of agricultural product (e.g., through decreasing use of fossil fuel, improving agricultural productivity and increasing vegetation cover).

CSA = Sustainable Agriculture + Resilience – Emissions.

How is CSA Different?

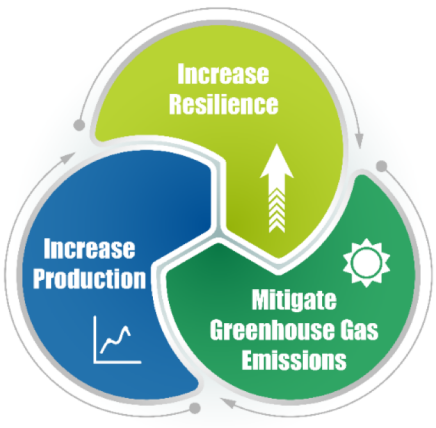
1. CSA places greater emphasis on **hazard and vulnerability assessments**, and **emphasises weather forecasting** (short term) and **climate scenario modelling** (long term) in the decision-making process for new agricultural interventions
2. SA promotes the **scaling up of approaches** that achieve **triple wins** (increase **production**, increase **resilience** and – if possible – **mitigate GHG emissions**), while at the same time **reducing poverty** and **enhancing ecosystem services**
3. CSA promotes a **systematic approach** to:
   a. Identifying **best bet** opportunities for agricultural investment
   b. Contextualising **best bet** options to make them best fit their specific context through learning and feedback loops
   c. Ensuring the **enabling environment** is in place so that farmers (and other stakeholders) can invest in CSA practices and technologies to catalyse adoption.

Key Messages:

1. To make climate smart decisions on which pest & disease control option for maize/sorghum best suits your farmers, you need to understand:
   - What pests are prevalent and how to identify these
   - How the climate/weather can affect the lifecycle/distribution of the specific pest/disease
   - Which cultural control options are suitable in preventing the build-up of pest populations or incidence of disease
   - How to control an outbreak of pest/disease if it does occur
2. Climate smart pest & disease control options are:
   - Continuous long-term proactive practices – **cultural control**
   - Short-term reactive practices – **biological, mechanical, chemical** (last resort) **control**.

Entry Points for CSA

- CSA practices and technologies
- CSA systems approaches
- Enabling environments for CSA.



CLIMATE SMART PEST AND DISEASE CONTROL OPTIONS FOR SORGHUM & MAIZE

This **Decision Tool** aims to help field-level extension staff make **climate smart decisions** on which pest and disease control options best suit their farmers' context. This tool is not designed as a technical guide to implementation; it is intended to assist extension staff in making climate smart decisions on improvements to their farming systems with their clients/farmers. Reference to technical guides relevant to the practices/technologies outlined are included after the Summary.

The tool focuses on the **Best Bet Climate Smart Pest & Disease Control Options for Maize and Sorghum** production in the Southern African Development Community (SADC) region.

These options are based on the principles of integrated pest management, selected as best bet options because they meet the following criteria:

- They are climate smart (see Table 1)
- They are applicable in multiple agroecological zones across the region
- They have high potential to address major constraints to maize and sorghum production in the region (Table 1).

These are **Best Bet** options. An understanding of the local context and farmer priorities is required in order to make these options **Best Fit** to individual farmer's needs.

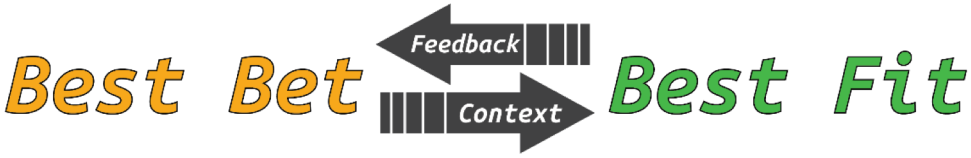
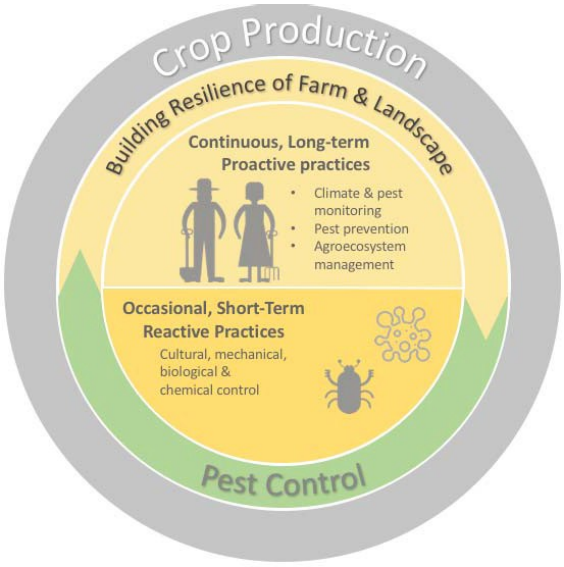


Table 1: Best Bet Climate Smart Pest & Disease Control Options that have potential to address climate risks across the SADC region.

Climate Smart Pest And Disease Management Option	What is it?	3 Pillars of CSA		
		Increase production	Resilience/ adaptation	Mitigate GHG emissions if possible
Continuous long-term proactive practices **(Cultural control)**	The principle of 'prevention is better than cure'. Practices include: climate & pest monitoring, pest prevention, and agroecosystem management	Reduced incidence of pests and diseases results in higher yields	Healthier and more pest-resilient farm and landscape Prediction and recognition of pest outbreaks enables earlier management decisions	Reduced losses result in lower GHG emissions per tonne produced
Occasional short term, reactive practices **(Mechanical, biological, chemical control)**	Control options for pests/ diseases once they have reached a level where the economic losses will be greater than the cost of controlling the pest/ disease outbreak	Reduced losses due to management of pest/ disease outbreaks	Farmers can make informed decisions resulting in sustainable losses	Reduced losses result in lower GHG emissions per tonne produced

WHICH CLIMATE SMART PEST & DISEASE MANAGEMENT OPTION IS BEST SUITED TO YOUR FARMER(S)?

