Climate-smart push–pull
Curriculum for Farmer Field Schools

icipe

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We are also grateful to Bonaventure Nyotumba and his team for compiling the Climate-smart push–pull curriculum.

icipe's mission is to help alleviate poverty, ensure food security and improve the overall health status of peoples of the tropics by developing and extending management tools and strategies for harmful and useful arthropods, while preserving the natural resource base through research and capacity building.

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Acronyms

AESA	Agroecosystem analysis
CAN	Calcium ammonium nitrate
CBO	Community based organisation
CREADIS	Community Research in Environment and Development Initiatives
CIMMYT	International Sorghum and Wheat Improvement Centre, Nairobi, Kenya
DERLTO	District Extension Research Liaison and Training Officer
FAO	Food and Agricultural Organisation of the United Nations
FFS	Farmer Field School
GM	Gross margin
HIV	Human immunodeficiency virus
icipe	International Centre of Insect Physiology and Ecology
KALRO	Kenya Agricultural and Livestock Research Organisation
NAADS	National Agricultural Advisory Services (Uganda)
NAARI	Namulonge Agricultural and Animal Research Institute
NARO	National Agricultural Research Organisation
NGO	Non governmental organisation
PDA	Provincial Director of Agriculture
PM&E	Participatory monitoring and evaluation
TVC	Total variable costs

Foreword

This book contains a Climate-smart push–pull curriculum for farmer field schools (FFS), to support smallholder farmers in Africa to manage the most significant constraints (stemborers, parasitic *Striga* weed, and poor soil fertility) to efficient production of staple cereal crops under hot, dry conditions. The Farmer Field School (FFS) approach is one of the field-tested technology transfer pathways that use participatory adult learning techniques. The FFS approach is beneficial for farmers because it improves the effectiveness of their practical learning and ensures that they benefit from innovative technologies.

We have based this curriculum on the push–pull technology that *icipe* (International Centre of Insect Physiology and Ecology) and partners developed over 20 years ago. Recently, *icipe* modified the conventional push–pull method through incorporating drought-tolerant companion plants, while achieving similar control of the constraints, but now with more extensive agroecological reach to areas affected by reduced and unpredictable rainfall, as well as rising temperatures. Climate-smart push–pull provides a crucial factor in further upscaling the technology, in keeping with the Centre's plans to expand this unique technology to as many farmers as possible in different agroecological zones and farming systems in Africa.

Push–pull involves planting two types of companion plants. Farmers plant a legume (*Desmodium*) between the rows of cereal crops, which makes the cereal crops unattractive to stemborers due to the chemicals *Desmodium* emits (which provides the 'push'). Farmers also plant a drought-tolerant grass (*brachiaria*) around the maize or sorghum plot as a trap crop, which due to the chemicals it emits, attracts stemborer moths for egg-laying, but allows only minimal larval survival (which provides the 'pull'). The chemicals that the intercropped *Desmodium* roots secrete control the parasitic *Striga* weed and deplete the *Striga* seed bank in the soil. *Desmodium* is a nitrogen-fixing legume. It also improves carbon sequestration in the ground and grows year-round, thus protecting the soil from erosion, conserving soil moisture, improving soil organic matter, and enhancing the abundance and diversity of below- and above-ground beneficial insects, such as bees.

At present, more than 160,000 smallholder farmers have adopted push–pull and realised a threefold increase in their cereal crop yields. push–pull had been expanded to nine African countries (Ethiopia, Kenya, Tanzania, Uganda, Rwanda, Burundi, Malawi, Zambia and Zimbabwe) by the end of 2017.

However, why Push–pull?

- The technology fits well with traditional mixed cropping systems in Africa; farmers can integrate beans into the system.
- The technology is economical and appropriate to resource-poor African farmers; it is based on locally available plants and does not require expensive external inputs.
- Farmers can integrate crop and livestock farming activities, as the plants used in push–pull provide high-value livestock fodder, thus facilitating milk production and expanding farmers' income sources, and solving the problem of shortage of livestock fodder.
- The technology improves gender equity, as women can quickly cut the fodder grasses.
- Push–pull has been found to control the fall armyworm (FAW), an invasive pest that has recently entered the continent.

- Push–pull provides integrated management of insect pests (stemborers and FAW), parasitic *Striga* weeds, and soil fertility.
- By reducing stemborers and FAW plant damage, it reduces maize ear rots and mycotoxins, such as aflatoxin and fumonisin (which are poisonous substances that fungi produce that contaminate cereals and similar crops).

This easy-to-read 168-page curriculum is filled with useful illustrations and contains frequently asked questions. We hope that the curriculum will be a valuable learning resource for farmers and extension workers of this innovative technology. We believe that the groundbreaking Climate-smart push–pull technology has potential to improve livelihoods of smallholder farmers and rural families, increase agricultural productivity, and enhance environmental sustainability and resilience while lessening the effects of climate change.

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17 May 2018

Preface

Smallholder farmers in Africa face many problems: their plots are too small to be economically productive; they have little or no money to invest in farm equipment; crop pests and diseases destroy most of their crops. The list is endless. The result is a vicious cycle of poverty and malnutrition.

Many efforts are being put into addressing the problems of smallholder farmers. This curriculum addresses the major problems that affect cereal production in Africa: stemborers and striga weed, and low soil fertility. Where these two pests have not been addressed, agricultural production has been severely affected. In some instances, crop failure of up to 100% has been recorded.

By combating the twin problem of stemborers and striga weed through the use of the Climate-smart push–pull technology, the smallholder farmer can maximise production and improve household health and income.

Purpose of the curriculum

The purpose of this curriculum is to guide farmers in learning the principles and practices of the Climate-smart push–pull technology so that they can apply them on their farms. Climate-smart push–pull is a knowledge-intensive technology, and there is a need to have a curriculum to guide the process of acquiring knowledge and skills in the use of the technology.

Target of the curriculum

The curriculum is aimed at the farmer, the extension staff, NGOs, collaborators and all others who are interested in the Climate-smart push–pull technology. It has been written in a simple language to enable farmers and others to read and understand it with ease.

Parts of the curriculum

The curriculum is divided into four main parts:

1. **The preseason weeks:** This part covers activities that prepare the ground for an effective push–pull Farmer Field School.
2. **Season 1:** This corresponds with the first sorghum cropping season. All activities follow the growth of the sorghum crop.
3. **The first off-season:** This is the period after the first sorghum crop season. Relevant learning activities are incorporated for the farmers to do before the next season.
4. **Season 2:** This corresponds to the second sorghum cropping season, and like in Season 1, activities follow the growth of sorghum.

How the curriculum was developed

This curriculum is the product of several people from the three eastern African countries: Kenya, Uganda and Tanzania. They include farmers, research scientists, agricultural extension officers from the Ministry of Agriculture and Ministry of Livestock and Fisheries, practitioners from NGOs, and donors. It was developed at *icipe* Thomas Odhiambo Campus in Mbita, Kenya. Later, a small group of experts fine-tuned the material from the workshop to enable easy facilitation and learning.

Implementation

Climate-smart push–pull is a knowledge-intensive technology that needs a curriculum designed to guide learning at various entry points of the technology for the smallholder farmers. This curriculum covers the key components of the Climate-smart push–pull technology written for direct implementation by farmer groups and individual farmers. It will be covered and applied by majority of the smallholder farmers in the region through Farmer Field Schools (FFS).

The FFS offer farmers opportunities aimed at enhancing learning by doing, getting involved in experimentation, problem-solving, discussion and decision-making. A Farmer Field School aims to educate farmers to understand their environment and farming practices, thus enabling them to make rational decisions in the use of resources and to identify appropriate practices and technologies that are relevant to their farming systems.

Assessment of the curriculum coverage

Participants in the Climate-smart push–pull Farmer Field School will evaluate the curriculum through active involvement. Lessons will involve a participatory approach in making field observations, experimentation, developing indicators/parameters, and recording and analysing information. The curriculum includes participatory monitoring and evaluation (PM&E) activities and tools to help the farmers, researchers and extension agents to monitor and evaluate the technology.

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Preseason

Pest problems of sorghum

Stemborers and striga weeds are the most destructive pests of cereal crops and can reduce yields of sorghum on smallholder farms. You can get yield losses of 30 to 100% if stemborers and striga are uncontrolled. Control of stemborers by insecticides and control of striga weeds by herbicides is expensive for resource-poor farmers. It is also not good for the environment. An emerging threat is the fall armyworm, an invasive species of American origin.

Stemborers

Stemborers are important pests of sorghum in Africa, but they also attack other crops, such as maize, millet and sugarcane. Damage is caused by larvae which first feed on young leaves, but soon enter into the stems. During the early stage of crop growth, the larvae may kill the growing points resulting in deadheart (Fig. 1).

Fig. 1. Deadheart caused by stemborer larvae

At a later stage of larval growth, extensive tunnelling (Fig. 2) inside the stem weakens the stalk so that it breaks and lodges. Damage caused by stemborers could result into 20 to 40% reduction in grain yields.

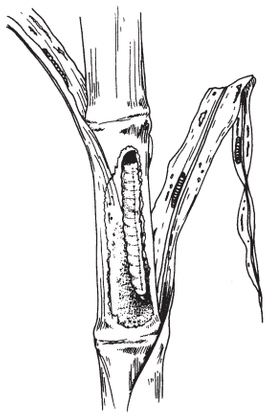


Fig. 2. Tunnelling of sorghum stalk by stemborer larva

Adult moths of stemborers are seldom seen in farmers' fields as they are inactive during daytime. They become active after sunset and lay their eggs during nighttime.

In eastern Africa two species of stemborers cause heavy damage to cereal crops — *Busseola fusca* (Fig. 3) and *Chilo partellus* (Fig. 4).

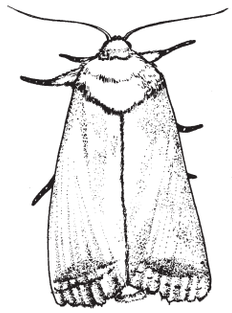


Fig. 3. *Busseola fusca*

Fig. 4. *Chilo partellus*

Busseola fusca is an African stemborer and is present in high and mid altitude areas (3,500 ft and above) like Kitale. *Chilo partellus* accidentally came to Africa from Asia in the 1930s. *Chilo partellus* is present in low and mid altitude areas (below 4,000 ft) like the Kenyan coast.

Adult female moths lay eggs on sorghum plants. *Busseola fusca* lays its eggs between stem and leafsheaths (Fig. 5), whereas *Chilo partellus* lays its eggs in form of egg batches on plant surface (Fig. 6). The eggs then hatch into larvae which, after feeding on leaves for two to three days, enter inside sorghum stems.

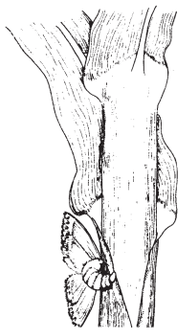


Fig. 5. *Busseola fusca* laying eggs

Fig. 6. *Chilo partellus* laying eggs

After larvae bore into sorghum stems, they feed and grow within the stems for 2 – 3 weeks.

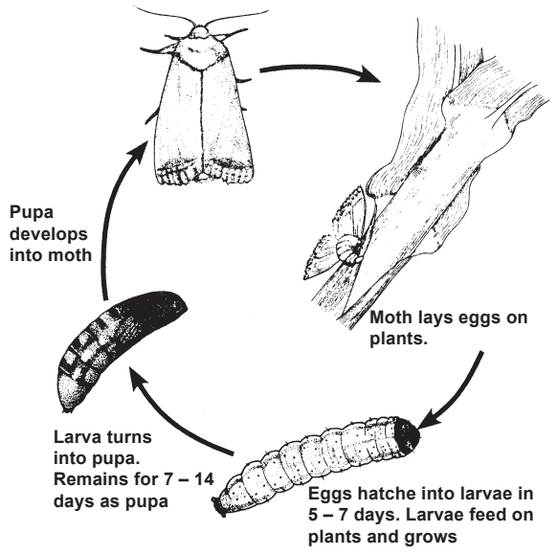


Fig. 7. Life cycle of *Busseola fusca* stemborer

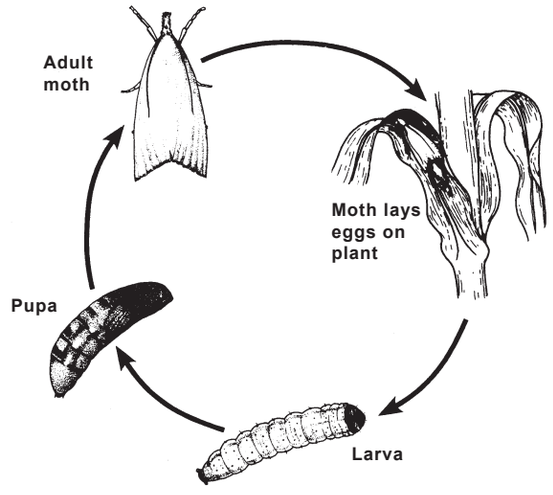


Fig. 8. Life cycle of *Chilo partellus* stemborer

When larvae are fully grown, they pupate and remain inside the sorghum stem for 7 – 14 days.

Adults emerge from pupae and come out of the stem (Figs 7 and 8). They mate and lay eggs on sorghum plants again and continue damaging the crop.

Fall armyworm (*Spodoptera frugiperda*),

Fall armyworm (*Spodoptera frugiperda*), FAW, is a species of American origin. It is a heavy feeder, thus it derives its name from its feeding habit. Once an 'army' of fall armyworm infest an area, they eat almost everything, before moving to the next available food source.

How to identify FAW

The fall armyworm has features that distinguish it from other armyworm species.

- Its head has a predominantly white inverted (upside-down) Y-shaped suture between the eyes (Fig. 9).

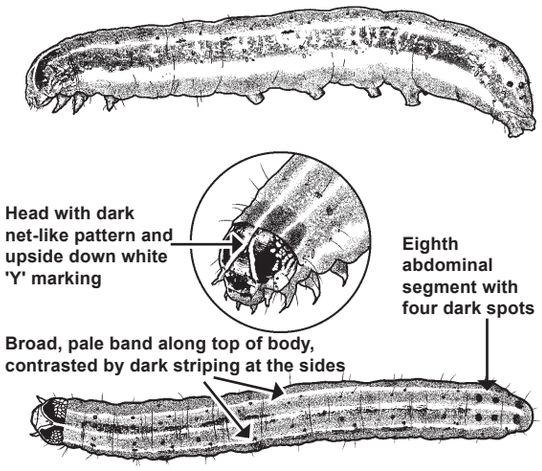


Fig. 9. The identifying features of fall armyworm

- Newly hatched larvae are greenish and have black heads. They move in a looping motion (Fig. 10).

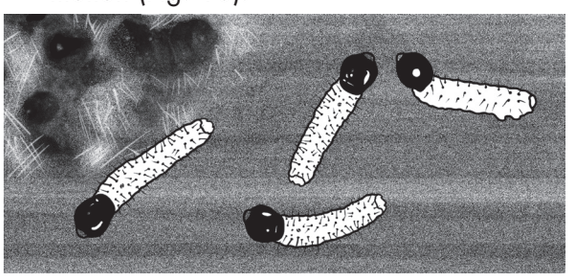
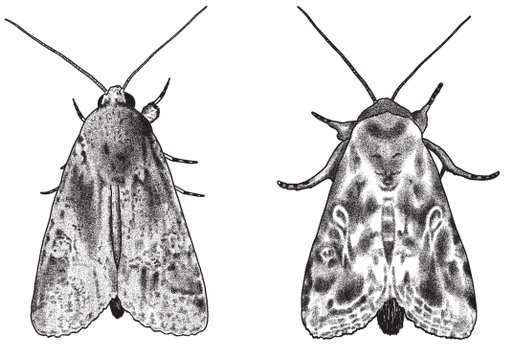


Fig. 10. Newly hatched fall armyworm larvae

- Mature larvae are smooth-skinned and vary in colour from greenish or brownish (light tan) to nearly black. They have three yellow-white hairlines (stripes) down their backs. There is a wider dark stripe and a wavy yellow-red blotched stripe on each side of their bodies. Full-grown larvae are about 1 – 1½ inches (38 mm) long.
- Fall armyworm has four dark spots arranged in a square on top of the eighth abdominal segment.
- The moths have dark grey, mottled (coloured spots) on the forewings, with light and dark splotches (marks). They also have a noticeable white spot near the extreme end of each (Fig. 11). The moths have a wingspan of 32 to 40 mm.



Female **Male**

Fig. 11. Adult fall armyworm moth

Feeding habits

The fall armyworm has a voracious appetite and is a heavy feeder. It feeds on more than 80 varieties of crops. Fall armyworm feeds any time of the day or night. However, it is most active early in the morning or late in the evening. When abundant, fall armyworm larvae (caterpillars) eat all the food at hand. Then they crawl in great armies to adjoining fields. They can also fly over 100 kilometres a day assisted by wind, thus they can spread fast.

Small fall armyworm larvae infest and feed on leaves, causing windowpane type feeding before moving to the leaf whorl. In the whorl, the larvae feed on tender leaf tissues until full-size. This leaves the plant stunted and unproductive. When leaves unfurl (unfold), irregular, elongated feeding areas or a row of holes across the leaves are visible. When fall armyworm feeds in the whorl it is called a budworm or a whorl-worm. Sometimes the main vein is cut causing the entire leaf tip to die. In rare cases, larvae may feed on panicles not yet emerged from the whorl. (Fig. 12).

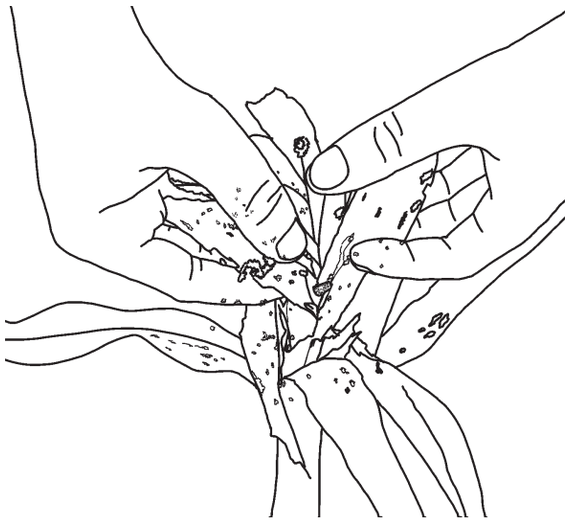


Fig. 12. Sorghum whorl destroyed by armyworms

When the caterpillars near maturity, they can completely destroy an entire crop in a few days. Worse, at the larva stage, the fall armyworm is a cannibal. It feeds on larvae of other species, meaning at maturation it colonises huge swathes of land.

Life cycle

The fall armyworm is an insect labelled as a successful invasive species. Its life cycle, and its ability to spread and reproduce quickly differentiate it from pests that farmers are used to, such as the African armyworm (*Spodoptera exempta*), a less destructive species.

The fall armyworm is a fertile insect, laying up to 2,000 eggs in a lifetime. The adult females lay eggs in batches of 100 to 200 on the underside of leaves. The eggs are white, pinkish or light green and dome-shaped; the base is flattened and the egg curves upward to a broadly rounded point at the apex. The egg measures about 0.4 mm in diameter and 0.3

mm in height. The female also deposits a layer of greyish scales between the eggs and over the egg mass. These gives the eggs a hairy or mouldy appearance.

The eggs take about 3 to 5 days to hatch. The larvae emerge and migrate to the whorl. The destructive larval stage takes 14 to 28 days, after which the pest climbs down from the plant to the soil near the plant for pupation.

The pupation process takes place, ranging from 1 to 2 weeks.

The adult moth emerges from the pupa and begins the egg laying cycle after 3 to 4 days (Fig. 13).

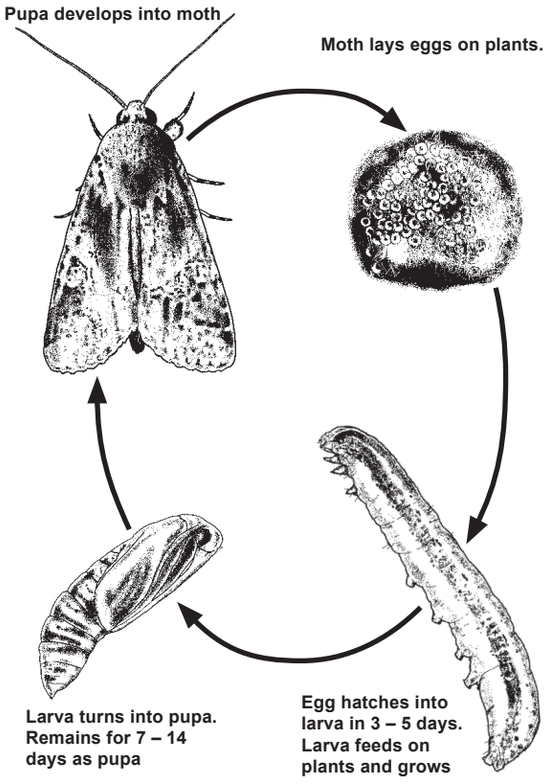


Fig. 13 The life cycle of fall armyworm

Striga weed

Striga or witchweed is a parasitic weed that affects sorghum in many parts of Africa reducing production by 30 to 100%. When a farm is infested with striga, the affected sorghum hardly grows more than one foot tall. The weed does not grow on its own but grows by attaching itself onto the host plants (Fig. 14). Each striga plant can produce 20,000 – 80,000 seeds, which lie dormant in the soil until a sorghum crop is planted again. This dormancy can last for over 15 years. As striga germinates, its roots grow towards the sorghum crop, penetrate the roots of the sorghum plant and start to draw nutrients from there. This causes severe stunting of the sorghum and yield loss.

Fig. 14. Striga weed attached to sorghum roots

In East Africa, there are two common species of the witchweed, *Striga hermonthica* and *Striga asiatica*. *Striga hermonthica* is common around the Lake Victoria basin while *Striga asiatica* is mainly found in the coastal areas. The most affected crops include sorghum, rice and sugarcane.

Farmers should control striga before it emerges from the ground, because by the time it emerges, much damage will have been caused. Although various control methods have been proposed, few farmers are able to avoid yield loss by these means. For example, though manual removal reduces re-infestation, it is uneconomical since most damage is done even before the weed emerges. Therefore, any control strategy has to begin within the soil.

Control of stemborers, fall armyworm and striga weed using the Climate-smart push–pull strategy

What is the 'Climate-smart push–pull' strategy?

icipe and its partners have developed an effective, cheap and environmentally friendly technology known as 'Climate-smart push–pull' to control stemborers and fall armyworm and suppress striga weeds in sorghum.

It is a simple cropping strategy, where the farmers use brachiaria grass and greenleaf desmodium legume for control of stemborers, fall armyworm and striga weed in sorghum fields.

Greenleaf desmodium is planted between the rows of sorghum. It produces a smell that stemborer and fall armyworm moths do not like. The smell 'pushes' away the moths from the sorghum crop.

Brachiaria grass is planted around the sorghum crop as a trap plant. brachiaria grass is more attractive to female moths and it 'pulls' the moths to lay their eggs on it. But brachiaria grass does not allow stemborer or fall armyworm larvae to develop on it due to poor nutrition for the larvae.

In addition, greenleaf desmodium, interplanted among the sorghum, reduces striga weed. It has been shown that nitrogen fixed by greenleaf desmodium and chemicals produced by the roots of greenleaf desmodium are responsible for suppressing the striga weed. Therefore, striga does not grow in the sorghum–greenleaf desmodium intercrop.

Benefits of adopting the Climate-smart push–pull strategy

When you adopt the Climate-smart push–pull strategy, you will:

- Increase sorghum yields by 25 – 30% in the areas where only stemborers or fall armyworm are a problem, but more than 100% where both stemborers, fall armyworm and striga are problems.
- Increase supply of cattle feed from brachiaria grass and greenleaf desmodium.
- Fix nitrogen into your farm by planting greenleaf desmodium legume, so you save on fertiliser costs.
- Protect soil from erosion as greenleaf desmodium acts as a cover crop.
- Retain soil moisture in your plot because greenleaf desmodium acts as a mulch.
- Get money from the sale of greenleaf desmodium seed at an attractive price.
- Make more money from increased milk production and sales.
- Save on farm labour as you do not have to manually remove striga weed from the farm.
- Protect sorghum from strong winds when surrounded by brachiaria grass.

In this curriculum, you will learn how to establish and maintain push–pull plots and increase your sorghum yield by controlling stemborers, fall armyworm and striga, and improving soil health.

For more information contact:

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  Tel: +254-20-8632000.
- **District Agricultural Officers near you.**

Preseason Week 1

	Topic	Duration	What you need for this lesson
1	Initial ground working	2 weeks	Meeting place

Preparing to launch a Farmer Field School (FFS) in a community

A Farmer Field School is a process, not a goal. It aims to increase the capacity of farmers to test new technologies in their own fields and assess results and their relevance to particular circumstances. Farmers interact with researchers and extension workers on a demand-driven basis, only asking for help where they are unable to solve a problem themselves.

A Farmer Field School is a dynamic process that is practised, controlled and owned by farmers to help them transform their observations to create a better understanding of their crops and livestock.

The initial step in formation of a Farmer Field School involves what we call ground working.

Topic: Initial ground working

Learning objectives

On completion of this topic, participants will:

- Become aware of FFS.
- Understand the importance of FFS.

Learning activities

The Ministry of Agriculture and partners can conduct a series of formal or informal meetings with interested farmers and community members, local government officers and non-governmental organisations before starting the FFS. The first meeting should be reasonably informal to introduce the FFS idea and to raise interest among potential participants.

Ground working is important, because of the following reasons:

- It introduces the FFS idea and creates interest among potential participants.
- It assesses the level of interest in the community.
- It creates a basis for ownership in the FFS to be formed.

FFSs are likely to be effective if the participants reside in the same village. This enhances the chances of community members establishing a FFS in the village and encourages the participants to continue with group activities after the FFS season ends. Such groups provide good entry points for other development efforts in the community.

Ideally, a request for a field school should come from the community itself. People who request training are likely to be motivated and responsible than those forced into a programme by some authority. Field days arranged by existing FFS can trigger such requests. In areas where the idea of FFS is unknown, interest can be created by working through active local leaders or exchange visits to an area where a FFS exists.

The timing of initial ground working is important. It should not be held at a time when potential participants, be it men or women, are engaged in other activities that might exclude them from participating. Through these initial meetings, it will be possible to confirm or identify the farming community's main interest areas or problems, and to check whether the community members are interested to attend a season-long course on

the subject. The groups are responsible for the care and maintenance of the study enterprise covering all aspects of the cropping cycle, from soil preparation, through planting, weed control, pest and disease control, harvesting, processing, postharvest storage, to marketing of produce. The approach is a season-long training following the seasonal activities of a crop. Issues related to financing of the FFS should be openly discussed, to make all arrangements transparent and to build trust.

It is important to spend time discussing potential participants' expectations and getting the group to decide whether any of these are unrealistic, to avoid problems later. The potential adult learners should be given enough opportunity to ask questions, get clarifications and make suggestions.

Preseason Week 2

	Topic	Duration	What you need for this lesson
1	Introduction to Farmer Field Schools	1 hour	Pieces of paper/ flip charts, pens/ markers, sorghum plant, a board to display
2	Levelling expectations	1 hour	
3	Setting of learning norms	1 hour	

Introduction

Farmer Field Schools (FFSs) are informal hands-on schools for adults who come together on a regular basis to learn the *'how and why'* of a particular topic. The FFS uses participatory methods to help farmers develop their analytical skills, critical thinking, and creativity, and to help them learn to make better decisions.

This lesson will introduce the community to what a field school is, the number of people involved, setting of norms and levelling of expectations in a FFS.

Topic 1: Introduction to Farmer Field Schools

Learning objectives

This topic serves to:

- Introduce the FFS methodology to the community and FFS members.
- Establish the interest of the community in using the FFS to learn about push–pull.
- Outline the principles and objectives of FFS.

Learning activities

- Facilitator-led introduction to FFS.
- Facilitator-led discussion on the need for FFS.
- Facilitator-led discussion on objectives and principles of FFS.

Facilitation procedure

- The facilitator initiates the activity by asking the farmers to draw a sorghum plant.
- Everybody knows how a sorghum plant looks like. Each person in the crowd can carry out this exercise or a few volunteers can make a drawing of a sorghum plant.
- The facilitator collects the drawings and displays them on a board or a place where all the participants present can see them.
- The facilitator asks participants to name the parts of the sorghum plant on the drawing and indicate the role of the different parts. The participants look, name and discuss whether the plant parts are labelled correctly and what role the parts do.
- If the parts on the drawing are not labelled correctly, the facilitator asks the participants to explain the reason for the difference in observation.
- Then the facilitator brings out a sorghum plant and shows it to the farmers, asking them to have a look and confirm the labelling and the role the different parts play.
- Participants discuss the different parts of the sorghum plant and the role each part plays.

Principles of FFS

- What the farmer wants rules.
- The field is the learning ground.
- Learning by doing.
- Extension workers are facilitators and not teachers.
- Participatory learning out of mistakes.
- Systematic training process.
- Learn how to learn.

- Unity is strength.
- Problem-posing/problem-solving.
- Every FFS is unique.

Topic 2: Levelling of expectations

To avoid disappointing FFS participants and making some drop out, it is important that the participants become aware of what they expect. At this early stage, participants can level out unrealistic expectations before committing themselves to participate in the FFS.

Learning objectives

On completion of this topic, participants will be able to:

- Indicate what they expect from the FFS course.
- Understand that not all their expectations are achievable through the FFS course.

Learning activity

- Facilitator-led introduction: Why would you like to join a FFS? What do you hope to gain? What do you expect from the facilitator?
- Group exercise: Participants organised into smaller groups discuss questions and present to the whole group their ideas.
- Facilitator-led discussion on unrealistic and realistic expectations.

How to level expectations

- Level expectations after the participants have introduced themselves. You can do this exercise with the whole group or with smaller groups.
- Ask the following questions.
  - Why have you joined the FFS?
  - What do you hope to gain?
  - What do you expect from the facilitator?
  - What do you think the facilitator expects from you?
- Divide the group into sub-groups of at most 5 participants and give them time to discuss the questions.
- One participant in the sub-group can write the answers on a flip chart.
- Invite a representative of each sub-group to present their responses to the whole group/ class.
- Summarise the group expectations.
- Guide the discussions and respond to each expectation. Ask the group members what they think about each expectation and whether it is realistic and achievable within the FFS cycle.

It is the responsibility of the facilitator to make sure that unrealistic expectations are levelled out and realistic expectations are made part of the FFS programme.

Topic 3: Setting of learning norms

For the smooth running of the FFS, it is important to set ground rules and norms to ensure a suitable learning environment. Interruptions such as people coming late or under influence of alcohol, mobile phones, absenteeism, domineering people and cases of non-participation, are not good for a learning environment.

Learning objectives

On completion of this topic, participants will be able to:

- Create a climate that enhances the learning process.
- Prevent negative influences that would interfere with the success of the FFS.
- Enhance members' accountability to the group.
- Train other participants how to organise and better manage themselves.

Learning activities

- Organise the class into groups of 4 – 6 members to discuss and list norms to guide good conduct in a FFS.
- Facilitator-led discussion on norms and reinforcements of the FFS programme.

- Listing of acceptable norms and reinforcements of the FFS.

How to set norms

- Find out from the group what learning norms are.
- Ask group members to list the learning norms.
- Guide the group to come up with more norms and suggestions on what should be done when a member does not respect the norms. For example, what should be done in the following instances?
    - Late comers: Member has to pay a fine; member has to dance, etc.
    - Absenteeism: Group can decide on how many sessions a participant needs to attend to be able to graduate (e.g. an attendance of 75% will be required).
    - Dominant people or lack of order in the group (you can use the stick, only the person holding the stick is allowed to speak. A person who would like to speak must raise his/her hand and be given the stick, or use a slogan to get the group's attention).
    - People not contributing to group work should pay for a day's labour.
    - Members who do not respect other people's opinions should be reprimanded.
- The learning norms should be pinned on the wall for everybody to see.

Preseason Week 3

	Topic	Duration	What you need for this lesson
1	Introduction to Farmer Field School implementation	2 hours	Facility to visualise the main points of the discussion, e.g. flip charts/ chalkboards, markers, masking tape; list of one or two names of successful projects and one or two names of failed projects introduced into the village or in the neighbouring village
2	Introduction to participatory monitoring and evaluation	2 hours	

Introduction

Adult learners volunteer to participate in a field school. To make the decision to participate, they need enough information on how the school will meet their needs and interests. This lesson will introduce participants to the importance of a field school.

Topic 1: Introduction to Farmer Field School implementation

Learning objectives

On completing this topic, participants will:

- Understand the objectives of the FFS.
- Identify where to locate the FFS.
- Identify activities to learn through FFS.
- Plan for official opening of the field school.

Learning activities

- Facilitator-led introduction on the objectives of FFS.
- Brainstorming and group discussion on appropriate location of FFS, learning activities and the appropriate time to open the school officially.
- Facilitator-led discussion on importance of having a productive and effective FFS.

Objectives of FFS

- Empower farmers with knowledge and skills.
- Sharpen the farmers' ability to make critical and informed decisions that make their farming profitable and sustainable.
- Sensitise farmers on new ways of thinking and problem solving.
- Help farmers learn how to organise themselves and their communities.
- Enhance relationships between farmers, extensionists and researchers to work together in testing, assessing and adapting a variety of options within their specific local conditions.

Identifying the suitable time for the FFS

Participants should be involved in scheduling the day of the week, time of the day and the frequency with which to hold the FFS meetings. Women may not have the same availability as men. It is also usually easier to gather farmers together for a meeting early in the day, before they start their routine activities. Meetings of about 4 hours may suit the majority of farmers, but the timing needs to be discussed with all the participants. The sessions of the initial phase of the school can commence before the start of the cropping season/cycle, when farmers are less busy with farm work. During the cropping season/cycle, sessions should be held regularly every one to two weeks.

Identifying the location of the school

Ensure that all participants' opinions regarding the proposed location are heard. The school should be located at a place that is:

- Accessible and acceptable to all the farmers.
- Suitable for the proposed enterprise and within or next to the community.
- Near a shade and in a comfortable, secure area for the group to draw, analyse the data and discuss findings.

Identifying the FFS activities

To start to identify initial topics that the FFS participants might like to learn, the participants can carry out a problem analysis for sorghum crop in the village. Volunteers (3 – 4) from the group can do this. These volunteers can talk about their experiences with sorghum production, and the problems and successes they have had. The group can brainstorm on key cross-cutting points from the different farmers' presentations that will help define the initial activities the group will learn about.

