



SORGHUM PRODUCTION TRAINING MANUAL



Zimbabwe Government



Food and Agriculture
Organization of the
United Nations



UKaid
from the British people

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A GUIDE TO THE TRAINER

In facilitating training it is essential to understand how adults learn, the role of the facilitator and participatory learning techniques that can be applied. Facilitators have an important task to deliver key messages which must excite interest and enthusiasm among the target group to learn and make decisions that lead to positive actions. The Agriculture Extension Worker and the Lead Farmers are central to the Farmer to Farmer Extension approach used by LFSP and their role as Trainers/Facilitators is critical in enhancing access to technical support to smallholder farmers for increased production and productivity.

The following highlights are a guide for these facilitators to deliver trainings that lead to positive change in farming practices and improve farmers' livelihoods.

Adult learning

The target audience (farmers) in trainings are adults and have experience, knowledge and skills. Each adult brings to the learning experience, preconceived thoughts and feelings that will be influenced by motivation, the amount of previous experience, the level of engagement in the learning process, and how the learning is applied. Learning something new is not just achieved in an instant. Referring back and making use of the knowledge and skill is the basis of the adult learning process. The new learning will have to be internalized (processing) by making it relevant to one's self. Only after this can the learning be applied when confronted with a similar situation. Remember the 20.40.80 principle of adult learning: Adults remember 20% of what they hear, 40% of what they hear and see, and 80% of what they hear, see, and do. It is advisable to use as much creativeness as possible.



When you hear you forget; when you see you remember and when you discover it is for life.

The role of the Facilitator

A facilitator is not an instructor and creates conditions for farmers to learn by arranging opportunities for the farmers to observe and interpret differences, to carry out simple tests and exercises, and through discussions. The facilitator encourages farmers to adopt an active role in the learning process through making use of participatory approaches which engage the participants as much as possible.

The main features of the attitude and role of a facilitator:

- To listen to farmers and respect their knowledge, experiences and perceptions,
- To give farmers the confidence to share their knowledge and experiences,
- To create suitable conditions and activities from which farmers can learn,
- To be responsive to farmers' needs and flexible in organizing the course,
- To increase farmers' knowledge, skills and problem-solving ability

Facilitation & Learning techniques

Facilitation is a process which is driven by a Facilitator who manages a learning environment (conducive atmosphere); through exchange of ideas; which involves ANALYSIS (detailed scrutiny or examination of an issue of common interest); which should lead to change or development.

Facilitation may include the following:

Plenary Introduction

A plenary introduction is normally the first activity to start a new training session. Its' main objective is to introduce the subject and to familiarize the participants to some basic concepts

by referring to familiar and related topics.

Brainstorming

The main objective of a brainstorming session is to introduce new topics and to discover new ideas and responses very quickly by having the group describing the topic or idea by listing an exhaustive list of related characteristics and condition

Small group discussions

Instead of discussing one subject with the whole group, more subjects can be discussed by using small groups. The main objective is to give every participant a way to actively participate in the discussion

Practical (field) activities

To give participants the opportunity to go to the field and experience a new technology by watching and doing. The objective is to learn through practicing new practice

Plenary discussion / presentation

The plenary discussion can follow directly after small group discussions, but does not need to do so. The objective of the plenary discussion/presentation is to synthesize the ideas of the participants about a (new) topic or information that is discussed within the group. A training session using the method of plenary discussion may split up in small groups.

Training Materials

Such materials as markers, flip charts, masking tape, training manual, and a session guide for guidance during the training are needed for each session of the training. . Fact sheets are particularly important especially if they are written in vernacular. The use of visual training aids such as pictures is also encouraged.

Training Evaluation Method

It is important to evaluate the training so that the trainer is informed about the impact of the training in terms of knowledge retention. Different training evaluation methods can be used e.g.:

- Pre- and post-tests
- Participants' feedback: through recaps.
- Final training evaluation checklist

SESSION ONE: INTRODUCTION

Preparation for the training: The trainer should take time to read and understand the training content. Interactive engagement with trainees should be encouraged throughout the session.

Learning outcomes

By the end of the session farmers should be able to:

1. Understand the importance of sorghum, its uses and production levels in Zimbabwe.
2. Appreciate and understand improved production methods/practices to address constraints in sorghum production

Duration: 1 hour

Methodology: Plenary/Presentation/Discussion/Brainstorming

Materials required

1. Flip charts and markers.
2. Fact sheets in vernacular language
3. Pictures/illustrations of the sorghum crop showing the morphology.

Discussion points: - Include the information below as you discuss with the farmers, ask as much as you can to open up for discussion.

IMPORTANCE OF SORGHUM

Sorghum is a traditionally important crop in Zimbabwe that can be grown in marginal areas where maize may not thrive. Sorghum is more nutritious than maize and is rich in carbohydrates, vitamins and minerals. It contains dietary fibre and has higher protein, calcium and iron content.

In Zimbabwe sorghum is an important cereal crop ranked second after maize. It is indigenous to Africa and is adapted to Africa's climate. It is drought resistant and able to withstand periods of water-logging. It is one of the few viable food grains for most food insecure areas and can be produced successfully in low rainfall areas in Zimbabwe including natural region IV which receives 450-650 mm of rainfall annually. Production of the main staple maize continues to dominate in these semi-arid areas of Zimbabwe where sorghum production would be more appropriate. This makes it pertinent that sorghum production is actively promoted in such marginal areas, especially given the adversities presented by climate change.

- There are basically two types of sorghum, that is, the white grained, normally used as mealie meal used to make sadza (thick porridge taken with relish) and thin porridge. The brown or red grained sorghum primarily used for brewing of traditional beer as well as a non-alcoholic fermented drink commonly known as 'maheu'.
- The sorghum stover is suitable for livestock feeding and the grain can be used in formulations for livestock feed.
- Sorghum is rich in iron and zinc and it is processed into a variety of nutritious foods, such as semi-leavened bread, couscous, dumplings and fermented and non-fermented porridges.

- Sorghum has been proven to be the best alternative to barley for lager beer brewing
- The straw of traditional tall sorghums is used to make palisades in Africa.
- Dye extracted from sorghum is used in West Africa to color leather red.
- Sorghum starch is another product.

SORGHUM PRODUCTION

Zimbabwe is estimated to have produced an average of 81 000 tonnes per annum between 2011 and 2015 (www.fao.org). The highest production of 175 000 tonnes was in 1987, while in 2016 sorghum production totalled 20 000 tonnes. In Zimbabwe average yield for the crop ranges from 0.5 to 0.7 tonnes per hectare, while on farm research trials indicate yields of an average 2 tonnes per hectare.

ACTIVITY 1.1

Break participants into groups and ask them to indicate the highest, average and lowest sorghum yields in their area. Ask them to analyse the causes of low sorghum yields and production, and what can be done to improve the yields and production.

ADDRESSING SORGHUM PRODUCTION CONSTRAINTS IN ZIMBABWE

Sorghum yields in Africa tend to be low as cultivation is still mainly characterised by traditional farming practices with low input levels (low or no inorganic fertiliser or pesticides) and use of traditional varieties or landraces. Often there is no surplus sorghum, without which processing industries cannot be vibrant. Traditional grain processing is labor-intensive and research and technical support are lacking.

Some of the constraints in sorghum production can be addressed through the following:

-
- Addressing negative perceptions on the consumption of sorghum (and other small grains). Raise awareness on dietary diversity, value addition and processing of sorghum through food fairs and other such for a.
- Ensuring farmers have high yielding varieties (hybrid seed and seed multiplication interventions) (*Ask farmers to name some of the improved sorghum varieties they are aware of*)
- Good agronomic practices including use of herbicides, lime and fertilizer application based on soil testing recommendations, pest and disease management. Most of these practices and technologies will be discussed in this manual under various sections.