Figure 1: Adapted from GACSA's Climate Smart Pest Management Practice Brief.



Integrated pest management (IPM) is the climate smart approach to pest management in **sorghum** and **maize**.

At the **production level**, there are two focus areas within IPM:

1. **Cultural control** options: Building resilience of the farm landscape to pest attacks
2. **Pest control options**: Biological, mechanical and chemical (last resort).

To make decisions on how best to build resilience of the farm to pests and diseases, farmers need to know the following:

- What pests are prevalent and how to identify them?
- How the climate/weather can affect the lifecycle/ distribution of the specific pest/disease?
- Which cultural control options are suitable for preventing the buildup of pest populations or incidence of disease?

If a pest/disease outbreak does occur, before making a **climate smart decision** on control, the farmer needs to know the following:

- The **economic threshold** for control measures
- Which **biological and mechanical control** options are **available**, and how **effective** they might be?
- Which **chemical control methods** are **available**, and how **safe** they are?

Koldstad

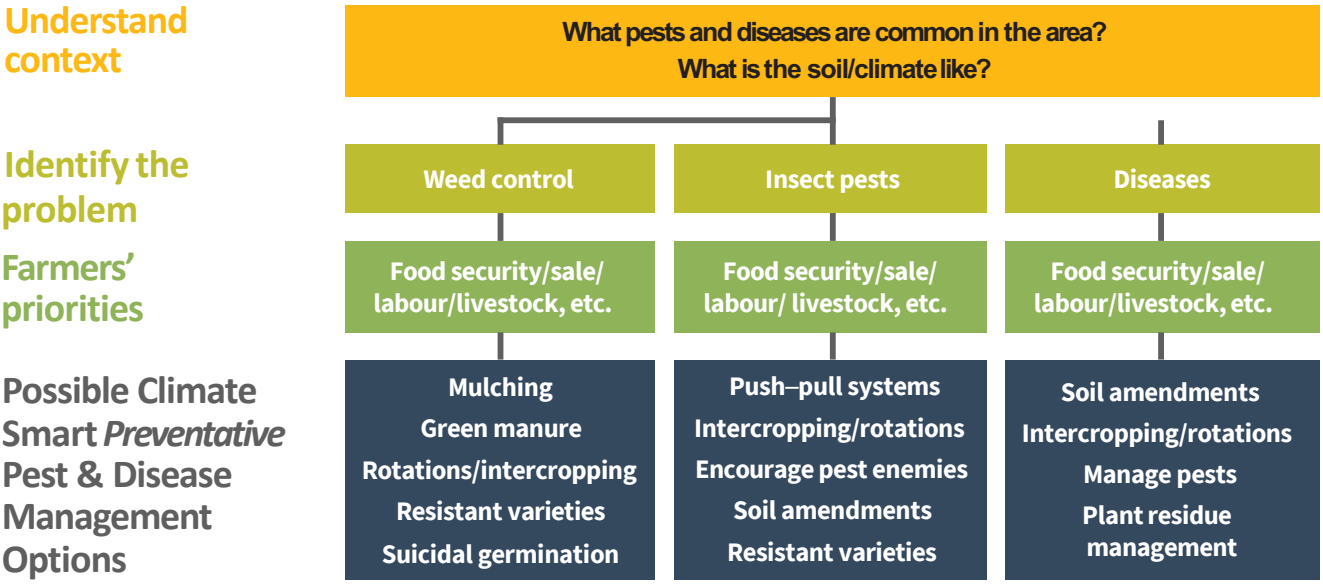
CLIMATE SMART PEST AND DISEASE CONTROL OPTIONS FOR SORGHUM AND MAIZE

Below are the climate smart pest & disease control options for sorghum/maize. They are **broadly applicable** across the SADC region. In many instances a **combination** of these options will give optimum results. While the practices are **Best Bet** options, they are not universally applicable. CSA is context specific, and each of these options will need to be tested under local conditions and adapted to make it **Best Fit** the local context.

CONTINUOUS LONG TERM, PROACTIVE PRACTICES (CULTURAL CONTROL OPTIONS)

The **Decision Point** below presents a decision tree for selecting climate smart cultural (preventative) pest/disease control options for maize/sorghum.

DECISION POINT



Integrated pest management (IPM) consists of 4 steps:

1. **Identification:** To prevent or control a pest/disease, it is vital to be able to accurately identify it
2. **Prevention:** This includes cultural approaches, such as use of disease-resistant varieties, disease-free seed and good practices in the field, such as the removal of infected material that could carry the problem over to the next crop. It also includes use of pesticides where this method is appropriate
3. **Monitoring:** The earlier a pest or disease is noticed, the earlier appropriate action can be taken to reduce losses and prevent its spread
4. **Control:** This includes both cultural approaches, such as the removal of infected plants, as well as use of appropriate pesticides.

IPM often involves a **combination** of several different options, and pesticides tend to be used when other approaches are inadequate for the problem at hand. They must always be used in accordance with the usage and safety information given on the packaging.

Identification – what pests and diseases are prevalent in your area?

There are many types of insects, weeds, diseases and other pests that can affect maize and sorghum. Identifying them is not always easy. It is important to **know exactly which pest is attacking your crop** before deciding on whether it is worth investing extra resources to control it.

If you are not sure what the main pests and diseases in the target area are, the first thing you need to do is find out. This can be done by asking a colleague, or working with the farmers themselves to identify pests and diseases. It is also important to be able to distinguish a nutrient deficiency from a disease.

The *Plantwise Factsheet Library* allows you to search for factsheets on various pests and diseases in multiple languages	***Plantix* allows the user to take a picture of the effected plant or pest. It will identify the disease/ pest from the photo and provide control options**	***African Soil Health Consortium (ASHC) – Crop Pests and Diseases:* A manual on the most important pests and diseases of the major food crops grown by smallholder farmers in Africa**
Plantwise Factsheet Library CABI Free	**Plantix – Grow Smart** PEAT GmbH Free	

The above tools include resources on how to **prevent** and **directly control** various pests and diseases during the cropping cycle, and during the postharvest period. The key signs of the most common pests and diseases of sorghum and maize in Africa are given in Table 2 below. You can find pictures ofeach of these on the internet, but it is worth downloading the Crop Pests and Diseases Manual from the African Soil Health Consortium, as this is an excellent resource to help you identify the main pests and diseases.