To develop skills needed to design and implement their experiments, it is important that a session on experimentation is conducted early in the FFS season. Participants can return to the topic of experimentation later during the season as they build their own skills and ideas.

Opening the FFS officially

For the development of the school and to ensure community support and replication of similar activities, it is important to start the school with a proper opening ceremony. This will give the local authorities (including farmer leaders) the opportunity to express to the participants their support and interest in the school.

Topic 2: Introduction to participatory monitoring and evaluation (PM&E)

Introduction

Participatory monitoring & evaluation (PM&E) is a process through which stakeholders at various levels are involved in monitoring or evaluating the process and results of a particular project or programme. The stakeholders may include local people, researchers, NGOs and policy makers. Evaluation is a process of determining whether the design and delivery of a programme were effective and whether the proposed outcomes were met. It begins with the initial planning phase and continues throughout the life of the programme. Evaluation done to improve or change the programme is called formative evaluation. The evaluation that focuses on the results or outcomes of a programme while it is in progress is called summative evaluation. Good programme evaluation provides useful feedback to all those concerned with a certain programme.

PM&E aims at measuring the effectiveness of a project, building ownership and empowering you, building accountability and transparency; and enabling you take corrective actions to improve achievement of better outcomes. In this lesson, you will learn why you should monitor and evaluate the farm activities you undertake in your farm or in a FFS.

Learning objectives

On completion of this topic, participants will be able to:

- Understand and explain the importance of PM&E.
- Discuss the principles of PM&E.

Learning activities

- Facilitator-led introduction on importance of participatory monitoring and evaluation.
- Organise participants into groups of 4 – 6 and let them brainstorm on the need for PM&E. Write on flip charts (the lead questions: "Why should you be involved in monitoring and evaluating group activities you are doing? What guidelines would you follow in doing PM&E?")
- Groups make presentations to the bigger group.
- Facilitator-led discussion on importance and principles of PM&E.

Notes

1. Purposes of PM&E

- *Assess what has been achieved.*
- *Measure progress in line with the set objectives.*
- *Improve monitoring for better management.*
- *Identify strengths and weaknesses.*
- *Check on the effectiveness of effort – is there a difference?*
- *Do cost: benefit analysis – were the costs reasonable?*
- *Collect information to plan.*
- *Share experience with others.*

2. Principles of PM&E

PM&E seeks to involve programme participants in reflecting and assessing the progress of their project.

Core principles of PM&E:

- *It involves you as active participants – you actively participate in making decisions about your project/ programme activities.*
- *It builds your capacity to analyse, reflect and take action.*
- *It encourages joint learning of stakeholders ot various levels.*
- *It promotes commitment to taking corrective actions. Facilitators are catalysts.*
- *Emphasises people-centeredness – relies on your creativity and knowledge about your environment.*
- *It draws on your local resources and capacities (abilities).*
- *It is gender-sensitive – considers both men and women as important players.*
- *It promotes empowerment in which you and the community are encouraged to take ownership, management and control of your own choices and decisions.*
- *It encourages partnership and sustainability.*

During PM&E, participants reflect on what to measure to reflect success and decide on how to monitor parameters, who should do it, where, with what and when. The following table can be helpful

How?		Who?	Where?	With what?	When?
Indicators	Tools				

Preseason Week 4

	Topic	Duration	What you need for this lesson
1	Field observations	30 minutes	Records showing inputs and costs; crops and livestock information; record sheets; and flip charts/chalkboards, markers, exercise books, pens
2	Attending FFS regularly	30 minutes	
3	Keeping farm records	1 hour 30 minutes	
4	Enterprise budgets	1 hour 30 minutes	

Introduction

Observing and keeping records are two important things on your farm. You learn a lot from the observations you make and the records you keep about what is happening on your crops and livestock. This in turn enables you to make good decisions. Records are essential for good planning and use of your limited resources. Without proper understanding of record keeping, you may not succeed in today's business world.

In this lesson, you will learn about:

- Field observations.
- Farm records.
- Enterprise budgets.

Topic 1: Field observations

Learning objective

On completion of this topic, participants will be able to explain the importance of making field observations.

Learning activities

- Facilitator-led discussion on the importance of field observations.
- Facilitator-led discussion on how to make field observations and how to record observations.
- Field walk to observe, identify and discuss the kinds of insects in a farm and the damage/benefits of such insects.

Topic 2: Attending FFS regularly

The success of a FFS depends on all members attending all the learning activities regularly and being involved in all group activities. Participants are expected to apply directly what they learn in the FFS. Therefore, it is important that every participant attends all the field school sessions.

Learning objective

On completion of this topic, participants will be able to understand the importance of attending FFS sessions regularly.

Learning activities

- Facilitator-led introduction on the importance of attending all sessions regularly.
- Brainstorming on rules to guide attendance of meetings.
- Learning how to use the attendance roll.

Topic 3: Keeping farm records

Learning objectives

On completion of this topic, participants will be able to:

- Explain the importance of farm record keeping.
- Prepare and explain the different types of farm records.

Learning activities

- Facilitator-led introduction: On importance of keeping farm records.
- Facilitator-led discussion on types of farm records and their preparation.

Notes

- *If you keep records properly, they will provide you with answers that lead to better farm management decisions.*
- *Record keeping should be simple to make it easy for you to use and to help you avoid making mistakes.*
- *For you to get maximum value out of your records, make sure you update them in a timely fashion.*

Topic 4: Enterprise budgets

A budget provides the answer to the question: What will be the profit or loss of doing a certain enterprise? Budgeting relates to the future. It tells us what the profitability of an enterprise or activity will be if we decide to use a certain production technology. Budgeting is a planning tool used by several kinds of people, including farmers, managers, extension specialists and policy makers.

Learning objectives

On completion of this topic, participants will be able to:

- Understand the importance of budgets as a tool in management of farm business.
- Develop budgets to compare the inputs used in various enterprises and eventually their net profits.

Learning activities

- Facilitator-led introduction on meaning of enterprise budgets (What is an enterprise budget?)
- Facilitator-led discussion of format for enterprise budgets.
- Brainstorming on the uses of enterprise budgets (Are enterprise budgets necessary?)
- Giving examples for group exercise.

Enterprise budgets

- Single budgets are easier to use, monitor and evaluate.
- Single enterprise budgeting has several uses which include:
  - Helps in considering the profitability of a single enterprise — Using the budgeting method helps one to investigate the profitability of a particular enterprise regardless of other farm enterprises.
  - Helps in monitoring and control — Budgeting can be used for comparing actual implementation with planning, and to identify and solve problems during the production season.
  - Helps in whole farm planning — The most important component of any planning method is the list of enterprise budgets and their gross margins. The single enterprise budget also enables the planner to 'grade' enterprises, and classify them according to their characteristics and profitability with regard to the production factors.
  - Helps in preparing normative budgets — Budgets of single enterprises are compiled by government agencies for planning and policy implementation for providing 'know-how' and information to the farmers and advising them on what to grow.

Preseason Week 5

	Topic	Duration	What you need for this lesson
1	Tools of participatory monitoring & evaluation	4 hours	Facility to visualise the main points of the discussion, e.g. flip charts/chalkboards, markers, masking tape; list of one or two names of successful projects and one or two names of failed projects introduced into the village or in the neighbouring village.

Introduction

Any activity, project or programme requires resources in developing and implementing it. It is, therefore, important that you check on how you begin. You need to choose and use the appropriate method or tool that will provide quality feedback. This will help to show whether the resources you are investing in the project are producing benefits or making profits.

PM&E tools help you to observe and analyse situations and performance and to understand what you are observing. Participatory monitoring and evaluation (PM&E) tools are management tools to enhance your learning and enable you take correct actions.

In this lesson, you will learn why you should monitor and evaluate the farm activities you undertake in your farm or in a FFS. You will also learn how to use relevant participatory monitoring and evaluation (PM&E) tools.

Topic: Tools of participatory monitoring and evaluation

Learning objectives

On completion of this topic, participants will be able to:

- Carry out evaluation using different PM&E tools.
- Reflect on what to monitor to measure success, and identify appropriate indicators to measure the identified parameters.
- Decide how to monitor parameters, who should do it, where, with what and when.

Learning activities

- Facilitator-led introduction to tools of PM&E.
- Identify practical cases of community projects that were successful or unsuccessful (failed) and brainstorm why they succeeded or failed.
- Identify and discuss the indicators of project success or failure.

Notes

1. Examples of PM&E tools

- ***Sketches and maps***

Sketches and maps can be used at the beginning of the programme (for planning purposes), during the process (for monitoring purposes) and at the end of the programme (for evaluation purposes) to locate the changes in the programme.

- ***Semi-structured interviews***

Informal dialogue and interviewing is one of the first steps in participatory planning activities. Taking time to talk to people will set the right atmosphere.

- ***Focus-group discussions***

A focus group consists of 4 – 8 people who collect information, clarify details or gather opinions about an issue. It facilitates the exchange of experiences. The group usually records its discussion and shares with the rest of the group.

- ***Daily activity analysis/diaries***

A diary keeps a record of events over time and can be used to collect information regarding changes in the field, lives of individuals or groups. Diaries are simple records of facts, such as the attendance of participants in the FFS.

- ***Change or success stories***

The change or success story of an individual or group identifies significant changes — positive and negative — relating to an activity. This highlights a project's impact and people's perception of it. Stories document a sequence of

events over time related to a person, location, household or organisation and help you to understand the history of a community or the impact of a programme. Stories also help the group to learn about people's experiences and expectations and can help highlight obstacles to plans.

- ***Transect walk***

The transect walk helps in mapping information collected and in monitoring. The participants take a structured walk (for example, in a zigzag) through a selected area, making observations using chosen indicators.

- ***Direct observation***

This includes any approach which relies on directly observing objects, events or relationships in the field, and keeping a record of the observations. Counting the number of stemborers or other insects and their predators, for example, helps farmers and outsiders to understand how the stemborers spread and endanger the crop.

- ***Evaluation wheel***

This uses indicators (such as attendance, appreciation of the specific content of the session, performance of the facilitator, level of overall satisfaction, participation by all members). The FFS group ranks these aspects on an agreed scale, say a ranking of 1 – 5. The reasons behind each score are discussed and solutions suggested for improvement.

2. Procedure for sharing success stories

***Step 1:** Ask one participant to describe one important enterprise introduced in the area that was a success. All participants should listen carefully to the story.*

***Step 2:** In groups of 4 – 6, participants discuss. (Lead question: What do you need to monitor to be able to measure success both on the group activities and among individual members?) Write the parameters on cards.*

***Step 3:** Let each group present its results. Fix the list of measurements and respective indicators on a chart for everyone to see.*

***Step 4:** Look at the indicators and identify the ones that are suitable and easy to measure, i.e., most SMART: specific, measurable, attainable, relevant and timely.*

***Step 5:** Divide the things discussed with the defined indicators among the groups.*

***Step 6:** Each group discusses which tools to use to measure the indicator (HOW), WHO should be responsible, WITH WHAT and WHEN and document their decisions in a table as below. The group can use the format of the table below.*

How?		Who?	Where?	With what?	When?
Indicators	Tools				

***Step 7:** Repeat Steps 1 – 6 with another participant for an enterprise or project that was unsuccessful. Get consensus from the others (if they come from the same village).*

***Step 8:** The larger group can go over the presentations of the groups with special emphasis on how realistic the monitoring plan is, the costs involved and where the funds will come from, level of knowledge the participants have in monitoring the tasks, whether they have resource persons, what training they require, and so on.*

Season 1

Season 1, Week 1

	Topic	Duration	What you need for this lesson
1	Preparing and laying out the Climate-smart push–pull plot	2 hours	Ruler/tape measure, string, pegs, sticks for measurement, mallet hammer, polyethylene tags or marker pens, Climate-smart push–pull manual
2	Planting the Climate-smart push–pull and the check plots	2 hours	*Jembes*/hoes, *pangas*/machetes, pegs, sticks, fertiliser, seed materials, (brachiaria, greenleaf desmodium and sorghum), dry sand, small bucket, small container (pot, tin, etc.) of good soil

Introduction

Two things are necessary when establishing a good and easy to manage Climate-smart push–pull plot: proper land preparation and careful layout of the field. Proper land preparation has the following advantages:

- It helps control weeds.
- It facilitates easy sowing and helps to establish good contact between seed and soil.
- It helps the seeds to absorb moisture easily.
- It provides sufficient aeration.
- It helps improve the water holding capacity of the soil.

If good management practices are followed, the brachiaria grass and greenleaf desmodium established this year will benefit your Climate-smart push–pull plot for 5 or more years.

This week's lesson is about these two important activities. Participants will learn how to prepare and lay out the Climate-smart push–pull and the check plots.

Topic 1: Preparing and laying out the Climate-smart push–pull plot

Learning objective

On completion of this topic, the participants will be able to demonstrate that they understand how to prepare and lay out land for the first season.

Learning activities

- Facilitator-led introduction on preparation and laying out of Climate-smart push–pull and check plots.
- Practical preparation of the two plots.
- Facilitator-led discussion on requirements for preparing and laying out Climate-smart push–pull plots.

How to prepare the Climate-smart push–pull plot

Note

If your land is slopping, the greenleaf desmodium and sorghum rows must run across the slope to avoid surface runoff and to reduce soil erosion.

Step 1: Mark out a plot measuring 21m by 21m using a tape measure, pegs and strings (To make sure it is a square, use a string to ensure the two diagonals have the same length).

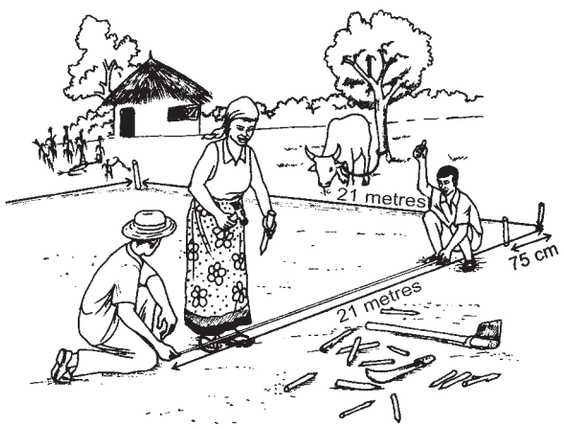

Fig. 15. Measuring a Climate-smart push–pull plot

Step 2: Put a peg at each corner of the measured area. Starting from a peg at one corner, put more pegs all around the plot at intervals of 75 cm (Fig. 15).

Step 3: Run a string from the first peg in one corner to the first peg on the opposite side of the field.

Step 4: Run the second string from the second peg to the second peg on the opposite side.

Step 5: Run the third string from the third peg to the third peg on the opposite side.

Step 6: Repeat Steps 3, 4 and 5 for all the other sides, until you have a plot looking like Fig. 16 below. The Climate-smart push–pull plot is now ready for planting.

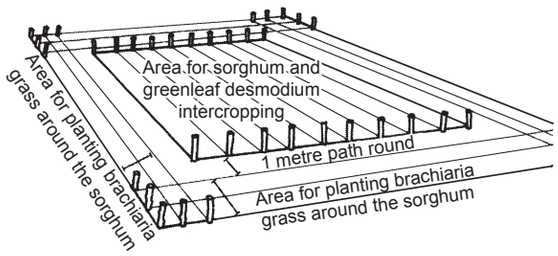

Fig. 16. A laid-out Climate-smart push–pull plot

How to prepare the check plot

Step 1: Demarcate a plot measuring 21m by 21m.

Step 2: Starting from one corner, put pegs along two opposite sides of the square at 75cm intervals.

Step 3: Run a string across from the first peg in one corner to the first peg on the opposite side and do the same up to the last peg.

What NOT to do

- Do not remove the pegs until your plot is fully planted.
- Do not plant Climate-smart push–pull in less than 21m by 21m plots as brachiaria grass tends to grow tall, therefore creating a shading effect on the sorghum crop.

Topic 2: Planting the Climate-smart push–pull and the check plots

This topic covers:

- Planting of brachiaria grass seeds or root splits.
- Planting the greenleaf desmodium.
- Planting the sorghum.

Learning objective

On completion of this topic, participants will be able to demonstrate how to plant on both Climate-smart push–pull and check plots.

Learning activities

- Facilitator-led introduction on planting the Climate-smart push–pull plot.
- Practical activities on planting of Climate-smart push–pull (sorghum, greenleaf desmodium and brachiaria grass) and the check plots.
- Discussions on planting all plots.

Planting order

1. Planting brachiaria grass

Brachiaria cv. Mulato II is the best variety of brachiaria grass for Climate-smart push–pull.

Follow these steps when planting brachiaria grass in your Climate-smart push–pull plot.

Step 1: Dig a shallow pit about 1 cm, at each peg on the border of the marked plot (Fig. 17).

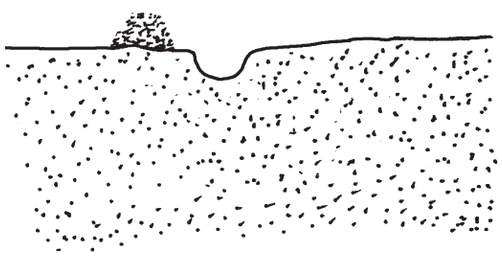

Fig. 17. Hole for planting brachiaria

Step 2: Apply one teaspoonful of DAP or NPK fertiliser or a handful of well-decomposed

farmyard manure in each hole and mix it well with soil.

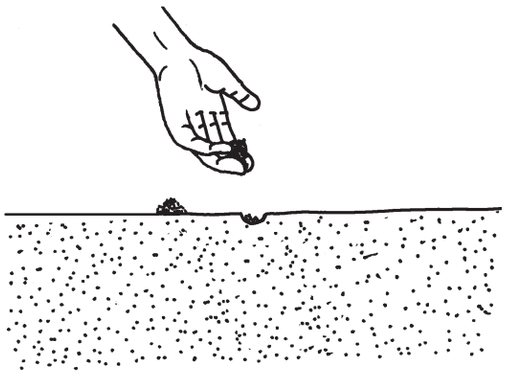

Fig. 18. Adding faryard manure to hole for planting brachiaria

Step 3: Drop 5 – 6 seeds into each hole Fig. 19.

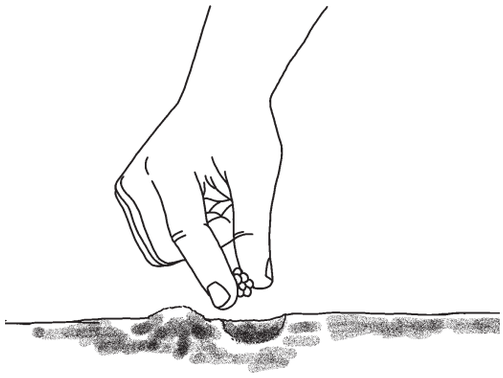

Fig. 19. Planting brachiaria seeds

Step 4: Cover with light soil ensuring planted seeds are sparsely well covered (Fig. 20).

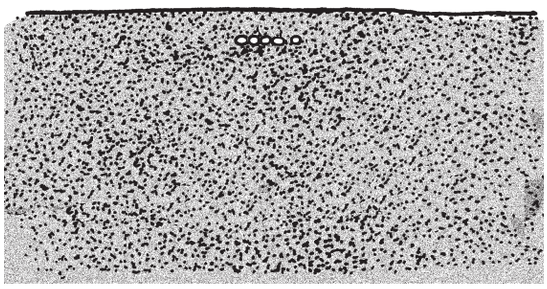

Fig. 20. Planted brachiaria seeds

Step 5: Repeat steps 1 to 4 for the rest of the rows, ensuring that the rows are 75 cm apart and 30 cm between the plants for the rows running alongside the desmodium. The spacing of 75 cm should be maintained at the head of the crop rows.

When complete, you will have three rows of brachiaria grass all round the sorghum field. Fig. 21.

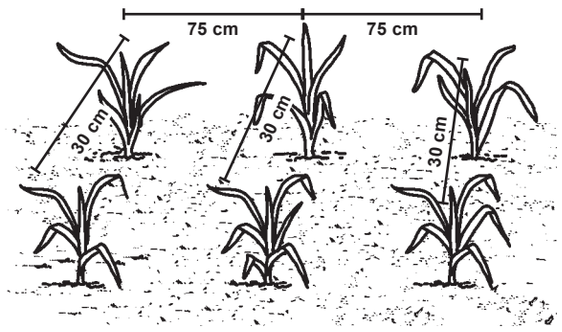

Fig. 21. Rows and plants at 75 cm apart

If you are using root splits, place them upright into the planting holes and cover with soil (Fig. 22. below)

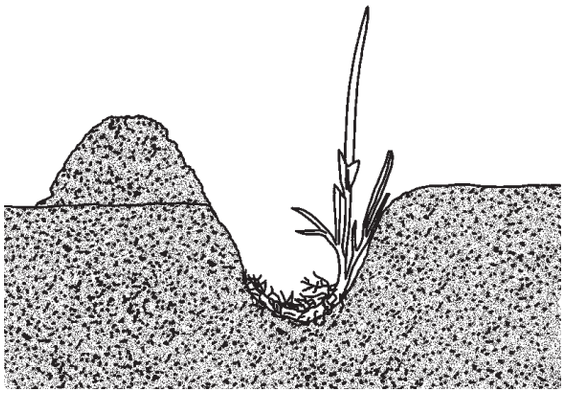

Fig. 22. Planting splits

Notes

- *Some farmers prefer to establish brachiaria grass in the short rains. The greenleaf desmodium and sorghum intercrop are established in the subsequent season. This helps to control stemborers and fall armyworm in the first season of Climate-smart push–pull establishment.*
- *Brachiaria grass can also be established in a nursery and the root splits used in the actual lay out field. This extra effort ensures germination and good plants surrounding the field.*

2. Planting greenleaf desmodium

Step 1: Start from the fourth peg at the corner of the marked plot and run a string to the fourth peg on the opposite side. Do the same for all the sides (Fig. 23).

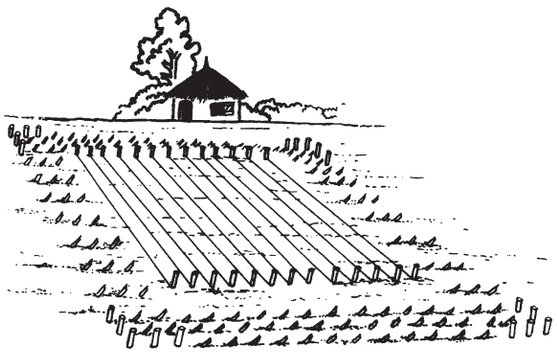

Fig. 23. Strings running across the plot

Step 2: Thoroughly mix greenleaf desmodium with fine sand in the ratio of one part greenleaf desmodium seed to two parts dry sand (Fig. 24).

- To plant a 21m by 21m plot you need 250g to 300g of greenleaf desmodium seed.

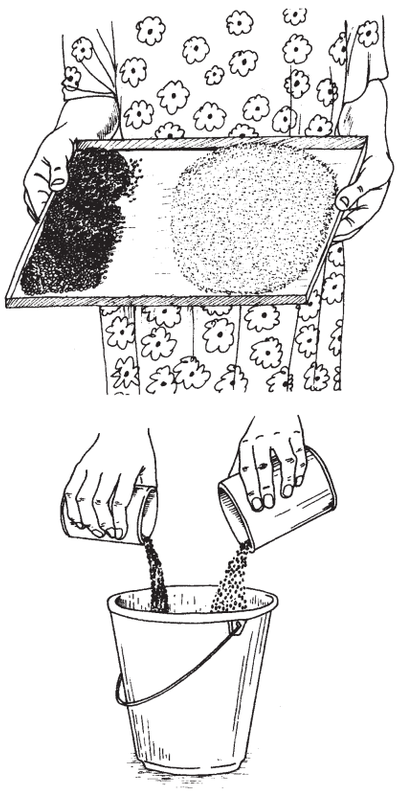

Fig. 24. Mixing greenleaf desmodium with fine sand

Step 3: Using a sharp pointed stick, make a furrow 1 – 2 cm deep along the string lines. Leave a 75 – cm space at the end of each row between the end of the greenleaf desmodium row and the inner row of brachiaria grass (Fig. 25).

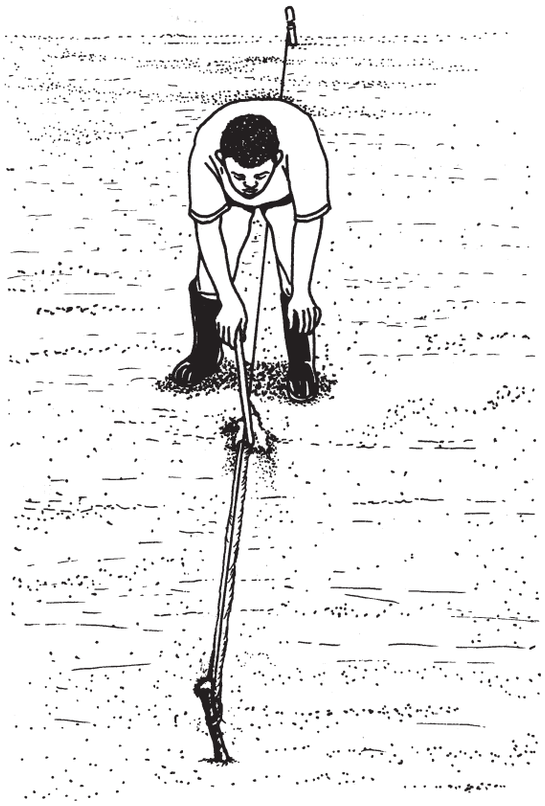

Fig. 25. Making a furrow for drilling greenleaf desmodium

Step 4: Drill fertiliser or farmyard manure along the furrows, and use a stick to mix it with soil, without covering or disturbing the furrows.

Step 5: Drill the greenleaf desmodium/sand mixture prepared in Step 2 into the furrow and cover with a light amount of soil (Fig. 26).

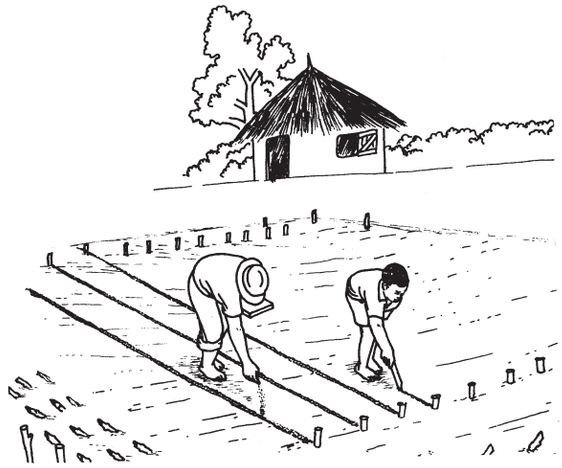

Fig. 26. Drilling greenleaf desmodium into furrows

- Greenleaf desmodium is drilled in the furrows at 75 cm row to row distance.

Notes

- *Plant greenleaf desmodium with the rains for maximum germination.*
- *Planting greenleaf desmodium in a straight line will save you a lot of time during the first weeding 3 weeks after planting. It will also help you to distinguish greenleaf desmodium seedlings from weeds.*
- *If you do not have greenleaf desmodium seeds, you can use greenleaf desmodium vines from any neighbouring farm. This should be done when there is adequate soil moisture to ensure good establishment. (See **Season 2, Week 1** on greenleaf desmodium vine propagation).*

Step 6: Plant greenleaf desmodium in a small container (pot, tin, etc.) and keep it in a shade and watered. These seedlings will help you to identify greenleaf desmodium seedlings in the field.

3. Planting sorghum

(a) Climate-smart push–pull plot

Step 1: Sorghum is planted in straight lines between the rows of greenleaf desmodium

- Ensure that the first row of sorghum is at least 1 m away from the inner row of brachiaria grass.
- The recommended spacing for sorghum is 75 cm between rows and 30 cm between hills in a row.

Step 2: Apply one teaspoonful or soda bottle top of triple superphosphate or two teaspoonfuls of single superphosphate per hole. You may also use a handful of good quality manure per hole. Cover with a small amount of soil.

Step 3: Plant two sorghum seeds per hole and then thin to one plant per hill after first weeding (**see Season 1, Week 5**).

Note

Planting in this way ensures that sorghum rows alternate with greenleaf desmodium rows (i.e., they should not be on the same row). This helps make ploughing easier in the next season.

(b) Check plot

In the Check plot the same sorghum variety is planted in the entire 21m by 21m plot

Step 1: Dig holes at 75 cm between rows and 30 cm within the rows.

Step 2: Apply one teaspoonful or soda bottle top of triple superphosphate or two teaspoonfuls of single superphosphate in each hole. You may also use a handful of good quality manure per hole. Cover with a small amount of light soil.

Step 3: Plant two sorghum seeds per hole. When the sorghum germinates you will thin to one plant per hill after the first weeding (**see Season 1, Week 5**).

What NOT to do

Do not do any planting if soil moisture is not enough or if the field is too dry.

Labour costs

	Activity	No. of people working on this activity	Time taken to complete the activity (hours)	Cost of labour per day	Total cost of this activity
Climate-smart push–pull plot	Field layout				
	Planting brachiaria grass				
	Planting greenleaf desmodium				
	Planting sorghum				
	Fertiliser application				
	Manure application				
	Any other activity				
Total					
Check plot	Field layout				
	Planting sorghum				
	Fertiliser application				
	Manure application				
	Any other activity				
Total					

Input costs

	Input used	Quantity used	Cost
Climate-smart push–pull plot	Sorghum seed		
	Greenleaf desmodium seed		
	Brachiaria grass		
	Fertiliser		
	Manure		
	Other		
Total			
Check plot	Sorghum seed		
	Fertiliser		
	Manure		
	Other		
Total			

Farmer's fields

General information				
Date				
Variety of sorghum planted				
Date of planting:		Fertiliser applied:		
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Rainfall: Number of days it rained the week before: _____				
Soils				
• Soil colour:				
• Soil moisture:				
• Soil depth:				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Season 1, Week 2

	Topic	Duration	What you need for this lesson
1	Gapping sorghum	30 minutes	Sorghum seeds, pen, *jembes*/hoes, pegs, sticks, strings, tape measure, ruler, greenleaf desmodium seeds (100 grams) and TSP fertiliser
2	Preparing land to plant greenleaf desmodium for seed production	1 hour	
3	Planting greenleaf desmodium	30 minutes	
4	Introduction to ecosystems	1 hour	Pieces of paper/ flip charts, pens/markers and a board to display

Introduction

It takes about 4 – 5 days for the sorghum to germinate. Sometimes some of the sorghum seeds fail to germinate. This leaves gaps in the field that need to be filled. This is called gapping. Gapping should be done at this stage so that the new sorghum can catch up with the rest of the crop.

Topic 1: Gapping sorghum

Learning objective

On completion of this topic, participants will understand and explain the importance and timing of gapping.

Learning activities

- Facilitator-led introduction on the importance and time of gapping.
- Practical activities on gapping of sorghum.
- Discussion.

How to gap sorghum (both in Climate-smart push–pull and check plots)

Step 1: Walk along the rows, identify gaps where sorghum seeds have failed to germinate and dig holes.

Step 2: Plant two sorghum seeds per hole and then thin to one plant per hill after first weeding (in Week 5). The thinned plants can be used to gap if soils are moist as sorghum is a hardy plant.

Notes

- *You do not have to apply fertiliser at this stage since you had applied earlier.*
- *Be careful not to step on the germinating greenleaf desmodium seedlings in the Climate-smart push–pull plot.*

Topic 2: Preparing land to plant greenleaf desmodium for seeds

Greenleaf desmodium is expensive to buy and the demand for planting material by farmers is high. This lesson will enable the farmer to produce greenleaf desmodium from seed or vines for their own use or for sale.

Learning objective

On completion of this topic, participants will demonstrate how to prepare a plot for greenleaf desmodium seed production.

Learning activities

- Facilitator-led introduction on greenleaf desmodium seed bed preparation.
- Practical activities on seed bed preparation.
- Discussion.

How to prepare land for planting desmodium

Step 1: Mark out a 10m by 10m plot.

Step 2: Before the onset of rains, you will have ploughed or dug your land by hand and broken the soil into fine particles. Greenleaf desmodium

has small seeds. Therefore, the soil should be carefully prepared so that it is as fine and clean as possible.

Step 3: Starting from one corner of the plot, put pegs along two opposite sides of the square at 75 cm intervals (Fig. 26).

Step 4: Run a string across from the first peg to the first peg on the opposite side. Do the same for all the pegs (Fig. 26).

Note

A 10m by 10m greenleaf desmodium plot can produce 3 – 4 kg of seed for sale and vines to establish your next Climate-smart push–pull plot.

Topic 3: Planting greenleaf desmodium

Learning objective

On completion of this topic, participants will be able to plant greenleaf desmodium for seed production.

Learning activities

- Facilitator-led introduction on planting of greenleaf desmodium seeds.
- Practical activities on seed planting.
- Discussion.

How to plant greenleaf desmodium

Step 1: For a 10m by 10m plot, thoroughly mix 100 g of greenleaf desmodium seed with 200 g fine sand, or a ratio of one part greenleaf desmodium to two parts sand (Fig. 24).

Step 2: Using a strong pointed stick, make a furrow 1 – 2 cm deep along the string lines (Fig. 25).

Step 3: Drill TSP fertiliser or farmyard manure along the furrows and use a stick to mix it without covering or disturbing the furrows.

Step 4: Drill the greenleaf desmodium /sand mixture prepared in Step 1 into the furrows and cover with a light amount of soil.

Step 5: Plant greenleaf desmodium in a small container (pot, tin, etc.) and keep it in a shade and watered. These seedlings will help you to identify greenleaf desmodium seedlings in the field.

Notes

- *Plant greenleaf desmodium with the rains for maximum germination.*
- *Planting greenleaf desmodium in a straight line will save you a lot of time during the first weeding after 3 weeks of planting. It will also help you to distinguish greenleaf desmodium seedlings from weeds.*

Topic 4: Introduction to ecosystems

Introduction

An ecosystem (short for ecological system) consists of both living and non-living things and the physical environment (habitat). A habitat is the place where a population lives. A population is a group of living organisms of the same kind living in the same place at the same time. All of the populations interact and form a community. The community of living things interacts with the non-living world around it to form the ecosystem. The ecosystem consists of many smaller complete ecosystems in a habitat. The habitat supplies organisms with food, water, warmth, air and minerals. Some interactions of the components result in higher benefits while others lead to losses. For crops and livestock, positive interactions result in higher productivity while negative interactions lead to lower yields (decreased productivity).

Farmers need to understand these interactions so as to maximise the positive ones for higher production and minimise the negative ones through better management. It is important for them to understand the functions and interactions of the various components, the living, the non-living and the physical environment.