Closing the session

- Give farmers time to ask questions and respond to the questions. In the event that there are some questions you cannot answer write down and refer to Extension Officers and give feedback in the next session.
- Go back to the learning outcomes and ask farmers to explain what they have understood on each of the outcomes. This will go a long way in assessing the effectiveness of this session

SESSION TWO: CROP REQUIREMENTS AND VARIETIES

Preparation for the training: The trainer should take time to read and understand the training content. Interactive engagement with trainees should be encouraged throughout the session.

Learning outcomes

By the end of the session farmers should be able to:

- 1) Know and understand the sorghum growth habit/cycle
- 2) Appreciate agro climatic and soil requirements for sorghum
- 3) Identify appropriate varieties to suit their environment.

Duration: 2 hours

Methodology: Plenary/Presentation/Discussion

Materials required

1. Flip chart and markers.
2. Fact sheets in vernacular language.

Discussion points: - Include the information below as you discuss with the farmers, ask as much as you can to open up for discussion.

THE SORGHUM CROP

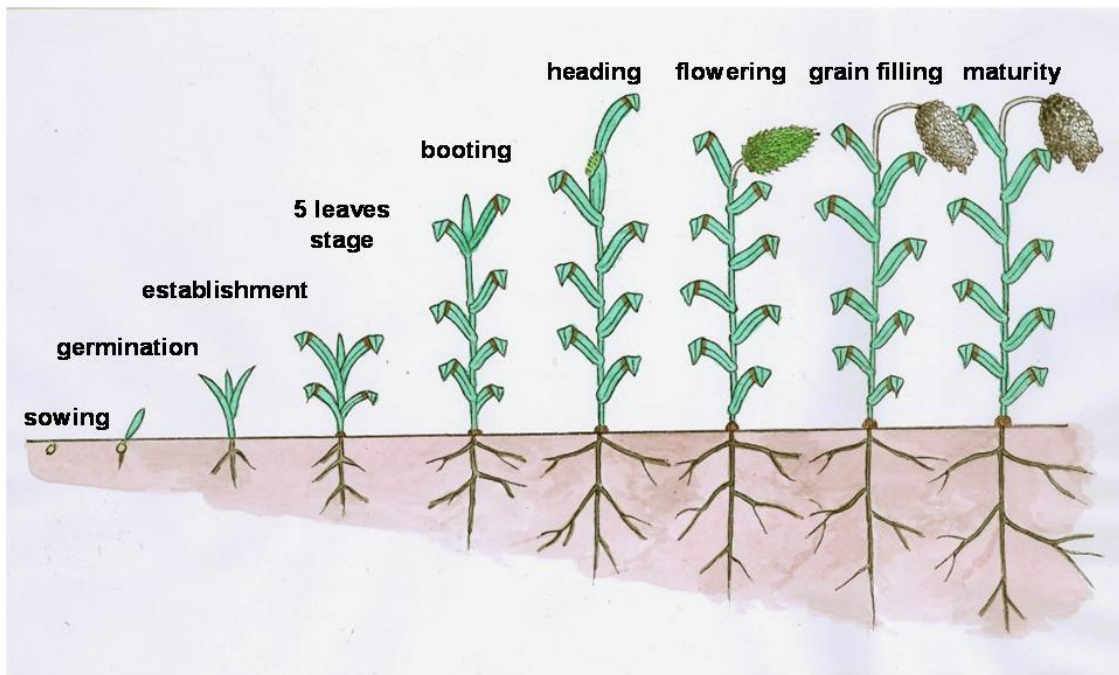
Sorghum belongs to the grass family together with maize, wheat, barley, pearl millet and finger millet. It is essential that farmers know the crop they are cultivating to adopt the most effective production practices.

Sorghum has an extensive root system which aids efficient moisture extraction and a smaller leaf area which reduces water loss through evapo-transpiration, the leaves have a waxy cuticle that retards drying. Drought conditions stop growth before flower initiation and plant remains vegetative, only resuming leaf production and flowering when conditions become more favourable. These features assist to make sorghum drought tolerant.

ACTIVITY 2.1

In plenary ask trainees to name the sorghum development stages and explain why it is important to know the stages.

Sorghum development stages



Adapted:

http://sanangelo.tamu.edu/programs/agronomy/publications/grain_sorghum/sorghum_plant_development.php

Stage 0. Emergence

Emergence generally occurs 3 to 10 days after planting. During emergence, growth is dependent upon soil temperature and moisture, planting depth, and seed ability to germinate.

Stage 1. Three-Leaf Stage

The three-leaf stage occurs when the collars of three leaves can be seen without dissecting the plant. Depending on the temperature, this stage may occur approximately 10 days after emergence.

Stage 2. Five-Leaf Stage

The five-leaf stage occurs when the collars of five leaves can be seen without dissecting the plant and occurs about three weeks after emergence. The root system develops rapidly at this stage. Stresses at this stage from weed competition, nutrients deficiencies, drought, or insect damage can dramatically reduce yields if not corrected.

Stage 3. Growing Point Differentiation

At this stage the growing point of the sorghum plant changes from vegetative to reproductive. Nutrient uptake is rapid and adequate supplies of nutrients and water are necessary to achieve maximum growth. This stage occurs approximately 30 days after emergence and is about one-third of the time from planting to physiological maturity.

Stage 4. Boot Stage

At this stage all the leaves are fully expanded, providing maximum leaf area and light interception. The head has reached full size and is encompassed by the flag-leaf sheath. Rapid

growth and nutrient uptake continue. Stress from lack of moisture or via herbicide injury may prevent the head from emerging completely from the flag-leaf sheath preventing complete pollination at flowering.

Stage 5. Half Bloom

This stage is defined as when half of the plants in a field have started to bloom. Flowering progresses from the tip of the head downward over a period of 4 to 9 days. Severe moisture stress can result in poor head filling.

Stage 6. Soft Dough

At this stage the grain has a dough-like consistency and grain fill is occurring rapidly. The lower leaves continue to senesce with 8 to 12 leaves remaining at this stage.

Stage 7. Hard Dough

By this stage approximately three-fourths of the grain dry weight has been attained. Nutrient uptake at this point is essentially complete. Severe moisture stress caused by an early freeze at this growth stage can result in light, chaffy grain.

Stage 8. Physiological Maturity

At this stage the maximum total dry weight of the plant has been reached. This stage is marked by the appearance of a dark spot on the opposite side of the kernel from the embryo. Grain moisture at physiological maturity depends on the hybrid, with typical moisture ranging from 25% to 35%.

AGRO-CLIMATIC AND SOIL REQUIREMENTS

- The best time to plant is when there is sufficient water in the soil and the soil temperature is 15 °C or higher at a depth of 10 cm. Temperature plays an important role in growth and development after germination. A temperature of 27 to 30 °C is required for optimum growth and development.
- Sorghum is grown mostly in areas with an annual rainfall range of 300 to 750 mm. It is grown in areas which are too dry for maize as crop is drought tolerant.
- Sorghum can be grown on many different soils but best yields are obtained on deep, fertile, well-drained loamy soils. However, it is quite tolerant of shallow soil and droughty conditions.
- Sorghum grows poorly on sandy soils, except where heavy textured subsoil is present.
- The crop is more tolerant of alkaline salts than other grain crops and can therefore be cultivated successfully on soils with a pH between 5.5 and 8.5.
- Sorghum can better tolerate short periods of waterlogging compared to maize. Soils with a clay percentage of between 10 and 30 % are optimal for sorghum production.