Table 2: Key Signs of the most important pests and diseases of maize and sorghum in Africa.

Key sign	Possible pest or disease
Maize	
• Small holes and small dark caterpillars in leaf funnel • Small holes in straight lines on the young leaves • Larvae droppings on leaves and in stems • Central leaves become dry and withered • Weak stems that break • Top of the plant wilts and turns yellow, then dries out and dies	maize stalk borer
• Tunnels and irregular-shaped holes in stored grain and significant quantities of dust	large grain borer
• Small caterpillars: yellowish-white to reddish-brown, dark brown to black head, black rows of short hairs running along backs • Fully-grown caterpillars 35 – 40 mm, dark brown, yellow-green, to red-brown with grey-black stripes along the side • Bore holes in cobs	cotton bollworm
• Spots surrounded by yellow haloes on lower leaves • Spots expand parallel to the leaf veins: light brown to grey, rectangular, up to 70 mm	grey leaf spot
• Yellow-green, brown or black powdery mould on maize ears	*Aspergillus* fungus
• Pink or red woolly mould between the ear and the husk, usually starting at tip of the ear and advancing downwards	*Fusarium* fungus

Key sign	Possible pest or disease
Maize (cont.)	
• Scattering of small yellow areas on leaves which merge; leaf becomes paler before the edges go brown and dry inwards • Sometimes young leaves die before they expand	maize lethal necrosis disease
• Stunted, yellow, scorched and wilted plants when the soil is still moist. • Attractive, brightly coloured (often purple) flowering weeds.	*Striga* or witchweed
Sorghum	
• Small caterpillars: yellowish-white to reddish-brown, dark brown to black head, black rows of short hairs running along backs • Fully-grown caterpillars 35 – 40 mm, dark brown, yellow-green, to red-brown, with grey-black stripes along the side	cotton bollworm
• Shrivelled or flat grains that result in empty or chaffy spikelets, and blighted or blasted looking panicles (heads)	sorghum midge
• Feeding marks on the funnel leaves, 'dead heart' and holes in the stems	sorghum stem borers
• Pale leaves with white stripes • Leaves narrower and more erect than usual • White areas dry up and go reddish-brown • Leaves shred • Plants stunted and usually produce no grain • Downy or woolly appearance on underside of leaves	sorghum downy mildew
• Huge flocks of small brown birds with red beaks feeding on sorghum and other small grains	quelea (weaver finch birds)
• Stunted, yellow, scorched and wilted plants when the soil is still moist • Attractive, brightly coloured (often purple) flowering weeds.	*Striga* or witchweed

Source: reproduced from the Pest and Disease Manual, ASHC

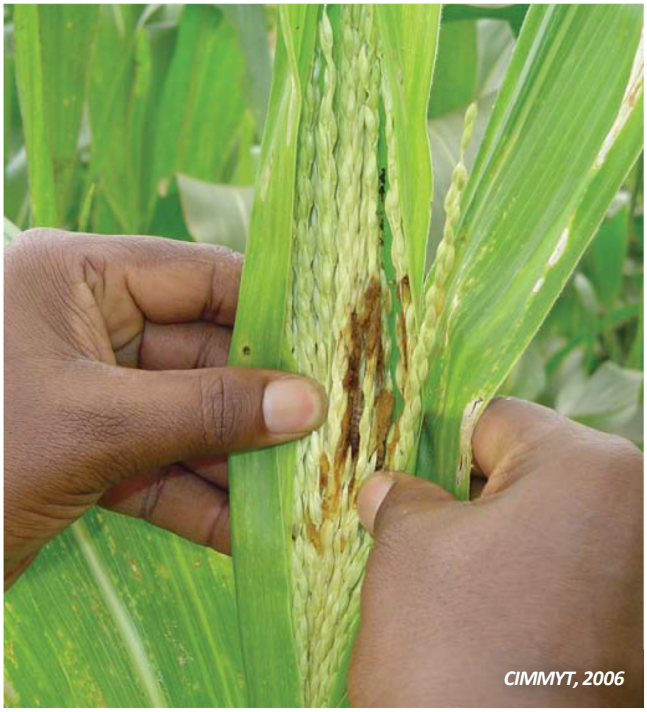
Climate smart decisions on cultural pest and disease control options focus on prevention, and need to be made at each stage in the cropping calendar.

All these decisions will depend hugely on the following factors:

- **Available labour** and who does what (men/women/youth)
- The **farming system** (rotations, livestock, etc.)
- **Socio economic factors** – access and availability of inputs, marketability, level of risk aversion
- **Cultural factors** – what are my neighbours doing?

TIP

See CCARDESA KP02 for a checklist of questions to help you understand the local context



CIMMYT, 2006

Prevention

When you know what pest/disease you are dealing with, it is easier to make decisions on preventative measures. Climate smart options for longer term control of pests and diseases are often referred to as **cultural control options**. These options are based on the principle of prevention is better than cure. They should be practised before signs of infestation/disease are seen on the crop. They focus on:

- **Improving soil fertility** to ensure healthy, vigorous plants that are more resilient to pests and diseases
  - Strong, well established plants are better able to cope with/recover from pest outbreaks, and are less likely to become diseased
- **Ecological diversity**
  - Growing different crops together (intercropping), or in rotation and maintaining diverse habitats for natural predators of key pests
  - Monoculture of maize/sorghum season after season is likely to allow pests to build up to levels that will cause significant (economic) crop losses

Cultural control practices focus on **soil health** and **biodiversity**. This means that the cultural component of integrated pest management is very closely related to Integrated Soil Fertility Management.