Learning objectives

On completion of this topic, participants will be able to:

- Understand different types of ecosystems.
- Build awareness of the relationships that exist between living and non-living things found in their environment.
- Appreciate that if one thing in this network of interaction is changed, it can influence all of the components of the ecosystem.

Learning activities

- Facilitator-led introduction on meaning and importance of an ecosystem.
- Through focus groups, farmers observe, analyse and make decisions on their field problems (Lead question: What relationships exist between living and non-living things in the farm?)
- Facilitator-led discussion on elements of an ecosystem.

Exploring interactions in an ecosystem

Step 1: Organise the group into small groups of 4–6 members. Each group will go to the field and do the following:

- Look around and list all the living and non-living things they can see.
- Discuss how the things observed are connected or how they affect each other.

Step 2: After 20 minutes of observation, discussion and note-taking return to the meeting place. Each group will do the following:

- Draw a picture showing all the things that they observed and draw lines to show which things are connected or affect each other.
- Make a presentation to the big group to explain what they have drawn.

Labour costs

	Activity	No. of people working on this activity	Time taken to complete the activity (hours)	Cost of labour per day	Total cost of this activity
Climate-smart push–pull plot	Gapping sorghum				
Check plot	Gapping sorghum				
Seed multiplication plot	Preparing land				
	Planting greenleaf desmodium				

Input costs for greenleaf desmodium multiplication plot

	Input used	Quantity used	Cost
	Greenleaf desmodium seed		
	Fertiliser		
	Manure		
	Other		
Total			

Farmer's fields

General information				
Date				
Age of sorghum in weeks				
Germination	**Poor**	**Average**	**Good**	
• Sorghum				
• Greenleaf desmodium				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*		*Hot/Cold*	

Indicator	Observation	
	Climate-smart push–pull field	Check plot
Emergence count		
Sorghum germination		
Seedling damage observations		

Season 1, Week 3

	Topic	Duration	What you need for this lesson
1	Gapping brachiaria grass	30 minutes	Brachiaria grass seeds/root splits, hoe/stick, Climate-smart push–pull manual, pen and paper, markers, flip charts
2	Agroecosystem analysis (AESA)	1 hour	
3	Group assessment	2 hours 30 minutes	

Introduction

Brachiaria grass seeds take 5–10 days to sprout while the root splits can sprout and become well established within three weeks of good rains. Sometimes, some of the planted brachiaria grass root splits fail to sprout. Therefore, you need to gap at this stage so that later in the season there is enough brachiaria grass to protect your sorghum crop against stemborers and fall armyworm, and to produce more fodder for your livestock.

Topic 1: Gapping brachiaria grass

Learning objective

On completion of this topic, participants will be able to understand and explain the importance and timing of gapping brachiaria grass.

Learning activities

- Facilitator-led introduction on the importance and time of gapping.
- Practical activities on gapping of brachiaria grass.
- Discussion.

Gapping brachiaria grass

Step 1: Walk along the rows and mark the gaps where brachiaria grass has not sprouted and dig holes.

Step 2: Place 5–6 seeds in the dug holes of areas along the row marked for replanting.

If you are using root splits, place them into the holes and cover with soil.

Topic 2: Introduction to agro-ecosystem analysis (AESA)

The AESA is a field-based analysis of the relationships of components observed in the field (such as soil, water, pests and their relationships). (Fig. 27) Participants learn to make regular field observations, analyse problems and opportunities encountered in the field and learn to improve decision-making skills regarding farm management. Participants thus develop the ability to assess and analyse problems, adopting a scientific procedure that consists of observation and analysis, followed by recommendations.

In this topic, participants will learn how to conduct AESA by visiting the experimental plots/ farms by observing the ecosystem, including interactions and ecological processes.

They do so by sampling, observing, recording and making comparison and analysis of information. This helps them to take actions based on sound information.

Learning objectives

On completion of this topic, participants will be able to:

- Become more aware of the things and interactions that make up the ecosystem of their fields – the 'agro-ecosystem'.
- Develop indicators for monitoring interactions and processes in the ecosystem.
- Use their understanding and observations of the agro-ecosystem as a basis for decision-making about crop/ livestock management.

Learning activities

- Facilitator-led introduction on meaning and importance of AESA.
- Group observations and discussions of the components of an agro-ecosystem (Lead question: What relationships exist between humans, crops, livestock and the physical environment?)
- Facilitator-led discussion on indicators of monitoring elements of an agro-ecosystem.

Procedure

Step 1: Organise the group into small groups of 4 – 6 members. Each group will go to the field and do the following:

- Look around the host farm and list all the living things (crops, livestock and insects) and non-living things they can see.
- Discuss how they are connected or how they affect each other.

Fig. 27. An AESA session

Step 2: After 20 minutes of observation, recording and discussion, return to the meeting place. Each group will do the following:

- Draw a picture showing all the things that they observed and draw lines to show which things are connected or affect each other.
- Make a presentation to explain what they have drawn to the big group.

Examples of indicators for monitoring interactions and processes through AESA

Frequency of monitoring	Indicators
At start of experiment	Initial land use, soil type, soil moisture, land area, date of planting, germination rate, etc.
Periodically	Signs of stemborer, fall armyworm and striga infestation, other pests, soil cover, soil life, soil moisture, etc.
Frequently	Rainfall, plant growth, pests and diseases, soil moisture, moisture stress, management practices carried out, labour input, benefits obtained
At end of experiment	Crop height, grain yield, biomass yield, soil nutritional level, total labour input, total benefits, cost/benefit analysis

Topic 3: Group assessment

Introduction

There is a lot to learn and this can be challenging. People learn at different rates. Some find it easy, while others may find it difficult. The aim of group learning lesson is to maximise the resource of the fast learners for the benefit of the whole group, through sharing of experiences and challenges. If you achieve all the above you will have an effective FFS experience.

Do not use negative criticism, be objective and positive in your comments.

Now you have been working together as a group for 6 – 7 weeks; and you have had time to apply on your farm what you have learned in the field school. It is time to go out and see how you and your colleagues have laid out your Climate-smart push–pull and the check plots. The purposes of this are to:

- Maximise your group learning.
- Learn from each other's (good and bad) experiences.
- Correct any errors that may have been made.

Learning objective

The objective of this assessment is to maximise interactive learning through group discussion and evaluation.

What to do in the assessment

Step 1: Form groups of 4 – 6 members.

Step 2: Each group visits each farm represented by the members in the group.

Step 3: Use the table below to assess the Climate-smart push–pull and the check plots, and discuss with the farmer. Rate each farm using this scale:

1 = Poor 2 = Average 3 = Good

	Climate-smart push–pull plot		Check plot	
What to check	**Rating**	**Comments**	**Rating**	**Comments**
Field preparation				
Layout of the field				
Cleanliness of the plots				
Germination of sorghum				
Brachiaria grass establishment				
Germination of greenleaf desmodium				
Germination of greenleaf desmodium in the pots				
Record-keeping				
Total rates				

Other comments

_____

_____

_____

Labour cost

	Activity	No. of people working on this activity	Time taken to complete the activity (hours)	Cost of labour per day	Total cost of this activity
Climate-smart push–pull plot	Gapping brachiaria grass				
	Other				

Farmer's field

General information				
Date				
Variety of sorghum planted				
Date of planting:		Fertiliser applied:		
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Rainfall: Number of days it rained the week before: _____				
Soils				
• Soils colour:				
• Soil moisture:				
• Soil depth:				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Season 1, Week 4

	Topic	Duration	What you need for this lesson
1	Sources of stemborer infestation	1 hour 30 minutes	Pictures and samples of grasses, hand lens (if available), sharp knives or blades, vials, Petri dishes, small containers, e.g. shoe polish containers; plastic buckets (5 litres)
2	Sources of fall armyworm infestation	1 hour 30 minutes	

Introduction

Many types of wild grasses grow in Africa. Stemborers live and feed on some of these grasses. Similarly, many types of useful insects that attack and destroy stemborers also live on these grasses. This lesson will show the farmers how wild grasses contribute to the overall management of stemborers in the Climate-smart push–pull strategy.

Topic 1: Sources of stemborer infestation

Learning objective

On completion of this topic, participants will be able to identify grasses on which stemborers prefer to live.

Learning activities

- Facilitator-led introduction on the various types of grasses on which stemborers prefer to live.
- Field visits to observe the presence of stemborers on various grasses.
- Discussion (Lead question: Which grasses have the highest stemborer presence?)

Topic 2: Sources of fall armyworm infestation

Learning objective

On completion of this topic, participants will be able to identify grasses on which fall armyworm prefer to live.

Learning activities

- Facilitator-led introduction on the various types of grasses on which fall armyworm prefer to live.
- Field visits to observe the presence of fall armyworm on various grasses.
- Discussion (Lead question: Which grasses have the highest fall armyworm presence?)

Identifying host grasses

Step 1: Form groups of 4 – 6 members. Facilitator leads groups in a field walk collecting five different types of grasses and dissecting 10 stems of each type of grass.

Step 2: Groups use the pictures provided to try and find out their names. Figures 28 – 30 are examples of common grasses.

Step 3: Groups give the local names of the grasses they have collected.

Step 4: The participants count and record the number of larvae present on each dissected grass type.

Fig. 28. Signal grass

Fig. 29. Wild sorghum

Fig. 30. brachiaria grass

Step 5: The participants place these in 20 plastic containers.

Step 6: Record your observations in the table shown below

Grass name	Local name	Total no. of stems dissected	Total no. of stemborer larvae	Number of larvae per stem
1.				
2.				
3.				
4.				
5.				
6.				
7.				

General information				
Date				
Crop health	**Poor**	**Average**	**Good**	
• Sorghum Climate-smart push–pull plot				
• Sorghum check plot				
• Brachiaria grass				
• Greenleaf desmodium				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Rainfall: Number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Farmers' comments after the lesson:

_____

_____

_____

_____

Season 1, Week 5

	Topic	Duration	What you need for this lesson
1	1st weeding, thinning and top dressing sorghum in both Climate-smart push–pull and check plots	2 hours	*Jembe,* CAN fertiliser, teaspoon/soda bottle top, greenleaf desmodium seedling planted in a pot/tin in Week 1, small amounts of greenleaf desmodium seeds, fine dry sand
2	Weeding (and top dressing) of brachiaria grass	1 hour	
3	Identifying desmodium seedlings	30 minutes	
4	Hand weeding and gapping desmodium	1 hour	

Introduction

Weeds compete with your crops (sorghum, greenleaf desmodium and brachiaria grass) for water, soil nutrients, light and space. Therefore, early weeding of crops is important. It is essential to carry out the first weeding when sorghum is three weeks old. If you delay the weeding your crops will be unhealthy.

Thinning of sorghum to one plant per hill is essential. If there are too many sorghum plants per hill, they will compete with each other for food and light, and not grow well.

Top dressing is particularly important in poor soils associated with striga, and for growing hybrid sorghum. At the time of topdressing, sorghum should be free of weeds. The need for top dressing is less after the third season in the Climate-smart push–pull plot.

Topic 1: 1st weeding, thinning and top dressing sorghum in both Climate-smart push–pull and check plots

Learning objectives

On completion of this topic, participants will:

- Understand and explain the importance and proper timing, weeding, thinning and top-dressing of sorghum.
- Demonstrate proper weeding, thinning and top dressing of sorghum.

Learning activities

- Facilitator-led introduction on importance and proper timing of weeding, thinning and top dressing of sorghum.
- Practical activities on weeding, thinning and top dressing of sorghum.
- Discussion.

The growth of sorghum plants in the first week is rather slow and it is during this period that weeds establish and become competitive.

- Weed competition is highest during the period of 2 to 6 weeks after sowing. This time is critical for weed control.
- It is important to keep your plot free of weeds during this critical period of weed competition.

Step 1: Carefully weed your sorghum using a *jembe* or hoe (Fig. 31).

Fig. 31. Weeding sorghum with a hoe

Step 2: Thin the sorghum to one plant per hill, leaving the healthiest plant.

Step 3: Top dress the sorghum with CAN at the rate of one teaspoon or soda bottle top per plant. Scoop the fertiliser and sprinkle it around the base of the sorghum plants leaving a space of 25 mm (2.5 cm) around the base. Be careful when applying the fertiliser, because if the fertiliser is sprinkled on the stem it can burn the sorghum.

Note

In places where striga is a problem, farmers apply half rates of fertiliser: One half during the first weeding and the other half during the second weeding.

Be careful not to step on the greenleaf desmodium seedlings planted in between the sorghum rows.

Topic 2: Weeding and top dressing of brachiaria grass

Learning objectives

On completion of this topic, participants will:

- Understand and explain the importance and the timing of weeding and top dressing brachiaria grass.
- Demonstrate weeding and top dressing of brachiaria grass.

Learning activities

- Facilitator-led introduction on importance and time of weeding and top dressing of brachiaria grass.
- Practically weed and top dress brachiaria grass.
- Discussions.

1st Weeding of brachiaria grass in Climate-smart push–pull plot

Step 1: Carefully weed your brachiaria grass using a *jembe* or hoe.

Step 2: (Optional step if your brachiaria grass is not growing well) Top dress the brachiaria grass with CAN at the rate of one teaspoon or soda bottle top per plant. Scoop the CAN fertiliser and sprinkle it around the base of the brachiaria grass. Leave a space of 25 mm (2.5 cm) around the base. Be careful when top dressing, because if the fertiliser is sprinkled on the stem it can burn the brachiaria grass.

Topic 3: Identifying greenleaf desmodium seedlings

Learning objectives

On completion of this topic, participants will recognise desmodium seedlings and differentiate them from weeds.

Learning activities

- Facilitator-led introduction on identifying desmodium seedlings.
- Practical observation of greenleaf desmodium seedlings and weeds of the same age.
- Discussion.

Identification of greenleaf desmodium seedlings

Step 1: Walk around and pick the weeds growing around the plot.

Step 2: Compare the weeds you have picked with the greenleaf desmodium seedlings in the pot/tins planted in Season 1, Week 1 and identify the differences.

Step 3: Walk through the field and see whether you can tell the difference between the greenleaf desmodium seedlings and the weeds growing on the plot.

Topic 4: Hand weeding and gapping desmodium

Learning objectives

On completion of this topic, participants will:

- Understand the importance of timing of hand weeding and gapping of greenleaf desmodium seedlings.
- Hand weed, gap and top dress desmodium seedlings.

Learning activities

- Facilitator-led introduction on the importance and proper timing for hand weeding and gapping of greenleaf desmodium.
- Hand weeding and gapping of greenleaf desmodium seedlings.
- Discussion.

Hand weeding and gapping greenleaf desmodium

Once you can tell the difference between the greenleaf desmodium seedlings and weeds, it will be easier for you to weed the greenleaf desmodium seedling rows.

Weeding

Step 1: Carefully walk down the greenleaf desmodium rows and look for weeds.

Step 2: Pull the weeds out gently by hand using a small sharp stick (Fig. 32). Continue until the whole plot is weeded.

Fig. 32. Weeding greenleaf desmodium by hand

Gapping

Step 1: Walk down the greenleaf desmodium rows and identify the gaps.

Step 2: Thoroughly mix desmodium seed with fine sand in the ratio of one part desmodium to two parts sand (Week 1, Fig. 24).

Step 3: Using a strong pointed stick, make a furrow 1 – 2 cm deep along the greenleaf desmodium lines where they need gapping.

Step 4: Drill the desmodium/sand mixture prepared in Step 2 into the furrow and cover with a light amount of soil.

Notes

- *If the soil is light and there is heavy rain just after planting, farmers may find the greenleaf desmodium rows have slightly moved. Therefore, they should make the rows straight after the first weeding. If you do this immediately after rains you may straighten the rows by gently pushing the soil and the seedlings with your hands.*
- *Weeding should only be done when the soil is moist. Weeding when the soil is dry disturbs the roots of greenleaf desmodium seedlings and can kill the young seedlings.*

Labour costs

	Activity	No. of people working on this activity	Time taken to complete the activity (hours)	Cost of labour per day	Total cost of this activity
Climate-smart push–pull plot	Sorghum: Weeding, thinning and top dressing				
	Weeding and gapping greenleaf desmodium				
	Weeding (and top dressing) brachiaria grass				
	Any other activity				
Total					
Check plot	Sorghum: Weeding, thinning and top dressing				
	Any other activity				
Total					

Input costs

	Input used	Quantity used	Cost
Climate-smart push–pull plot	Fertiliser		
	Other		
Total			
Check plot	Fertiliser		
	Other		
Total			

General observations (AESA): Farmer's fields

General information				
Date				
Crop age				
Crop health	**Poor**	**Average**	**Good**	
• Sorghum Climate-smart push–pull plot				
• Brachiaria grass				
• Greenleaf desmodium				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Rainfall: Number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*		*Hot/Cold*	

Season 1, Week 6

	Topic	Duration	What you need for this lesson
1	Identifying stemborers	1 hour 30 minutes	Stemborers: Picture of moths and real moths; stemborer eggs
2	Identifying fall armyworm	1 hour 30 minutes	Fall armyworm: Picture of moths and real moths; fall armyworm eggs
3	Identifying striga	1 hour 30 minutes	• Samples of striga at various stages of growth • Knives, pictures of damaged plants, hoe, flip charts, posters, marker pens, masking tapes
4	Gapping of greenleaf desmodium (seed plot)	40 minutes	Small amounts of greenleaf desmodium seed, fine sand to gap the greenleaf desmodium seedling rows

Topic 1: Identifying stemborers

Introduction

Stemborers are a big threat to sorghum and cereal production in Africa. The Climate-smart push–pull technology aims to eliminate this problem; and hence, improve the agricultural productivity of the small-scale farmer. This topic is designed to help you to identify and understand stemborers.

Learning objectives

On completion of this topic, farmers will:

- Identify the stemborer eggs, larvae, pupae and adult moths.
- Describe the life cycle of stemborers.

Learning activities

- Facilitator-led introduction on identification of stemborers.
- Field walks to identify stemborers.
- Facilitator-led discussion on description of life cycle of stemborers.

Procedure

Step 1: The facilitator shows the farmers pictures of the two types of stemborer: *Busseola fusca* (Fig. 33) and *Chilo partellus* (Fig. 34).

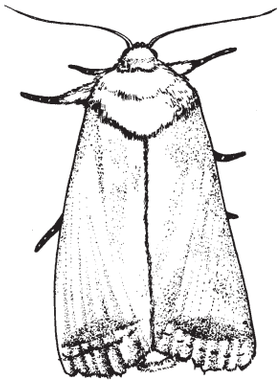

Fig. 33. ***Busseola fusca***

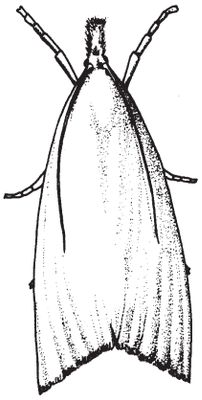

Fig. 34. ***Chilo partellus***

Step 2: Farmers walk around the plots and recover stemborers from grasses by dissecting the plants.

Step 3: Farmers note the type of grass where the stemborers are the most present.

Step 4: Farmers come together and try to identify which of the stemborers are *Chilo partellus* and which are *Busseola fusca.*

Step 5: Farmers walk into the check plot and identify the eggs of stemborers in sorghum.

Note

Busseola fusca *lays its eggs between stem and leafsheaths (Fig. 35) and* ***Chilo partellus*** *lays its eggs on plant surface in form of egg batches (Fig. 36).*

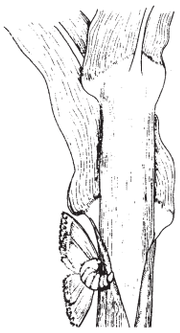

Fig. 35. *Busseola fusca* laying eggs on sorghum

Fig. 36. *Chilo partellus* laying eggs on sorghum leaf surface

Step 6: Farmers infest the potted plants (planted in **Season 1, Week 4**) with stemborer eggs.

Topic 2: Identifying fall armyworm

Introduction

The fall armyworm (*Spodoptera frugiperda*), FAW, is an insect that feeds on more than 80 plant species. These include maize, rice, sorghum and sugarcane. It also feeds on vegetable crops and cotton. It has a voracious appetite, and given the correct environmental conditions, it reproduces and spreads quickly. Since late 2016, this insect pest has been spreading across much of sub-Saharan Africa. It can be one of the more difficult insect pests to control in a field. The Climate-smart push–pull technology aims to minimise loss of the sorghum yield that would otherwise occur in a field. This topic is designed to help you identify and understand fall armyworm.

Learning objectives

On completion of this topic, farmers will:

- Identify the fall armyworm eggs, larvae, pupae and adult moths.
- Describe the life cycle of fall armyworm.

Learning activities

- Facilitator-led introduction on identification of fall armyworm.
- Field walks to identify fall armyworm.
- Facilitator-led discussion on description of life cycle of fall armyworm.

Procedure

Step 1: The facilitator shows the farmers pictures of fall armyworm (Figs. 37-38).

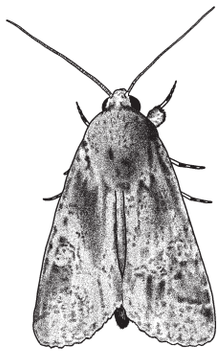

Fig. 37. *Spodoptera frugiperda* female adult

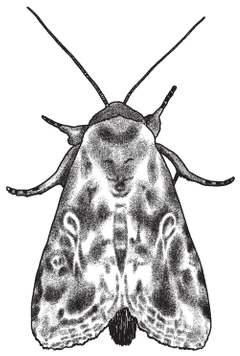

Fig. 38. *Spodoptera frugiperda* male adult

Step 2: Farmers walk around the plots and collect fall armyworm from plants.

Step 3: Farmers come together and try to identify fall armyworm larvae.

Step 4: Farmers walk into the check plot and identify the eggs of fall armyworm in sorghum.

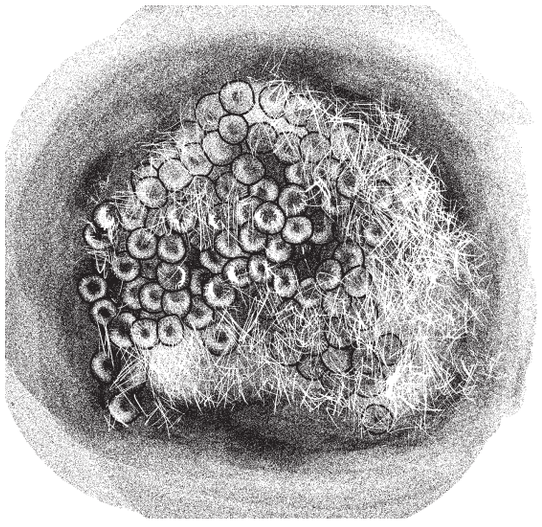

Fig. 39. Fall armyworm egg mass

Note

The adult females lay eggs in batches of 100 to 200 on the underside of leaves. The eggs are white, pinkish or light green and dome-shaped. The female also deposits a layer of greyish scales between the eggs and over the egg mass. This gives the eggs a hairy or mouldy appearance.

Topic 3: Identifying striga

Introduction

Striga or (commonly known as witchweeds) is a genus of parasitic weeds that affect cereal crops in many parts of Africa, sometimes causing a total loss of the crop. The weed does not grow on its own. It grows by attaching itself onto a host plant. As striga seed germinates, its roots grow and penetrate, and attach to the host crop's roots to get food. This makes the crops stop growing normally (severe stunting) leading to huge yield losses. The most affected crops include sorghum, maize, rice and millet.

Many farmers cannot identify striga and they do not know how dangerous the weed is. This topic will help you to understand striga and identify the damage it causes to your sorghum.

Learning objectives

On completion of this topic, farmers will:

- Identify different types of striga weed.
- Describe striga biology and the damage it causes to sorghum plants.

Learning activities

- Facilitator-led introduction on identification of striga.
- Field walks to identify striga.
- Facilitator-led discussion on description of striga biology and damage.

Fig. 40. *Striga hermonthica*: pinkish flowers

Fig. 41. *Striga asiatica*: Deep red flowers

Procedure

Step 1: Farmers are shown samples of striga weeds *Striga hermonthica* (Fig. 40) and *Striga asiatica* (Fig. 41).

Step 2: Farmers observe and discuss features of striga: Leaves, flowers and seeds.

Step 3: Farmers are shown samples of striga–infested sorghum (Fig. 42).

Fig. 42. Striga weed attached to sorghum roots

Step 4: Farmers walk in the fields around the plots and see whether they can identify striga.

Step 5: Mark 10 striga-infested plants for observation in Week 10.

Topic 4: Gapping of greenleaf desmodium on the seed production plot

Introduction

Some of the greenleaf desmodium seeds that were drilled into the soils may not have germinated. This is easy to tell from the gaps between the growing seedlings. Gapping or filling the spaces where desmodium failed to grow needs to be done early so that the whole crop can grow together.

Learning objective

On completion of this topic, participants will demonstrate proper gapping of greenleaf desmodium seedlings on the seed production plot.

Learning activities

- Facilitator-led discussion on importance and the proper ways of gapping of greenleaf desmodium.
- Actual gapping of the greenleaf desmodium.

How to gap greenleaf desmodium on the seed production plot

Step 1: Walk along the rows of greenleaf desmodium and mark the gaps where desmodium failed to grow. Take care not to step on the young seedlings.

Step 2: Thoroughly mix desmodium with fine sand in the ratio of one part desmodium to two parts sand (Fig. 24 on page 24 of this book).

Step 3: Using a strong pointed stick, make a furrow 1 – 2 cm deep along the greenleaf desmodium lines where they need gapping.

Step 4: Drill the desmodium/sand mixture prepared in Step 2 into the furrow and cover with a light amount of soil.

Notes

- *You do not need fertiliser during gapping, because the fertiliser you applied during planting is still in the soil.*
- *You should gap when the soil is moist so that the seeds can germinate and catch up with the already growing crop.*

Labour cost

	Activity	No. of people working on this activity	Time taken to complete the activity (hours)	Cost of labour per day	Total cost of this activity
Seed multiplication plot	Gapping greenleaf desmodium				
	Other				

General observations (AESA): Farmer's fields

General information				
Date				
Crop age				
Crop health	**Poor**	**Average**	**Good**	
• Sorghum Climate-smart push–pull plot				
• Brachiaria grass				
• Greenleaf desmodium				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Rainfall: Number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Farmers' comments after the lesson:

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Season 1, Week 7

	Topic	Duration	What you need for this lesson
1	2nd weeding of sorghum	45 minutes	*Jembe*, hoe, sharp stick
2	2nd weeding of brachiaria grass	30 minutes	
3	2nd hand weeding of desmodium	1 hour	
4	1st hand weeding of greenleaf desmodium seed production plot	1 hour	

Introduction

By now, your sorghum is five weeks old and new weeds have grown that you will need to remove, otherwise they will affect the growth of your sorghum crop. Similarly, new weeds have grown in your brachiaria and desmodium. This time desmodium has grown and you can recognise it.

Topic 1: 2nd weeding of sorghum

Learning objective

On completion of this topic, participants will be able to:

- Understand the importance of 2nd weeding of sorghum.
- Demonstrate proper weeding of sorghum.

Learning activities

- Facilitator-led introduction on the importance of 2nd weeding of sorghum
- Actual weeding on both Climate-smart push–pull and the check plots
- Discussions on weeding sorghum fields.

How to weed sorghum

Carefully weed your sorghum using a *jembe* or a hoe.

- Make sure you cover the bottom part of the sorghum plants with ample soil.
- You may have applied the first half of fertiliser on your sorghum plot. Now you can apply the second half.

Topic 2: 2nd weeding of brachiaria grass

Learning objectives

On completion of this topic, participants will:

- Understand and explain the importance and the timing of 2nd weeding of brachiaria grass.
- Demonstrate proper weeding of brachiaria grass.

Learning activities

- Facilitator-led introduction on the importance and time of 2nd weeding of brachiaria grass.
- Practically weed brachiaria grass.
- Discussions on weeding brachiaria grass.

How to weed brachiaria grass

Carefully weed your brachiaria grass using a *jembe* or hoe.

- Take care not to weed close to the base of the growing grass and the young root splits, otherwise you will interfere with the roots. The weeds close to the base can be pulled out by hand.
- There is no need to add fertiliser to your brachiaria grass at this stage.

Topic 3: 2nd hand weeding of greenleaf desmodium

Learning objectives

On completion of this topic, participants will:

- Understand the importance and timing of 2nd hand weeding of greenleaf desmodium.
- Practically demonstrate the 2nd hand weeding of the greenleaf desmodium.

Learning activities

- Facilitator-led introduction on importance and the proper time for 2nd hand weeding.
- Actual hand weeding.
- Discussions on weeding greenleaf desmodium.

Hand weeding and gapping of greenleaf desmodium

At this time, you can tell the difference between the greenleaf desmodium seedlings and weeds, but remember that the gapped plants will be much smaller than the original crop.

Walk down the rows of greenleaf desmodium seedlings and look for the weeds. Carefully pull them out by hand using a small sharp stick (Fig. 43). Continue untill the whole plot is weeded.

Fig. 43. Weeding the greenleaf desmodium plot

Note

It is not necessary to apply fertiliser at this stage.

Topic 4: 1st hand weeding of greenleaf desmodium seed production plot

Learning objectives

On completion of this topic, participants will be able to:

- Understand the importance of hand weeding of greenleaf desmodium.
- Hand weed the greenleaf desmodium seed production plot.

Learning activities

- Facilitator-led introduction on importance and the proper time for hand weeding and gapping of greenleaf desmodium.
- Hand weeding and gapping of greenleaf desmodium seedlings.
- Discussions.

Now that you can tell the difference between the greenleaf desmodium seedlings and weeds, it is easy for you to weed the greenleaf desmodium seedlings.

Walk down the rows of greenleaf desmodium seedlings in the seed production plot and look for the weeds. Carefully pull them out by hand using a small sharp stick (Fig. 43). Continue until the whole plot is weeded.

Note

Weeding should only be done when the soil is moist. Weeding when the soil is dry disturbs the roots of desmodium seedlings. This can kill the young seedlings.

Labour costs

	Activity	No. of people working on this activity	Time taken to complete the activity (hours)	Cost of labour per day	Total cost of this activity
Climate-smart push–pull Plot	Weeding sorghum				
	Weeding greenleaf desmodium				
	Weeding brachiaria grass				
	Any other activity				
Total					
Check plot	Sorghum: Weeding				
	Any other activity				
Total					
Seed multiplication plot	Greenleaf desmodium weeding				
	Any other activity				
Total					

General observations (AESA): Farmer's fields

General information				
Date				
Crop age				
Crop health	**Poor**	**Average**	**Good**	
• Sorghum Climate-smart push–pull plot				
• Brachiaria grass				
• Greenleaf desmodium				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Stemborers				
Striga				
Rainfall: Number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Season 1, Week 8

	Topic	Duration	What you need for this lesson
1	Stemborer damage and symptoms	1 hour	Samples of striga at various stages of growth, knives, pictures of damaged plants, hoe, flip charts, posters, marker pens, masking tape
2	Fall armyworm damage and symptoms	1 hour	
3	Identifying striga	30 minutes	

Topic 1: Stemborer damage and symptoms

Introduction

Now that you already know what stemborers are, it is important that you are also able to identify the damage they cause to your crop, and the damage symptoms.

Learning objective

On completion of this topic, participants will be able to recognise damage caused by stemborers in sorghum.

Learning activities

- Facilitator-led introduction to stemborer damage and the effects on sorghum plants.
- Identifying damage caused by stemborers.
- Field walks to observe stemborer infestation and damage level.
- Observing the plants in pots (from Week 6) for stemborer damage.
- Discussions.

Notes

- *Stemborers are most destructive during the larvae stage. The larvae first feed on young leaves but soon enter into the stems where they feed and grow for 2 – 3 weeks (Fig. 44).*
- *During early stage of the crop growth, larvae may kill the growing points resulting in deadheart (Fig. 45).*
- *At a later stage of growth, extensive tunnelling inside the stem weakens the stalk so that the plant breaks or lodges (Fig. 46).*

Fig. 44. Sorghum leaves showing damage caused by stemborer

Fig. 45. Deadheart caused by stemborer larvae feeding inside sorghum plants

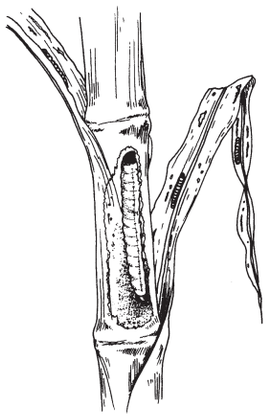

Fig. 46. A stemborer larva feeding inside sorghum stem

Topic 2: Fall armyworm damage and symptoms

Introduction

Now that you already know what fall armyworm is, it is important that you are also able to identify the damage fall armyworm causes to your crop, and the damage symptoms.

Learning objective

On completion of this topic, participants will be able to recognise damage caused by fall armyworm in sorghum plants and their symptoms.

Learning activities

- Facilitator-led introduction on fall armyworm damage and the effects on sorghum plants
- Identifying damage caused by fall armyworm.
- Field walks to observe fall armyworm infestation and damage level.
- Discussions on observations made.