THE SORGHUM VARIETIES

ACTIVITY 2.2

Ask participants to name the types of sorghum commonly grown in the area. What do they consider when choosing type/ variety to plant?

Factors to consider when selecting varieties

When choosing a variety to grow in your particular farming area some of the factors to consider include:

- The growing period (days to maturity),
- Yield potential,
- Susceptibility to bird damage/losses,
- Pest and disease resistance.

Table 2.1 below indicates sorghum varieties commonly grown in Zimbabwe.

Table 2.1: Common Sorghum varieties in Zimbabwe

Variety	Seed Colour	Unique characteristics	Days to maturity	Yield potential
SV1	Creamy white grain	-Open pollinated -Semi dwarf, 1.25 to 1.8m tall -Semi compact medium sized head -Very hard grain with excellent milling quality -Produces 2-3 tillers per plant	115 to 125 days	3 to 6t/ha
SV2	Pearl white grain	-Semi dwarf with an average plant height of 1.4 to 1.6m -Open pollinated -Thin stemmed -Produces 1-2 tillers per plant	110 to 115 days	3 to 6t/ha
SV3	Creamy white grain	-Semi dwarf -Plant height 1.14 to 1.59m -Open pollinated -Semi loose heads -Generally does not tiller	112 to 124 days	3.8 to 8t/ha
SV4	White grain	-Semi dwarf, open pollinated variety -Average height of 1.3m -Generally does not tiller	Medium maturity, 113 to 127 days to maturity	3.4 to 9.0t/ha
NS5511	Red seed	-Hybrid (cannot be used as retained seed) -Early maturing Bird damage resistant	110 to 120 days to maturity	4 to 6 t/ha
Macia	Creamy white seed	-Open pollinated variety Height of 1.2 to 1.5m -Excellent milling quality	120-125 days to maturity	
DC75	Red seeded	-Open pollinated -Normally used for brewing	120-125 days to maturity	3 to 6 t/ha

Closing the session

- Give farmers time to ask questions and respond to the questions. In the event that there are some questions you cannot answer write down and refer to Extension Officers of ENTERPRIZE staff and give feedback in the next session.
- Go back to the objectives and ask farmers to explain what they have understood on each of the objectives. This will go a long way in assessing the effectiveness of this session.

SESSION 3: LAND PREPARATION

Preparation for the training: The trainer should take time to read and understand the training content. Interactive engagement with trainees should be encouraged throughout the session.

Learning outcomes

By the end of the session they should be able to:

1. Appreciate the different methods and equipment used in land preparation for the sorghum crop.
2. Understand and appreciate importance of CA practices in land preparation
3. Understand the importance of timeliness of land preparation.
4. Practice land preparation using different techniques and equipment

Duration: 4 hours

Methodology: Plenary/Presentation/Discussion/Brainstorming /Demonstration

Materials required

1. Flip chart and markers.
2. Fact sheets in vernacular language.
3. Pictures/posters showing the different land preparation implements and the land preparation operations
4. Hoes, strings, measuring sticks, pegs for demonstrating manual CA land preparation.
5. Rippers, ploughs and draught animals (oxen, donkeys) for demonstrating land preparation.

Activity 3.1

Inquire from farmers:

- *What are your experiences with regard to land preparation for sorghum in your area? (method, timing, challenges)*

TILLAGE SYSTEMS

Sorghum grain is small seeded, and so it should be grown on a well-prepared seedbed. The seedbed preparation should begin soon after the previous crop is harvested to allow enough time for weed control, decay of crop residue, storage of soil moisture and soil firming. Farmers have an option to prepare land using conventional or conservation tillage. Farmers are encouraged to use minimal tillage practices as opposed to conventional practice of ploughing. Ploughing year after year destroys the soil structure and buries soil organic matter which is rich in essential nutrients. At planting, the seedbed should be firm and moist.

- Under conventional tillage, farmers plough their fields using the animal drawn single mould board plough. On average, depth of ploughing can reach 30cm. Ploughing results in the soil structure being disturbed. This results in soil becoming loose and prone to soil erosion. Over time, a plough pan (compacted layer of soil) will develop, which makes it difficult for roots or water to penetrate. Farmers normally plough in early winter after the previous crop has been harvested when there is usually some residual soil moisture. This reduces the costs of ploughing, enables the required depth to be attained and controls winter weeds. After ploughing the land is frequently left to allow

clods to break down by the weathering action of wet-dry cool-warm cycles. However, many farmers disc harrow the cloddy land immediately to conserve subsoil moisture and to control winter weeds

- The current trend is to use reduced tillage systems which address the disadvantages associated with conventional tillage. *Trainees should be encouraged to opt for conservation tillage.*

Activity 3.2

Ask the participants if they are practising minimum tillage. Why are they practising/not practising it? What are the benefits and challenges associated with CA?

The 3 possible tillage methods are highlighted in the table below.

Table 2: Possible tillage Methods

Basin method	Ripper tine method	Conventional method
-Remove weeds from previous season -Dig basins (15cm long, 15cm wide & 15cm deep) at a spacing of 75cm inter-row and 15-20cm in-row. It is at times recommended to increase in the in-row spacing to 40 cm, this will facilitate excavation of basins. <i>-Alternatively, planting furrows can be made to the recommended inter-row spacing using hoes</i>	-Remove weeds from previous season -Open planting on lines on un-ploughed land using a ripper tine at 75cm between rows	-Using the conventional plough turn the soil, burying all crop residues and weeds. Ploughing should always be done across the slope -If the land has many clods, an ox-drawn harrow can be used to break the clods and create a fine tilth -Open planting lines at 75cm apart for sorghum

CONSERVATION/MINIMUM TILLAGE

Conservation tillage may also be conducted using a hoe to mark holes or furrows to which will be the planting stations. An ox- drawn ripper may also be used to mark furrows under conservation tillage. Apart from the planting station, the rest of the field is not disturbed.



Marking furrows using hoes



Marking rip lines using ox drawn ripper

Ripping

Ripping also known as mulch ripping involves use of ripper tines to make rip lines along the intended planting row, following the contour line. Planting stations are marked out along the row with a hoe ready for hand planting, or the seed is sown directly into the furrow by hand or with a machine planter (hand seeder, jab planter) and then covered. It is useful where soils have a hard top-soil or surface crust, and/or where crops are to be grown. Ripper tines are available which fit onto the ox-plough beam after removal of the mouldboard.

Zero Tillage

Zero-tillage involves sowing the crop directly into an untilled soil. Planting stations are made with hoes, or the seed is sown with a specially made machine planter (hand seeder, jab planter). The great benefits of zero-tillage are that it does not require draught power, while soil and water are conserved, and yields may be stabilised or enhanced.

Benefits of Minimum or conservation tillage

CA reduces soil erosion by as much as 60%-90% depending on the conservation tillage method. Pieces of crop residue shield soil particles from rain and wind until new plants produce a protective canopy over the soil. Organic matter added as crop residue decomposes creates an open soil structure that lets water in more easily, reducing runoff.

Activity 3.4

Demonstrate how to make planting basins, planting furrows and rip lines for sorghum planting. Give the trainees and opportunity to try their hands at the different methods. Attention should be paid to such detail as measurements (inter-row, in-row and basin/furrow dimensions)

Closing the session

- Give farmers time to ask questions and respond to the questions. In the event that there are some questions you cannot answer write down and refer to Extension Officers and give feedback in the next session
- Go back to the objectives and ask farmers to explain what they have understood on each of the objectives, this can help to measure the effectiveness of your session.