Many of the climate smart options for cultural control are covered in other Decision Tools within this series:

- **CCARDESA KP06 – Climate Smart Soil Amendment Options**
  - Compost, green manure/cover crops, organic + inorganic inputs, biochar, Integrated soil fertility management, liming
- **CCARDESA KP07 – Climate Smart Planting System Options**
  - Intercropping with legumes, rotations, relay cropping, diversification (crops, cultivars, rotations)
- **CCARDESA KP08 - Climate Smart Land Preparation Options**
  - Minimum/zero till
- **CCARDESA KP09 – Climate Smart Variety Selection Options**
  - Crop selection, selecting for resistance/tolerance to specific pests/diseases and/or abiotic stresses (drought, heat, salinity, etc.)
- **CCARDESA KP10 – Climate Smart Water Harvesting Options**
  - Improve soil moisture storage (mulching and options for increasing soil organic matter – linked back to ISFM)
  - Using infected plant residues for mulch material is dependent on what the crop has been infected with. In some cases the residues should be:
    - » Removed and burned (if in doubt, this is the safest option)
    - » Fed to animals
    - » Dried in the sun before being spread on the ground
    - » Can be left on the field
- **CCARDESA KP12 – Climate Smart Agroforestry Options**
  - Trees to increase soil fertility and provide shelter for advantageous insects

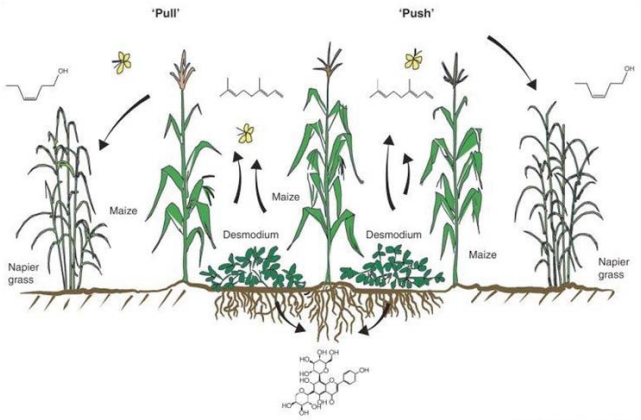
To make climate smart decisions on cultural options for pest/disease control, you need to work with your farmers to understand the following issues:

- The current farming system (agronomic practices and the socio-economic status of the farming household)
- Current, probable and predicted changes in rainfall and temperatures
  - This will help in predicting pest/disease outbreaks.

The push–pull technique

An important cultural practice not covered in the other decision tools is the **push–pull** technique. This is a good method for preventing stalk borers and *Striga* (witchweed) in maize/sorghum. This is a system in which ***Desmodium***, a repellent plant, and **Napier** or Brachiaria **grass**, a trap crop, are intercropped with maize/sorghum to push and pull the insect away from the maize /sorghum respectively.

Figure 2: The push–pull technique.



Source: EZScreen

Plant Napier grass, Bana or Briachiaria (Brachiaria is the best for push pull) along the border around the field, and plant one row of *Desmodium* (silver leaf or green leaf varieties) between every three rows of maize/sorghum. The *Desmodium* should be planted first, as soon as the rains begin, so that it begins to repel the stalk borers before the maize/sorghum emerges.

At least three rows of Napier or Brachiaria grass should be planted around the borders of the maize field. The *Desmodium* produces a smell that is offensive to the adult moths; this pushes the moths away from the maize/sorghum.

The stalk borers are more attracted to Napier grass than maize/sorghum, and so the border of Napier grass will pull the moths away from the maize to lay their eggs on the Napier grass.

When the larvae bore into the Napier grass, however, the plant produces a sticky glue-like substance that traps them, and they die. An additional benefit of this system is that *Desmodium* is a legume that fixes nitrogen into the soil; it also acts as a ground cover that supresses *Striga*, a parasitic weed.

Disadvantages of this system include the space taken up by the Napier grass; also the cost and lack of availability of seed. *Desmodium* can be grown from both seed and shoot under different sunshine conditions, and is frost tolerant once germinated.

Borer Damage, CIMMYT, 2006

Know your soil

Healthy soil equals healthy plants, and healthy plants are much more likely to survive pest and/or disease attacks.

Climate Smart Options for improving soil fertility are detailed in **CCARDESA KP06 – Climate Smart Soil Amendment Options**.

Climate Smart Soil Amendment Options include the addition of the following:

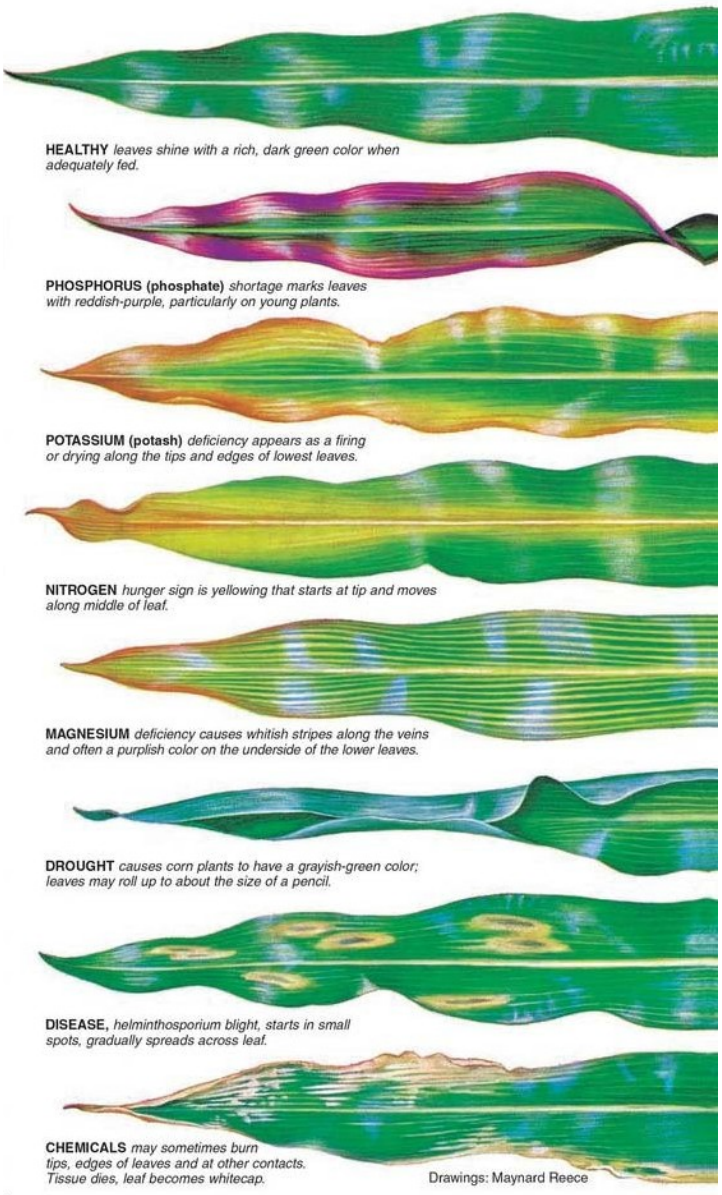
- **Organic matter** – compost, manure, etc.
- **Green manure**
- **Biochar**
- **Organic and inorganic inputs** (Compost/ manure and fertiliser).