Notes

- *Fall armyworm is most destructive during the larval stage. The caterpillars (larvae) migrate to new feeding areas in the cool of the night (Fig 47). Early infestation may be hard to notice before the population builds up, unless you observe the field closely (Fig. 48). This is mainly because the eggs hatch to young larvae that feed on the surface, usually on the undersides of leaves. Feeding results in semi-transparent patches, or 'windows', on the leaves. The larvae eventually burrow/drill into plant parts and hide inside (Fig. 49).*

Fig. 47. Sorghum plant bearing damage caused by fall armyworm larvae

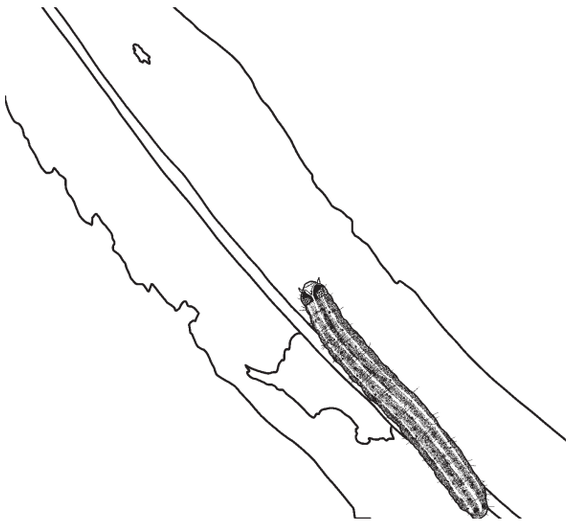

Fig. 48. Larva on a sorghum leaf

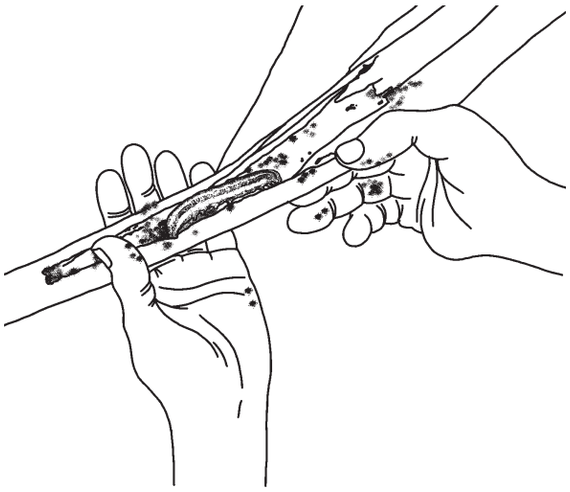

Fig. 49. Armyworm larva inside the stem of the sorghum plant

- *To locate fall armyworm in sorghum whorls, the whorl leaf must be pulled from the plant and unfolded. Large quantities of frass (caterpillar poo), which resembles wet sawdust, is present where the larvae feed within the whorl.*
- *Often, their presence is noticed when damage to the plant is already severe. Intensive feeding of the crop may look like a severe case of hailstones.*
- *Fall armyworm may also infest sorghum panicles after panicle emergence. Young, small larvae feed first on spikelet flowering parts. As larvae grow larger, they feed on developing kernels. Most damage to kernels is caused by larger larvae and about 80% of kernel consumption is by the last two larval instars (an instar is a developmental stage between two periods of moulting). Frass and moulds are associated with panicle infestations by fall armyworm.*

Topic 3: Identifying striga

This is a continuation of **Week 6, Topic 3.** By this stage some of the striga plants have emerged above the ground. Some level of damage is also obvious.

Learning objectives

On completion of this topic, participants will be able to:

- Identify emerging striga weed.
- Identify symptoms of damage on crops that are infested with striga.

Learning activities

- Facilitator-led introduction of striga weed.
- Observation of striga plants in the field.
- Measure the height of healthy and striga-infested sorghum plants marked in Week 6.
- Discussions on observations made.

General observations (AESA): Farmer's fields

General information				
Date				
Crop age				
Crop health	**Poor**	**Average**	**Good**	
• Sorghum Climate-smart push–pull plot				
• Brachiaria grass				
• Greenleaf desmodium				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Stemborers				
Fall armyworm				
Striga				
Rainfall: Number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*		*Hot/Cold*	

Indicator	**Observation**	
	Climate-smart push–pull field	**Check plot**
Height of sorghum (in cm or ft)		
Natural weeds		
No. of striga plants		
Stemborer infestation on sorghum (Y/N)		
Stemborer infestation on brachiaria grass (Y/N)		
Fall armyworm infestation on sorghum (Y/N)		
Number of larvae on 5 damaged plants		
Number of larvae on 5 potted plants		

Season 1, Week 9

	Topic	Duration	What you need for this lesson
1	The biology of stemborers	1 hour	Petri-dishes/shoe polish containers, sharp knives
2	The biology of fall armyworm	1 hour	
3	2nd weeding of greenleaf desmodium seed multiplication plot	30 minutes	

Introduction

This week is a continuation of topics on stemborer, fall armyworm and striga covered in **Weeks 6 and 8.**

Topic 1: The biology of stemborers

Learning objectives

On completion of this topic, participants will understand and describe the life cycle of stemborers from egg to larval stages.

Learning activities

- Facilitator-led introduction on the stemborer life cycle from eggs to larvae.
- Field walks to identify and collect stemborer damaged plants.
- Observe the potted plants from **Week 6** for stemborer damage.
- Discussions.

Procedure

Step 1: Collect 5 damaged plants from the field and 5 potted plants that were infested with eggs in **Week 6.**

Step 2: Carefully dissect the plants and observe and count the stemborer larvae inside the stem and in the whorl/funnel.

Step 3: Record the damage and the number and size of stemborer larvae.

Topic 2: The biology of fall armyworm

Learning objectives

On completion of this topic, participants will understand and describe the life cycle of fall armyworm from egg to larval/caterpillar stages.

Learning activities

- Facilitator-led introduction on the fall armyworm life cycle from eggs to larvae.
- Field walks to identify and collect fall armyworm – damaged plants.
- Observe the potted plants from **Week 6** for fall armyworm damage.
- Discussions.

Procedure

Step 1: Collect 5 damaged plants from the field and 5 potted plants that were infested with eggs in **Week 6**.

Step 2: Carefully dissect the plants and observe and count the fall armyworm larvae inside the stem and in the whorl/funnel.

Step 3: Record the damage, and the number and size of fall armyworm larvae.

Topic 3: 2nd weeding of greenleaf desmodium seed multiplication plot

Learning objectives

On completion of this topic, participants will be able to:

- Understand and explain the importance of hand weeding of greenleaf desmodium.
- Learn hand weeding of the greenleaf desmodium seed production plot.

Learning activities

- Facilitator-led discussion on importance and the proper time for hand weeding and gapping of greenleaf desmodium.
- Hand weeding and gapping of greenleaf desmodium seedlings.

Now that you can tell the difference between the greenleaf desmodium seedlings (Fig. 50) and weeds, it is easy for you to weed the greenleaf desmodium seedlings.

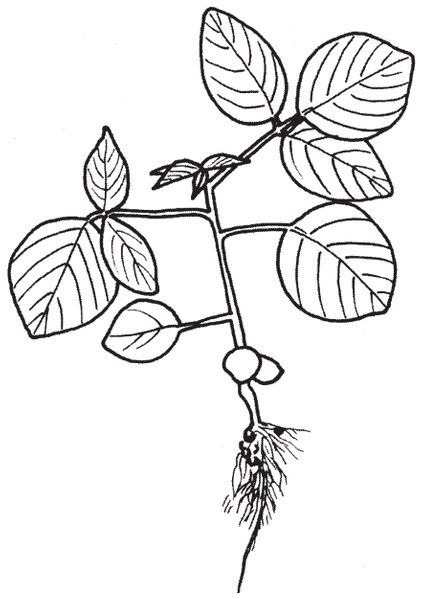

Fig. 50. Greenleaf desmodium plant at early stages (3 weeks old)

Just walk down the rows of greenleaf desmodium seedlings and look for the weeds. Carefully pull them out by hand using a small sharp stick (Fig. 43 on page 48 of this book). Continue until the whole plot is weeded.

Notes

- *Weeding should only be done when the soil is moist. Weeding when the soil is dry disturbs the roots of greenleaf desmodium seedlings. This can kill the young seedlings.*
- *Care must be taken not to dig so close to the base of the desmadium as this can weaken the root.*

Labour costs

	Activity	No. of people working on this activity	Time taken to complete the activity (hours)	Cost of labour per day	Total cost of this activity
Seed multiplication plot	Weeding greenleaf desmodium				
	Any other activity				
Total					

General observations (AESA): Farmer's fields

General information				
Date				
Crop age				
Crop health	**Poor**	**Average**	**Good**	
• Sorghum Climate-smart push–pull plot				
• Brachiaria grass				
• Greenleaf desmodium				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Stemborers				
Fall armyworm				
Striga				
Rainfall: Number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Stemborer and armyworm infestation

Indicator	Observation		
	Climate-smart Push–pull	Check plot	Potted plants
Number of stemborer larvae on 5 damaged plants			
Number of fall armyworm larvae on 5 damaged plants			
Average size of stemborer larvae on 5 damaged plants			
Average size of fall armyworm larvae on 5 damaged plants			
Number of stemborer larvae on 5 potted plants			
Number of fall armyworm larvae on 5 potted plants			
Average size of stemborer larvae on 5 potted plants			
Average size of fall armyworm larvae on 5 potted plants			

Season 1, Week 10

	Topic	Duration	What you need for this lesson
1	Biology of striga	1 hour	*Jembe*, basin, water (to wash the roots), tape measure to measure the height of plants

Introduction

By now you can identify striga and explain how it affects your crops. Our topic this week will help you understand how it grows and multiplies.

Topic: Biology of striga

Learning objective

On completion of this topic, participants will be able to understand and describe striga growth and multiplication.

Learning activities

- Facilitator-led introduction on striga biology.
- Observations on striga growth.
- Discussions.

Procedure

Step 1: Measure the height of 10 striga – infested plants that were marked in **Week 6** and compare with 10 healthy plants.

Step 2: Observe and count the number of striga above the ground 15 cm around the sorghum plant.

Step 3: Carefully dig 15 cm around the 5 smallest striga–infested sorghum plants and lift them out with the soil around their roots.

Step 4: Wash the soil carefully from the roots and observe:

- How the striga roots are attached to the sorghum plant roots.
- The number of striga plants that have come above the ground and those that have not emerged.

Step 5: Record the number of striga plants per sorghum plant.

Indicator	Observation	
	Climate-smart push–pull plot	Check plot
Average height of 10 healthy sorghum plants (in cm)		
Average height of 10 marked striga–infested sorghum plants (in cm)		
Average no. of striga plants around 10 marked sorghum plants		
Average no. of striga plants below ground		

General observations (AESA): Farmer's fields

General information				
Date				
Crop age				
Crop health	**Poor**	**Average**	**Good**	
• Sorghum Climate-smart push–pull plot				
• Brachiaria grass				
• Greenleaf desmodium				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Stemborers				
Fall armyworm				
Striga				
Rainfall: Number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Farmers' comments after the lesson:

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Season 1, Week 11

	Topic	Duration	What you need for this lesson
1	Introduction to profitability analysis	2 hours	All records, calculator, flip charts, chalkboards, marker pens, pens, exercise books, record sheets, record samples of receipts and expenses on crops and livestock enterprises

Introduction

This lesson aims to familiarise participants with the basic methods of checking whether a farming enterprise is making or losing money. This is what you would put in any activity on your farm (costs):

- Money to buy inputs and pay hired workers.
- The time your family and you spend on that enterprise.

This is what you get out of the enterprise (income):

- Use it yourself and not have to buy it from the shop/market. You can then save the money you could have spent and use it for another enterprise.
- Sell produce from that enterprise.

You need to keep proper records of what you put in (cost) and what you get from any farming enterprise (income or benefit) so that you can know whether that enterprise is making money, or making a loss for you.

This lesson will introduce you to two main types of records called the **costs** and **benefits** records. You will learn why you need to keep them and how to use them.

Topic: Introduction to profitability analysis

Learning objectives

On completion of this topic, participants will be able to:

- Explain the importance of recording costs incurred and benefits received.
- Compare the costs and the benefits of two enterprises (Climate-smart push–pull and check plots).

Learning activities

- Facilitator-led introduction on the importance of keeping receipts and expense records.
- Exercise on provided examples of receipts (revenues) and expenses (costs).
- Calculating total expenses and total income.
- Discussion on record keeping.

Recording expenses and receipts for Climate-smart push–pull and check plots

Step 1: Facilitate discussion on costs related to farmers' own practices and Climate-smart push–pull plots (seed, brachiaria grass, fertiliser, labour for land preparation, planting, weeding, etc.)

Step 2: List all the possible costs in both the Climate-smart push–pull and check plots.

Step 3: Facilitate discussion on possible incomes related to farmers' own practices and Climate-smart push–pull plots (yield, fodder, milk, etc.)

Step 4: List all the possible incomes in both the Climate-smart push–pull and check plots.

Step 5: Facilitate brief discussion on how to keep good income records and how to calculate the total income received.

Exercise on recording expenses (costs) and receipts (income)

Step 1: Facilitator to explain the general procedure of the activity and participants' role in it.

Step 2: Ask one of the participants with experience of recording costs of farm inputs to develop a record sheet for expenses and incomes of a specific farm enterprise (e.g., crop).

Step 3: Ask another participant with experience of recording costs of farm inputs to develop a record sheet for expenses and income of another farm enterprise (e.g., livestock).

Step 4: Ask the participants to calculate the total costs and the income received.

Procedure for calculating expenses and income

Cost analysis of Climate-smart push–pull and check plot expenses

Activity	Input	Push–pull			Check plot		
		Qty	Unit price	Total value	Qty	Unit price	Total value
		a	b	c = a × b	d	e	f = d × 8
Land preparation	Labour Equipment						
Planting greenleaf desmodium, sorghum, brachiaria grass	Labour Seed Fertiliser						
Weeding Gapping	Labour						
Top dressing	Fertiliser Labour						
Harvesting	Labour Transport						
Processing	Labour						
	Total costs (T)						

Benefits analysis of revenues from Climate-smart push–pull and check plot (After compiling benefits in each season)

Enterprise	Push–pull			Check plot		
	Qty	Unit	Gross value	Qty	Unit	Gross value
Sorghum (bags)						
Brachiaria (10 kg) (bundles/wheelbarrows)						
Greenleaf desmodium (3 kg)						
(Other produce)						
Total gross value						

General observations (AESA): Farmer's fields

General information				
Date				
Crop age				
Crop health	**Poor**	**Average**	**Good**	
• Sorghum Climate-smart push–pull plot				
• Brachiaria grass				
• Greenleaf desmodium				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Stemborers				
Striga				
Rainfall: Number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Season 1, Week 12

	Topic	Duration	What you need for this lesson
1	Group learning (assessment)	4 hours	All records, calculator, flip chart, chalkboards, marker pens, pens, exercise books, record sheets, record samples of receipts, and expenses on crops and livestock enterprises.

Introduction

Now you have been working together as a group for 16 – 17 weeks, and you have had time to apply on your farm what you have learned in the field school. It is time to go out and see what you and your colleagues have done so that we can all learn from each other's experiences.

This is the second group learning activity since we started the Climate-smart push–pull Farmer Field School. At this stage, we have mature Climate-smart push–pull fields.

Topic: Group assessment

Learning objective

The objective of this group learning activity is to maximise interactive learning through group evaluation of individual farm activities related to the FFS experiment.

Learning activities

- Facilitator-led introduction on group evaluation.
- Farm visits in groups formed in **Week 3**.
- Discussion of group results.

What to do in the assessment

Step 1: Join the groups that you formed in **Week 3**. Each group can be made up of 4 – 6 members.

Step 2: Visit each farm represented by the members in the group.

Step 3: Use the table below to assess the push–pull and the check plots and discuss with the host farmer. Rate each farmer using this scale:

1 = Poor 2 = Average 3 = Good

	Climate-smart push–pull Plot		Check Plot	
	Rating	Comments	Rating	Comments
What to check				
Establishment of sorghum				
Weeding of sorghum				
Establishment of brachiaria grass				
Weeding of brachiaria grass				
Establishment of greenleaf desmodium				
Weeding of greenleaf desmodium				
Record keeping				
Total rates				

Comment on greenleaf desmodium seed multiplication plot (Rates 1 – 3) _____

(1 = Poor 2 = Average 3 = Good)

Other comments

_____

_____

_____

_____

_____

_____

General observations (AESA): Farmer's fields

General information				
Date				
Crop age				
Crop health	**Poor**	**Average**	**Good**	
• Sorghum Climate-smart push–pull plot				
• Brachiaria grass				
• Greenleaf desmodium				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Stemborers				
Fall armyworm				
Striga				
Rainfall: Number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Season 1, Week 13

	Topic	Duration	What you need for this lesson
1	Harvesting brachiaria grass and greenleaf desmodium from Climate-Smart Push–pull	1 hour	A *panga*, ruler or tape measure, *jembe*, chopping log, gunny bags
2	Utilisation of brachiaria grass and greenleaf desmodium from Climate-smart push–pull	1 hour	

Introduction

One of the benefits of Climate-smart push–pull is the rich fodder that can be used to improve the productivity of your livestock. As long as you practice Climate-smart push–pull, you will have fodder to feed your livestock. This lesson will show you how to use fresh brachiaria grass and greenleaf desmodium to feed your livestock and provide you with your first benefit from your Climate-smart push–pull plot.

Topic 1: Harvesting brachiaria grass and greenleaf desmodium from Climate-smart push–pull

Learning objective

On completion of this topic, participants will demonstrate how to correctly and systematically harvest brachiaria grass from a Climate-smart push–pull plot.

Learning activities

- Facilitator-led introduction on importance of harvesting brachiaria grass and greenleaf desmodium at correct stage and in a systematic manner.
- Practical activities on brachiaria grass harvesting.
- Practical activities on greenleaf desmodium harvesting.
- Facilitator-led discussion on fodder production from Climate-smart push–pull. (Lead question: What are the advantages and disadvantages of weeding and applying slurry daily or after harvesting an entire row?)

Note

The best time to harvest brachiaria grass to feed your livestock is when the grass is up to 3 ft (1 metre) high if growth is lush. Do not let your brachiaria grass to seed and get too old because it becomes poor quality livestock feed.

If all the brachiaria matures to harvesting height, the farmer should cut and conserve as hay before it seeds.

Step 1: Start harvesting the inner row nearest the sorghum and harvest this row around the field first, **as much as your livestock needs each day (see tables at the end of this lesson)**(Fig. 51). Always leave a stem height of 1 inch (2.5cm) from the ground at harvesting.

Fig. 51. Harvesting brachiaria grass

Step 2: After you have completed harvesting the inner row, start harvesting the middle row. As you cut the grass, weed and apply manure, slurry or CAN between the cut lines.

How to correctly harvest greenleaf desmodium for fodder

The best stage for harvesting greenleaf desmodium is when it has covered the ground and is starting to flower. For the first season, greenleaf desmodium can be ready for harvesting when sorghum is physiologically mature.

Start harvesting greenleaf desmodium from one side of the plot as per the daily utilisation needs. Collect and take it to the feeding place. (See topic on feed utilisation below). Always leave a stem height of 2 to 4 inches (5 to 10 cm) from the ground at harvesting. See Fig. 52.

Fig. 52. Harvesting desmodium

What NOT to do

- Do not cut or harvest the brachiaria grass across the brachiaria grass rows so as to leave an opening into the Climate-smart push–pull sorghum plot.
- During the first season, do not harvest the greenleaf desmodium until it has established well, or if it has not covered the ground.

Topic 2: Utilisation of brachiaria grass and greenleaf desmodium from Climate-smart push–pull

Learning objective

On completion of this topic, the participants will demonstrate how to prepare and mix brachiaria grass and greenleaf desmodium to feed livestock.

Learning activities

- Facilitator-led introduction on the importance of a balanced animal ration.
- Facilitator-led discussion on importance of brachiaria grass and greenleaf desmodium as feed.
- Practical activities on brachiaria grass and greenleaf desmodium chopping.
- Practical activities on greenleaf desmodium and brachiaria grass ration mixture making.
- Discussion on utilisation of Climate-smart push–pull products.

How to correctly utilise fodder from Climate-smart push–pull

During the wet season, cut brachiaria grass and leave it in the open for at least 30 minutes before chopping. This allows the brachiaria grass to loose some water (wilt) and increases the roughage eaten by the livestock.

Step 1: Carry the harvested fodder to the chopping area, preferably near the feeding area.

Step 2: Chop the harvested brachiaria grass and greenleaf desmodium separately into small pieces of about 1 inch (2.5 cm) (Fig. 53).

Fig. 53. Chopping greenleaf desmodium and brachiaria grass and feeding to livestock

Step 3: Mix three parts of chopped brachiaria grass with one part of chopped desmodium.

Notes

- *To avoid wastage the chopped forage should be fed to livestock in a feed trough.*
- *During the dry season, chop the sorghum stover (See Utilisation of sorghum stover in **Week 18**) into small pieces and mix with the chopped brachiaria grass and desmodium.*

- Always remember to give your livestock the recommended mineral supplements.

What NOT to do

Never allow livestock to graze in the Climate-smart push–pull plot as they will destroy the greenleaf desmodium and the brachiaria grass.

Brachiaria grass and greenleaf desmodium requirements for various breeds of livestock during the rainy season

Breed	Brachiaria grass		Greenleaf desmodium		Total forage	
	Kg/day	Gunny bags/day	Kg/day	Gunny bags/day	Kg/day	Gunny bags/day
Friesian/Ayshire	68 – 82	1. 47 – 1. 78	22 – 28	0. 47 – 0. 60	90 – 110	1. 94 – 2. 38
Guernsey/Jersey	49 – 64	1. 06 – 1. 39	16 – 21	0. 34 – 0. 45	65 – 85	1. 40 – 1. 84
Zebu cattle	49	1. 06	16	0. 34	65	1. 11
Dairy bull	34 – 49	0. 74 – 1. 06	11 – 16	0. 24 – 0. 34	45 – 65	0. 98 – 1. 40
Dairy goat	7. 5 – 11	0. 16 – 0. 24	2. 5 – 4	0. 05 – 0. 08	10 – 15	0. 21 – 0. 32

Brachiaria grass and greenleaf desmodium requirements for various breeds of livestock during the dry season

Breed	Brachiaria grass		Greenleaf desmodium		Total forage	
	Kg/day	Gunny bags/day	Kg/day	Gunny bags/day	Kg/day	Gunny bags/day
Friesian/Ayrshire	53 – 60	1. 15 – 1. 30	17 – 20	0. 36 – 0. 4	70 – 80	1. 51 – 1. 70
Guernsey/Jersey	41 – 49	0. 89 – 1. 06	14 – 16	0. 30 – 0. 35	55 – 65	1. 19 – 1. 21
Zebu cattle	39	0. 84	14	0. 30	55	1. 14
Dairy bull	26 – 39	0. 56 – 0. 84	9 – 14	0. 2 – 0. 3	35 – 55	0. 76 – 1. 14
Dairy goat	6 – 10	0. 13 – 0. 21	2 – 3	0. 04 – 0. 06	8. 5 – 13. 5	0. 17 – 0. 27

Note

One gunny bag of chopped material weighs approximately 46 kg.

Labour costs

	Activity	No. of people working on this activity	Time taken to complete the activity (hours)	Cost of labour per day	Total cost of this activity
Climate-smart Push–pull plot	Harvesting 10 kg of brachiaria grass*				
	Harvesting 3 kg of greenleaf desmodium*				
	Any other activity				
Total					

**These amounts can feed one dairy goat per day.*

Note

Now that you hove calculated the cost of cutting fresh fodder you do not have to do this again. All you have to do is enter in the table below the amount of fodder you use each week.

Benefits

	Type of benefit	Quantity	Amount (market price)
Climate-smart push–pull plot	10 kg brachiaria grass		
	3 kg greenleaf desmodium		
	Other benefit		

General observations (AESA): Farmer's fields

General information				
Date				
Crop age				
Crop health	**Poor**	**Average**	**Good**	
• Sorghum Climate-smart push–pull plot				
• Brachiaria grass				
• Greenleaf desmodium				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Stemborers				
Striga				
Rainfall: Number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Season 1, Week 14

	Topic	Duration	What you need for this lesson
1	How to make and use compost manure	3 hours	A hoe, spade and a two – meter stick

Introduction

Composting is great for the environment. Compost manure is an organic fertiliser that can be made by decomposing plant materials, animal dung and urine, and food left-overs through the help of naturally-existing micro-organisms. These materials are collected and concentrated in a small area. This enables them to decompose fast. Compost is created when these organic materials reach a point where they can no longer decompose. At this stage, it becomes a nutritious fertiliser. The purpose of making compost manure is to recycle the nutrients in the plant and animal leftovers back to the soil and to also create humus.

Topic: How to make and use compost manure

Learning objective

On completion of this topic, participants will demonstrate how to correctly prepare and apply compost manure to their Climate-smart push–pull plots.

Learning activities

- Facilitator-led introduction on activities of the week.
- Facilitator-led discussions on the advantages and disadvantages of compost manure.
- Practical exercise: Visiting pre-established pit.
- Discussion on the exercise.

Note

The use of compost manure will not in itself raise yields. Proper agricultural practices (such as Climate-smart push–pull technology) also need to be applied.

Requirements for optimum decomposition of compost heaps:

- **Micro-organisms:** The quality and rate of decomposition depends on the number of micro-organisms present. Therefore, the more the number of micro-organisms, the better the quality and rate of decomposition.
- **Appropriate environment:** Micro-organisms require adequate humidity, food, air and warmth to be able to remain alive and multiply.
- **Proper arrangement of the organic material to be decomposed:** This is to facilitate the work of the micro-organisms.

Basic requirements for preparing compost

1. Refuse:

Choice of refuse depends on its capability to decompose. Use high nitrogen refuse (such as legumes, fruits and vegetables) and high carbon ingredients (such as straw and seed husks). Availability of nitrogen enables micro-organisms to effect the decomposition process. The materials to be decomposed should be prepared into smaller bits and thorough mixing is also necessary for high quality.

2. Micro-organisms:

Micro-organisms, which include bacteria, fungi, earthworms, ants, termites, millipedes and others, are responsible for the decomposition of the refuse.

3. Prevalence of optimum temperature:

The compost heap undergoes four stages namely:

a. **Lukewarm stage:** Sugar, starch and fats breakdown at this stage.

b. **Rise of temperature to highest level possible:** The weed, seeds and disease-causing organisms in the refuse heap are destroyed at this stage. Farmers are hereby advised to aim at heaps of 1.5 metres. This allows for optimum temperatures in the heap.

c. **Cooling down stage:** Temperatures in the heap go down.

d. **Maturation stage:** Compost manure is ready for farm use.

4. Air:

For the micro-organisms to get the oxygen required for respiration, there should be an adequate amount of air in various parts of the heap.

5. Moisture content:

For optimal functioning of micro-organisms, moderate moisture should be present in the heap. Too little moisture renders the micro-organisms inactive, whereas too much of it will block the air passages. The following practices ensure the presence of moderate moisture in the heap:

a. Preparing the compost heap under a shade to shield it from the wind.

b. Frequently sprinkling the heap with moderate amount of water.

c. Preparing the compost in a pit during drought or hot weather conditions.

d. Covering the heap with internal as well as external covers.

6. Turning and mixing the compost manure heap:

Turn and thoroughly mix the compost heap to ensure high quality compost manure.

Compost preparation process

The choice of the method of preparation of compost manure depends on:

a. Amount and type of refuse available.

b. The capability of the farmer in making compost.

c. Climatic conditions.

Three major compost preparation methods exist:

i. **In special boxes.**

ii. **In compost pits:** This is applicable where there is lack of water or rain. Site for making compost pit should be flat, with no possibility of water getting into the pits. The pit should not exceed a depth of one metre to limit the problem of inadequate air.

iii. **On the earth's surface:** This method is mainly used by farmers in regions that have adequate rains or where there are other sources of water.

The following steps in making compost are applicable to all the methods:

1. Making simple compost from household organic trash or crop residues

Household organic trash or crop residues (such as banana peels, beanstalks or groundnut shells, coffee husks and livestock manure) can be used to make regular quantities of compost. Normally, three pits are used. Uniform decomposition and thorough mixing of the materials are facilitated by turning the materials from one pit to another.

Step 1: Choose a flat, cool shady area and prepare three pits measuring 2 m long by 1.5 m wide and 0.5 m deep.

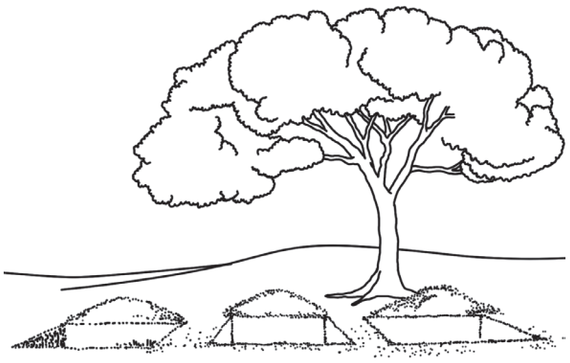

Fig. 54. Compost pits

Step 2: Fill the first pit with organic trash or crop residue to the brim. This process takes time.

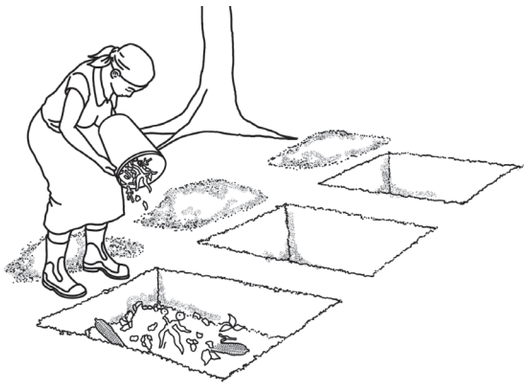

Fig. 55. Filling the first pit with organic trash or crop residue to the brim

Step 3: When the first pit is full, transfer the materials to the second pit. Then refill the first pit.

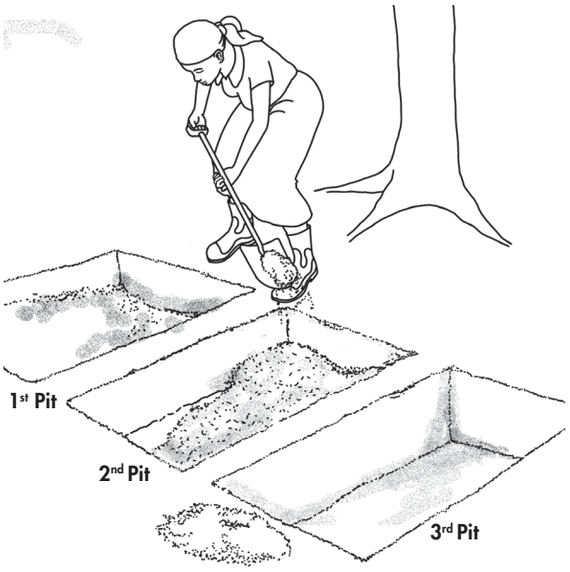

Fig. 56. Transferring material to the second pit

Step 4: Add ash and diluted animal urine (if available) to the content in the second pit. This is done in the ratio 1 part urine:3 parts water.

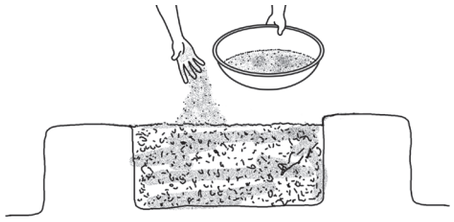

Fig. 57. Adding ash to the second pit

Step 5: Cover the heap in pit 2 with a layer of topsoil of 5 cm followed by dry vegetation to avoid evaporation of moisture.

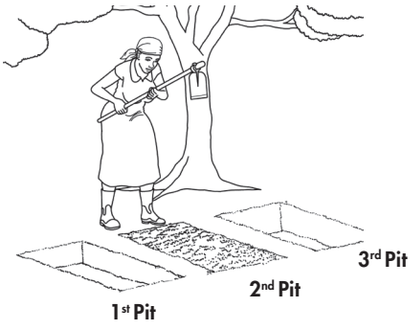

Fig. 58. Covering pit 2

Step 6: Water the heap in the second pit at frequent intervals. This is, however, not necessary when it is raining.

Fig. 59. Compost pits

Step 7: After three weeks, transfer the contents of the second pit to the third pit and cover as in Step 5 and water as required.

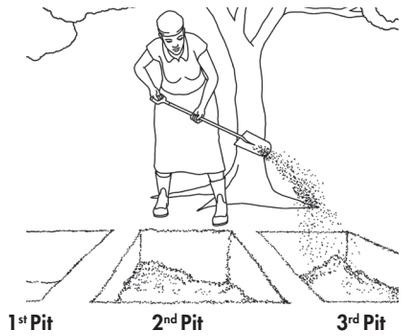

Fig. 60. Compost pits

Step 8: To check the temperature of the heap, drive a dry, sharp stick at an angle into the third pit. Remove it and feel it for warmth every 7 days. Continue this until the stick when removed feels cool indicating that the compost is ready.

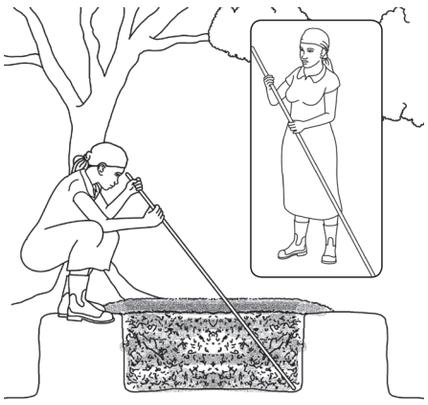

Fig. 61. Checking the temperature of the compost heap

Step 9: Repeat the pit process from Step 2 to Step 8 to get a continuous supply of compost manure.

2. Making vegetation compost

This is made out of fibrous materials (such as hedge cuttings, maize stalks and fodder remains, plant materials both dry and green, livestock manure, topsoil and ash).

Step 1: Choose a flat, cool shady area for preparation of compost.

Step 2: Prepare three pits measuring 2 m long by 1.5 m wide, with a depth of 0.3 m for a wet region or 1 m for a dry region.

Step 3: Loosen the soil at site 1.

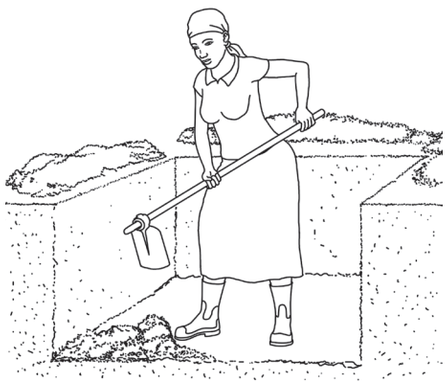

Fig. 62. Loosening the soil at site 1

Step 4: Put the fibrous material chopped to a length of about 5 cm on the bottom layer of the first pit to about 30 cm thick and sprinkle with water.

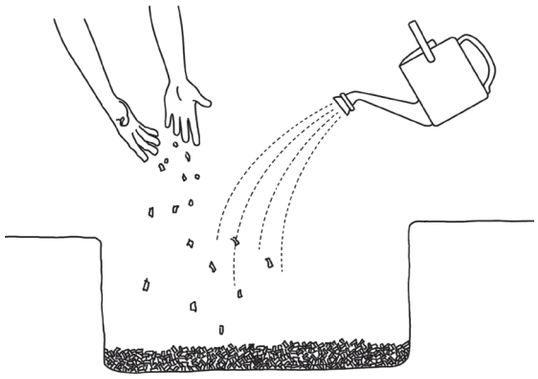

Fig. 63. Adding fibrous chopped material to the bottom layer of the first pit

Step 5: Form a 10 cm thick second layer by putting in dry vegetation material (such as grass, banana leaves and tree leaves), and sprinkle with water.

Step 6: Put a 2 cm thick layer of fresh or semi-decomposed animal dung or slurry from a biogas plant. This layer works to add nitrogen, so as to enable micro-organisms to function well and to add phosphate and other plant nutrients.