SESSION FOUR: BASAL FERTILIZER APPLICATION AND PLANTING

Preparation for the training: The trainer should take time to read and understand the training content. Interactive engagement with trainees should be encouraged throughout the session.

Learning outcomes

By the end of the session they should be able to:

1. Explain the importance of planting early in the season
2. Explain the various planting methods which can be used under sorghum production
3. Practise planting sorghum using available equipment
4. Thin sorghum to the desired plant population at the appropriate time
5. Practise the correct application of basal fertilizer in a sorghum crop.

Duration: 4 hours

Methodology: Plenary/Presentation/Discussion and Demonstration

Materials required

1. Flip chart and markers.
2. Fact sheets in vernacular
3. Hand seeder, jab planter for demonstrating direct seeding.

PLANTING TIME

Optimum planting date is determined by the first effective rains, planting must be undertaken when the seed bed has adequate moisture and the head initiation should not coincide with midseason dry spells. Sorghum may be planted after the first effective rains, normally late November or early December in Zimbabwe. However farmers are advised to be guided by weather forecasts, given the climate change prevalence. November planting with the onset of the first rains is the safest under dryland conditions. In order to exploit these early rains, fields need to be ready before the rains (i.e. in October) and seed and fertiliser must be on hand, so that as soon as the first rains fall, fields may be planted. Planting in December will produce low yields, and is very risky, because the crop may suffer from drought stress at the end of the season, while pests (e.g. stalk borer) and diseases are more prevalent on late planted crops. Planting basins and furrows should be ready before the rains so that they can capture and concentrate the rains that fall.

BASAL FERTILIZER APPLICATION

Ideally, the amount of fertilizer and lime to apply should be determined through soil testing. However, as a general rule, the recommended rate of basal fertilizer application for optimal yields is 200 kg/ha. Basal fertilizer should always be applied before or at planting, under the seed, making sure that it does not get into direct contact with the seed. This is achieved by covering the fertilizer with a layer of soil (1-2 cm thick) before seeding.

The different methods of manure and basal fertilizer application are indicated in table 4.1.

Table 4.1: Different methods of manure and basal fertilizer application

Basin method	Ripper-tine method	Conventional method
<ul style="list-style-type: none"> Apply 1-2 handfuls of well-rotted manure/compost in each basin and mix with the soil Apply 2 heaped beer bottle caps (equivalent of 200 kg/ha) of basal fertilizer per basin 	<ul style="list-style-type: none"> Apply 1-2 handfuls of well-rotted manure/compost over 30 cm along each planting line/furrow Apply 2 heaped beer bottle caps (equivalent of 200 kg/ha) of basal fertilizer over 30 cm along the furrow/planting line 	<ul style="list-style-type: none"> Apply 1-2 handfuls of well-rotted manure/compost over 30 cm along each planting line/furrow Apply 2 heaped beer bottle caps (equivalent of 200 kg/ha) of basal fertilizer over 30 cm along the furrow/planting line

PLANT SPACING, DEPTH AND POPULATION

Seeding rate and plant population

Seeding rate varies from 7 to 12 kg/ha depending on the different seed sizes as well as the desired plant population. The plant population varies from 130 000 to 150 000 plants per hectare. Poor seed quality, poor seedbed preparation, insufficient soil moisture, insects and diseases can result in a poor stand. The quantity of seed should therefore be increased to compensate for a poor stand. On the other hand, the population may be too high for the prevailing water and nutrient supply, if germination is good.

Planting depth

Sorghum has a small seed and should be planted shallow. A planting depth of 25 mm is satisfactory with sufficient water. Under drier conditions the seed should be planted deeper, but no more than 50 mm. Planting depth is also determined by soil type. On heavy soils, the planting depth should not be more than 25 mm, while on light soils the depth can be as much as 50 mm. It is important that the soil surrounding the seed is firm to ensure rapid absorption of water and therefore germination.

Row width

Sorghum is planted in areas with a wide range of rainfall and soil conditions. Wide rows are recommended for the low-rainfall areas and on soils with poor water-holding capacity. In areas with good, deep soils and a high rainfall, narrow rows are recommended. The width of rows and the spacing of plants in the row determine the plant population. The closer the spacing, the more plants there will be per unit area.

The recommended plant spacing is as follows:

Inter row: 60 to 70 cm for areas with moderate rainfall and 90cm for drier areas.

In-row: 15 to 20cm for areas with moderate rainfall and 30cm for drier areas.

Recommended plant population for sorghum is 130 000 to 150 000 plants per hectare.

PLANTING METHOD

Two methods of planting can be used, that is, hand planting and machine (planter) planting. When machine planted, sorghum is normally planted using maize planters. Adaptations should be made by using the correct planter plates. When planting, care should be taken not to closely space the seeds because this will result in the germinated plants competing for space, nutrients and water. In such instances thinning to the correct/ideal spacing must be done.



FIGURE 4.1: USE OF DIRECT SEEDER FOR PLANTING SORGHUM

The different methods of planting sorghum are described in table 4.2

Table 4.2: Different sorghum planting methods

Basin method	Ripper-tine method	Conventional method
<ul style="list-style-type: none"> • Plant 5 pips per basin • Cover the seeds with 2-3 cm of clod-free soil 	<ul style="list-style-type: none"> • Drill the seed thinly in the planting furrow so that individual seeds are 10-15 cm apart. • Cover the seeds with 2-3 cm of clod-free soil • Seeds can also be drilled using a direct seeder calibrated for the particular crop • <i>The same method can be used on planting furrows dug using hoes.</i> 	<ul style="list-style-type: none"> • Drill the seed thinly in the planting furrow so that individual seeds are 10-15 cm apart • Cover the seeds with 2-3 cm of clod-free soil • Seeds can also be drilled using a direct seeder calibrated for sorghum.

THINNING

High plant population can lead to poor crop growth, especially under drought conditions. It is, therefore, advisable to thin out extra plants 2-3 weeks (3-4 leaf stage) after emergence to maintain a plant population in the range of 130,000 – 150,000 plants per hectare. Thinned plants can be transplanted on wet days to fill gaps. However, transplanted plants will not be as productive as the directly seeded plants. Thinning guidelines are indicated in table 4.3

Table 4.3: Thinning guidelines

Basin method	Ripper-tine method	Conventional method
<ul style="list-style-type: none"> At 2-3 weeks after germination or at the 3-4 leaf stage uproot the weakest & leave the 2 strongest plants per basin If the soil moisture is favourable, the uprooted plants can be transplanted The resultant average number of plants per basin should be 2 	<ul style="list-style-type: none"> At 2-3 weeks after germination or at the 3-4 leaf stage thinning by uprooting to the recommended spacing (15-20 cm in the row). The removed plants can be transplanted provided the soil moisture is favourable 	<ul style="list-style-type: none"> At 2-3 weeks after germination or at the 3-4 leaf stage thinning by uprooting to the recommended spacing (15-20 cm in the row). The removed plants can be transplanted provided the soil moisture is favourable

Activity 4.1

Demonstration and hands on tasks by trainees on the different aspects covered in the session: different planting methods and thinning.

Closing the session

- Give farmers time to ask questions and respond to the questions. In the event that there are some questions you cannot answer write down and refer to Extension Officers and give feedback in the next session
- Go back to the objectives and ask farmers to explain what they have understood on each of the objectives, can help to measure the effectiveness of your session

SESSION FIVE: CROP NUTRITION

Preparation for the training: The trainer should take time to read and understand the training content. Interactive engagement with trainees should be encouraged throughout the session.