Nutrient deficiencies in sorghum and maize will make the crops more susceptible to pests and diseases. It is important to be able to recognise the main nutrient deficiencies so that the appropriate soil amendments can be applied.

When applying top dressing fertilisers, make sure that the field is weed-free as the fertiliser will otherwise be 'stolen' by the weeds, which may then outcompete the maize/sorghum.

Integrated soil fertility management practices should always be applied. The aim of this approach is to continuously improve practices on the farm – based on experience gained and the latest information available.

Figure 3: Examples of nutrient deficiencies in maize and sorghum leaves.



If you are unsure what type of soil you have, there are lots of videos to help you...

How to test your soil - texture (sand, silt, clay composition)
Central West Local Land Services
June 22, 2014

Soil texture by feel
UCDavisIPO
Sep 1, 2010

Know your climate/weather

Early planting at the onset of rains, when soil is moist to at least 30 cm deep, helps to control pest/disease outbreaks:

- The crop matures early and escapes attack by pests
- It is strong enough to withstand infestation from pests that will become more serious as the season progresses
- The crop does not have to compete with weeds from an early stage.

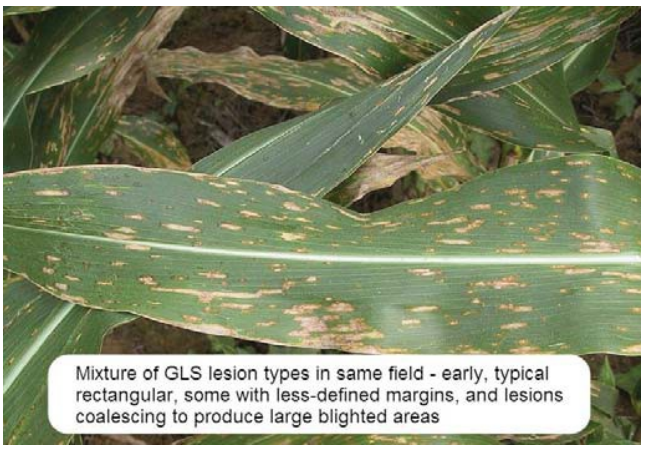
By predicting the start of the rainy season, you can help your farmers prepare for planting as soon as the rains arrive. Weather can also affect pests. For example, heavy rain showers can kill the 1st, 2nd, and 3rd instar larvae of **fall armyworm**; so even though damage can be observed in the field, it's possible that many larvae may have died at this stage.

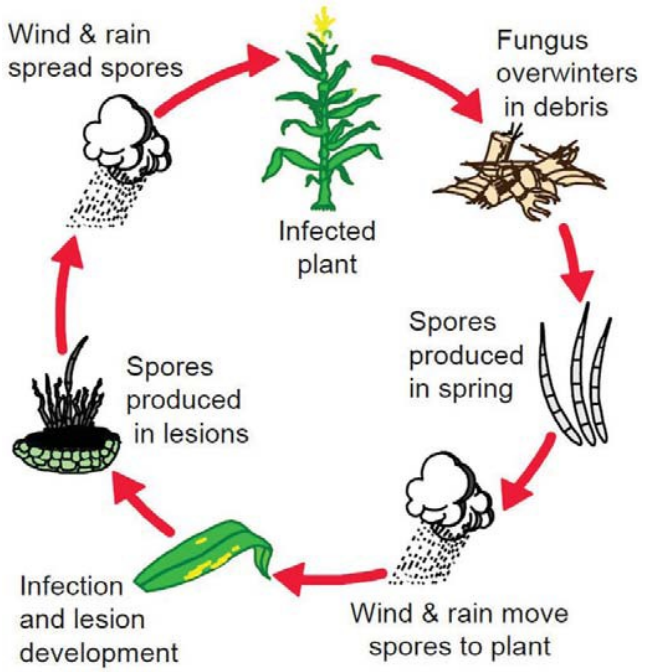
Another example is maize grey leaf spot, caused by a fungus called *Cercospora zeae-maydis*. This disease has become pandemic in Africa. The fungus only infects maize and produces spores following periods of high humidity. These spores are dispersed by wind and rain to the lower leaves, where they start to form lesions. Figure 4 illustrates the lifecycle of the fungus, and shows what it looks like on plant leaves. Weather forecasting information can therefore be very useful in preventing the spread of this fungus, and/or making decisions on preventative control options. This fungus can survive within infested maize crop residues present on the soil surface during intercrop periods. It can lead to losses of 20% to 70%.

Variety/seed selection

Diseases can be carried on seeds so, if using seed from previous crop, only use seeds from disease-free fields. Certified seed purchased from shops tends to be disease free. If you know the prevalent pests and diseases, it may be possible to access disease/pest resistant varieties. Caution needs to be observed when selecting for disease/pest resistance to ensure that the variety also has other desirable traits, such as early maturity, colour, etc. For more on climate smart variety selection, see **CCARDESA KP 09** on **Climate Smart Seed Selection for Sorghum, Maize & Rice**. Pre-treated seeds coated in herbicides/pesticides may be available in the local market. Alternatively, it may be possible to treat seeds with herbicides/insecticides to protect against pests such as *striga* at farm level.