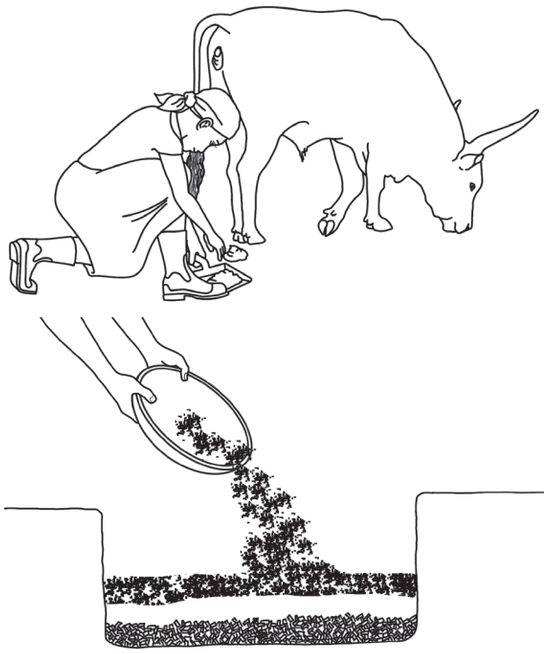

Fig. 64. Adding a layer of fresh or semi-decomposed animal dung or slurry from a biogas plant

Step 7: Sprinkle ash to just cover the materials. Ash contains calcium and potassium. These help in regulating pH.

Step 8: Add a 15 – 20 cm thick layer of green vegetation (such as green plants preferably leguminous) and kitchen trash that decompose easily.

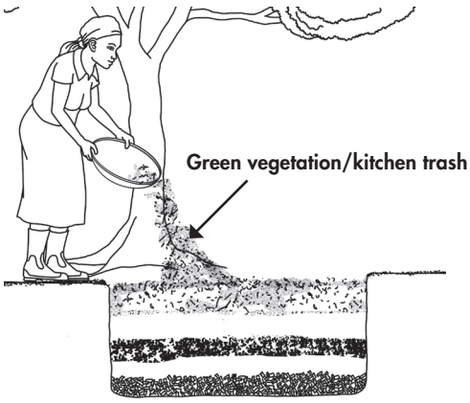

Fig. 65. Adding a layer of green vegetation and kitchen trash

Step 9: Sprinkle with topsoil to a thickness of 2 cm. Topsoil prevents ammonia produced from escaping, prevents loss of temperature, and increases plant nutrients in the heap.

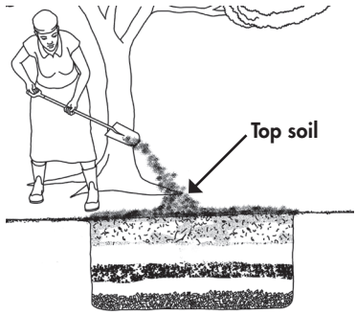

Fig. 66. Sprinkling topsoil

Step 10: Sprinkle water on the whole pile adequately.

Step 11: Repeat the procedure from Step 5 to Step 10 until the pile is about 1.5 m high.

Fig. 67. Sprinkling topsoil onto the compost heap

Step 12: Put a final layer of topsoil to a thickness of about 5 cm. To prevent evaporation of moisture, cover the whole pile with dry vegetation or banana leaves.

Fig. 68. Covering the pile with banana leaves

Step 13: Take a dry sharp stick of about 2 m long into the pile at an angle. This is to help in determining whether the pile is dry or wet. Decomposition will have started within 2 – 3 days if the stick when removed feels warm and moist. Remove the stick and feel it to monitor the moisture and warmth every 7 days.

Fig. 69. Using a stick to determine whether a pile is wet or dry

Step 14: The pile should be watered every 3 to 5 days, depending on the weather conditions.

Step 15: After 3 weeks, turn the pile from the first pit to second pit. Turn it in such a way that

the different layers mix. Continue monitoring for warmth and moisture.

Step 16: After another 3 weeks, turn the pile again. Continue monitoring for warmth and moisture every 3 days. The compost is ready when the stick finally feels cool.

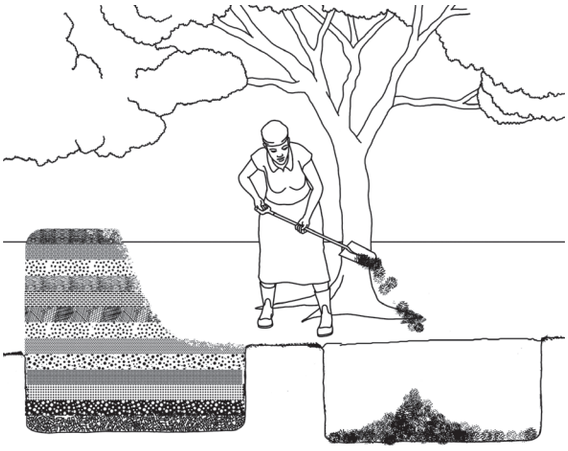

Fig. 70. Turning the pile again

If the compost is ready before the planting season, remove it and store it in a shade covered with a layer of topsoil, banana leaves or polythene, and it should be kept moist.

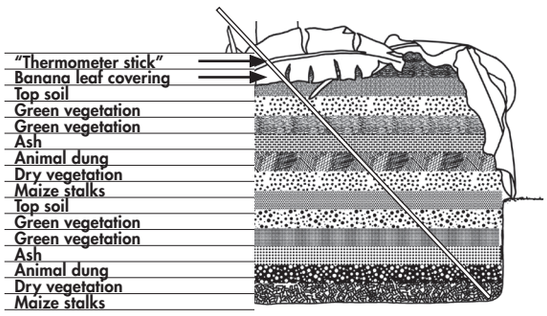

Fig. 71. Composition of a vegetation compost pit

Note:

If the compost is ready before the planting season, remove it and store it in a shade. It should be covered with a layer of topsoil, banana leaves or polythene. It should also be kept moist.

Characteristics of good compost manure

Good compost manure is one that is:

- fully decomposed,
- smooth to the touch,
- darkish brown in colour,
- of pleasant odour,
- of average moisture content,
- without too much heat,
- of good structure,
- free from weeds, disease-causing organisms or live seeds of any kind,
- rich in plant nutrients that it slowly releases to the soil for use by plants.

Application of compost

Compost should be incorporated on the surface soil for best results. During land preparation period, compost manure should be spread over the entire planting area. Loosen the soil with a hoe and mix it with the manure. It could be put in either furrows or rows where crops will be planted. Even though, placing it in planting holes is a tedious exercise, although it is helpful, especially when the amount of manure available is inadequate.

Note:

One bucket of compost manure is adequate for one square metre of soil. However, the larger the amount of compost manure applied, the higher the yields and the longer the soil remains productive.

Season 1, Week 15

	Topic	Duration	What you need for this lesson
1	Using gross margins in profitability analysis	2 hours	Record of receipts and expenses (optional); record sheets, calculator, and flip charts/chalkboards, markers, exercise books, pens

Introduction

When establishing a new enterprise, it is important to consider the economic value it will contribute to your whole farm business. The three ways of calculating the economic value are: the **gross margin, return to land** and **return to labour**. Gross margin is the simplest and the most commonly used.

Gross margin is the difference between the gross income earned from an enterprise and the variable costs (see the table on the next page) incurred in the enterprise for a given period of time (usually per year or per cropping season). A gross margin enables you to evaluate the performance of enterprises that have similar requirements for capital and labour.

Gross margins provide a useful tool in terms of farm management, budgeting and estimating the likely **returns or losses** of a particular enterprise (say, crop). They can, therefore, help you to improve your management or streamline your production.

This week's lesson will show you how to calculate gross margins of Climate-smart push–pull and check plot enterprises on your farm. The same approach can be used in determining gross margins of any other enterprise on your farm.

Topic: Using gross margins for profitability analysis

Learning objectives

On completion of this topic, participants will be able to:

- Explain the importance of gross margin and how to use it.
- Calculate gross margins for the two farm enterprises: Climate-smart push–pull and check plots.

Learning activities

- Facilitator-led introduction on the importance of gross margin and how to use it (Provide examples of receipts and expenses from growing a given crop in a given season).
- Calculate total revenues (income) received and total expenditures (all the input costs and the cost of all hired services) incurred to get gross margins.
- Facilitator-led discussion on importance of gross margins.

Procedure of calculating gross margins

Step 1: Facilitator to explain the general procedure of the activity and the participants' role in it.

Step 2: Using the previous records of costs incurred on the Climate-smart push–pull and check plots, the participants add up all the variable costs incurred, e.g., costs of seed, brachiaria grass, fertiliser, labour, etc.

Step 3: Similarly, using the records of incomes from the Climate-smart push–pull plot and check plot the participants add up all the income received, if any from sorghum, fodder, milk, etc. If no income has been received, reasonable imaginary numbers can be used to learn how to calculate gross margins.

Step 4: Subtract the total expenses from the total income to get the gross margin.

Step 5: Compare the gross margins from the Climate-smart push–pull and the check plots per unit area (per acre/hectare basis). This is a useful means of comparing the enterprises against each other.

Notes

Variable costs: *These are costs that vary directly with the level of output of an activity. For example, if the area under sorghum is increased by 50% then seed, fertiliser, and labour will also increase (though not necessarily by about 50%). Variable costs may determine the yield (level of output) of that activity.*

Fixed costs: *These are costs that do not vary with the level of output of an activity. For example, if you own land, that is your fixed cost.*

Total variable costs (TVC) = Inputs + Operational costs + Equipment costs

Total revenue (TR) = Revenue from Sorghum + Desmodium + brachiaria grass + ……

Gross margin = TR – TVC

Cost analysis of Climate-smart push–pull and check plots

Activity	Input	Climate-smart push–pull			Check plot		
		Qty	Unit price	Total value	Qty	Unit price	Total value
		a	b	c = a × b	d	e	f = d × e
Land preparation	Labour Equipment						
Planting greenleaf desmodium, sorghum, brachiaria grass	Labour Seed Fertiliser						
Weeding/Gapping	Labour						
Top dressing	Fertiliser Labour						
Harvesting sorghum	Labour Transport						
Harvesting fodder	Labour						
Making silage	Labour Inputs						
Processing	Labour						
	Total costs (T)						

Benefit analysis of Climate-smart push–pull and check plots (after compiling benefits in each season)

Enterprise	Climate-smart push–pull			Check plot		
	Qty	Unit	Gross value	Qty	Unit	Gross value
Sorghum (bags)						
Brachiaria grass (units of 10 kg)						
Milk						
Other produce						
Total gross value						

Benefits (Please keep filling the number of units each week as you cut)

	Type of Benefit	Quantity	Unit market price	Total value
Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	Milk			
	Other benefit			

General observations (AESA): Farmer's fields

General information				
Date				
Crop age				
Crop health	**Poor**	**Average**	**Good**	
• Sorghum Climate-smart push–pull plot				
• Brachiaria grass				
• Greenleaf desmodium				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Stemborers				
Striga				
Rainfall: Number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Season 1, Week 16

	Topic	Duration	What you need for this lesson
1	Animal manure collection, storage and application to brachiaria grass	1 hour	Shovels, *jembes*, wheelbarrows, basins, drum, zero grazing unit with slurry pit, well-decomposed manure, *panga* or a sickle, string, gunny bag, rake
2	Collecting, storing and applying slurry to brachiaria grass	30 minutes	
3	Making and utilising desmodium hay	2 hours	

Introduction

Climate-smart push–pull has many by-products. Some of them are useful in improving the soil health on the Climate-smart push–pull and on other parts of the farm. This lesson will show you how to use compost, manure and slurry from animals to improve your land. The lesson will also show you how to conserve some of the by-products of Climate-smart push–pull to feed your animals.

Topic 1: Collecting, storing and applying animal manure on brachiaria grass

Brachiaria grass is a heavy feeder of soil nutrients, and the soil needs to be replenished regularly. Farmyard manure is a good and cheap way of doing this. The best results can be achieved during the rainy season.

Farmyard manure is a decomposed mixture of livestock dung and urine with straw and litter used as bedding material and residue from the fodder fed to the livestock. Manure improves soil fertility where fodder and crops are grown. Manure also improves the soil texture and the capacity of the soil to absorb and hold water.

Learning objectives

On completion of this topic, participants will:

- Understand the importance of farmyard manure.
- Collect and store manure.
- Apply manure to brachiaria grass.

Learning activities

- Facilitator-led introduction to importance of farmyard manure and handling to apply it to brachiaria grass.
- Practical activities on collection, storage and manure application to brachiaria grass.
- Facilitator-led discussions (Lead question: What makes good quality manure?)

Procedures

1. How to collect, decompose and store manure

Note

Manure quality will be good if the cows are fed with high quality feed such as legumes and brachiaria grass.

Step 1: Collect animal manure from the animal *boma* regularly and high carbon material, such as dry leaves and dry grass clippings.

Step 2: Select a location where you can build a one metre square pile and have room to turn it.

Step 3: Spread about 8 cm layer of dry organic material on the square area. Spread about 5 cm of dry animal manure (cow dung) on top of it. Continue layering until the pile is 1 metre tall. Water the pile as you build it so it is slightly damp all the way through. Cover with a layer of soil.

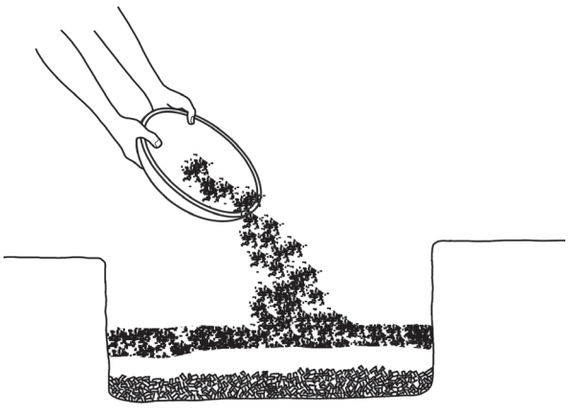

Fig. 72. Building the square meter pile

Step 4: Turn the pile using a shovel or a forked jembe at least twice a month to ensure that all the materials are well decomposed. Keep the pile moist but not soggy.

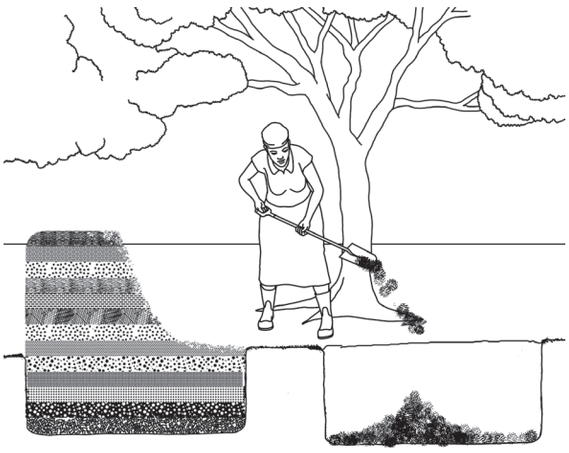

Fig. 73. Turning the pile

Check the temperature of the centre of the pile when you turn it. It should be between 48 and 70 degrees Celsius.

Step 5: Use the compost when it stops heating in the centre and is dark brown, crumbly, and has an earthy smell.

Leave the well-decomposed manure under the shade until you are ready to use it.

2. How to apply manure to brachiaria grass

Step 1: After cutting the brachiaria grass, first apply manure and then weed. This allows the manure to mix well with the soil.

Step 2: Spread two handfuls of well decomposed manure on and around the base of cut brachiaria and weed.

What NOT to do

Do not heap soil and manure on brachiaria grass during weeding. This will expose the shallow roots and reduce the plant growth.

Topic 2: Collecting, storing and applying slurry to brachiaria grass

Cattle slurry is a mixture of cow dung, urine and feed leftovers available from the zerograzing stable.

Learning objective

On completion of this topic, participants will demonstrate how to collect, store and apply slurry to brachiaria grass.

Learning activities

- Facilitator-led introduction to the importance and use of slurry.
- Practical activities on slurry application to brachiaria grass.
- Facilitator-led discussion.

How to collect and apply slurry to brachiaria grass

Step 1: Collect fresh slurry in a pit or drum and allow it to 'mature' by keeping it covered for at least two weeks.

Step 2: Pour mature slurry in furrows dug between brachiaria grass rows and cover with soil. This will reduce loss of nitrogen. Best results can be achieved if this is done after harvest during the rainy season.

Note

600 to 700 kg of liquid slurry is enough for brachiaria grass in a 21 m by 21 m Climate-smart push–pull plot for a year.

What NOT to do

- Do not spread the fresh slurry directly on brachiaria grass or you will burn it.
- Never leave the slurry pit or drum uncovered because it will loose nitrogen.

Topic 3: Making and utilising desmodium hay

Introduction

You can use the greenleaf desmodium you trim from your plot to feed your livestock. The surplus can then be conserved in the form of hay for later use.

Learning objective

On completion of this topic, participants will demonstrate how to make and utilise desmodium hay.

Learning activities

- Facilitator-led introduction to the importance of, and the procedures for, making quality hay from desmodium.
- Practical activities on greenleaf desmodium hay making and utilisation.
- Facilitator-led discussion on importance and procedures of greenleaf desmodium hay making.

Source of material for making hay

- The trimmed greenleaf desmodium during (**Season 2, Weeks 6** and **8**)
- When you cut back greenleaf desmodium after the seed has been harvested (**Season 2, Week 21**).

Note

For the first season, greenleaf desmodium can be ready for harvesting when sorghum is physiologically mature.

Step 1: Cut half a row of fresh desmodium, transfer immediately to a shade. Spread to dry. Always leave a stem of 2 to 4 inches (5 to 10 cm) high from the ground at harvesting.

Note

You will need the greenleaf desmodium vines from the Climate-smart push–pull plot to establish your new Climate-smart push–pull plot in the second season. Once you have the vines for the new plot you can harvest all the greenleaf desmodium and make hay. You can make greenleaf desmodium hay from any amount of greenleaf desmodium.

Step 2: Use the rake to turn the cut greenleaf desmodium once a day to allow for quick wilting. Avoid overdrying the hay. Two to four days drying should be sufficient depending on the moisture content of the plant. Well dried hay should not break easily on handling.

Step 3: Collect and store the hay in a dry place away from rain and any form of moisture. If you leave it outside, use a tarpaulin or polythene sheet to cover it; if you have small amounts put in bundles or gunny bags and keep in a store.

How to make bales

For large amounts you can reduce the space needed for storage by making bales.

Step 1. Make a bottomless wooden baling box measuring 3 by 2.5 by 2.5 feet. Arrange strings across the box as shown in Fig. 60.

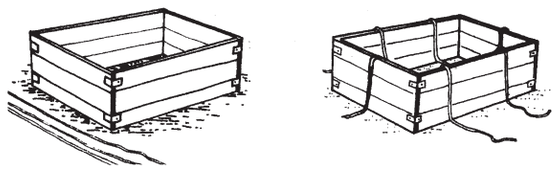

Fig. 74. Bottomless wooden boxes

Step 2: Put the hay in the box in layers.

Step 3: Compress by trampling on the material in the box (Fig. 61).

Fig. 75. Putting and compressing hay

Step 4: Once the box is full and compacted, tie the strings from the opposite sides of the box tightly (Fig. 62). Properly compressed hay should weigh 15 – 20 kg.

Fig. 76. Tying the box

Step 5: Remove the bale from the box and store in a raised place free of moisture (Fig. 63). Allow plenty of air circulation to prevent mould from forming.

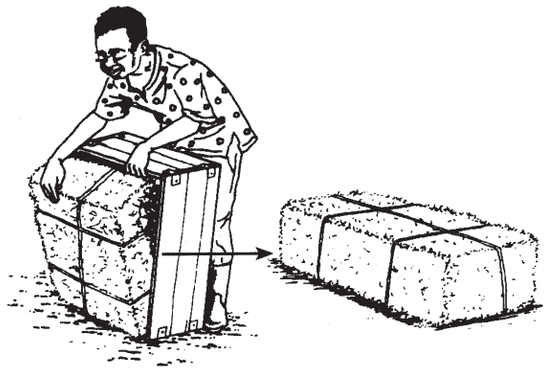

Fig. 77. Removing the bale from the box

Use the greenleaf desmodium hay to improve the nutritive value of brachiaria grass. Mix one part of greenleaf desmodium hay to five parts of chopped fresh brachiaria grass (1:5).

Refer to greenleaf desmodium feeding table in Week 13.

What NOT to do

- Do not dry the cut greenleaf desmodium directly in the sun.
- The greenleaf desmodium hay should not be exposed to rain.

Labour Costs

	Activity	No. of people working on this activity	Time taken to complete the activity (hours)	Cost of labour per day	Total cost of this activity
Climate-smart push–pull plot	Harvesting greenleaf desmodium				
	Any other activity				
Total					

Benefits (Please keep filling the number of units each week as you cut)

	Type of benefit	Quantity	Unit market price	Total value
Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	1 kg greenleaf desmodium hay (1 unit)			
	Milk			
	Other benefit			

General observations (AESA): Farmer's fields

General information				
Date				
Crop age				
Crop health	**Poor**	**Average**	**Good**	
• Sorghum Climate-smart push–pull plot				
• Brachiaria grass				
• Greenleaf desmodium				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Stemborers				
Striga				
Rainfall: Number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Season 1, Week 17

	Topic	Duration	What you need for this lesson
1	Recording greenleaf desmodium pests	2 hours	Plastic jars or clear bottles and gloves for handling the beetles

Introduction

Blister beetles are the most common pests of greenleaf desmodium. They are brightly coloured beautiful insects. They have orange/yellow or red bands (spots) on their backs often with coloured antenna. However, some types of blister beetles have uniform metallic black colour. Blister beetles are also major pests of other crops, such as okra, cowpea, bean and sweet potatoe.

Adult beetles eat up the flowers of greenleaf desmodium so that you do not get any seeds from the affected plant. The larvae do not feed on greenleaf desmodium; they feed on grasshopper eggs.

Blister beetles appear on greenleaf desmodium around October/November just after the rains.

They are called blister beetles because if you touch them they produce a chemical that can cause blisters on your skin.

Topic: Recording greenleaf desmodium pests

Learning objectives

On completion of this topic, participants will identify and record some common types of blister beetles found in desmodium crops.

Learning activities

- Facilitator-led introduction on importance of recording greenleaf desmodium pests.
- Practical exercise (Field walks to collect blister beetles).
- Discussion (Lead question: How important are blister beetles and other flower pests to farmers?)

Step 1: Walk in the greenleaf desmodium plot and collect blister beetles (Fig. 64). Use gloves. Do not handle them with your bare hands. Use the drawings to identify the beetles (Fig. 64).

Step 2: Walk around the farm and record the number of blister beetles on different crops.

Step 3: Destroy the beetles.

At the moment no affordable method exists to control blister beetles for smallscale farmers. The record you are making now will help scientists to develop affordable control measures.

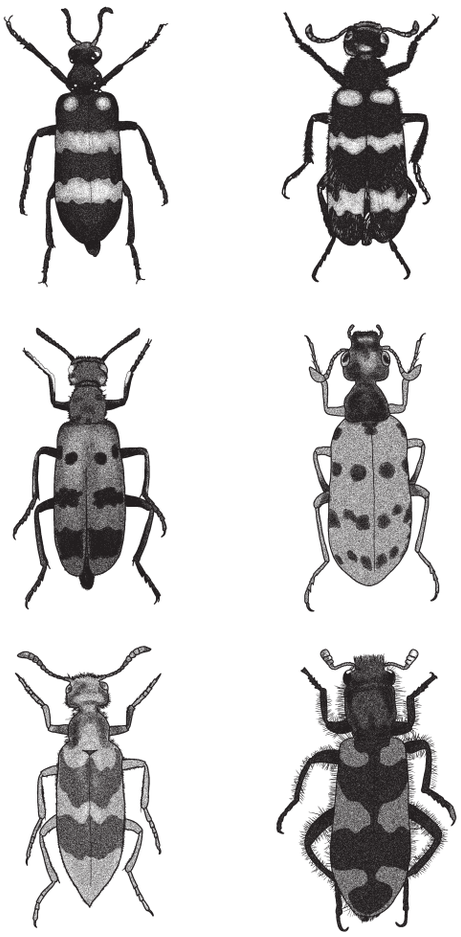

Fig. 78. Blister beetles

Greenleaf desmodium pests

Plot	Type 1	Type 2	Type 3	Type 4	Grasshoppers
Established push–pull plot					
Greenleaf desmodium multiplication plot					
Check plot					
Other crops					
1					
2					
3					
4					

Please write the name of the crops.

Benefits (Please keep filling the number of units each week as you cut)

	Type of benefit	Quantity	Unit market price	Total value
Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	1 kg greenleaf desmodium hay (1 unit)			
	Milk			
	Other benefit			

General observations (AESA): Farmer's fields

General information				
Date				
Crop age				
Crop health	**Poor**	**Average**	**Good**	
• Sorghum Climate-smart push–pull plot				
• Brachiaria grass				
• Greenleaf desmodium				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Stemborers				
Striga				
Rainfall: Number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Season 1, Week 18

	Topic	Duration	What you need for this lesson
1	Harvesting sorghum	2 hours	Tape measure, weighing balance, *panga*, wheelbarrows or sacks for carrying the sorghum panicles, poles, string
2	Storing sorghum stover	45 minutes	

Introduction

This is the time you have been waiting for. Your sorghum is now ready for harvesting and storing. This lesson discusses when and how to harvest and store sorghum.

You have two plots: The Climate-smart push–pull and the check plot. Make sure that you harvest each plot separately and keep the sorghum from each plot separately. This will help you to know the difference in yields between the two plots.

Topic 1: Harvesting sorghum

Learning objective

On completion of this topic, participants will be able to:

- Explain the right time to harvest sorghum.
- Demonstrate how to harvest sorghum.

Learning activities

- Facilitator-led introduction on sorghum harvesting.
- Practical exercise:
  - Measuring the height of the sorghum.
  - Harvesting.
  - Dissecting some stalks to check for stemborers.
- Discussion (Lead questions: What is the relationship between sorghum height and yield? What happens to the stemborers that are in the stover?)

When to harvest sorghum

- When to harvest sorghum can be a difficult decision, due to uneven maturity. Depending on the variety, stalks and leaves may still be green when the grain is ready for harvest.
- Sorghum grains go through an immature 'milk' stage when a pierced kernel will bleed a milk-like juice.
- Sorghum is usually harvested by hand when it has reached physiological maturity, which means the grain is hard and does not produce milk when crushed.
- At this stage the moisture content is at 18 – 22% and seeds will have a black layer at the basal portion.

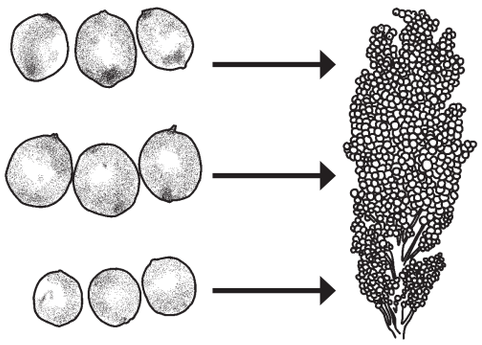

Fig. 79. How sorghum matures

Fig. 80. Sequence of sorghum grain

Sequence of maturing sorghum kernels

Grains of sorghum mature from the top of the head and progress downward to the base. Therefore, it is important to check grain at the bottom of the head to determine whether the grain is mature. Initially, hard starch accumulates at the top or crown of each kernel. The grain is considered mature once the hard starch has

filled to the base of the kernel. Mature grain will be hard to penetrate when pinched at the bottom of the kernel between your fingernails and should have a black spot at its base.

Notes

- *Sorghum grains absorb moisture from the atmosphere. Therefore, grain moisture content can change a few percentage points during the day.*
- *Ensure to check grain moisture before harvesting and stop harvest before evening if moisture content increases above suggested storage levels.*

How to harvest sorghum

- Harvesting of sorghum can be done by hand using a sickle or sharp knife.
- Cut the heads with sickles or a sharp knife from plants in the field or cut the whole plant and remove the heads later.

Note

Sorghum meant for seed production should be harvested at maturity stage. On the other hand, that meant for fodder can be cut when still green and fresh. Leave it in sun for it to wilt for 12 hours then chop and feed to the animals. To make silage, start harvesting at dough stage (when the grain is at milky and hardening stage). For dual-purpose sorghum, cut the head with a knife or use a combine harvester.

Sorting and drying of sorghum

- Sun dry the harvested panicles (heads) to a moisture level of 12 – 23%.

Topic 2: Storing sorghum stover

Introduction

Sorghum stover from your last crop can be used to feed your livestock. Apart from providing feed during the dry season when other materials are in short supply, this also helps remove stemborer larvae and pupae from the field.

Learning objective

On completion of this topic, participants will demonstrate how to store and utilise sorghum stover.

Learning activities

- Facilitator-led introduction on the importance of sorghum stover as a dry season livestock feed.
- Practical activities on sorghum stover storage and utilisation.
- Discussion.

How to store sorghum stover

Sorghum stover can be stored either loose or baled. Loose storage is easier for the smallscale farmer.

Step 1: Cut the stover after the heads have been harvested and assemble them into bundles that are easy to carry.

Step 2: Identify the place for storage. This can be against a tree or three poles tied together at the top. This should be placed under a shade.

Step 3: Carry the stover to the selected storage place. Stack it in a slanting position to allow rain water to run off (Fig. 67). This will ensure that only the stover on the surface will be spoiled while the inner ones retain their good quality.

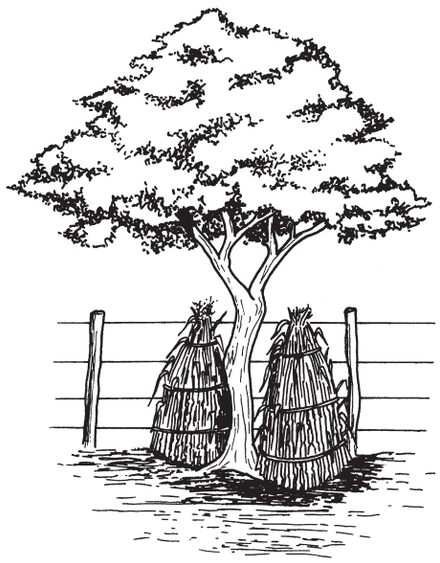

Fig. 81. Storing sorghum stover in a shade

Step 4: To feed stover to your animals cut it into small pieces (2 to 4 inches) as per your daily need. Stover is not very good quality feed and protein rich materials like desmodium hay and fodder should be added to it.

Another option to minimise termite or insect damage, is to cut the dry stovers cut clean without rooted soil clumps, bundle and store it on a slatted raised floor with shaded cover from weathering effects.

Notes

- *Alternatively, the dry sorghum stover should be cut clean without rooted soil clumps, then bundled and stored on a slatted, raised floor with shaded cover to protect it from weathering effects. This also minimises damage by termites or other insects.*
- *Make sure you have used up all the stover before the start of the next season or the stemborers that are in the stover will infest your new crop.*

What NOT to do

Do not leave stover intended for livestock feed on the ground in the Climate-smart push–pull farm.

Labour costs

	Activity	No. of people working on this activity	Time taken to complete the activity (hours)	Cost of labour per day	Total cost of this activity
Climate-smart push–pull plot	Harvesting sorghum				
	Collecting and stacking stover				
	Other activity				
Total					
Check plot	Harvesting sorghum				
	Collecting and stacking stover				
	Other activity				
Total					

Estimated benefits

	Estimated quantity	Value
Stover from Climate-smart push–pull		
Stover from check plot		

Benefits (Please keep filling the number of units each day as you cut)

	Type of benefit	Quantity	Unit market price	Total value
Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	1 kg greenleaf desmodium hay (1 unit)			
	Milk			
	Other benefit			

General observations (AESA): Farmer's fields

General information				
Date				
Crop age				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Rainfall				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Stemborer assessment at harvest

Indicator	**Observation**	
	Climate-smart push–pull plot	**Check plot**
Number of stemborer larvae on 5 damaged plants		
Average size of stemborer larvae on 5 damaged plants		

Season 1, Week 19

	Topic	Duration	What you need for this lesson
1	Threshing and storing of sorghum	1 hour	Gunny bags, weighing balance, 2 kg tins (*gorogoro*) Sorghum sheller (optional)
2	Harvesting desmodium pods	45 minutes	

Introduction

This week has two topics:

- Threshing and storing sorghum.
- Harvesting of greenleaf desmodium pods.

Topic 1: Threshing and storing of sorghum

Last week, we discussed when and how to harvest sorghum. We then harvested the sorghum. This week, we look at how to thresh and store the sorghum.

Note

It is important to select only healthy and clean sorghum heads for threshing. Diseased and rotten heads must be destroyed, because they may contain aflatoxin that is poisonous to you and to your livestock. ***Do not eat or feed them to your livestock.***

- After harvest, sorghum must be dried in the sun for 4 to 5 days and threshed when completely dry (at 12 to 23 percent moisture). If you fail to dry the sorghum well, it can attract storage pests that may bring aflatoxin.
- Threshing can be done by hand or power thresher.
- After threshing, the grain should be dried for 3 or more days, cleaned by winnowing and stored in a dry place protected from rats.

Learning objectives

On completion of this topic, participants will be able to:

- Explain the appropriate methods of threshing and storing sorghum.
- Demonstrate how to thresh and store sorghum.

Learning activities

- Facilitator-led introduction on sorghum threshing and storage.
- Practical exercise:
  - Threshing the dried sorghum panicles.
  - Cleaning and weighing threshed sorghum.
  - Recording weights of threshed sorghum.
- Discussions.

Things to do:

Step 1: Thresh the sorghum that you harvested and left to dry last week.

Step 2: Clean and weigh the sorghum. Keep separate records for Climate-smart push–pull and for check plots.

Topic 2: Harvesting desmodium pods

After you have harvested sorghum you can start harvesting greenleaf desmodium pods. You can continue harvesting the pods for another 2–3 weeks, as not all the pods will be ready at the same time. Today we will discuss when and how to harvest mature pods.

Learning objective

On completion of this topic, participants will be able to:

- Explain the right method of harvesting greenleaf desmodium pods.
- Demonstrate how to harvest greenleaf desmodium pods.

Learning activities

- Facilitator-led introduction on greenleaf desmodium harvesting.
- Practical exercise – Harvesting desmodium pods.
- Discussions.

Things to do:

Step 1: Walk around the edge of the Climate-smart push–pull plot and pick pods that are either green, yellow or brown.

Step 2: Break open the pods and observe the seeds inside.