Learning outcomes

By the end of the session they should be able to:

1. Explain the importance of fertilizer application and timing
2. Explain the various methods fertilizer application
3. Practice correct application of fertilizers

Duration: 2.5 hours

Methodology: plenary/presentation/discussion/ and demonstration

Materials required

1. Flip chart and markers.
2. Fact sheets.
3. Pictures showing symptoms of NPK deficiency in crops.
4. Fertilizer/manure samples.

SORGHUM NUTRIENT REQUIREMENTS

Activity5.1

Inquire from farmers their experience with fertilizer use in sorghum production

Discussion Points: Discuss with farmers some of the best practices in sorghum soil fertility management and if possible use examples and guided by the notes below.

- Lime and fertilizer application rates should be informed by soil test recommendations. Soil sampling is therefore recommended.
- Generally, less fertiliser (200 kg/ha) is required or applied to the sorghum crop compared with maize.
- However, sorghum responds well to manure applications, and where the rainfall is favourable, will respond well to a low application of basal fertilizer followed by top dressing.
- Utilising a cereal – legume rotation can be beneficial. Sorghum – sun hemp rotation has been found to work well.

USE OF ORGANIC MANURE

Kraal manure can be added to soil and will also help to improve structure and water holding capacity of soil. Before application manure can be treated or sterilized by covering with black plastic, this allows it to decompose and release nutrients and kills weeds

- **Basin method:** Apply 1-2 handfuls of well-rotted manure/compost in each basin and mix with the soil.
- **Ripper tine:** Apply 1-2 handfuls of well-rotted manure/compost over 30 cm along each planting line/furrow.
- **Conventional method:** Apply 1-2 handfuls of well-rotted manure/compost over 30 cm along each planting line/furrow.

BASAL FERTILIZERS

- Compound D: (100 to 300 kg of 7.14.7 per ha) is recommended and should be applied before planting. The fertilizer should be placed under the seed, making sure that it does not get into direct contact with the seed by having 1-2cm layer of soil between them.
- **Basin method:** Apply 2 heaped beer bottle caps (equivalent of 200 kg/ha) of basal fertilizer per basin. Ensure that there is no direct contact between the fertilizer and seed.
- **Ripper tine:** Apply 2 heaped beer bottle caps (equivalent of 200 kg/ha) of basal fertilizer over 30 cm along the furrow/planting line. Ensure that there is no direct contact between the fertilizer and seed.
- **Conventional method:** Apply 2 heaped beer bottle caps (equivalent of 200 kg/ha) of basal fertilizer over 30 cm along the furrow/planting line. Ensure that there is no direct contact between the fertilizer and seed.

TOP DRESSING

- A top dressing of 100 to 200 kg per ha of 28 - 34% N fertilizer is recommended and should be applied at 4-6 weeks from crop emergence date.
- Place the top dressing fertilizer 5-10 cm from the plant and avoid getting the fertilizer into contact with the plant to avoid fertilizer burn.
- Top dressing must be done when the soil is moist, preferably soon after raining.
- Split application is recommended at 4 weeks and second application at 6 weeks from planting date.

Activity 5.2

Pass around pictures showing nitrogen; phosphorus and potassium deficiency and ask farmers to identify the causes of deficiency in each case. Depending on when the training is done there may be scope to use real plants for the nutrient deficiency symptoms.

Symptoms of deficiencies

Below are deficiency symptoms which should inform farmers on the nutrients that are lacking for optimal crop growth and productivity. These symptoms can help indicate what corrective actions the farmers need to take to remedy the nutrient deficiency.

Nitrogen (N)



Symptoms of nitrogen deficiency

The symptoms of nitrogen deficiency are poor plant growth, pale green/yellow leaves. Yellowing starts with young plants, and at a more mature stage older leaves start yellowing first, with a characteristic inverted V-shape.

Phosphorus (P)



Symptoms of phosphorous deficiency

Deficiency is manifested when leaves of young plants turn dark green with reddish-purple margins and tips.

Potassium (K)



Symptoms of potassium deficiency

Deficiency of K is initially noted as yellow or necrotic leaf margins, beginning at the lower leaves and spreading to the upper leaves.

Activity 5.3

PRACTICAL: DEMONSTRATION ON CORRECT APPLICATION OF FERTILIZERS

Demonstrate the correct placement of Compound D and Ammonium nitrate fertilizers. Get all the participants to practise the correct application (rate and placement) of the fertilizers.

Closing the session

- Give farmers time to ask questions and respond to the questions. In the event that there are some questions you cannot answer write down and refer to Extension Officers and give feedback in the next session
- Go back to the objectives and ask farmers to explain what they have understood on each of the objectives, and you may close the session by asking these questions, this can help to measure the effectiveness of your session

SESSION SIX: WEED MANAGEMENT

Preparation for the training: The trainer should take time to read and understand the training content. Interactive engagement with trainees should be encouraged throughout the session.

Learning outcomes

By the end of the session they should be able to:

1. Understand and appreciate the importance of timely weeding.
2. Identify the common problem weeds in sorghum
3. Appreciate and understand the different control methods for common weeds.

Duration: 2 hours

Methodology: Plenary/Presentation/Discussion and Demonstration

Materials required

1. Flip chart and markers.
2. Fact sheets
3. Herbicide samples and labels
4. Knapsack sprayer
5. Weed samples

Discussion Points: Discuss with farmers common weeds and weed management in sorghum where possible use examples and guided by the notes below.

Weeds are unwanted plants that grow amongst crops in the field. Weeds compete with the plant for water, nutrients, space and light. Like other plants, weeds use the food and water from the soil that is being used by our crops. These weeds, once removed, will result in healthier crops and plant growth and crops yields improve. A properly timed weed management program can minimize the effects of weeds on growth, development and yield of sorghum

WHY AND WHEN SHOULD WEED MANAGEMENT BE DONE

Inefficient weed control is one of the main causes of low yields in sorghum.

- Some weeds become alternative hosts of pests and diseases. They reduce profits by lowering the quality, quantity, yields and value of sorghum.
- Some weeds are parasitic and poisonous to sorghum.
- It is important to control weeds throughout, but especially in the early stages of crop growth.
- This can be done through use of herbicides, cultural methods and hoe weeding.
- As a general recommendation, first weeding at 5 to 6 leaf stage, just before top dressing. The second weeding is done after 6 to 7 weeks
-
- It is recommended to use herbicides for sorghum on soils with more than 25 % clay. *More than 25% clay is determined by wetting soil in the hand (after removing particles larger than 2mm) and making it into a ball. When the ball is placed between the thumb and the forefinger and it forms a ribbon 2.5 to 6 cm then the clay content is more than 25%.*

Types of Weeds

- Weeds can be as annual categorised (complete their life cycle within one season) and perennial weeds (their life cycle is more than one year). Black jack and striga (witchweed) are examples of annual weeds, while couch grass is an example of a perennial weed.
- Perennial weeds multiply through roots and stems. Mechanical weeding only cuts off the tops but the bottom continue consuming the nutrients and water meant for crops. These should be controlled early before the beginning of the season as later attempt of control them will damage the crop.
- Weeds are also classified as grasses or broadleaf. This classification is usually important for deciding on the choice of herbicide to use since the action of most herbicides is specific to the weed type.

COMMON WEEDS IN SORGHUM



Striga



Rapoko grass



Spiderwort



Bermuda grass



Yellow nutsedge

Striga (Witchweed)

The root parasite Striga can damage the crop and mainly occurs under low-input farming conditions. The parasitic plants are single stemmed with bright red flowers. Most of the damage is done before the parasite emerges from the soil.

The symptoms of Striga damage include leaf wilt, leaf roll and leaf scorch, even though the soil may have sufficient moisture. The host plant wilts, its growth is stunted and it may shrivel and die. Yield losses can reach significant levels (up to 100%). The tiny seeds are disseminated by wind, water and animals, and remain viable in the soil for 15 to 20 years.