Figure 4: Maize grey leaf spot on maize plant and an illustration of its lifecycle.





Source: www.pioneer.com

Understand farmers' priorities

There are a substantial number of variables in the local and household context of the farmer that may affect their ability to implement climate smart cultural pest and disease control solutions for their maize and sorghum crops. As an extension provider, it is important to understand these and to work within these constraints. Apart from having an in-depth understanding of the current farming system and agronomic practices, you should also work with your farmers to understand the following:

- **Tenure** – does the farmer own or rent the land?
  - Many farmers, especially those in female-headed households, do not actually own the land they use and may be unwilling to invest in longer-term solutions that will take several seasons to demonstrate results
- Does the farmer require an **immediate return** in terms of production or reduced inputs, or are they willing to wait for the benefits?
  - A food-insecure household aiming for food security may have different priorities to a farmer who is already food secure, and aiming at growing a cash crop
- Do **men and women** have the same level of access to inputs such as compost/manure, legume seeds, fertiliser, improved seeds, etc.?
- Who is **responsible for the labour** involved in each of the climate smart soil amendment options being recommended?
  - Will labour need to be hired?
  - Will the solution require children to be kept home from school?
- Are there any **cultural barriers** or issues with peer pressure that might inhibit farmers from changing specific practices?

OCCASIONAL SHORT TERM, REACTIVE PRACTICES

With most pests and diseases, the earlier the problem is noticed the better. If detected early, it will be easier to act to help prevent severe losses occurring or stop the pest or disease spreading throughout the crop and beyond to neighbouring fields. The best way of achieving this is to inspect the crop regularly and systematically.

One way to do this is to walk through the field or plot, following an M-shaped pattern. This will ensure the farmer does not just look around the edges, but also looks in the middle. If any problems are noticed, the farmer should carefully examine the plants for signs of the problem and clues as to the cause. Signs on the crop might include the following:

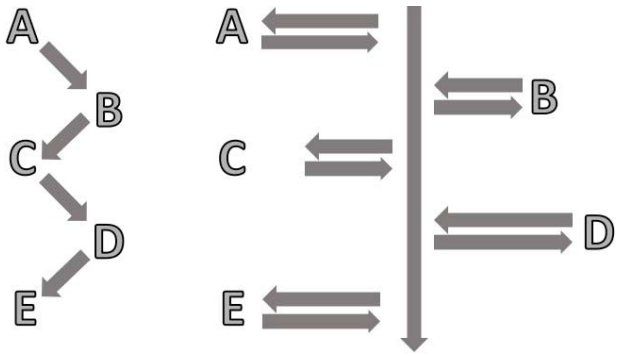
- Has the plant wilted – that is, has the plant become less rigid than normal and is drooping?
- Are the leaves more yellow than usual?
- Have the leaves changed from green to some colour other than yellow?
- Are the plants smaller than usual?
- Have parts of the plant died?
- Are there unusual streak patterns on the leaves or stems?
- Do the leaves have spots on them?
- Are the leaves chewed – are there holes in them that look as though they have been eaten?
- Are there signs of the animals that might have done this?
- Are the leaves blistered or wrinkled?
- Are the leaves or fruits an unusual shape?
- Are the leaves smaller than usual and/or bunched closer together than usual?
- Do the leaves have patterns of lighter green and yellow, giving a mottled or patchwork effect?

- Are there brown marks on the edges of the leaves?
- Is there an unusual growth on the surface of the leaves or other parts of the crop?
- Are there holes in the stem or grain?
- Are there lumps or swellings on the leaves or other parts of the plant?
- Are parts of the plant rotting – that is, becoming soft and slimy?

If any of these signs are seen, the farmer should be encouraged to seek help from an extension worker, knowledgeable local farmer, or staff at the local agro-dealer or research station.

The **Decision Point** below shows the importance of regular field inspections in the climate smart control of pest & diseases of maize/sorghum.

Figure 5: Sample scouting patter for maize field at the early and late whorl stages (left), and at the VT and Reproductive stages (right).



Source: CIMMYT2018: Fall Armyworm in Africa, Aguide to IPM

DECISION POINT

Systematic field inspections

At least weekly inspections using the 'M' Pattern

Identify the problem

Weed/insect/disease

Farmer context

What is the 'action threshold'? Is this threshold affected by the farmers' priorities?

Control options

Mechanical control	Biological control	Chemical control (last resort)

Possible Climate Smart Pest/Disease Management Practices

Weeding/roguing by hand/hoe Manually remove pests Bottle traps, etc.	Encouraging natural predators (e.g., cats to control mice)	Use of organic or chemical control

Before deciding on which form of control is most appropriate, you need to work with your farmer to decide if it is worth investing in control measures at all. Is the pest causing, or, if left uncontrolled, will it cause economic damage or loss?

The **action threshold** is the level of infestation that justifies the costs of control. It must be determined if the pest numbers or infected areas are high enough to warrant spending money on control. The action threshold may be different at different points in the plant life cycle.

- More mature plants may be able to tolerate higher levels of infestation
- It may be more difficult/dangerous to apply chemical control to more mature plants, as the farmer may be spraying above their heads.

Biological damage (for example, holes in leaves) often occurs without there being any yield/economic loss. The potential (controlling) impact of beneficial species also needs to be considered.

If the pest level is below the threshold, then no pesticide treatment should be applied. If the pest level is above the threshold, then control treatment is required. Unfortunately, **action thresholds** are context specific and are not always available. The next step is to select the most appropriate control method, which must meet the following criteria:

- Effective
- Practical
- Economic
- Safe.

Table 3: Example of action thresholds for fall armyworm for different types of farmer at different stages of maize growth.