- The seeds inside the green pods are soft and green and not ready for harvesting.
- In the yellowish or brownish pods the seeds are brownish-green and hard. These are ready for harvesting.

Note

If you delay harvesting when the pods are brownish, you will loose the seeds, as the pods may fall due to rain and wind.

Step 3: How to harvest the pods

- Harvest the pods every 3 – 4 days when the pods have turned yellow and brown.
- Put on an apron made of polythene material. This stops the pods from sticking to your clothes.
- Walk through the plot and hand-strip the ripe pods and place them in an open tin (Fig. 68).

Fig. 82. Harvesting greenleaf desmodium pods

- Keep the open tin in a shaded but secure place for 3 days. This will allow them to ferment.
- After the 3 days dry them in the sun for another 4 days.

Note

One acre (0.4 ha) of well-managed and properly harvested desmodium seed crop can give 50 to 60 kg of seed. In Kenya, this can earn a farmer between Kshs 30,000 and 50,000 when sold at the current market price of Kshs 600 to 800 per kilogramme of seeds.

Labour costs

	Activity	No. of people working on this activity	Time taken to complete the activity (hours)	Cost of labour per day	Total cost of this activity
Climate-smart push–pull plot	Harvesting desmodium pods				
	Threshing sorghum				
	Other activity				
Check plot	Threshing sorghum				
	Other activity				

Benefits (Please keep filling the number of units each day as you cut)

	Type of benefit	Quantity	Unit market price	Total value
Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	1 kg greenleaf desmodium hay (1 unit)			
	Milk			
	Other benefit			

General observations (AESA): Farmer's fields

General information				
Date				
Crop age				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Rainfall				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Season 1, Week 20

	Topic	Duration	What you need for this lesson
1	Processing and marketing of greenleaf desmodium seeds	2 hours	Weighing balance, containers (2 kg tins), a flat grinding stone, rubber sole of an old shoe, wire mesh (30cm by 30cm), polythene clothing, *jembe*, *panga*, carry bags
2	Improving soil fertility	45 minutes	

Introduction

Desmodium seed is valuable, either for expanding your Climate-smart push–pull or for sale. In this topic we discuss the processing of the pods harvested in **Week 19**. We also discuss how you can market your seeds.

Topic 1: Processing and marketing of greenleaf desmodium seeds

Lesson objective

On completion of this topic, participants will learn how to process and discuss how to market their desmodium seeds.

Learning activities

- Facilitator-led introduction on processing and marketing desmodium seeds.
- Practical work on seed processing.
- Discussions (Questions to guide discussions: e.g., how can we generate market for desmodium seeds?)

Processing desmodium seeds

Step 1: After the pods have been sun-dried, thresh them using a stone and an old rubber shoe sole (Fig. 69).

Fig. 83. Threshing of greenleaf desmodium pods

You can also put the pods in a gunny bag and thresh them, but this can damage some of the seeds and they will not germinate when planted.

Step 2: After threshing, winnow the seeds to remove husks and dust (Fig. 70).

Fig. 84. Winnowing greenleaf desmodium seed

Step 3: Sieve the seeds using a 30cm by 30cm wire mesh (the type used for mosquito screen on windows). This will give you clean seeds. Weigh the seeds.

Step 4: Store the seeds in a dry, clean tin or an airtight container.

Step 5: The husks can be used to feed your animals.

Marketing desmodium seeds

Desmodium seeds are expensive and the farmer can sell them for extra income. Many farmers

are taking up Climate-smart push–pull and so they need the seeds. The seed companies are also looking for seeds to sell to more farmers. The ready market for desmodium seeds comes with challenges. If you want to sell to seed companies, you need to be organised into a group so that you can be certified. In Kenya, the recognised authority is the Kenya Plant Health Inspectorate Service (KEPHIS).

Topic 2: Improving soil fertility

Introduction

Taking good care of your soil will keep it healthy. Soils need enough moisture, air and supplies of food (soil nutrients). These help the plants to grow better and sustain good living things in the soil, such as earthworms.

Climate-smart push–pull plays an important role in conserving and improving the health of the soil.

The brachiaria grass that is grown around the sorghum crop helps conserve and improve soil fertility in many ways by:

- Stopping soil erosion by runoff.
- Binding the soil and acting as a wind breaker.

Desmodium helps improve soil health by:

- Providing good ground cover, thus preventing erosion and helping retain soil moisture during the dry season.
- Fixing nitrogen, thus enriching the soil with nutrients for growing plants.
- Increasing soil fertility with leaves that fall on the ground as it grows.

This lesson covers the various aspects of soil conservation and shows how Climate-smart push–pull helps improve soil health.

Learning objective

On completion of this topic, participants will understand the important aspects of soil fertility and how Climate-smart push–pull helps improve soil health.

Learning activities

- Facilitator-led introduction on how to tell healthy soil from poor soil.
- Observations of soil fertility indicators.
- Facilitator-led discussions.

How to tell if your soil is getting healthier

Here are things to observe in the Climate-smart push–pull and the check plots:

Soil quality indication

		Climate-smart push–pull plot		Check plot	
Soil quality indicator	**Soil quality indicator questions**	**Yes**	**No**	**Yes**	**No**
Organic matter	Is the soil getting darker?				
Soil structure	Is the soil getting softer underfoot? Is it easier to work on?				
Runoff	Does rain soak into the soil quickly? (Rain soaks fast and water does not stay on the surface.)				
Soil moisture	Does the soil stay moist for longer period after rains?				
Soil life (aeration)	Does the soil have many earthworms? Are there many holes in the soil, and worm casts on the surface?				
Crops' health	Do your crops look vigorous and healthy?				
Crop yields	Are your yields improving?				
Root growth	Do the crop roots grow well?				
Presence of weeds	Do the soils have the type of weeds that like to grow on fertile soils?				
If you answered Yes to these questions, your soil is getting better!					

Note

Improving soil can take several seasons. This is still an early stage to see much improvement.

Labour costs

	Activity	No. of people working on this activity	Time taken to complete the activity (hours)	Cost of labour per day	Total cost of this activity
Climate-smart Push–pull plot	Processing greenleaf desmodium seed				
	Other activity				

Benefits from desmodium seed

	Type of benefit	Quantity	Unit market price	Total value
Climate-smart push–pull plot	Greenleaf desmodium seed			
	Greenleaf desmodium husks			
	Other benefit			

Benefits (Please keep filling the number of units each day as you cut)

	Type of benefit	Quantity	Unit market price	Total value
Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	1 kg greenleaf desmodium hay (1 unit)			
	Milk			
	Other benefit			

General observations (AESA): Farmer's fields

General information				
Date				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Rainfall				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Season 1, Week 21

	Topic	Duration	What you need for this lesson
1	Harvesting the greenleaf desmodium from multiplication plot	30 minutes	*Panga* (machete) or sickle and gunny bag or wheelbarrow

Topic 1: Harvesting the greenleaf desmodium multiplication plot

It is now time to harvest seed from your desmodium multiplication plot. You will have learned how to do this on the Climate-smart push–pull plot in **Week 19.**

Labour costs

	Activity	No. of people working on this activity	Time taken to complete the activity (hours)	Cost of labour per day	Total cost of this activity
Desmodium multiplication plot	Harvesting greenleaf desmodium pods				
	Other activity				

Benefits (Please keep filling the number of units each day as you cut)

	Type of benefit	Quantity	Unit market price	Total value
Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	1 kg greenleaf desmodium hay (1 unit)			
	Milk			
	Other benefit			

General observations (AESA): Farmer's fields

General information				
Date				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Rainfall				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Off season

Off season, Week 1

	Topic	Duration	What you need for this lesson
1	Land preparation		Ploughs, *jembes*/hoes, pegs, sticks, strings, tape measure, ruler, greenleaf desmodium vines and TSP fertiliser
2	Processing greenleaf desmodium seed from multiplication plot		Weighing balance, containers (2 kg tins), a flat grinding stone, rubber sole of an old shoe, wire mesh (30cm by 30cm), clear polythene bags
3	Addressing risk and uncertainty	1 hour	Record of receipts and expenses (optional); record sheets; calculator, and flip charts/chalkboards, markers, exercise books, pens

This week you need to prepare the land for planting the check plot and the new Climate-smart push–pull plot to be planted with vines.

Topic 1: Land preparation

- Clear your land during the dry season.
- Plough and harrow your land to a fine tilth (until the soil has no large lumps) before the onset of the rains.

Note

For the established Climate-smart push–pull plot the land preparation and planting will be done together after the onset of the rains.

Topic 2: Processing greenleaf desmodium seed from multiplication plot

You need to process the greenleaf desmodium seed that you harvested in the multiplication plot. **Please refer to the Week 20 lesson on processing**.

Topic 3: Addressing risk and uncertainty

Risk and uncertainty are important factors that influence the chances of a farmer adopting a new technology. Decision-making, which involves choosing between possible alternative actions, is one of the most important activities that a farmer has to do to adopt the technology. It is also an act of management that cannot be ignored or postponed. A farmer making a decision with some knowledge of the probability (chance) of making a good decision does so under condition of risk. On the other hand, a farmer making decisions without knowledge of the probability of making a 'good' or 'bad' decision does so under the condition of uncertainty. However, there is no certainty that a 'good' decision will be the 'right' decision. That is, while the farmer may act rationally, following the right procedures, he/she has no control over the outcome. This is because farmers' make decisions in a risky and ever-changing environment. Information and experience are important in determining the quality of decisions farmers make.

Changes in technologies, markets, government policies and social factors all contribute to the risky environment in which farmers carry out their activities. For example, households may be willing to take more risks if they receive insurance/support from social networks, and governmental and non-governmental organisations.

This lesson will provide an introduction to the terminology, types, and strategies used in addressing risk and uncertainty in day-to-day activities.

Learning objectives

On completion of this topic, participants will be able to:

- Explain the importance of addressing risk and uncertainty.
- Identify various types of risks that affect farming decisions.

- Suggest strategies of addressing risk and uncertainty.

Learning activities

- Facilitator-led introduction on importance of addressing risk and uncertainty.
- Form three sub-groups of 6 – 8 members to brainstorm on the various types of risks farmers operate in and the strategies they use to address them.
  - Group 1: Common production problems – Risks and uncertainties and what action(s) they propose to address these.
  - Group 2: Common marketing problems – Risks and uncertainties and what action(s) they propose to address these.
  - Group 3: Common financial problems – Risks and uncertainties and what action(s) they suggest to address these.
- Facilitator-led discussion on options the participants wish to test and to agree on:
  - What information will be required and from what sources,
  - how to record the information, and
  - how to analyse the information.

Notes

Types of risks

- *Production and technical risks (drought, insufficient fodder, problems in adapting new technologies to local conditions, e.g. appropriate cover crop species, pests and diseases).*
- *Marketing and price risks (price fluctuations of inputs and outputs)*
- *Financial risks (interest payments, changes in interest rates, ability to generate cash).*
- *Institutional risks (breakdown in services supply, management problems in FFS, change in support and subsidies).*
- *Human and personal risks (sickness).*

Effective risk management may involve:

- Anticipating that an unfavourable event may occur and acting to reduce the chance of it happening; and,
- Taking actions to reduce the adverse consequences of risk should an unfavourable event occur.

Labour costs

	Activity	No. of people working on this activity	Time taken to complete the activity (hours)	Cost of labour per day	Total cost of this activity
Multiplication plot	Processing greenleaf desmodium seed				
Check plot	Land preparation				
	Other activity				
Climate-smart push–pull vine plot	Land preparation				
	Other activity				

Benefits from greenleaf desmodium seed

	Type of benefit	Quantity	Unit market price	Total value
Multiplication plot	Greenleaf desmodium seed			
	Greenleaf desmodium husks			
	Other benefit			

Benefits of livestock feed (Please keep filling the number of units each day as you cut)

	Type of benefit	Quantity	Unit market price	Total value
Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	1 kg greenleaf desmodium hay			
	5 kg silage (1 unit)*			
	Other benefit			

**5 kg of silage is what a dairy goat eats in a day.*

General observations (AESA): Farmer's fields

General information				
Date				
Crop age				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Rainfall: Number of days it rained the week before _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Note

You need to watch for the rain. If it is raining enough for planting you should plan for planting next week. If not, continue with the gross margin analysis (Season 2, Week 2).

Off Season, Week 2

	Topic	Duration	What you need for this lesson
1	Gender in Climate-smart push–pull	2 hours	Questionnaires, access and control of resources chart
2	HIV and Climate-smart push–pull		

Introduction

Gender refers to how the society looks at the relations between men and women. These relations, and the roles women and men play, are determined by culture. The roles differ from one society to another with respect to age, class, race, ethnicity, abilities and disabilities.

Topic 1: Gender in Push–pull

Learning objective

On completion of this topic, participants will evaluate the gender issues that may affect the adoption of Climate-smart push–pull technology.

Learning activities

- Facilitator-led discussions on the importance of gender issues in new programmes.
- Group discussions.

The gender priority areas for Climate-smart push–pull are:

- How to involve men, women and children in push–pull.
- The place of rural women as a valuable resource and driver of local livelihoods and how Climate-smart push–pull can address their specific needs.

Issues to discuss

Fill in the role played by men and women in the table below.

Issue	Men	Women	Children
Labour			
Income			
Information and knowledge on new technologies			
Decision on resources use			
Decisions on utilisation of benefits			
Land ownership			
Priority setting			
Freedom of expression			
Use of time			

What you can do

One way of addressing gender issues in Climate-smart push–pull is to remember that different communities have different cultural and social ways of addressing issues. Try and understand these factors in your community by discussing the following questions:

1. If you want to introduce a new technology in the community, who should you involve first?
2. What are the relationships that exist between men and women; for instance, are they allowed to attend meetings alone?
3. What time of the day can you involve women and men, or women alone?
4. What activities on the farm are specifically for men?
5. What activities on the farm are specifically for women?
6. Are there crops that should be grown and tended by either the men or the women?
7. Who sells the farm products?

8. Who keeps the money?
9. Who decides what to spend the money on?
10. How do both women and men access information?
11. What roles do children play at home and in the community?

The answers to these questions will help you to design activities that take into account the needs of men, women and children.

Topic 2: HIV/AIDS and Climate-smart push–pull

Introduction

HIV/AIDS is a serious threat to farming in general and Climate-smart push–pull is not exempted from its effects. As the technology is being implemented, issues relating to the disease need to be addressed. Remember the following important facts.

- People living with HIV/AIDS need additional nutrition to fight the disease. Unproductive land means less food for everyone. People living with HIV may be stigmatised by the community, so are often the first to be left without food.
- An unhealthy population is unproductive. Ill people cannot look for work on their farms. HIV reduces the number of hands that can be put to work.
- The number of orphans increases. This puts an extra burden on the households that take the children in and on the community as a whole. The orphans do not get enough to eat as parents may feed their own children first.
- Women have more work, because they care for both people living with HIV/AIDS and orphans.

HIV/AIDS spreads quickly for several reasons: cultural practices, lack of basic healthcare services, poor information about the disease and sudden increase in income.

Learning objective

On completion of this topic, participants will understand issues of HIV that may affect the farmers' ability to benefit from Climate-smart push–pull.

Learning activities

- Facilitator-led introduction of HIV and its relationship to household health and push–pull.
- Group discussions.
- Presentations by guest speakers.

Why you should openly discuss HIV

HIV puts a double burden on households:

They need extra resources to take care of the sick, but HIV takes away the most productive members of the household, thus impoverishing people. The following are some of the consequences of HIV:

- Poverty makes people more vulnerable to HIV. Little information about the disease is available in remote areas and many people cannot read the literature warning them about its dangers. Many believe that the disease is a problem only in the towns. Some assume that people in rural areas cannot be infected or affected.
- People engage in various activities that expose them to unprotected sex and multiple partners. In farming communities, men go to towns to sell farm products or to work. They may have girlfriends or use the services of prostitutes there.
- Some women and men have multiple partners. Women may engage in commercial sex work to try and make ends meet.
- Traditional liquor is brewed in most rural areas. People who drink these brews are at risk, because they lack judgment and may practice unsafe sex in their drunken state.

The following are some of the traditional practices that facilitate the spread of the disease:

- People living with HIV are stigmatised and so people may be afraid to use testing and counselling centres, because they are afraid of being shunned by their communities.
- In most communities, it is a taboo to discuss sex-related issues. It is, therefore, difficult to disseminate information about HIV.
- Some communities view HIV as a curse and a result of being bewitched. They do not relate it to human behaviour.
- Some people have taken a fatalistic attitude. They believe that death in any form is death and see no need to be careful about their sex life.
- Men may go away to urban areas for long periods to work or to look for work. This exposes them and their wives to casual sex partners.
- Some communities encourage polygamy. If the husband or one of the wives is infected, the others will contract the HIV virus too.
- In some communities, a deceased's brother inherits his widow. If the man died of an HIV-related medical condition, the woman spreads the disease to her new husband.
- Most farming communities practice circumcision for boys and girls in groups. The tools used may not be cleaned and sterilised. If one person is infected the whole group is exposed to the disease.
- Most babies are delivered by poorly-trained and ill-equipped traditional birth attendants. They do not use protective measures and rarely sterilise the blade they use to cut umbilical cords. If the mother or the attendant are infected, the disease may spread easily.

Risky and non-risky behaviours

Definitely a risk

- Having sexual intercourse with multiple partners without a condom.
- Sharing a needle for drug use or for injections.
- Sharing knives for circumcision.
- Sharing needles for ear piercing.

Probably a risk

- Being born to a mother who is HIV positive (mother-to-child transmission).
- Getting blood transfusion.
- Sharing a toothbrush.
- Deep kissing.

Definitely NOT a risk

- Abstaining from sexual Intercourse.
- Being close to a person living with HIV who is coughing.
- Donating blood.
- Using a public telephone.
- Shaking hands with a person living with HIV.
- Hugging a person living with HIV or AIDS.
- Living with a person with HIV or AIDS.
- Being bitten by a mosquito.
- Having a mutually monogamous and faithful relationship with a person who has tested negative for HIV.

Sources: Kenya Adolescent Reproductive Health Programme (KARHP), PATH and Population Council.

Season 2

Season 2, Week 1

	Topic	Duration	What you need for this lesson
1	Preparing the Climate-smart push–pull plot for 2nd and subsequent season planting	1 hour	*Panga*, *jembe* or hoe, sacks to carry the cut material and 2 kg TSP fertiliser, bucket/watering can
2	Laying out and establishing a new Climate-smart push–pull plot using greenleaf desmodium vines	1 hour 30 minutes	Ruler/tape measure, string, pegs, sticks for measurement, mallet hammer, polyethylene tags or marker pens, Climate-smart push–pull manual
3	Managing greenleaf desmodium seed multiplication plot	1 hour	

Note

This lesson to be done only if there is enough rain for planting. If not, continue with Gross Margin Analysis in ***Season 2, Week 2****, and wait for the rains to come).*

Introduction

This is the start of the second season. We have three topics to discuss this week:

1. How to prepare the land for planting 2nd season sorghum in the Climate-smart push–pull plot established during the 1st season.
2. How to establish a new Climate-smart push–pull plot using greenleaf desmodium vines from your already established greenleaf desmodium seed multiplication plot.
3. Managing greenleaf desmodium multiplication plot for the second season.

Topic 1: Preparing the Climate-smart push–pull plot for 2nd and subsequent season planting

Learning objective

On completion of this topic, participants will prepare a Climate-smart push–pull plot for the second and subsequent seasons.

Learning activities

- Facilitator-led introduction on activities of the week.
- Field work: Land preparation and planting in established Climate-smart push–pull plots.
- Discussion on the exercise.

How to prepare the 2nd season Climate-smart push–pull plot

Step 1: Cut back the greenleaf desmodium leaving a stubble of 6 cm above the ground to encourage regrowth. Keep and feed to livestock.

Step 2: Hand weed the desmodium.

Step 3: Dig or plough well between the rows of greenleaf desmodium.

Step 4: Weed the brachiaria grass.

Step 5: Plant sorghum in between greenleaf desmodium rows at a spacing of 30 cm. Apply 1 teaspoonful or soda bottle top of TSP or DAP fertiliser. You may also use a handful of well-decomposed manure per hole.

Topic 2: Laying out and establishing a new Climate-smart push–pull plot using greenleaf desmodium vines

Learning objective

On completion of this topic, participants will be able to demonstrate that they understand how to lay out and establish a new Climate-smart push–pull plot using greenleaf desmodium vines.

Learning activities

- Facilitator-led introduction on the use of greenleaf desmodium vines to establish a Climate-smart push–pull plot.
- Practical on the layout and planting of the Climate-smart push–pull plot.
- Discussion (lead question on the economics of using vines as compared to seed).

How to lay out the Climate-smart push–pull plot

Note

If your land is slopping, it is essential that the rows of your plot run across the slope.

Step 1: Mark out a plot measuring 21m by 21m square, using a tape measure, pegs and string.

Step 2: Put a peg at each corner of the measured area. Starting from this peg, put pegs along all sides of the square at 75 – cm intervals.

Step 3: Run a string from the first peg to the first peg on the opposite side of the plot.

Step 4: Run the second string from the second peg to a second peg on the opposite side.

Step 5: Repeat steps 1 to 4 for the second and third rows, ensuring that the rows are 75 cm apart and 30 cm between the plants for the rows running alongside the desmodium. The spacing of 75 cm should be maintained at the head of the crop rows.

Step 6: Repeat steps 3, 4 and 5 for all the other pegs, until you have a plot looking like Fig. 71.

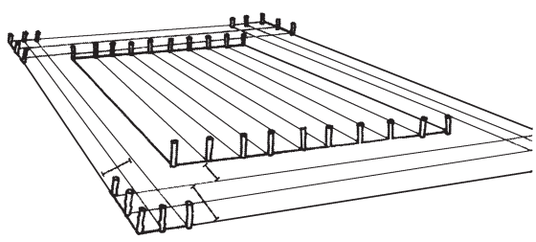

Fig. 85. A laid out Climate-smart push–pull plot

What NOT to do

- Do not remove the pegs or string until your plot is fully planted (see **Season 1, Week 1** on planting).
- Do not plant Climate-smart push–pull in less than 21m by 21m plots as brachiaria grass tends to grow lush and this is the smallest recommended size for cost-benefit ratio.

Note

The Climate-smart push–pull plot should be planted in this order.

1. Planting brachiaria grass

Step 1: Dig a hole at each peg on the border of the marked plot.

Step 2: Apply one teaspoonful of triple superphosphate fertiliser or 2 handfuls of well decomposed farmyard manure in each hole.

Step 3: Drop 5 – 6 seeds into each hole.

Step 4: Cover with light soil ensuring that planted seeds are sparsley covered.

Step 5: Repeat steps 1 to 4 for the second and third rows, ensuring that the rows are 75 cm apart and 30 cm between the plants for the rows running alongside the desmodium. The spacing of 75 cm should be maintained at the head of the crop rows.

(For illustration see **Season 1, Week 1**).

2. Planting greenleaf desmodium vines

Step 1: Use the vines from the seed multiplication plot and the established Climate-smart push–pull plot. Use **mature** vines with at least three to four internodes with hair roots to establish greenleaf desmodium in between sorghum rows.

Step 2: Using a sharp pointed stick make a furrow 1 to 2 cm deep along the string lines. Leave 75 cm space between the ends of the greenleaf desmodium row and inner row of the brachiaria grass. Place the vines in the furrows with the hair roots facing down.

Step 3: Cover the vines, including the leaves with light soil if the moisture level is low. This ensures that the leaves do not loose moisture. Otherwise if it is raining just cover the vines only.

Note

For good establishment of the greenleaf desmodium, ensure there is enough moisture in the soil. Do NOT plant the vines if it is dry.

3. Planting sorghum in Climate-smart push–pull plot

Plant sorghum in between greenleaf desmodium rows at a spacing of 30 cm. Apply 1 teaspoonful or soda bottle top of TSP or DAP fertiliser. You may also use a handful of well - decomposed manure per hole.

4. Planting sorghum in check plot

Step 1: Plant sorghum in the entire 21m by 21m plot in straight lines at 75cm between rows and 30cm between hills in a row.

Step 2: Apply one teaspoonful or soda bottle top of triple superphosphate or two teaspoonfuls of single superphosphate per hole. You may also use a handful of good quality manure (**Season 1, Week**) per hole.

Topic 3: Managing greenleaf desmodium seed multiplication plot

Now that you have harvested all the pods and used the mature vines to establish your new Climate-smart push–pull plot, it is time to manage the seed multiplication plot to ensure that you have a healthy crop for the next season. Cutting back the greenleaf desmodium now allows you to:

- Weed the crop, thus encouraging vigorous regrowth in the next season.
- Get fodder and hay for your animals in the dry season.
- Get vines for establishing a new greenleaf desmodium multiplication plot (optional).

Learning objective

On completion of this topic, farmers will learn how to manage their greenleaf desmodium seed multiplication plot in the second and subsequent seasons.

Learning activities

- Facilitator-led introduction on management of greenleaf desmodium for the second season and establishment of greenleaf desmodium vine nursery (optional).
- Practical exercise: Cutting back and weeding greenleaf desmodium and establishing a new nursery (optional).
- Facilitator-led discussions on the advantages and disadvantages of establishing a greenleaf desmodium seed nursery by use of vines (optional).

Notes

- *Steps 1 to 5 below are optional if you want to establish a new greenleaf desmodium multiplication plot.*
- *Steps 6 and 7 must be done to maintain your greenleaf desmodium multiplication plot in good condition for your second season.*

Step 1: Identify a suitable site near a water source where you can prepare a 10m by 10m greenleaf desmodium vine nursery. Ensure the soil is broken down until it is fine and ensure the soil has enough moisture for planting vines. If not, water the seedbed.

Step 2: Select vines from the seed multiplication plot and the established Climate-smart push–pull plot. Use **mature** vines with at least three to four internodes with hair roots to establish greenleaf desmodium in between sorghum rows.

Step 3: Cut the vines close to the main plant and carefully pull it out. Try not to damage the hair roots.

Step 4: Using a sharp pointed stick, make a furrow 1 to 2 cm deep along the line in your new nursery. The lines should be 75 cm apart. Place the vines in the furrows with the hair roots facing down.

Step 5: Cover the vines. If there is no rain, water the vines at least twice a week.

Step 6: After you have cut the vines and planted them in the nursery, cut the greenleaf desmodium leaving stubble 4 – 6 cm above the ground to encourage regrowth. Use the cut material as fodder for your livestock or to make hay.

Step 7: Weed the greenleaf desmodium using a hoe or a *jembe* and apply half kilogramme (kg) of TSP or 1 kg DAP fertiliser to the whole plot.

Labour costs

	Activity	No. of people working on this activity	Time taken to complete the activity (hours)	Cost of labour per day	Total cost of this activity
Climate-smart push–pull vine plot	Field layout				
	Planting brachiaria grass				
	Planting greenleaf desmodium				
	Planting sorghum				
	Fertiliser application				
	Any other activity				
Total					
Established Climate-smart push–pull plot	Cutting back greenleaf desmodium				
	Land preparation and weeding of greenleaf desmodium				
	Weeding brachiaria grass				
	Planting sorghum				
	Fertiliser application				
	Any other activity				
Total					
Check plot	Field layout				
	Planting sorghum				
	Fertiliser application				
	Any other activity				
Total					
Old greenleaf desmodium seed multiplication plot	Cutting back greenleaf desmodium				
	Weeding greenleaf desmodium				
	Fertiliser application				
Total					

Input costs

	Input used	Quantity used	Cost
Climate-smart push–pull vine plot	Sorghum seed		
	Greenleaf desmodium vines		
	Brachiaria grass		
	Fertiliser		
	Manure		
	Other		
Total			
Climate-smart push–pull plot	Sorghum seed		
	Fertiliser		
	Other		
Total			
Check plot	Sorghum seed		
	Fertiliser		
	Manure		
	Other		
Total			
Seed multiplication plot	Fertiliser		
	Other		
Total			

Benefits of livestock feed (Please keep filling the number of units each week as you cut)

	Type of benefit	Quantity	Unit market price	Total value
Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	Greenleaf desmodium vines			
	5 kg silage (1 unit)			
	Milk (litre)			
	Other benefit			

General observations (AESA): Farmer's fields

General information				
Date				
Planting date				
Variety				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Rainfall: Number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Season 2, Week 2

	Topic	Duration	What you need for this lesson
1	Participatory monitoring and evaluation (PM&E)		
2	Calculations of real gross margins for Climate-smart push–pull plot, check plot and seed multiplication plot		Record of receipts and expenses (optional), record sheets, calculator and flip charts/chalkboards, markers, exercise books, pens

Topic 1: Participatory monitoring & evaluation (PM&E)

You did this lesson in **Preseason, Week 5**. Refer to it for this lesson.

Topic 2: Calculations of real gross margins for Climate-smart push–pull plot, check plot and seed multiplication plot

You did this lesson in **Season 1, Week 15**. Refer to it for this lesson.

Benefits of livestock feed (Please keep filling the number of units each week as you cut)

	Type of benefit	Quantity	Unit market price	Total value
Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	Greenleaf desmodium vines			
	5 kg silage (1 unit)			
	Milk (litre)			
	Other benefit			

General observations (AESA): Farmer's fields

General information				
Date				
Planting date				
Variety				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Rainfall: Number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Season 2, Week 3

	Topic	Duration	What you need for this lesson
1	Gapping sorghum	30 minutes	Sorghum seeds, pen, *jembes*/hoes, pegs, sharp sticks, strings, tape measure, ruler, greenleaf desmodium seeds (100 grammes) and TSP fertiliser
2	Weeding and top dressing greenleaf desmodium seed multiplication plot	30 minutes	

Topic 1: Gapping sorghum

You did this lesson in **Season 1, Week 2**. Please refer to details in the lesson.

Note

Remember that you do not need to apply fertiliser during gapping because you applied when you planted your sorghum.

Topic 2: Weeding and top dressing greenleaf desmodium seed multiplication plot

You did this lesson in **Season 1 Week 7**. Please refer to details in this lesson.

Labour costs

	Activity	No. of people working on this activity	Time taken to complete the activity (hours)	Cost of labour per day	Total cost of this activity
Climate-smart push–pull vine plot	Gapping sorghum				
	Any other activity				
Total					
Established push–pull plot	Gapping sorghum				
	Any other activity				
Total					
Check plot	Gapping sorghum				
	Any other activity				
Total					
Seed multiplication plot	Fertiliser application				
Total					

Input costs

	Input used	Quantity used	Cost
Seed multiplication plot	Fertiliser		
	Other		
Total			

Benefits of livestock feed (Please keep filling the number of units each week as you cut)

	Type of benefit	Quantity	Unit market price	Total value
Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	Greenleaf desmodium vines			
	5 kg silage (1 unit)			
	Milk (litre)			
	Other benefit			

General observations (AESA): Farmer's fields

General information				
Date				
Planting date				
Variety				
Crop emergence				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Rainfall: number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Season 2, Week 4

	Topic	Duration	What you need for this lesson
1	Gapping brachiaria grass in the new plot	30 minutes	Brachiaria grass cuttings/root splits /vines, hoe/stick,Climate-smart push–pull manual, pen and paper
2	Group assessment	3 hours	All records, calculator, flip chart, chalkboards, marker pens, exercise books and pens. Record samples of receipts and expenses on crops and livestock enterprises, and record sheets.

Topic 1: Gapping brachiaria grass in the new plot

You did this lesson in **Season 1**. Please refer to the details in **Season 1, Week 3**.

Topic 2: Group assessment

Introduction

Now you have been working together as a group for several months and you have had time to apply on your farm what you have learned in the field school. It is time to go out and see how you and your colleagues have laid out your new Climate-smart push–pull and how you are managing your established plot so that you can:

1. Maximise your learning from each other's experiences
2. Correct any mistakes that may have been made.

This is the third group assessment since you started the Climate-smart push–pull Farmer Field School. As with the first assessment in **Season 1, Week 3, and second group assessment in Season 1, Week 12,** this is a good time to check that everything is being done properly and if not, correct any mistakes.

Learning objective

The objective of this assessment is to maximise learning through group evaluation.

Learning activities

- Facilitator-led introduction on group evaluation.
- Form evaluation groups.
- Farm visits, observations and completion of evaluation forms by groups.
- Discussion.

What to do in the assessment

Step 1: Make groups of 4 – 6 members.

Step 2: Visit each farm represented by the members in the group.

Step 3: Use the following table to assess the Climate-smart push–pull and the check plots, and discuss with the host farmer. Rate each farm using this scale:

1 = Poor 2 = Average 3 = Good

	2nd season Climate-smart push–pull plot		2nd season check plot		1st season Climate-smart push–pull with vines	
What to check	Rating	Comments	Rating	Comments	Rating	Comments
Field preparation						
Layout of the field						
Cleanliness of the plots						
Germination of sorghum						
Brachiaria grass establishment						
Brachiaria grass maintenance						
Brachiaria grass cutting						
Trimming desmodium						
Weeding greenleaf desmodium						
Sprouting of greenleaf desmodium vines						
Record keeping						
Total rates						

Other comments on the seed multiplication plot (rate 1 to 3):

1=Poor 2 = Average 3 = Good

More comments _____

_____

_____

_____

_____

_____

_____

Labour costs

	Activity	No. of people working on this activity	Time taken to complete the activity (hours)	Cost of labour per day	Total cost of this activity
Climate-smart Push–pull vine plot	Gapping brachiaria grass				
	Any other activity				
Total					

Benefits (Please keep filling the number of units each week as you cut)

	Type of benefit	Quantity	Unit market price	Total value
Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	Greenleaf desmodium vines			
	1 kg greenleaf desmodium hay			
	5 kg silage (1 unit)			
	Milk (litre)			
	Other benefit			

General observations (AESA): Farmer's fields

General information				
Date				
Crop health	**Poor**	**Average**	**Good**	
• Sorghum Climate-smart push–pull plot				
• Brachiaria grass sprouting				
• Greenleaf desmodium				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Stemborers				
Striga				
Rainfall: Number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Season 2, Week 5

	Topic	Duration	What you need for this lesson
1	Analysis of household assets	2 hours	Climate-smart push–pull manual, pens, markers, flips charts
2	Emerging issues of interest	2 hours	

Topic 1: Analysis of household assets

Learning objectives

On completion of this topic, participants will be able to:

- Explain the different types of assets.
- Discuss how Climate-smart push–pull can contribute to household assets.

Learning activities

- Facilitator-led introduction on meaning and importance of doing asset analysis.
- In sub-groups of 4 – 6 members, brainstorm on the various types of assets and how Climate-smart push–pull can contribute to these.
- Facilitator-led discussion on asset analysis and how asset growth can be influenced by adoption of Climate-smart push–pull.