- Damage is done in the first month of vegetative growth, when the fully parasitic young witch weeds have not yet emerged

- There is no chemical which can fully control the weed.
- Rotation with cotton, groundnut and cowpea will reduce the incidence of Striga.
- Hand pulling the plants before flowering could be used..
- Weeds can be removed mechanically, using manual labour or implements such as hoes.
- Cultural practices such as ploughing during winter or early spring is also an effective method of controlling weeds.
- It can be controlled using a trap crop of Sudan grass, which will be ploughed under after two months' growth.

METHODS OF CONTROLLING WEEDS

- Field scouting remains critical for post-emergent weed control. Manage fields with heavy weed populations as soon as possible after weed emergence.

Manual or Mechanical methods

Weeds can be removed manually (hand weeding and use of hand tools) and mechanically (using mechanical implements).

- For sorghum effective weed control requires 2 to 3 weedings. Carry out the first weeding within 2 weeks after planting and the second as soon as weeds appear around 5–6 weeks after planting, depending on weed pressure. Avoid weeding immediately after it has rained as this would not offer effective weed control.
- Weeding can be done with use of implements such as ox drawn or tractor drawn cultivators

Cultural practices

Practices that allow early establishment give the crop a competitive advantage over many weeds.

- Proper seed placement, fertility management, planting date, and seeding rates can help establish a healthy, competitive sorghum crop.
- Ploughing during winter is an effective method of controlling weeds.

Chemical methods

Chemicals formulated as liquids, granules or gases can be applied to kill germinating, growing weeds or seeds. Herbicides offer a cost effective method of weed control if used properly.

- Application should be based on correct weed identification.
- The choice of herbicide, however, depends on the predominant weed species and the availability of the herbicide.
- Herbicides are available for pre-emergence or post emergence weed control depending on time of application. If herbicide is applied at planting, one weeding may be required at 5–6 weeks after planting depending on weed presence.

HERBICIDE APPLICATION

Types of herbicides

- Pre-plant: incorporate into the soil before planting
- Pre-emergence: applied after planting before germination of the weed , e.g. Lasso
- Post emergence: applied after emergence of crop and weeds

Common herbicides in Sorghum Production

Table 3 below shows some of the recommended herbicides for use in sorghum production.

Table 3: Herbicides which can be used in sorghum

Active ingredient	Trade Name	Timing	Application rates and details
Atranex	Atrazine	Pre and early post-emergence	3-4 litres per hectare Controls most annual grasses and broad leaf weeds. Not to be used on course soils. Long residual effect.
Metolachlor	Dual Magnum	Pre-emergence	2-3 litres per hectare Controls some annual broad leaf weed, grass weeds and yellow nutsedge
Bentazon	Basagran	Post-emergence	2-4 litres per hectare Controls broad leaf weeds and suppresses yellow nutsedge. Apply at first 3 leaf stage and use higher rates and more water for sedge
Paraquat	Gramoxone	Post-emergence	1.5 - 2 litres per hectare for control of various broad leaf weeds and all grasses. Non selective foliar applied herbicide.
Glyphosate	Round Up	Post-emergence	4 -5 litres per hectare depending on weed size. Non selective foliar applied herbicide. Active on annual and perennial weeds.

It should be noted that some of the above are trade names given as examples. The products may contain the same or different active ingredients.

Farmers may need to take note of the following general points on herbicide use.

- Carefully read and fully understand the herbicide label before using the herbicide
- Rates of application are usually lower when herbicides are applied as mixtures. Some herbicides cannot be mixed. It is always advisable to consult the company that manufactures the chemical or their agents when in doubt about its use.
- Never buy unlabeled chemicals; you might damage your crop after applying a wrong chemical.
- Never buy chemicals where the expiry date is not shown. Expired chemicals do not work.
- Always consult the local Extension Worker for guidance on the use of herbicides.

Seek advice from knowledgeable people e.g. agricultural experts from AGRITEX, Universities, Department of Research and Specialist Services, seed suppliers or experienced sorghum farmers

Closing the session

- Give farmers time to ask questions and respond to the questions. In the event that there are some questions you cannot answer write down and refer to Extension Officers and give feedback in the next session
- Go back to the objectives and ask farmers to explain what they have understood on each of the objectives, and you may close the session by asking these questions, this can help to measure the effectiveness of your session.

SESSION SEVEN: PEST AND DISEASE MANAGEMENT

Preparation for the training: The trainer should take time to read and understand the training content. Interactive engagement with trainees should be encouraged throughout the session.

Learning outcomes

By the end of the session they should be able to do the following:-

1. Identify the major sorghum pests and diseases.
2. Appreciate and understand the management of the major pests and diseases.

Duration: 2 hours

Methodology: plenary/presentation/discussion/ and demonstration

Materials required

1. Flip chart and markers.
2. Fact sheets with pictures of pests and diseases.
3. Pictures of common pests and diseases

Discussion Points: Discuss with farmers common pests and disease management in sorghum where possible use examples and guided by the notes below.

MAJOR PESTS OF SORGHUM AND MANAGEMENT





Low levels of pests may be of little concern, but when they increase above certain limits they must be controlled otherwise economic losses may occur.

- When chemical sprays are used, safety precautions and correct application techniques must be followed.
- Integrated pest management whereby various methods are applied to protect the crop by suppressing insect populations and limiting damage. These measures include the following: chemical control, biological control, plant resistance and cultural control.
- Application of chemicals should be done after scouting and after determination of the economic threshold (are there sufficient pests to cause economic damage)
- Pesticides should be used as a last resort. When used, priority should be given to pesticides that are safer for the environment and people (green and orange triangles)

ACTIVITY 7.1

Enquire from farmers on major sorghum pests in the area and how they manage them?

Table 7.1: Pests of Economic Importance in sorghum production in Zimbabwe

Pest	Management		Chemical control and Application rates
<p>Stalkborer <i>The most important pest of sorghum. Symptoms starts with small holes in leaves then in stems. Larvae then channel through the stem eating the central part.</i></p> <p>-</p>		<p>-Cultural methods include deep ploughing and destruction of stover to destroy overwintering larvae, rotation with legumes to interrupt the life cycle of stem borers and addition of nutrients to the soil.</p> <p>-Chemical control include Carbaryl 5 dust; Carbaryl 85WP; Dipterex and Thionex; Kombat</p>	<p>Carbaryl 85%: 2kg/ha; Dipterex 2.5%: 1-2kg/ha.</p> <p>Carbaryl is applied as full cover after emergence. Ensure penetration into the funnel.</p>
<p>African Army worm <i>Pests cut and chew causing extensive damage in sorghum. They also consume the lamina leaving midribs thereby reducing the photosynthetic area.</i></p>		<p>Controlled by use of contact insecticides which include:</p> <p>-Carbaryl 85WP -Karate 5EC</p>	<p>Apply as full cover spray</p>
<p>Aphids <i>These usually appear during head emergence and flowering, they suck sap from the leaves.</i></p>		<p>Systematic control after head emergence with chemicals.</p>	<p>Malathion 85% and Dimethoate (rogor)</p>
<p>American ball worm <i>Chewed grain laying on the ground is evidence of attack</i></p>		<p>Use of chemicals recommended</p>	<p>Thiodan (Endosulphan) recommended for control</p>

Birds:

The worst nightmare for the sorghum farmer and can cause significant damage and reduction in yield. These become a problem as the crop approaches maturity.