Maize crop stage	V-stage	Action threshold for smallholder farmer	Action threshold for village-level progressive farmer
Early whorl stage	VE–V6	20% (10%–30%)	20% (10%–30%)
Late whorl stage	V7–VT	40% (30%–50%)	40% (30%–50%)
Tassel & silk stage	R1–R3	No-spray Unless low-toxicity & supportive of conservation biological control	20% (10%–30%)

Source: CIMMYT2018: Fall Armyworm in Africa, Aguide to IPM

Mechanical

Mechanical control methods include the following options:

- Traps (e.g., bottle traps)
- Hand weeding/hoeing of weeds
- Hand picking of insects
- Rogueing of infected plants
  - Only if these are isolated and the infestation has not spread
- Removal of infected plant residues for burning/feeding to livestock
- Sorting of stored grain, etc.

Biological

Biological control focuses on the introduction/protection of predators of the pest. Spraying with chemicals can often kill beneficial insects as well as pests, so it may be better not to spray if beneficial insects are present. The use of cats to control mouse populations in stored grain is an example of biological control. Every use should be made of local farmer knowledge when making decisions on biological control options.

Chemical

Chemical control should always be the **last resort**. While chemical pesticidescan be hugely effective, they are expensive and must be applied precisely to be effective. Locally made 'organic' pesticides can be effective at controlling lower levels of pests. These recipes often include **neem** and **chilli**, among other ingredients. Again, **local farmer knowledge** should be sought before making decisions.

Some pests such as **fall armyworm** and **locusts** can spread rapidly across huge areas if climatic conditions are right (i.e. strong wind and/or rain forecast). It is vital that these pests are effectively monitored. Detecting incidence of these pests in a field must be reported immediately, as this will help specialists to monitor and track the pest so that early warnings can be disseminated if necessary.

Pesticide safety and efficacy

Pesticides are easy to use and effective. However, pesticides are often misused and can cause human health effects and environmental contamination. Repeatedly using pesticides with the same mode of action (or method for controlling a pest) can lead to a build up of resistance, making the pesticides less effective.

Many countries have problems with counterfeit pesticide products being sold and used. These counterfeit products are often poorly labelled or mislabelled; they may contain too little active ingredient or even none. It is therefore important that farmers only buy pesticides from reputable suppliers, such as respected local agro-dealers.

Buying cheap products from travelling salesmen or at informal markets should be avoided. Ideally, farmers should buy only as much pesticide as they need for the current season. This will avoid them having to store pesticides, which can represent a **danger, especially for children**. Fortunately, small packs of many pesticides are now readily available from agro-dealers. It is also potentially dangerous if a friend or neighbour gives a farmer some leftover pesticide in a container other than the original packaging. In this case, the farmer will not know what the pesticide is, how it should be used, or whether it is out of date.

Safe use of pesticides

When using pesticides, it is important to **use them safely** to protect both the farmer and the consumers, to **reduce environmental contamination,** and to **maintain the efficacy** of the pesticides.

Farmers must use appropriate safety precautions when mixing and using pesticides. This includes reading and following the label recommendations for use, using the right **personal protective equipment (PPE)**, and practising **personal hygiene**. Information that can be found on the product label includes the following:

- PPE required
- What crops and pests the product can be used for
- Dosage rate
- Timing of application
- The time required before anyone can re-enter the field after spraying (REI)
- The number of days a product must be sprayed prior to harvest (PHI)
- Other precautions.

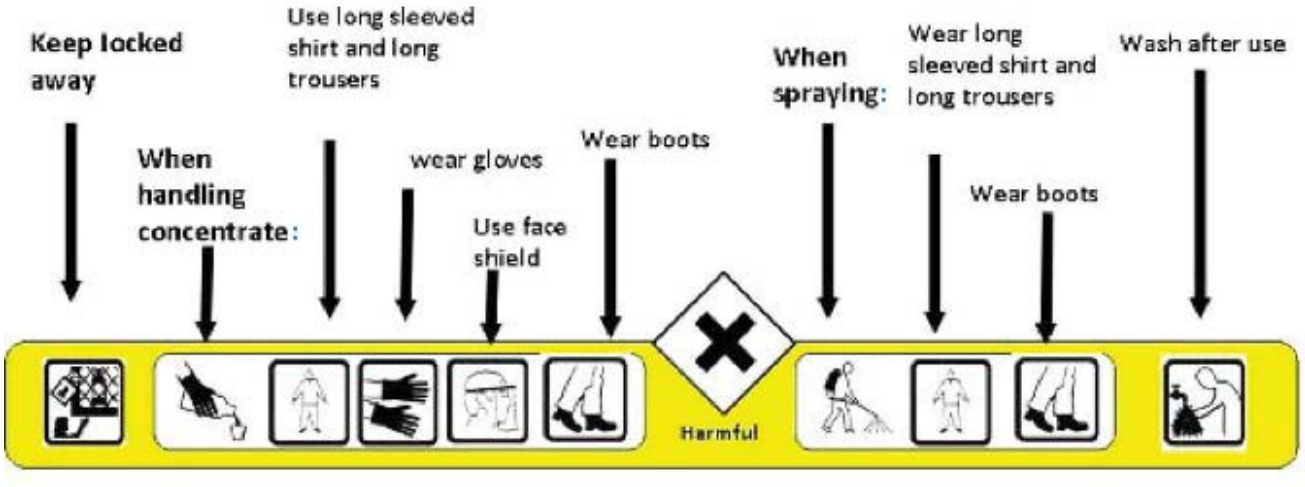
It is important that farmers **read and understand** what is on the **label** prior to use. If they are unable to read it or do not understand it, then they should find someone to help them, such as a local extension agent or family member.

Farmers should be encouraged to **use personal protective equipment (PPE)** when mixing and spraying pesticides. At a minimum, a farmer should wear the following when applying pesticides:

- Long sleeved shirt
- Long trousers
- Goggles, glasses or a face shield to protect the eyes
- Boots (preferably rubber or impermeable boots)
- Gloves (preferably rubber or impermeable gloves)
- A dust mask (for dry formulations), or respiratory protector
- A hat.