Notes

- ***Financial*** *– This denotes the financial resources that people use to achieve their livelihood objectives. It includes the availability of cash or equivalent that enables people to adopt different livelihood strategies.*
- ***Human*** *– This represents the skills, knowledge, ability to labour and good health, that together, enable people to pursue different livelihood strategies and achieve their livelihood objectives.*
- ***Social*** *– This is taken to mean the social resources upon which people draw in pursuit of their livelihood objectives.*
- ***Physical*** *– This represents capital that is created by economic production. It includes infrastructure, such as roads, irrigation works, electricity, equipment and housing.*
- ***Natural*** *– This consists of land, water and biological resources, such as trees, pasture and biodiversity.*

Topic 2: Emerging issues of interest

When farmers meet in groups, they discuss the results of their experimentation, learning from one another and devising new ways to solve problems. Training in groups is helpful in many ways: mutual learning is encouraged, solidarity is built, and a base is created for further technological discussion and problem solving. This process brings up new issues of interest for farmers. This session is meant to discuss, clarify, and plan for action.

Learning objectives

On completion of this topic, participants will be able to:

- Discuss some key issues that have emerged after attending the field school so far
- Plan for appropriate action.

Learning activities

- Facilitator-led introduction on the importance of addressing emerging new issues.
- Through focus groups, participants brainstorm on new emerging issues (Lead questions: What interesting issue have you observed or felt that requires discussion with the rest of the group? How does it affect you? How does it affect other members? What needs to be done to address the issue?)
- Facilitator-led discussion on key issue summarised from group presentations.

Benefits (Please keep filling the number of units each week as you cut)

	Type of benefit	Quantity	Unit market price	Total value
Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	Greenleaf desmodium vines			
	1 kg greenleaf desmodium hay			
	5 kg silage (1 unit)			
	Milk (litre)			
	Other benefit			

General observations (AESA): Farmer's fields

General information				
Date				
Crop age				
Crop health	**Poor**	**Average**	**Good**	
• Sorghum • brachiaria grass • greenleaf desmodium				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Rainfall: Number of days it rained the week before: ____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Other comments:

_____

_____

_____

_____

_____

_____

Season 2, Week 6

	Topic	Duration	What you need for this lesson
1	1st weeding, thinning and top dressing of sorghum	1 hour 30 minutes	*Jembe*/hoe, sharp stick, CAN fertiliser, teaspoon/soda bottle top
2	1st weeding and top dressing of brachiaria grass in both Climate-smart push–pull plots	1 hour	
3	Greenleaf desmodium weeding and trimming (established Climate-smart push–pull crop)	30 minutes	
4	1st weeding of greenleaf desmodium in the vine-established Climate-smart push–pull plot	30 minutes	
5	Weeding and rouging (removing off-types) on the greenleaf desmodium seed	30 minutes multiplication plot	

Topic 1: 1st weeding, thinning and top dressing of sorghum

Follow instructions in **Season 1, Week 5**.

Top dress after the dew has dried from the leaves, as fertiliser falling on the leaves burns them.

Topic 2: 1st weeding and top dressing brachiaria grass in both Climate-smart push–pull plots

Follow the instructions for the lesson in Season 1, Week 5.

Top dress after the dew has dried from the leaves. This way, if any fertiliser falls on the leaves, it will not burn the plant.

Topic 3: Weeding and trimming greenleaf desmodium (Established Climate-smart push–pull crop)

Introduction

If you managed your greenleaf desmodium well in the first season, it is now well established. If let alone it can grow faster than your sorghum. You must trim it so that it does not compete with your sorghum for soil nutrients and light. If you delay in trimming, it can suppress the growth of sorghum and reduce the yields from your plot.

After you have trimmed the greenleaf desmodium, you must also weed it otherwise weeds will compete for nutrients and light.

If managed properly, the greenleaf desmodium will last for more than five years.

Refer to Season 1, Weeks 5 and 7.

Topic 4: 1st weeding of greenleaf desmodium in the vine established Climate-smart push–pull plot

Introduction

The greenleaf desmodium plot you established using vines is now ready for weeding. The vines grow faster than seedlings. However, some weeds still grow within the vines and they must be removed.

Walk between the rows of greenleaf desmodium vines. Using a sharp stick, loosen the soil around the weeds and carefully remove the weeds by hand.

Note

Do not weed if the soil is dry, as this can destroy the greenleaf desmodium roots and kill the plant.

Topic 5: Weeding and rouging (removing off-types) on the greenleaf desmodium seed multiplication plot

Introduction

If you are maintaining a greenleaf desmodium seed multiplication plot you must:

- Weed the plot.
- Keep the surrounding 2 m clear of all other plants. As the greenleaf desmodium grows it will spread and cover the 2 m space.
- Ensure that there are no off-types present in the plot.

Step 1: Clear a 2 m strip around the greenleaf desmodium plot using a *panga* and a *jembe*.

Step 2: Walk within the vines and using a sharp stick loosen the soils around the weeds and carefully remove weeds and off-types by hand.

Input costs

	Input used	Quantity used	Cost
Established push–pull plot	Fertiliser		
	Other		
Total			
Vine Climate-smart push–pull vine plot	Fertiliser		
	Other		
Total			
Check plot	Fertiliser		
	Other		
Total			
Seed multiplication plot	Fertiliser		
	Other		
Total			

Labour costs

	Activity	No. of people working on this activity	Time taken to complete the activity (Hours)	Cost of labour per day	Total cost of this activity
Climate-smart push–pull vine plot	Weeding and thinning sorghum				
	Top dressing sorghum				
	Weeding and top dressing brachiaria grass				
	Weeding greenleaf desmodium				
	Any other activity				
Total					
Established Climate-smart push–pull plot	Weeding and thinning sorghum				
	Top dressing sorghum				
	Weeding and top dressing brachiaria grass				
	Weeding and trimming greenleaf desmodium				
	Any other activity				
Total					
Check plot	Weeding and thinning sorghum				
	Top dressing sorghum				
Total					
Seed multiplication plot	Weeding and rouging				
	Fertiliser application				
Total					

Benefits (Please keep filling the number of units each week as you cut)

	Type of benefit	Quantity	Unit market price	Total value
Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	Greenleaf desmodium vines			
	5 kg silage (1 unit)			
	1 kg greenleaf desmodium hay (1 unit)			
	Milk (litre)			
	Other benefit			

General observations (AESA): Farmer's fields

General information				
Date				
	Sorghum	**Brachiaria grass**	**Greenleaf desmodium**	
Planting date				
Crop emergence				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Rainfall: Number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Season 2, Week 7

	Topic	Duration	What you need for this lesson
1	Utilisation of fresh greenleaf desmodium and hay	1 hour	A *panga*, ruler or tape measure, *jembe*, chopping log, gunny bags, polythene sheets
2	Comparison of stemborer, fall armyworm and striga damage between Climate-smart push–pull and check plots	2 hours	Samples of striga at various stages of growth, knives, pictures of damaged plants, hoe, flip charts, posters, marker pens, masking tape

Topic 1: Utilisation of fresh greenleaf desmodium and hay

You learned how to use fresh greenleaf desmodium and how to prepare greenleaf desmodium hay in **Season 1, Weeks 13** and **16**. Please follow the same instructions.

Learning activities

- Facilitator-led introduction on importance of a balanced animal ration.
- Practical activities on brachiaria grass and greenleaf desmodium chopping.
- Practical activities on greenleaf desmodium and brachiaria grass ration mixture.
- Facilitator-led discussion on importance of brachiaria grass and greenleaf desmodium as feed.

How to correctly utilise fodder from Climate-smart push–pull

Notes

- *During the wet season cut brachiaria grass and leave it in the open for at least 30 minutes before chopping. This allows the brachiaria grass to loose some water (wilt) and increases the roughage eaten by the livestock.*
- *To ovoid wastage the chopped forage should be fed to livestock in a feeding trough.*
- *During the dry season, chop the sorghum stover into small pieces and mix with the chopped brachiaria grass and greenleaf desmodium.*
- *Always remember to give your livestock the recommended mineral supplements.*
- *Never allow livestock to graze in the Climate-smart push–pull plot, as they will destroy the greenleaf desmodium and the brachiaria grass.*

Topic 2: Comparison of stemborer, fall armyworm and striga damage between Climate-smart push–pull and check plots

By now your sorghum is 6 weeks old and it will be showing signs of striga, fall armyworm and stemborer damage. It is time to start evaluating how your Climate-smart push–pull plots are performing as compared to your check plot, as you did in **Season 1, Week 8.** The first thing is to check for stemborer, fall armyworm and striga attack.

Learning objective

On completion of this topic, participants will start to evaluate the effectiveness of Climate-smart push–pull in controlling stemborers, fall armyworm and striga.

Learning activities

- Facilitator-led introduction to stemborer and striga damage.
- Field exercises.
- Discussions (Are there any differences between the plots?)

Step 1: Starting from one corner, walk to the opposite corner (diagonally) of any plot. As you walk, stop at **every fifth plant** and look for any sign of stemborer, fall armyworm and striga damage. Record what you have noticed.

Look for:

- Signs of stemborer damage.
  - Leaf damage.

- Deadheart.

- Signs of fall armyworm damage.
  - Leaf damage
  - Whorl damage/Deadheart
  - Presence of frass
- Signs of striga damage.
  - Stunted growth.
- The number of striga plants within 15 cm around the plant.

Step 2: Repeat Step 1 from a different corner and walk diagonally to the opposite corner.

Step 3: Repeat Steps 1 and 2 in the other plots.

Note

At the end of the exercise, you will have looked at more plants in the check plot than in the Climate-smart push–pull plots.

2nd season Climate-smart push–pull plot

What to record	Number	*Percent damage
Total number of plants observed		
Total number of plants with signs of stemborer leaf damage		
Total number of plants with signs of fall armyworm leaf damage		
Total number of plants with deadheart		
Total number of striga-stunted plants		
Total number of striga weeds around sorghum plants (15 cm)		

**The facilitator will work out the percentages and discuss them with the farmers.*

Vine established Climate-smart push–pull plot

What to record	Number	*Percent damage
Total number of plants observed		
Total number of plants with signs of stemborer leaf damage		
Total number of plants with signs of fall armyworm leaf damage		
Total number of plants with deadheart		
Total number of striga stunted plants		
Total number of striga weeds around sorghum plants (15 cm)		

**The facilitator will work out the percentages and discuss them with the farmers.*

Check plot

What to record	Number	*Percent damage
Total number of plants observed		
Total number of plants with signs of stemborer leaf damage		
Total number of plants with signs of fall armyworm leaf damage		
Total number of plants with deadheart		
Total number of striga stunted plants		
Total number of striga weeds around sorghum plants (15 cm)		

**The facilitator will work out the percentages and discuss them with the farmers.*

Labour costs

	Activity	No. of people working on this activity	Time taken to complete the activity (hours)	Cost of labour per day	Total cost of this activity
Established Climate-smart Push–pull plot	Harvesting 10 kg of brachiaria grass*				
	Harvesting 3 kg of greenleaf desmodium*				
	Any other activity				
Total					
Vine-established Climate-smart push–pull	Harvesting 10 kg of brachiaria grass*				
	Harvesting 3 kg of greenleaf desmodium*				
	Any other activity				
Total					

Benefits (Please keep filling the number of units each week as you cut)

	Type of benefit	Quantity	Unit market price	Total value
Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	Greenleaf desmodium vines			
	5 kg silage (1 unit)			
	1 kg greenleaf desmodium hay (unit)			
	Milk (litre)			
	Other benefit			
Vine Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	1 kg greenleaf desmodium vines (1 unit)			
	5 kg silage (1 unit)			
	1 kg hay (1 unit)			
	Milk (litre)			
	Other benefit			

General observations (AESA): Farmer's fields

General information				
Date				
Date planted				
Crop health	**Poor**	**Average**	**Good**	
• Sorghum Climate-smart push–pull plot				
• brachiaria grass				
• greenleaf desmodium				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Stemborers				
Striga				
Fall armyworm				
Rainfall: Number of days it rained the week before: ____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Season 2, Week 8

	Topic	Duration	What you need for this lesson
1	2nd weeding of sorghum and brachiaria and 2nd trimming and weeding of greenleaf desmodium in established Climate-smart push–pull plot	1 hour 30 minutes	A *panga*, ruler or tape measure, *jembe*, chopping log, gunny bags, polythene sheets, greenleaf desmodium cuttings
2	Utilisation of trimmed greenleaf desmodium	2 hours	

Topic 1: 2nd weeding of sorghum and brachiaria grass, and 2nd trimming and weeding of greenleaf desmodium in established Climate-smart push–pull plot

- It is two weeks since you last weeded your plots and new weeds have now grown. You must weed them to keep your plot free of weeds.
- It is also two weeks since you last trimmed the greenleaf desmodium in your established Climate-smart push–pull plot. It is now time to trim it again; otherwise, it will compete with your sorghum. It is also time to weed the greenleaf desmodium.
- The greenleaf desmodium in the vine-established Climate-smart push–pull plot may also need trimming and depending on the amount of rain you have received, it may also need weeding.

Learning activities

- Facilitator-led introduction to the importance of trimming greenleaf desmodium and weeding all the crops: sorghum, brachiaria grass and greenleaf desmodium.
- Practical activities on trimming and weeding.
- Facilitator-led discussions.

Greenleaf desmodium trimming and weeding

Step 1: Using a sharp *panga*, trim the greenleaf desmodium so that its leaves do not touch the base of the sorghum. Feed the cut greenleaf desmodium to your livestock. **See Topic 2 below**.

Step 2: Weed the greenleaf desmodium using a *panga* or a small narrow hoe.

Sorghum and brachiaria grass weeding

Carefully weed your sorghum and brachiaria grass using a *jembe* or hoe.

Note

As you learned in Season1, some farmers in striga-infested areas apply fertiliser when sorghum is 3 weeks and when it is 5 weeks old.

Topic 2: Utilisation of trimmed greenleaf desmodium

Introduction

When you trim greenleaf desmodium, especially in the Second Season, you might have more fodder than you need for the day. You can conserve the extra greenleaf desmodium as hay to use in times of need. (**See Season 1, Week 16**).

The freshly-trimmed greenleaf desmodium can be used directly as livestock feed (Please **see Season 1, Week 13**).

Labour costs

	Activity	No. of people working on this activity	Time taken to complete the activity (hours)	Cost of labour per day	Total cost of this activity
Established Climate-smart push–pull plot	Weeding sorghum				
	Weeding brachiaria grass				
	Trimming greenleaf desmodium				
	Any other activity				
Total					
Vine-established Climate-smart push–pull plot	Weeding sorghum				
	Weeding brachiaria grass				
	Trimming greenleaf desmodium				
	Any other activity				
Total					
Check plot	Weeding sorghum				
	Other activity				
Total					

Benefits (Please keep filling the number of units each week as you cut)

	Type of benefit	Quantity	Unit market price	Total value
Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	1 kg greenleaf desmodium hay (1 unit)			
	5 kg silage (1 unit)			
	Milk (litre)			
	Other benefit			

General observations (AESA): Farmer's fields

General information				
Date				
Crop age				
Crop health	**Poor**	**Average**	**Good**	
• Sorghum Climate-smart push–pull plot				
• brachiaria grass				
• greenleaf desmodium				
Observations				**Farmer's comments**
Stemborers	**Low**	**Medium**	**High**	
• Established Climate-smart push–pull plot				
• Vine established Climate-smart push–pull plot				
• Check plot				
Fall armyworm	**Low**	**Medium**	**High**	
• Established Climate-smart push–pull plot				
• Vine established Climate-smart push–pull plot				
• Check plot				
Striga	**Low**	**Medium**	**High**	
• Established Climate-smart push–pull plot				
• Vine established Climate-smart push–pull plot				
• Check plot				
Rainfall: Number of days it rained the week before: _____				
Soil moisture				
Wealher: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Note

*Please record stemborer, fall armyworm and striga damage as **low, Medium** or **High.***

Season 2, Week 9

	Topic	Duration	What you need for this lesson
1	Comparison of stemborers, fall armyworm and striga between Climate-smart push–pull plots and check plot	2 hours	Samples of striga at various stages of growth, knives, pictures of damaged plants, hoe,flip charts, posters, marker pens, masking tapes, sharp sticks
2	2nd Weeding and rouging of greenleaf desmodium seed plot	1 hour 30 minutes	

Topic 1: Comparison of stemborers, fall armyworm and striga between Climate-smart push–pull plot and check plot

By now your sorghum is 8 weeks old and it will be showing more signs of striga, fall armyworm and stemborer damage. You need to continue monitoring how your Climate-smart push–pull plots are performing as compared to your check plot

Learning objective

In this lesson, participants will continue their evaluation of the effectiveness of Climate-smart push–pull in controlling stemborers, fall armyworm and striga.

Learning activities

- Facilitator-led introduction on stemborer, fall armyworm and striga damage.
- Field exercise.
- Discussions.

Step 1: Starting from one corner, walk to the opposite corner (diagonally) of any plot. As you walk, stop at **every fifth plant** and look for any sign of stemborer, fall armyworm and striga damage. Record what you have noticed.

Look for:

- Signs of stemborer damage.
  - Leaf damage.
  - Deadheart.
- Signs of fall armyworm damage.
  - Leaf damage.
  - Whorl damage – deadheart.
  - Presence of frass.
- Signs of striga damage.
  - Stunted growth.
  - The number of striga plants within 15 cm around the plant.

Step 2: Repeat step 1 from a different corner and walk diagonally to the opposite corner.

Step 3: Repeat steps 1 and 2 in the other plots.

Note

At the end of the exercise you will have looked at more plants in the check plot than in the Climate-smart push–pull plots.

2nd season Climate-smart push–pull

What to record	Number	*Percent damage
Total number of plants observed		
Total number of plants with signs of stemborer leaf damage		
Total number of plants with signs of fall armyworm damage		
Total number of plants with deadheart		
Total number of striga stunted plants		
Total number of striga weeds around sorghum plants (15 cm)		

**The facilitator will work out the percentages and discuss them with the farmers.*

Vine-established Climate-smart push–pull plot

What to record	Number	*Percent damage
Total number of plants observed		
Total number of plants with signs of stemborer leaf damage		
Total number of plants with signs of fall armyworm damage		
Total number of plants with deadheart		
Total number of Striga stunted plants		
Total number of striga weeds around sorghum plants (15 cm)		

**The facilitator will work out the percentages and discuss them with the farmers.*

Check plot

What to record	Number	*Percent damage
Total number of plants observed		
Total number of plants with signs of stemborer leaf damage		
Total number of plants with signs of fall armyworm damage		
Total number of plants with deadheart		
Total number of striga stunted plants		
Total number of striga weeds around sorghum plants (15 cm)		

**The facilitator will work out the percentages and discuss them with the farmers.*

Topic 2: 2nd weeding and rouging of greenleaf desmodium seed plot

Introduction

It is three weeks since you last weeded and rogued the greenleaf desmodium seed multiplication plot. It is now time to do it again.

Step 1: Clear a 2 metre strip around the greenleaf desmodium plot using a *panga* and a *jembe*.

Step 2: Walk within the vines and using a sharp stick loosen the soils around the weeds and carefully remove weeds and off-types by hand.

(**See Week 6**)

Labour costs

	Activity	No. of people working on thls activity	Time taken to complete the activity (hours)	Cost of labour per day	Total cost of this activity
Seed multiplication plot	Weeding and rouging greenleaf desmodium				
	Any other activity				
Total					

Benefits of livestock feed (Please keep filling the number of units each week as you cut)

	Type of benefit	Quantity	Unit market price	Total value
Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	1 kg greenleaf desmodium hay			
	5 kg silage (1 unit)			
	Milk (litre)			
	Other benefit			

General observations (AESA): Farmer's fields

General information				
Date				
Crop age				
Crop health	**Poor**	**Average**	**Good**	
• Sorghum Climate-smart push–pull plot				
• brachiaria grass				
• greenleaf desmodium				
Observations				**Farmer's comments**
Stemborers	**Low**	**Medium**	**High**	
• Established Climate-smart push–pull plot				
• Root split and vine-established Climate-smart push–pull plot				
• Check plot				
Fall armyworm	**Low**	**Medium**	**High**	
• Established Climate-smart push–pull plot				
• Root split and vine-established Climate-smart push–pull plot				
• Check plot				
Striga	**Low**	**Medium**	**High**	
• Established Climate-smart push–pull plot				
• Root split and vine-established Climate-smart push–pull plot				
• Check plot				
Rainfall: Number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Farmers' comments after the lesson:

_____

_____

_____

_____

Season 2, Week 10

	Topic	Duration	Whet you need for this lesson
1	Improving soil fertility	45 minutes	*Jembe, panga*, clear polythene bags, pens, flip chart

Topic: Improving soil fertility

In **Season 1, Week 20** we discussed the need to keep your soil healthy. It is now time to see if there are any changes in the soil.

Learning objective

On completion of this topic, farmers will understand more about the important aspects of soil fertility and how Climate-smart push–pull helps improve soil health.

Learning activities

- Facilitator-guided introduction on improving soil fertility.
- Observations of soil fertility indicators.
- Discussions of any changes in the plots between **Season 1, Week 21**and now.

How to tell if your soil is getting healthier

Step 1: Go to the established Climate-smart push–pull plot and pull out 10 mature vines and wash the roots carefully. Observe for nodules.

Note

The nodules have good bacteria (rhizobia) that help to add nitrogen to your soil that your plants can use (nitrogen fixation). If the nodules are bigger, there is more nitrogen fixation in your soil.

Step 2: Walk around the Climate-smart push–pull plots and check plot. observe and fill the table below.

		Established Climate-smart push–pull plot		Climate-smart push–pull plot with vines and root splits		Check plot	
Soil quality indicator	Soil quality indicator questions	Yes	No	Yes	No	Yes	No
Organic matter	Is the soil getting darker?						
Soil structure	Is the soil getting softer underfoot? Is it easier to work on?					-	
Runoff	Does rain soak into the soil quickly? (Rain soaks fast and water does not stay on the surface.)						
Soil moisture	Does the soil stay moist for longer period after rains?						
Soil life (aeration)	Does the soil have many earthworms? Are there many holes in the soil, and worm casts on the surface?						
Crop yields	Are your yields improving?						
Roots	Do the crop roots grow well?						
Presence of weeds	Do the soils have the type of weeds that like to grow on fertile soils?						
If you answered Yes to these questions, your soil is getting better! If you answered No, discuss the reasons.							

Benefits of livestock feed (Please keep filling the number of units each week as you cut)

	Type of benefit	Quantity	Unit market price	Total value
Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	1 kg greenleaf desmodium hay			
	5 kg silage (1 unit)			
	Milk (litre)			
	Other benefit			

General observations (AESA): Farmer's fields

General information				
Date				
Crop age				
Crop health	**Poor**	**Average**	**Good**	
• Sorghum Climate-smart push–pull plot				
• brachiaria grass				
• greenleaf desmodium				
Observations				**Farmer's comments**
Stemborers	**low**	**Medium**	**High**	
• Established Climate-smart push–pull plot				
• Root split and vine-established Climate-smart push–pull plot				
• Check plot				
Striga	**low**	**Medium**	**High**	
• Established Climate-smart push–pull plot				
• Root split and vine-established Climate-smart push–pull plot				
• Check plot				
Rainfall: Number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Farmers' comments after the lesson:

_____

_____

_____

Season 2, Week 11

	Topic	Duration	What you need for this lesson
1	Sorghum diseases	4 hours	Pictures of diseased sorghum,flip charts, pens, marker pens, samples of IR-sorghum
2	Disease-resistant sorghum		
3	Planning Field Day		

Topic 1: Sorghum diseases

Introduction

Some of the common diseases that affect sorghum include: Maize dwarf mosaic, head smut, rough spot, gray leaf spot and anthracnose. In each area there are sorghum varieties that are resistant or tolerant to these diseases. To maximise sorghum production from Climate-smart Push–pull, farmers must use the right variety of sorghum.

Learning objective

On completion of this topic, farmers will know more about sorghum diseases and the available disease resistant varieties of sorghum in their area.

Learning activities

- Facilitator-led introduction on sorghum diseases.
- Practical exercise: Participants list sorghum diseases, their symptoms and disease resistant sorghum varieties.
- Discussion (Lead question: What do farmers know about sorghum diseases, and what resistant varieties are locally available?)

The following are some of the diseases that affect sorghum, and how to recognise them.

1. Maize dwarf mosaic virus (MDMV)

Maize dwarf mosaic is a viral disease that occurs over all the sorghum producing areas. Its ability to cause damage is dependent on the presence of an over-seasoning virus host (mainly Johnson grass), aphid populations to facilitate virus transmission and the susceptibility of the varieties being grown.

Symptoms: Affected plants have mottled (light green blotches) terminal leaves. These alternate light-green and darker-green areas in the leaf can be more easily seen when held between the viewer and a light source. Observers should always look at the newest leaves for the most severe symptoms. Highly susceptible hybrids are stunted with chlorotic symptoms in the upper leaves and suffer significant yield losses. Some hybrids produce a red leaf symptom when plants are infected and when night temperatures are below 13°C.

2. Head smut (*Sporisorium sorghi, Sporisorium spp.*)

Head smut is caused by fungi. The disease emergence favours cool dry soils.

Symptoms Head replaced by brown, powdery mass of fungal spores covered by gray to brown membrane; entire head may be affected or fungus may be localised at the top, bottom or sides of the head; plants are usually or normal height.

3. Anthracnose, (*Colletotrichum graminicola*)

Anthracnose is caused by fungus. The disease emergence favours warm temperatures.

Symptoms Small, circular red lesions (spots) with a distinct margin develop on leaves and stems;

lesions may enlarge during humid weather conditions; plant becomes defoliated; tan spots with red margins may appear on upper parts of stems; plants may die before reaching maturity.

4. Charcoal rot (*Macrophomina phaseolina*)

Charcoal rot is caused by fungus. Damage from the disease is usually greatest in fields which are subject to drought stress, in-fertile soil and overcrowded fields.

Symptoms Lower stalk appears shredded and dark gray; small, black fungal structures on internal parts of the stalk giving tissues a dark gray colour; pith decomposes leaving only the outer stem tissue; infected plants will usually lodge.

5. Gray leaf spot (*Cercospora sorghi*)

Gray leaf spot is caused by fungus.

Symptoms Small red spots on leaves which enlarge to form rectangular lesions between leaf veins; lesions may coalesce to form stripes or irregular blotches, disease emergence is favoured by periods of warm and wet weather during the growing season.

6. Rough spot

Rough spot is caused by fungus (*Ascochyta sorghi*). The disease is problematic but generally causes only minor losses when present.

Symptoms Small, oval or elongated red spots on leaves; lesions coalesce and develop hard black fungal fruiting bodies, giving the leaves a sandpaper-like texture; rough areas may become large enough to kill entire leaf. The diseases-causing fungi survive between growing seasons on crop debris.

7. Zonate leaf spot (*Gloeocercospora sorghi*)

Symptoms Concentric or zoned patches of red and purple bands separated by straw colored or tan bands on leaves; spots often occur in a semi-circular pattern along leaf margins; salmon coloured spore masses may develop on lesions during periods of wet weather, can be spread via infested seed; common disease of sorghum during wet weather.

Sorghum pests

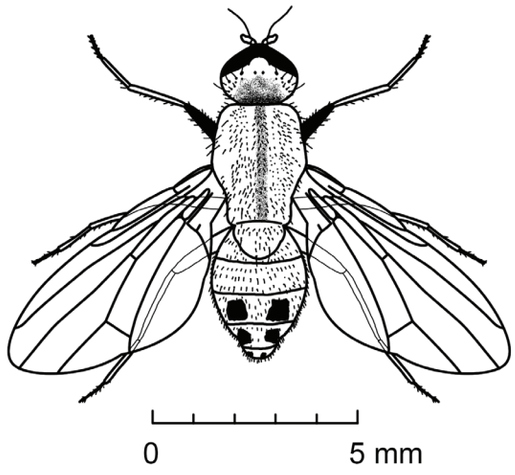

Fig. 86. Sorghum shoot fly

Sorghum shoot fly *(Atherigona soccata)*

This is one of the most destructive insect pests of sorghum. It causes significant losses at the seedling stage of the crop. An adult shoot fly looks like a housefly. However, it is smaller in size (3-5 mm long), greyish in colour and its abdomen is yellow with brown patches.

Damage:

The damaging stage is the larval stage (larvae or maggots). The larvae or maggots are yellowish or whitish in colour and grow up to 8 mm long. The fly lays eggs either at the base of young shoots near soil surfaces, or on leaves in older plants. The maggots crawl inside the sheath and bore into the heart of the young shoots killing the growing point and the youngest leaf, which turns brown and withers. This damage is known as "dead heart". When good growing conditions prevail the young plants are usually able to compensate the damage by producing new tillers, which may partly escape attack.

However, the ripening of the heads later will be unequal. In weak plants, repeated infestation may cause serious losses. Sometimes the damage is so severe that many seedlings die and the field has to be replanted. Older plants (over 30 days after seedling emergence) are generally not damaged by the shoot fly. When infested, the damaged leaf instead becomes thin and papery, and wraps around the other leaves. As a result, the plants may fail to grow normally. Late infestations may also damage the panicle in the formative stage, resulting in rotting or drying up of a portion of the panicle affected by shoot fly damage.

Sorghum midge *(Stenodiplosis sorghicola)*

The sorghum midge is likely the most damaging and widely distributed of all sorghum insects. It occurs in most of the regions where the crop is grown in Africa. An adult sorghum midge is reddish-orange in colour, with a yellow head, brown antennae and legs, and gray membranous wings. Sorghum midge is a 1.3 mm long, fragile-looking insect. The female lays about 50 yellowish-white cylindrical eggs per day between the glumes of flowering spikelets of sorghum. These hatch in two to three days. Larvae start off colourless, changing to dark orange when fully grown.

Larvae take 9-11 days to develop and pupate between the glumes of the spikelets within a period of 3 days. A generation is completed in 14-16 days, meaning, multiple generations during a season and so high infestation levels when sorghum is flowering. Sorghum midge larvae prevent kernel development and cause direct grain loss. Typically, a sorghum panicle infested by sorghum midge will have various proportions of normal kernels scattered among no kernel-bearing spikelets.

Topic 2: Field day planning

Field day is only five weeks away. There is a lot of work to do to make it a success. There are some suggestions in **Season 2, Week 15** that you can use as a guide.

To help you select the member's farm to host the field day, we suggest that you use some or all of the criteria in the tables below.

You will have a lot of things to do. Here are some suggestions:

1. Assign responsibilities for the field day
2. Tell people about it – The farming community, colleagues from other field schools, the provincial administration (DO, Chief, Assistant Chief, etc.), the Ministries of Agriculture, Livestock and Fisheries Extension staff, NGOs and CBOs, church groups, schools, and the media (radio, newspaper, etc.)
3. Make a programme and agree on the time, what is to be covered and stick to it.
4. Make a budget.

5. Prepare an evaluation sheet.

Benefits of livestock feed (Please keep filling the number of units each week as you cut)

	Type of benefit	Quantity	Unit market	Total value price
Climate-smart Push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	1 kg greenleaf desmodium hay			
	5 kg silage (1 unit)			
	Milk (litre)			
	Other benefit			

General observations (AESA): Farmer's fields

General information				
Date				
Crop age				
Crop health	**Poor**	**Average**	**Good**	
• Sorghum Climate-smart push–pull plot				
• brachiaria grass				
• greenleaf desmodium				
Observations				**Farmer's comments**
Stemborers	**Low**	**Medium**	**High**	
• Established Climate-smart push–pull plot				
• Root split and vine established Climate-smart push–pull plot				
• Check plot				
Striga	**Low**	**Medium**	**High**	
• Established Climate-smart push–pull plot				
• Root split and vine established Climate-smart push–pull plot				
• Check plot				
Rainfall: number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Season 2, Week 12

	Topic	Duration	What you need for this lesson
1	Napier stunt disease and its management	2 hours	Samples of a diseased plant (must be destroyed immediately after use), a *jembe*
2	Recording greenleaf desmodium pests on Climate-smart push–pull and seed multiplication plots	1 hour	Plastic jars or clear bottles, clear plastic bags for handling the beetles

Topic 1: Napier stunt disease and its management

Introduction

In eastern Africa (including Ethiopia), the major threat to livestock production and the adoption of push–pull and by extention Climate-smart push–pull strategy, comes from **Napier stunt disease**. The disease causes severe stunting of the Napier grass and a severe yield reduction creating a shortage of livestock feed. Napier stunt disease is spread by insects.

At present, for smallscale farmers, there is no affordable control for Napier stunt disease other than to remove and destroy the affected plants. If you do not remove the affected plants the disease will spread very quickly to the healthy plants.

The symptoms of the disease appear only during the regrowth of harvested Napier grass. You need to recognise these symptoms so that you can reduce the spread of the disease.

Learning objective

On completion of this topic, participants will recognise symptoms of Napier stunt disease and how to reduce its spread.

Learning activities

- Facilitator-led introduction on:
  - The importance of the disease and how farmers can reduce its spread both on their farms and on the other farms.
  - Recognising the symptoms of the disease.
- Practical exercise: Identifying and destroying the affected plants.
- Discussions.

Step 1: Discuss the symptoms

What to look at	Healthy plant	Diseased plant
Colour	Green	Yellow
Leaves	Wide	Narrow
Height	Tall	Stunted
Internodes	Long	Short

Step 2: Walk in the field and identify and record the diseased plants in the Climate-smart push–pull plots and other Napier grass on the farm. Remove and destroy the diseased plants.

Step 3: Take a root split from a healthy Napier grass and plant it where you uprooted the diseased plant.

Note

The new plant will not be affected by the disease simply by being planted in the same hole. The disease is spread by insects.

Napier stunt disease incidence

	Yes	No	Number of infected plants
Established push- pull			
Vine-established Push–pull			
Other Napier grass on the farm			

Note

To reduce the spread as much as possible, you should walk around the farm and remove and destroy all the affected plants.

Topic 2: Recording greenleaf desmodium pests on Climate-smart push–pull and seed multiplication plots

Introduction

In **Season 1, Week 17,** you learnt about blister beetles, pests of greenleaf desmodium. We need to continue observing them and the flowers they are feeding on.

Remember they are called blister beetles because if you touch them they produce a chemical that can cause blisters on your skin.

Learning objective

Participants continue to identify and record the common types of blister beetles found on greenleaf desmodium and what other crops they are damaging.

Learning activities

- Facilitator-led introduction on the common types of blister beetles found on greenleaf desmodium crops and what other crops they are damaging.
- Practical exercise (Field walks to collect blister beetles).
- Discussions.