- Bird scaring is the only effective way of minimizing bird damage, but community co-operation in planting dates may also help to spread the risk. Red/Brown sorghum is bird resistant.
- Farmers are encouraged to harvest early to minimize bird damage.
- Clear possible habitats around the field
- Growing of sorghum by many farmers in same locality will reduce losses.






MAJOR DISEASES OF SORGHUM

ACTIVITY

Inquire from farmers on major diseases in the area and how they manage them?

The major sorghum diseases in Zimbabwe are leaf blight, covered kernel smut and charcoal rot. Diseases of economic importance in Zimbabwe are shown in table 7.2.

Table 7.2: Diseases of Economic importance in sorghum in Zimbabwe

Disease	Picture	Management/ Control
<p>Head Smut <i>The entire head is replaced by a large smut gall covered by a thick white membrane. This is the most common disease in sorghum. The disease spores are easily carried by wind and rain, spreading the disease to other plants</i></p>		<ul style="list-style-type: none"> -Use of resistant varieties e.g. Macia. -Use of certified disease free seed. -Roguing smutted heads and burning them - Crop rotation
<p>Covered kernel Smut <i>Symptoms include all kernels in affected smut head destroyed and replaced by a dark brown powdery mass</i></p>		<ul style="list-style-type: none"> -Use of resistant varieties e.g. Macia. -Use of certified disease free seed. -Roguing smutted heads and burning them - Crop rotation
<p>Charcoal Rot <i>Symptoms include root rot, soft stalks, lodging of plants, premature drying of stalks, and poorly developed panicles with small inferior-quality grain</i></p>		<ul style="list-style-type: none"> -Good management practices that reduce moisture stress e.g. proper management of crop residue, crop rotation, avoiding excessive plant populations, balancing fertility levels, and growing drought-tolerant varieties. Lodging-resistant hybrids represent the best means of control. -Use Apron Star for seed dressing.
<p>Leaf blight <i>Large elliptical spots up to 20 mm wide and 100 mm long, initially water-soaked, but drying to straw-coloured spots with red, purple or tan margins depending on the hybrid</i></p>		<ul style="list-style-type: none"> -Rotation with non -susceptible crops. -Use of resistant hybrids e.g. Macia. -Seed dressing with Captan or Thiram. -Use of foliar fungicides.
<p>Ergot <i>Sorghum ergot is a disease caused by a fungus that infects the ovaries of sorghum flowers and often converts them into a white, fungal mass . The most obvious external symptom of infection is the abundant exudation from infected flowers of an amber-coloured, sticky fluid, or "honeydew,"</i></p>		<ul style="list-style-type: none"> -Use seed treatment fungicides such as Captan and Thiram -Prevent sorghum ratoon and sorghum volunteer development

<i>which often drips onto the leaves and soil.</i>		
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Closing the session

- Give farmers time to ask questions and respond to the questions. In the event that there are some questions you cannot answer write down and refer to Extension Officers and give feedback in the next session
- Go back to the objectives and ask farmers to explain what they have understood on each of the objectives, and you may close the session by asking these questions, this can help to measure the effectiveness of your session.

SESSION EIGHT: HARVESTING & POST HARVEST MANAGEMENT

Preparation for the training: The trainer should take time to read and understand the training content. Interactive engagement with trainees should be encouraged throughout the session.

Learning outcomes

By the end of the session they should be able to do the following:-

1. Identify signs of physiological maturity for sorghum and when harvesting should practically be done
2. Appreciate and understand the different sorghum harvesting methods and post-harvest management practices
3. Identify sorghum post-harvest loss points and how to address them
4. Understand sound sorghum storage practices, including improved storage structures.

Duration: 2 hours

Methodology: Plenary/Presentation/Discussion and Demonstration

Materials required

1. Flip chart and markers.
2. Fact sheets is available

ACTIVITY 8.1

Ask Farmers before the session:

What are some of the indicators that you consider when deciding to start harvesting sorghum? What are the different sorghum harvesting methods you use? What are their strengths and weaknesses?

Discussion Points: Discussion with farmers their experiences harvesting sorghum, when to harvest, how, technologies, reduction of harvesting losses. Be guided by the notes below.

HARVESTING SORGHUM

Harvesting is done when the crop reaches physiological maturity which is indicated by the following indicators:

- The spot where the grain attaches to the inflorescence turns from green to black.
- Yellowing and drying of leaves

Where birds are a serious problem, heads can be harvested at this stage and dried on floors or racks.

When hand harvesting, the sorghum heads are cut. The heads are dried in heaps on the ground or threshing floor. If the entire plant is cut by hand, it should be stacked and left in the field to dry and

mature for 10 to 14 days, and then threshed. A combine harvester can be used to harvest the sorghum. Hand harvested heads can be threshed by a stationary combine, hand beating or by driving cattle over the layers of sorghum heads.

Discuss why using cattle to thresh sorghum by driving them over the cut sorghum heads is strongly discouraged.

YIELDS

Sorghum hybrid yields range from 3 to 6 tonnes depending on the variety.

POST HARVEST MANAGEMENT FOR SORGHUM

Post-harvest options are generally all the activities that can be carried out after the harvesting of crops in order to convert it to use by man and animal. It can be classified into primary and secondary processing.

ACTIVITY 8.2

Break farmers into groups and ask them to:

- *List the causes of losses in sorghum harvesting and postharvest handling*
- *Ask the participants to propose management practices to curb each of the losses*

Major losses are incurred during field drying/harvesting, storage, and homestead drying. Harvesting, threshing, winnowing/cleaning, and storage are the critical farm level loss points for sorghum.

Table 8.1 illustrates the main critical loss points (with % loss in brackets), loss types, causes of loss for sorghum and practices to manage the losses.

Table 8.1: Critical farm level loss points for sorghum

Loss point	Type & nature of loss	Causes of loss	Proposed loss management practices
Field drying & harvesting (13.9%)	<u>Quantitative</u> lodging, rodents, termites, storage insect infestation, theft, domestic animals, wildlife damage, <u>Qualitative</u> late rains (rotting, sprouting, moulds), storage insect infestation	-delayed/late harvesting -poor harvest management -varietal susceptibility	-early harvesting (immediately after attainment of physiological maturity may be ideal but not feasible due to high moisture content (<i>discussion point</i>) -early harvesting, use of proper method of harvesting, gleaning.
Storage (9.4%)	<u>Quantitative</u> storage insect pests, theft, termites, rodents, <u>Qualitative</u> Fungal infestation, discolouration of grain, storage pests	-poor storage structures -poor storage practices (drying, insect control) -resistance to grain protectants by some pests such as LGB - high moisture content at storage	-use of improved grain storage structures, -hermetic storage for pests like LGB -drying grain to the recommended moisture content before storage -proper storage management (use of recommended grain protectants as instructed)

		-poor shelling practices	
Homestead drying (7.2%)	<u>Quantitative</u> Wildlife & domestic animals, spoilage from rains, shattering/spillage. <u>Qualitative</u> spoilage from rains	-poor drying structures -poor management of drying process	-use of recommended improved drying structures (materials, dimensions, roof) -proper grain handling during drying to minimize spillage and shattering -introduction of appropriate and affordable drying technologies (e.g. solar)

Drying

Drying should target to reduce the moisture content to 12-12.5%

- Sorghum heads can be dried naturally by putting the heads on top of a black plastic/concrete floor or traditional cribs using the sun.
- Artificial drying is done through the use of threshers.

Threshing

This is the separation of grain from the heads. This is normally done manually using beating sticks or through the use of grain shellers.