Warning symbols are used on labels to indicate what type of PPE should be used for both mixing and spraying the product. If a field has been sprayed, it is vital to check how long the farmer must wait before it is safe to re-enter the field to inspect the crop.

Figure 6: Pictograms on a sample pesticide product.



Source: Stewardship Community1

WHO Class and Colour Code	
1a	Extremely hazardous
1b	Highly hazardous
2	Moderately hazardous
3	Slightly hazardous
U	Unlikely to present acute hazard
O	Obsolete as a pesticide

A colour code system, based on the World Health Organisation pesticide toxicity classification, is used on labels to inform farmers about the level of toxicity of the product: red indicates the most dangerous pesticides.

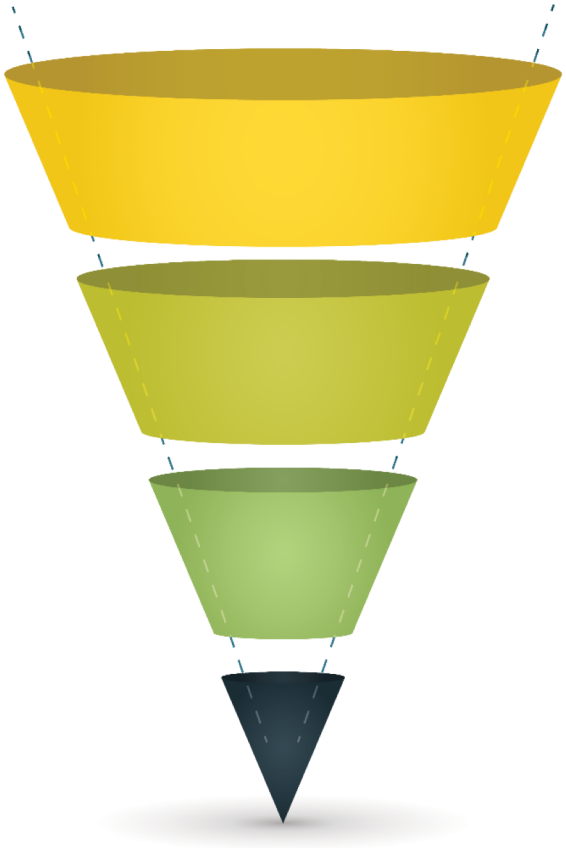
ANALYSIS AND REFLECTION

It is important to follow up the control method selected to evaluate its effectiveness. This can involve the following:

- Repeat visits to the field to monitor and/or scout for specific pests/diseases
  - This can be done every 47 days, but re-entry protocols must be observed if chemical control has been used.

- Looking back at the whole growing season and reflecting with farmers on the effectiveness of the control measures implemented.:
  - The amount of labour expended, when and by whom (men/women/children), should be assessed.
  - Were the control methods selected cost effective?
  - What could be done to minimise the incidence of pests/ diseases next year?
    - »Do crop residues need to be removed and burned?
    - »How might this affect the farmers ability to mulch and thus to grow crops the next season
    - »Can a rotation crop be introduced to break pest and disease cycles?

TO SUMMARISE



STEP 1: Know Your Context

- What pests and diseases are prevalent in the area?
- What is the soil fertility like?
- What is the climate (rainfall/temperatures, etc.)
- Farmer Priorities?

STEP 2: Identify the Pest/Disease

- Regularly monitor the crops and scout for pests and diseases

STEP 3: Is Short Term Control Required?

- Decide on 'action thresholds'
- What mechanical, or biological control options are available?
- Is chemical control required, and is it feasible?

STEP 4: Identify Long Term Cultural Control Options

- Was control effective? Why/Why not?
- What can be done to prevent pest and disease for next season?:

WHERE CAN I FIND MORE INFORMATION?

The following resources, which were used as reference for the development of this Knowledge Product, provide valuable additional reading on this subject. Please also refer to the CCARDESA website (www.ccardesa.org), the full series of Knowledge Products, and associated Technical Briefs. Translations of this Knowledge Product to French and Portuguese was achieved using machine translation tools, and the results were checked by an accredited translator.

- **The CCARDESA Knowledge Hub** – KPs 6, 7, 8, 9, 10 & 12
- **Plantwise** – Factsheets for farmers – *Striga*
  - 100s of fact sheets available. Each one dedicated to a specific pest/disease. You will need to be able to identify the problem so you can find the correct factsheet. They have an App. to help with that too. Excellent resources
- **CTA** – Practical Guide Series 2: How to Control *Striga*
  - Short, practical guide comparing different and joint control measures for pests
- **FAO** – Integrated Management of the Fall Armyworm on Maize; A guide for farmer field schools in Africa
  - Excellent resource for any extension officer faced with existing/potential outbreaks of fall armyworm. Many of the principles in this manual can be used to control other pests. Well worth reading
- **ASHC** – Handbook For Integrated Soil Fertility Management
  - An excellent resource that every extension officer should have access to
- **ASHC** – Sorghum and Millet Nutrient Management
  - A very practical resource for anyone growing sorghum or millet
- **ASHC** – Maize–Legume Cropping Systems
  - A practical guide to growing maize and legumes. Excellent resource for extension staff in the field
- **ASHC** – Sorghum–Legume and Millet–Legume Cropping Systems
  - A practical guide to growing maize and legumes. Excellent resource for extension staff in the field
- **ASHC** – Crop Pests and Diseases; A manual of the most important pests and diseases of the major food crops grown by smallholder farmers in Africa
  - A really useful guide to identifying and controlling the main pests and diseases of the most important food crops. Every Extension Officer should download a copy
- **Croplife International** – Trainee Manual; Introduction to Integrated Pest Management
  - Wordy and short on illustrations. A comprehensive guide to IPM
- **GACSA** – Climate Smart Pest Management; Implementation Guidance for Policymakers and Investors
  - Targeted towards policy makers, not field staff. Worth a read to get the bigger picture
- **International Plant Biotechnology Outreach** – Maize in Africa
  - An excellent overview of maize in Africa, with sections on the main pests and diseases of the crop.

Pixabay, 2017