Procedure

Step 1: Walk in the greenleaf desmodium plot and collect examples of blister beetles. Use gloves. Do not handle them with your bare hands. **Use the drawings to identify the beetles.** (Fig. 64 on page 79 of this book)

Step 2: Walk around the farm and record the number of blister beetles on different crops.

Step 3: Destroy the beetles.

Remember that at the moment there is no affordable method to control blister beetles for smallscale farmers. The record you are making now will help scientists to develop affordable control measures.

Plot	Type 1	Type 2	Type 3	Type 4	Grasshoppers
Established Climate-smart push–pull plot					
Greenleaf desmodium multiplication plot					
Root split and vine-established Climate-smart push–pull plot					
Check plot					
Other crops					
1					
2					
3					
4					

**Please write the name of the crop.*

Benefits (Please keep filling the number of units each week as you cut)

	Type of benefit	Quantity	Unit market price	Total value
Climate-smart push–pull plot	10 kg Napier grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	1 kg greenleaf desmodium hay (1 unit)			
	5 kg silage (1 unit)			
	Milk (litre)			
	Other benefit			

General observations (AESA): Farmer's fields

General information				
Date				
Crop age				
Crop health	**Poor**	**Average**	**Good**	
• Sorghum Climate-smart push–pull plot				
• Napier grass				
• greenleaf desmodium				
Observations				**Farmer's comments**
Stemborers	**Low**	**Medium**	**High**	
• Established Climate-smart push–pull plot				
• Root split and vine-established Climate-smart push–pull plot				
• Check plot				
Striga	**Low**	**Medium**	**High**	
• Established Climate-smart push–pull plot				
• Root split and vine-established Climate-smart push–pull plot				
• Check plot				
Rainfall: Number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Season 2, Week 13

	Topic	Duration	What you need for this lesson
1	Planning for Field Day	3 hours	—

Topic: Planning for Field Day

Field day is only three weeks away. There is a lot of work to do to make it a success. The suggestions in **Season 2, Week 15** should guide you to prepare for this important day. To help you select the member's farm, we suggest that you use some or all of the criteria in tables above.

You will have a lot of things to do as you prepare for the field day. Take time and use the guidelines given in **Season 2, Week 11** to prepare for it.

Benefits (Please keep filling the number of units each week as you cut)

	Type of benefit	Quantity	Unit market price	Total value
Estalished Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	1 kg greenleaf desmodium hay			
	5 kg silage (1 unit)*			
	Milk (Litre)			
	Other benefit			
Vine-estalished Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	1 kg greenleaf desmodium hay			
	5 kg silage (1 unit)*			
	Milk (Litre)			
	Other benefit			

General observations (AESA): Farmer's fields

General information				
Date				
Crop age				
Crop health	**Poor**	**Average**	**Good**	
• Sorghum Climate-smart push–pull plot				
• Brachiaria grass				
• Greenleaf desmodium				
Observations				**Farmer's comments**
	Low	**Medium**	**High**	
Rainfall: Number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*		*Hot/Cold*	

Season 2, Week 14

	Topic	Duration	What you need for this lesson
1	Comparison of stemborers, fall armyworm and striga between Climate-smart push–pull plots and check plot	1 hour 30 minutes	Field records, pens, brachiaria grass, greenleaf desmodium, sorghum grain, minerals, *panga*, buckets, chopping log, polylhene sheet, gunny bags, water, wheelbarrows
2	Training on fodder preparation from Climate-smart push–pull and home-made ration formulation	1 hour 30 minutes	
3	Planning Field Day	1 hour	

Topic 1: Comparing stemborers, fall armyworm and striga between Climate-smart push–pull plots and check plot

By now your sorghum is 14 weeks old and it will be showing more signs of striga, fall armyworm and stemborer damage. You need to continue evaluating how your Climate-smart push–pull plots are performing compared to your check plot.

Learning objective

In this lesson, participants will continue their evaluation of the effectiveness of Climate-smart push–pull in controlling stemborers, fall armyworm and striga.

Learning activities

- Facilitator-led introduction on the effectiveness of Climate-smart push–pull in controlling Stemborers and striga.
- Field exercise of checking stemborer, fall armyworm and striga damage.
- Discussions (Lead question: Which plot is most affected by stemborers, fall armyworm and striga weeds?)

Step 1: Starting from one corner, walk to the opposite corner (diagonally) of any plot. As you walk, stop at **every fifth plant** and look for any sign of stemborer, fall armyworm and striga damage. Record what you have noticed.

Look for:

- Signs of stemborer damage.
  - Leaf damage.
  - Whorl damage/deadheart.
- Signs of fall armyworm damage.
  - Leaf damage.
  - Whorl damage/deadheart.
  - Presence of frass.
- Signs of striga damage.
  - Stunted growth.
  - The number of striga plants within 15 cm around the plant.

Step 2: Repeat step 1 from a different corner and walk diagonally to the opposite corner.

Step 3: Repeat Steps 1and 2 in the other plots.

Note

At the end of the exercise, you will have looked at more plants in the check plot than in the Climate-smart push–pull plots.

2nd season Climate-smart push–pull plot

What to record	Number	*Percent damage
Total number of plants observed		
Total number of plants with signs of stemborer leaf damage		
Total number of plants with signs of fall armyworm leaf damage		
Total number of striga stunted sorghum plants		
Total number of striga weeds around sorghum plants (15 cm)		

**The facilitator will assist the farmers to work out the percentages and discuss them.*

Vine-established Climate-smart push–pull plot

What to record	Number	*Percent damage
Total number of plants observed		
Total number of plants with signs of stemborer leaf damage		
Total number of plants with signs of fall armyworm leaf damage		
Total number of striga stunted sorghum plants		
Total number of striga weeds around sorghum plants (15 cm)		

**The facilitator will assist the farmers to work out the percentages and discuss them.*

Check plot

What to record	Number	*Percent damage
Total number of plants observed		
Total number of plants with signs of stemborer leaf damage		
Total number of plants with signs of fall armyworm leaf damage		
Total number of striga stunted sorghum plants		
Total number of striga weeds around sorghum plants (15 cm)		

**The facilitator will assist the farmers to work out the percentages and discuss them.*

Topic 2: Training on fodder preparation from Climate-smart push–pull and home-made ration formulation

Introduction

On the farm, there are various feed types, including products from the Climate-smart push–pull plot. Some of these feeds can be used to formulate cheap and balanced concentrate ration at reduced costs.

Learning objective

At the end of this lesson, participants will be able to identify different feed sources on the farm and make simple concentrate rations that can be utilised by livestock at a reduced cost.

Learning activities

- Facilitator-led introduction on key issues to consider when formulating a ration for livestock.
- Practical activities on livestock ration formulation.

- Discussions (Lead question: How much can you feed to your livestock each day?)

How to make a ration

Note

When formulating a good ration you should consider the feed requirements for the animal to be fed.

A good concentrate ration should consist of the following ingredients:

- Energy (sorghum)
- Protein (greenleaf desmodium) and
- Minerals (commercial mineral licks).

How to mix

Before formulating, the farmer is advised to seek expert opinion from livestock agencies on the nutritive value and mixing levels.

Ensure that sorghum and greenleaf desmodium are properly dried. Well dried greenleaf desmodium hay will make good ingredient if available. It is advisable to make the greenleaf desmodium hay in advance before formulating your ration. (**See Season 1, Week 16, Topic 3:** Making and utilising greenleaf desmodium hay).

Step 1: Collect and assemble the ingredients to be used in making the concentrate ration.

Step 2: Chop the greenleaf desmodium hay into small pieces.

Step 3: Mix at a ratio of four parts of sorghum grain with one part of the chopped greenleaf desmodium hay.

Step 4: Mill the mixture into coarse flour using a hammer mill.

Note

In situations where greenleaf desmodium hay and sorghum mixture is not accepted by the millers, you can mill the sorghum separately. The greenleaf desmodium hay can be ground or hand crushed separately. Thereafter, thoroughly mix the two ingredients as recommended.

Step 5: Your concentrate ration is ready for use or storage. Put it in a gunny bag and store in a dry place. It is advisable to use the concentrate ration within 2 months.

Step 6: If the ration is used as a substitute to commercial dairy meal, give 4 kg (2 *gorogoro*) per milking session for a dairy cow or 2 kg (1 *gorogoro*) for a dairy goat.

What NOT to do:

Do not use rotten sorghum or store the ration in a moist place to avoid aflatoxins.

Benefits (Please keep filling the number of units each week as you cut)

	Type of benefit	Quantity	Unit market price	Total value
Established Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	1 kg greenleaf desmodium hay (1 unit)			
	5 kg silage (1 unit)			
	Milk (litre)			
	Other benefit			
VIne-established Push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	1 kg greenleaf desmodium hay (unit)			
	5 kg silage (1 unit)			
	Milk (litre)			
	Other benefit			

General observations (AESA): Farmer's fields

General information				
Date				
Crop age				
Crop health	**Poor**	**Average**	**Good**	
• Sorghum Climate-smart push–pull plot				
• brachiaria grass				
• greenleaf desmodium				
Observations				**Farmer's comments**
Stemborers	**Low**	**Medium**	**High**	
• Established Climate-smart push–pull plot				
• Root splits and vine established Climate-smart push–pull plot				
• Check plot				
Fall armyworm	**Low**	**Medium**	**High**	
• Established Climate-smart push–pull plot				
• Root splits and vine established Climate-smart push–pull plot				
• Check plot				
Striga	**Low**	**Medium**	**High**	
• Established Climate-smart push–pull plot				
• Root splits and vlne established Climate-smart push–pull plot				
• Check plot				
Rainfall: Number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Topic 3: Field Day!

Field day is only two weeks away. There is a lot of work to do to make it a success. There are some suggestions in **Season 2, Week 15** on what to do. Use them as a guide.

Season 2, Week 15

	Topic	Duration	What you need for this lesson
1	Final group assessment	3 hours	Pens, checklist of performance and management of enterprises, farmers' records, Flip charts, marker pens, Checklist for Field Day events
2	Field Day planning	1 hour	

Topic 1: Final group assessment

Introduction

Now you have been working together as a group for two seasons and you have had time to apply on your farm what you have learnt in the field school. It is time to go out for the fourth and last time to see what you and your colleagues have done so that you can all learn from each other's experiences and select the best Climate-smart push–pull plots so that you can hold the Field Day there next week.

Learning objective

The objective of this assessment is to maximise learning through group evaluation of individual plots.

What to do in the assessment

Step 1: Join the groups that you formed in **Season 1, Week 3.** Each group should have 4 – 6 members.

Step 2: Visit each farm represented by the members in the group.

Step 3: Use the table below to assess the Climate-smart push–pull and the check plots.

Discuss with the host farmer. Rate each farm using this scale:

1= Poor 2 = Average 3 = Good

2nd season Climate-smart push–pull	2nd season Check plot	1st season Climate-smart push–pull plot	2nd season Check plot		1st season Climate-smart push–pull vines	
What to check	**Rating**	**Comments**	**Rating**	**Comments**	**Rating**	**Comments**
Overall field management						
Weeding of the plots						
Sorghum stand						
Brachiaria grass management						
Greenleaf desmodium management						
Record keeplng						
Total rates						

	Greenleaf desmodium multiplication Plot	
What to check	**Rating**	**Comments**
Stand of greenleaf desmodium		
Weeding of the plot		
Off-types		
Quantity of seed produced		
Quality of seed		
Record keeping		
Total rates		

Topic 2: Planning for field day

Field Day is next week. You need to select one of the member's farms, where you will be able to observe, exchange experiences and show the general farming community the result of your work. This is an excellent opportunity for the community to gain a better understanding of what happens in a FFS and what the benefits and problems of this approach are.

To help you select the member's farm, we use some or all of the criteria in tables above.

You will have a lot of things to do. Here are some suggestions:

1. Assign responsibilities for the field day.
2. Tell people about it - The farming community, colleagues from other field schools, the provincial administration (DO, Chief, Asst. Chief,etc.), the Ministries of Agriculture, Livestock and Fisheries, Extension staff, NGOs and CBOs, church groups, schools,and the media.
3. Make a programme and agree on the time and what is to be covered.
4. Make a budget.
5. Prepare evaluation form.

Benefits (Please keep filling the number of units each week as you cut)

	Type of benefit	Quantity	Unit market price	Total value
Climate-smart Push-pullplot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	1 kg greenleaf desmodium hay (1 unit)			
	5 kg silage (1 unit)			
	Milk (litre)			
	Other benefit			

General observations (AESA): Farmer's fields

General information				
Date				
Crop age				
Crop health	**Poor**	**Average**	**Good**	
• Sorghum Climate-smart push–pull plot				
• brachiaria grass				
• greenleaf desmodium				
Observations				**Farmer's comments**
Stemborers	**Low**	**Medium**	**High**	
• Established Climate-smart push–pull plot				
• Vine Climate-smart push–pull plot				
• Check plot				
Striga	**Low**	**Medium**	**High**	
• Established Climate-smart push–pull plot				
• Vine Climate-smart push–pull plot				
• Check plot				
Rainfall: Number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Season 2, Week 16

	Topic	Duration	What you need for this lesson
1	Field Day	4 hours	Chairs, tables, posters, Climate-smart push–pull brochures, Climate-smart push–pull FFS curriculum, refreshments, writing material, pens, displays of Climate-smart push–pull materials and produce,collaborators and guest of honour

Field day

- It will still be necessary to carry out and record the activities you need to do on this day.
- Start on time.
- Each participant to do his/her duty.
- Ensure everything planned is in place.
- Follow the programme.

Benefits (Please keep filling the number of units each week as you cut)

	Type of benefit	Quantity	Unit market price	Total value
Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	1 kg desmodium hay (unit)			
	5 kg silage (1 unit)			
	Milk (litre)			
	Other benefit			

General observations (AESA): Farmer's fields

General information				
Date				
Crop age				
Crop health	**Poor**	**Average**	**Good**	
• Sorghum Climate-smart push–pull plot				
• brachiaria grass				
• greenleaf desmodium				
Observations				**Farmer's comments**
Stemborers	**Low**	**Medium**	**High**	
• Established Climate-smart push–pull plot				
• Root splits and vine Climate-smart push–pull plot				
• Check plot				
Striga	**Low**	**Medium**	**High**	
• Established Climate-smart push–pull plot				
• Root splits and vine Climate-smart push–pull plot				
• Check plot				
Rainfall: Number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Season 2, Week 17

	Topic	Duration	What you need for this lesson
1	Report of the field day	4 hours	Data on field day (list of visitors, new farmers), record of questions asked and responses, record of greenleaf desmodium sales and orders, formal evaluation questionnaires of field day

Report of the field day

After your field day, write a brief report on it. This shall be used as one of the indicators in your final evaluation of the Farmer Field School in **Second Season, Week 22**.

Things to note

1. Attendance.
2. Areas of interest from non-group farmers.
3. What went on well?
4. What did not go well?
5. Suggestions for improvement.

	Type of benefit	Quantity	Unit market price	Total value
Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	1 kg greenleaf desmodium hay			
	5 kg silage (1 unit)			
	Milk (litre)			
	Other benefit			

General observations (AESA): Farmer's fields

General information				
Date				
Crop age				
Observations				**Farmer's comments**
Size of panicles	**Low**	**Medium**	**High**	
• Established Climate-smart push–pull plot				
• Vine-established Climate-smart push–pull plot				
• Check plot				
Rainfall: number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Season 2, Week 18

	Topic	Duration	What you need for this lesson
1	Harvesting sorghum	2 hours	Tape measure, weighing balance, *panga*, wheelbarrows or sacks for carrying the sorghum heads (panicles)

Introduction

Your sorghum is now ready for harvesting. You have three plots: Two Climate-smart push–pull plots and one check plot. As in last season make sure that you harvest each plot separately and keep the sorghum from each plot separately. This will help you to know the difference in yields between the three plots.

You will also measure the height of the sorghum plants and dissect them to observe the number of stemborer larvae and pupae.

Topic: Harvesting sorghum

Learning objectives

On completion of this topic, participants will be able to:

- Explain the right time to harvest sorghum.
- Demonstrate how to harvest sorghum.

Learning activities

Practical exercise:

- Measuring the height of the sorghum.
- Harvesting.
- Dissecting some stalks to check for stemborers.
- Facilitator-led discussions on the relationship between sorghum height, fall armyworm and stemborer damage (including larvae and pupae), and sorghum yield.

Remember some key points about harvesting, of sorghum panicles:

- Sorghum is usually harvested by hand when it has reached physiological maturity – which means the grain is hard and does not produce milk when crushed.
- Cut the heads with sickles or a sharp knife from plants in both the Climate-smart push–pull and the check plots or cut the whole plant and remove the heads later. Leave them in the open to dry.
- Sun dry the harvested panicles to a moisture level of 12 – 23% and may be ready for harvest when the leaves are still green and thresh and store the grain.

Notes

- *Steps 1 to 3 below can be done only on the Farmer Field school plot.*
- *Step 4 should be done on each farmer's plot.*
- *Harvesting: Sorghum meant for seed production should be harvested at maturity stage. On the other hand, sorghum meant for fodder can be cut when still green and fresh. Leave it in the sun for it to wilt for 12 hours then chop and feed to the animals. To make silage, start harvesting at dough stage (when the grain is at milky and hardening stage). For dual-purpose sorghum, cut the head with a knife or use a combine harvester.*

Step 1: Starting from one corner of a plot walk to the opposite corner (diagonally). As you walk stop at **every fifth plant,** measure and record its height and then cut it at the base. Carry all the plants you have cut out of the plot and dissect them and record the number of stemborer larvae and pupae.

Step 2: Repeat Step 1 from a different corner and walk diagonally to the opposite corner.

Step 3: Repeat Steps 1and 2 in the other plots.

Note

At the end of the exercise you will have looked at more plants in the check plot than in the Climate-smart push–pull plots.

Step 4: Now harvest the crop keeping separate records for each plot.

- Stalk cutting method: Leave stalks from Climate-smart push–pull and check plots in separate piles until they are dry. Then take the weight of panicles.
- Keep the records from the three plots separately.

Labour costs

	Activity	No. of people working on this activity	Time taken to complete the activity (hours)	Cost of labour per day	Total cost of this activity
Established Climate-smart push–pull plot	Harvesting sorghum				
	Collecting and stacking stover				
	Other activity				
Total					
Root splits and vine-established Climate-smart push–pull plot	Harvesting sorghum				
	Collecting and stacking stover				
	Other activity				
Total					
Check plot	Harvesting sorghum				
	Collecting and stacking stover				
	Other activity				
Total					

Estimated benefits

	Product	Estimated quantity	Estimated value
Established Climate-smart push–pull plot	Sorghum (50 kg bag)		
	Stover		
Root splits and vine-established Climate-smart push–pull plot	Sorghum (50 kg bag)		
	Stover		
Check plot	Sorghum (50 kg bag)		
	Stover		

Benefits of livestock feed (Please keep filling the number of units each week as you cut)

	Type of benefit	Quantity	Unit market price	Total value
Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	1 kg greenleaf desmodium hay			
	5 kg silage (1 unit)			
	Milk (litre)			
	Other benefit			

General observations (AESA): Farmer's fields

General information				
Date				
Observations				**Farmer's comments**
Rainfall: number of days it rained the week before: _____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Farmers' comments after the lesson:

_____

_____

_____

_____

_____

_____

Season 2, Week 19

	Topic	Duration	What you need for this lesson
1	2nd Harvesting of greenleaf desmodium from the two Climate-smart push–pull plots and the greenleaf desmodium multiplication plot	2 hours	Gunny bags, balance, 2 kg tins (*gorogoro*) sorghum sheller (optional)
2	Threshing and storage of sorghum	2 hours	

Topic 1: 2nd harvesting of greenleaf desmodium from the two push–pull plots and the greenleaf desmodium multiplication plot

After you have harvested sorghum, you can start harvesting greenleaf desmodium pods and continue harvesting for another 2 – 3 weeks, as not all the pods will be ready at the same time. Today we will discuss when and how to harvest.

You learned how to harvest greenleaf desmodium pods from the Climate-smart push–pull plots in **Season 1, Week 19.**

Please refer to the lesson details.

Remember: This is a continuous activity that should continue for the next two to three weeks as the pods mature.

Topic 2: Threshing and storage of sorghum

Last week we discussed when and how to harvest sorghum. We then harvested the sorghum. This week we look at how to thresh and store the sorghum.

Notes

- ***Harvesting:*** *Sorghum meant for seed production should be harvested at maturity stage. On the other hand, sorghum meant for fodder can be cut when still green and fresh. Leave it in the sun for it to wilt for 12 hours then chop and feed to the animals. To make silage, start harvesting at dough stage (when the grain is at milky and hardening stage). For dual-purpose sorghum, cut the head with a knife or use a combine harvester.*
- *It is important to select only healthy and clean panicles for threshing. Diseased and rotten panicles must be destroyed because they may contain aflatoxin.*

After threshing, the grain should be dried for 3 or more days, cleaned and stored in a dry place protected from storage.

Note

Keep separate records for Climate-smart push–pull plots and for the check plot.

Labour costs

	Activity	No. of people working on this activity	Time taken to complete the activity (hours)	Cost of labour per day	Total cost of this activity
Established Climate-smart push–pull plot	Threshing sorghum				
	Harvesting greenleaf desmodium				
	Other activity				
Total					
Vine-established Climate-smart push–pull plot	Threshing sorghum				
	Harvesting greenleaf desmodium				
	Other activity				
Total					
Check plot	Threshing sorghum				
	Other activity				
Total					

Estimated benefits

	Product	Quantity	LocalMarket Value
Established Climate-smart push–pull plot	Sorghum (*gorogoro*)		
Vine Climate-smart push–pull plot	Sorghum (*gorogoro*)		
Check plot	Sorghum (*gorogoro*)		

Benefits of livestock feed (Please keep filling the number of units each week)

	Type of benefit	Quantity	Unit market price	Total value
Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	1 kg hay			
	5 kg silage (1 unit)			
	Milk (litre)			
	Other benefit			

General Observations (AESA): Farmer's Fields

General information				
Date				
Observations				**Farmer's comments**
Rainfall: Number of days it rained the week before:_____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Farmers' comments after the lesson:

_____

_____

_____

_____

_____

_____

Season 2, Week 20

	Topic	Duration	What you need for this lesson
1	Processing greenleaf desmodium seed	2 hours	Weighing balance, containers (2 kg tins), a flat grinding stone, rubber sole of an old shoe, wire mesh (30 cm by 30 cm), polythene clothing, *jembe*, *panga*.
2	Final assessment questionnaire	30 minutes	

Topic: Processing greenleaf desmodium seed

You learned how to process greenleaf desmodium in **Season 1, Week 20**. Please refer to that lesson for details.

Labour costs

	Activity	No. of people working on this activity	Time taken to complete the activity (hours)	Cost of labour per day	Total cost of this activity
Climate-smart push–pull plot	Processing greenleaf desmodium seed				
	Other activity				

Benefits from greenleaf desmodium seed

	Type of benefit	Quantity	Unit market price	Total value
Climate-smart push–pull plot	Greenleaf desmodium seed			
	Greenleaf desmodium husks			
	Other benefits			

Benefits of livestock feed (Please keep filling the number of units each week)

	Type of benefit	Quantity	Unit market price	Total value
Climate-smart push–pull plot	10 kg brachiaria grass (1 unit)			
	3 kg greenleaf desmodium (1 unit)			
	1 kg hay			
	5 kg silage (1 unit)			
	Milk (litre)			
	Other benefits			

General observations (AESA): Farmer's fields

General information				
Date				
Observations				**Farmer's comments**
Rainfall: Number of days It rained the week before: ____				
Soil moisture				
Weather: Sunny/Cloudy/Rainy	*Windy/Still*	*Hot/Cold*		

Final assessment questionnaire (Hand out the final assessment questionnaire)

Season 2, Week 21

	Topic	Duration	What you need for this lesson
1	Managing the greenleaf desmodium	1 hour	*Panga*, *jembe*, chopping log, gunny bag, polythene sheet, molasses, bucket, sprinkler, string, rake
2	Gross margin analysis	2 hours	

Topic 1: Managing the greenleaf desmodium

Now that you have harvested all the pods from your Climate-smart push–pull plots and seed multiplication plot, you have two choices:

1. Harvest the greenleaf desmodium for fodder and hay-making (**see Season 1, Weeks 13, 14** and **16**).
2. Leave the greenleaf desmodium to produce mature vines (as we did in Season 1) to establish new Climate-smart push–pull plots or for sale of vines to neighbouring farmers.

Topic 2: Gross margin analysis

In **Season 1, Week 15,** you learned about gross margin analysis. Please refer to the lesson details.

Note

Assessment of adoption rates (farmers practising Climate-smart push–pull) to be factored in the questionnaire.

(Questionnaires returned)

Season 2, Week 22

	Topic	Duration	What you need for this lesson
1	Evaluation of the FFS Curriculum	3 hours 30 minutes	Climate-smart push–pull manual, pen, markers, flips charts
2	Preparation for graduation	30 minutes	Certificates, questionnaires.

Topic 1: Evaluating the Climate-smart push–pull Curriculum for FFS

Now that you have come to the end of your field school for learning about the Climate-smart push–pull technology, you need to assess the value of what you have been doing. Evaluation looks at programme activities, human resources, material resources, information and facts in order to monitor progress and effectiveness, consider costs and efficiency, show where changes are needed and to help to plan more effectively.

This lesson shows you how to evaluate the school that you have been attending for over 40 weeks.

Learning objectives

On completion of this topic, participants will be able to:

- State and explain reasons for evaluating the Climate-smart push–pull curriculum for FFS.
- Discuss and explain reasons for success or failure of the field school.
- Explain the effectiveness of the technology in making a difference to crop yields and incomes.

Learning activities

- Facilitator-led introduction on meaning and importance of curriculum evaluation.
- Groups of 4 – 6 members discuss overall performance of the FFS.
- Divide a wall chart into three parts and brainstorm on these questions focusing on things that went well, things that did not go well or things that were not useful and suggestions for next time/improvements. Groups then to present their discussions.
- Facilitator-led discussion on relevance of the curriculum, duration of the school (too short/too long), effectiveness and quality of facilitation, integration of the FFS curriculum into farmer's interests and way of life.

Importance of doing evaluation

Evaluation in FFS is important in several ways

1. Achievement – Assessing what has been achieved. (knowledge skill attitudes. etc.).
2. Measuring progress in accordance with the objectives of the school.
3. Improving monitoring for better management.
4. Identifying strengths and weaknesses to strengthen the school and programme.
5. Checking if the school or programme efforts made a difference.
6. Checking the cost-benefit of the FSS, to assess whether the costs were reasonable compared to the benefits achieved.
7. Collecting information to plan and manage programme activities later.
8. Sharing experiences to prevent others from making mistakes or encouraging them to use similar methods.
9. Improving effectiveness to have more impact.
10. Allowing for better planning more in line with the needs of participants, especially at the community level.

Note

Facilitator to inform the participants that in addition to the group evaluation of the FFS curriculum, information related to the individual FFS members will be gathered through a questionnaire to be given some time later. The individuals will provide answers to a set of questions to find out what has happened after the school.

Some lead questions in assessing the FFS curriculum.

1. What were the most valuable things for you about the FFS?
2. What was the least valuable thing about the FFS?
3. Did you find it easy to participate in the school?
4. How did you find the quality of facilitation in terms of:
   a) Presentation skills.
   b) Listening skills.
   c) Interest in what people have to offer.
   d) Clear thinking and observation of the whole group.
   e) Understanding of the overall objectives.
   f) Helping participants make use of the most decisions to do their tasks.
5. Does the technology work for you?
6. How many other farmers have adopted the technology from you?
7. What suggestions do you have for improving the performance of the school?

Example of a table that can be filled to establish impact among individual FFS members and the group.

Name of FFS Participant _____ Name of FFS: _____

District _____ Division: _____ Sex: 1= Male 2 = Female

Parameter	At start of FFS	First season	Second season
Livelihood/food security information			
Size of land under Climate-smart push–pull technology			
Number of food secure months during the training session			
Yearly income from farm			
Yearly income from Climate-smart push–pull			
Yield per unit area			
Amount of milk per month			
Number of livestock on the farm a) dairy cows b) dairy goats c) Other			
Use of manure (quantity per acre)			
Use of fertiliser {quantity per acre)			
Number ot other farmers adopting Climate-smart push–pull			
AND SO ON…			

Topic 2: Preparing for graduation

Like all schools, the FFS must come to an end. Members need to develop some basic criteria of who qualifies to graduate. They may for instance use the attendance records or other considerations. The graduation event marks the end of the FFS session (cycle/season) and is a festive moment where farmers celebrate their achievements. Such an event requires invitation of key stakeholders to grace the occasion and to establish future collaboration and support. The members need to decide where the graduation event will be held, who will be invited, activities to be performed on this day, allocation of responsibilities, graduation certificates, etc.

Season 2, Week 23

Graduation and certification	Duration
Things that should be in place: • Programme • Place for the event • Furniture • Certificates • Meals (optional)	The whole day

Graduation and certification

Group members to ensure that all the things planned for the graduation are in place. Good organisation of the event will lead to an interesting and motivating graduation.

Follow-up

Follow-up after graduation is very important. At the end of a learning cycle and graduation ceremony, the FFS in most cases continues as a farmer group. The group may have problems that were not addressed in the study cycle, hence the need to plan for post-FFS. This could cover both technical and socio-economic activities. Such a follow-up activity may or may not require a facilitator to assist the group or funds for the study process. The FFS graduates can use the group to engage in other productive activities aimed at improving their livelihoods.

Frequently asked questions

Q. What is the maximum and minimum size of the Climate-smart push–pull plot?

A. A Climate-smart push–pull plot cannot exceed 50 m × 50 m and cannot go below 21 m × 21 m using border rows of brachiaria grass.

Q. What is the minimum width of Climate-smart push–pull plot?

A. Not less than 15 metres.

Q. Where can I obtain brachiaria grass and greenleaf desmodium seeds?

A. Brachiaria grass can be obtained from neighbours who have planted their farms with push–pull. Greenleaf desmodium seed is sold by Western Seed Company in Kitale.

Q. What can I do if I don't get greenleaf desmodium seeds?

A. Use greenleaf desmodium root splits or vines from your neighbour. However, ensure that you plant them immediately and when there is adequate soil moisture.

Q. How effective is Climate-smart push–pull against FAW, stemborers and striga weed?

A. Climate-smart push–pull is very effective. It is even better than insecticides for the control of stemborers and better than manual removal of striga weed, both in terms of cost and effective control.

Q. How long can the Climate-smart push–pull plot be kept?

A. You could benefit from your Climate-smart push–pull plot for 5 or more years if well managed.

Q. Can I be given a dairy animal if I establish a Climate-smart push–pull plot?

A. No. But you can qualify for various projects on dairy animals.

Q. Can I graze my cattle directly on the Climate-smart push–pull plot?

A. No. Grazing cattle directly destroys greenleaf desmodium and brachiaria grass.

Q. Can I practice Climate-smart push–pull if I don't have livestock?

A. Yes, because you can sell brachiaria and greenleaf desmodium forage and seed to your neighbour and greenleaf desmodium can improve fertility of your soil.

Q. Can I intercrop other crops and trees in the Climate-smart push–pull plot?

A. No.

Q. Are there alternatives to brachiaria grass and greenleaf desmodium?

A. Yes. Forage sorghums like Sudan grass can be used to trap stemborers instead of brachiaria grass and molasses grass can be used to repel stemborers instead of greenleaf desmodium. However, molasses grass does not control striga weed.

Q. How long can greenleaf desmodium survive in a prolonged drought?

A. Greenleaf desmodium can always regenerate after a drought. However you are advised to plough and re-establish a Climate-smart push–pull plot in case of a prolonged drought where greenleaf desmodium fails to regenerate.

Q. Can I plant sorghum first, then brachiaria grass after a few weeks?

A. No. You are advised to plant brachiaria grass before planting sorghum or if late plant both crops at the same time.

Q. When do I start reaping the benefits of the Climate-smart push–pull plot?

A. You can reap benefits during second cropping season in areas where farmers plant sorghum twice in a year and during the second year in areas where farmers only plant once in a year.

Q. Can I use Climate-smart push–pull on maize?

A. You can intercrop greenleaf desmodium with sorghum to repel stemborers and control striga weed.

Q. Is Climate-smart push–pull effective against other weeds and insect pests?

A. Greenleaf desmodium in the Climate-smart push–pull can reduce other weeds by smothering them but both brachiaria grass and greenleaf desmodium may not reduce other insect pests.

Q. Where can I obtain brachiaria grass and greenleaf desmodium seeds?

A. Brachiaria grass can be obtained from neighbours who have planted their farms with push–pull. Greenleaf desmodium seed is sold by Western Seed Company in Kitale.

Q. What can I do if I don't get greenleaf desmodium seeds?

A. Use greenleaf desmodium root splits or vines from your neighbour. However, ensure that you plant them immediately and when there is adequate soil moisture.

Q. How effective is Climate-smart push–pull against stemborers, fall armyworm and striga weed?

A. Climate-smart push–pull is very effective. It is even better than insecticides for the control of stemborers and fall armyworm, and better than manual removal of striga weed, both in terms of cost and effective control.

Q. Can I be given a dairy animal if I establish a Climate-smart push–pull plot?

A. No. But you can qualify for various projects on dairy animals.

Q. If I don't have greenleaf desmodium seed, can I plant only brachiaria grass in my Climate-smart push–pull plot?

A. Yes. If you plant only brachiaria grass, you will be able to reduce stemborers on sorghum but you will not be able to control striga weed.

Q. Can Climate-smart push–pull technology work in all parts of Kenya or Africa?

A. Yes. But only in areas recommended for growing greenleaf desmodium. You will need to consult your agricultural extension staff.

Q. Can I use other varieties of brachiaria grass other than brachiaria cv. Mulato II grass?

A. Yes, though field tests have shown that brachiaria cv. Mulato II gives you the best results.

Q. Can I use other species of greenleaf desmodium other than silverleaf?

A. Yes. You can use silverleaf greenleaf desmodium, but the results of Greenleaf with sorghum are the best. Silverleaf greenleaf desmodium do best in wetter areas.

This easy-to-read curriculum shows farmers how to manage three of the major pests of sorghum–stemborers and striga weed–in the eastern and southern Africa region without the use of chemical pesticides. The "Climate-smart push–pull' strategy is a novel system of intercropping designed to manage the agroecohabitat for higher sorghum yields, while at the same time providing fodder, enriching the soil and conserving biodiversity.

Climate-smart push–pull can also be adapted for millet and has been successfully used in maize fields. It is an affordable, appropriate and socially acceptable technology for use by Africa's farmers.

A mature climate-smart push–pull plot

Fall armyworm damage

Goats feeding on brachiaria and desmodium

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