Storage

Sorghum best stored as whole grain and most importantly the seed stored at 12 to 13 % moisture or less. The objective of storage is to preserve as much as possible of the value of the grain for its intended future use. This means either retaining as high a proportion of viable seeds as possible for planting at the next harvest or preserving as much as possible of the food value of the grain for as long as possible. Several factors lead to the loss of viability and nutrients, however globally the main causes of loss are the depredations of pests (insects, birds and rodents) and mould damage. Germination of the grain (sprouting) also results in losses, although on a smaller scale. During storage, the grain can be protected from weevils through applying grain protectants. Examples on the market include Actellic Super Chirindamatura dust.

Storage methods

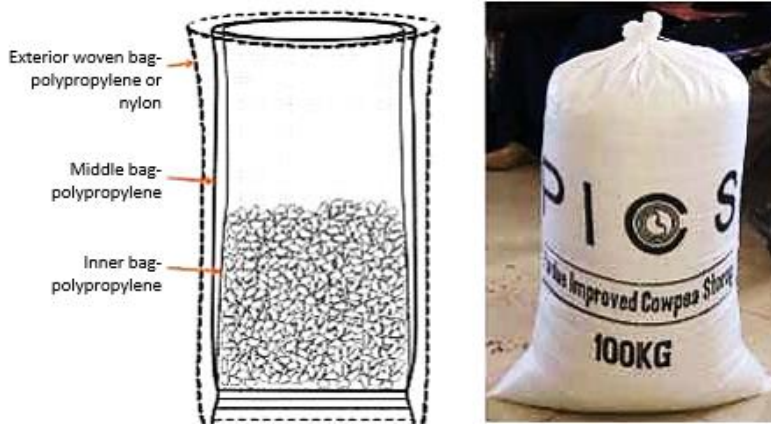
The sorghum grain can be stored for future use in hermetic bags or Metal silos, which come in different sizes (500kg, 1000kg, 2000kg).

IMPROVED STORAGE STRUCTURES

1. Hermetic bags

Hermetic bags are made of a multi-layer polythene material that incorporates a gas barrier that restricts oxygen, carbon dioxide and water vapour movement. The effectiveness of hermetic storage is hinged on low oxygen environment together with elevated carbon dioxide levels. These hermetic sacks are made in a variety of sizes that can hold 50kg to 3 tonnes of grain/seed. They are appropriate for smallholder farmers who may want to store small quantities of seed for planting in the next season.

The bags are prone to damage by rodents, therefore rodent management is very critical



Features of a hermetic bag.

Source: (<https://www.rockefellerfoundation.org/blog/awareness-key-reducing-podt-harvest/>)

Metal Silos



Metal silo

Source: *Institute of Agricultural Engineering, Ministry of Agriculture Mechanisation and Irrigation Development.*

A metal silo is a cylindrical structure, constructed from galvanized iron sheet and hermetically sealed, preserving grain and killing any insect pests that may be present in the grain. The impact of metal silo technology includes improving food security, empowering smallholder farmers, enhancing income opportunities and job creation, and safeguarding the agro-ecosystems. Picture below metal silo shows the different components of a metal silo. The metal silo can be fabricated in different sizes, 100 kg–3000 kg holding capacity by trained local artisans, with the corresponding prices of \$72.00 to \$422.00 (IAE prices, 2015/16). Peak Trading (Pvt) Ltd sells 2 ton metal silos at \$350 each (2016). The use of metal silo, therefore, should be encouraged in order to prevent storage losses and seed quality and viability.

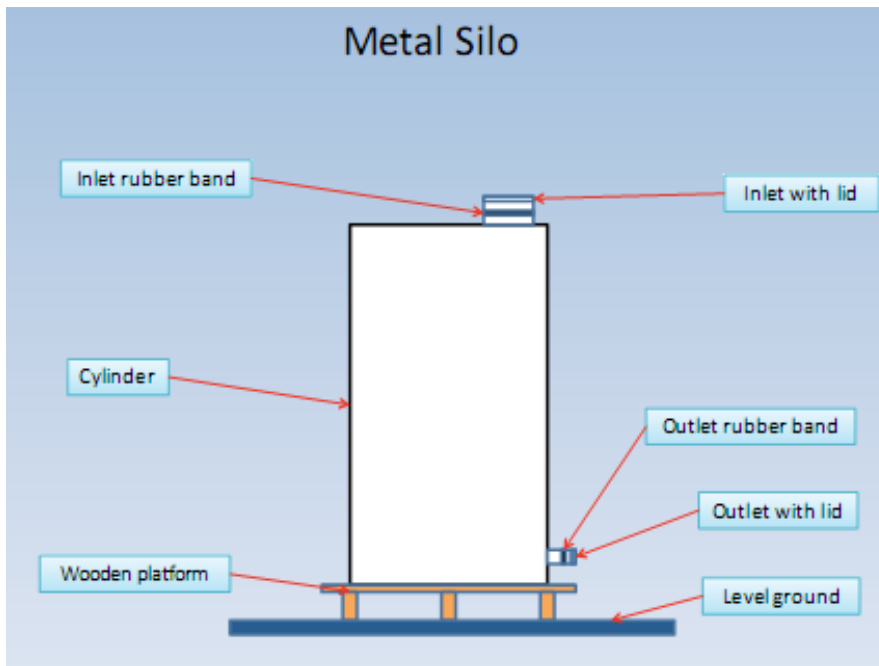


Fig 4: Components of a metal silo

Source: *Institute of Agricultural Engineering, Ministry of Agriculture Mechanisation and Irrigation Development.*

Advantages of Silos

- Keeps grain for long without damage
- Low maintenance costs
- Cheap in the long run
- Saves space
- Easy to load & off load
- Theft proof (provided it is placed in a secure structure)
- Rodent proof
- No need for chemicals
- Decent & attractive

Improved Granaries



Source: Institute of Agricultural Engineering, Ministry of Agriculture Mechanisation and Irrigation Development.

An ideal granary should be easy to construct using local durable materials, easy to maintain, durable, economic, of suitable size, theft proof, fire proof, socially acceptable, useable for different commodities or purposes, readily accessible for loading and inspection. It should protect the seed from insect pest infestation and complete admix chemicals, protect seed from vermin, keep the seed dry and cool thereby inhibiting mould growth, seed respiration and insect multiplication. These requirements dictate how and with what materials a store should be built. The basic components of an improved granary are: foundation, floor on a raised platform, walls, roof, compartment walls, compartment ceiling, main door and compartments. Reducing post-harvest losses will contribute significantly to improving yield, quality and household income to grain farmers. Adoption of the storage technologies highlighted in this paper will significantly contribute to loss reduction.

ACTIVITY 8.3

Visit appropriate grain storage technologies/structures within the area to acquaint participants with the technologies.

Closing the session

- Give farmers time to ask questions and respond to the questions. In the event that there are some questions you cannot answer write down and refer to Extension Officers and give feedback in the next session
- Go back to the objectives and ask farmers to explain what they have understood on each of the objectives, and you may close the session by asking these questions, this can help to measure the effectiveness of your session.

SESSION NINE: MARKETING

Preparation for the training: The trainer should take time to read and understand the training content. Interactive engagement with trainees should be encouraged throughout the session.

Sorghum is marketed through the formal and informal level. It is graded into 4 grades A; B; C and D in Zimbabwe as indicated below.

Sorghum Grade	A	B	C	D
Moisture Content (max %)	12.5	12.5	12.5	12.5
Test Density (Kg/hl min)	70	68	65	-
Extraneous matter (% max)	1	2	3	
Broken+ Chipped (% max)	4	5	8	
Unthreshed (% max)	5	10	15	
Other Types (% max)	3	4	5	
Germinative test (% max)	80	75		

Adopted from the AGRITEX Sorghum Manual

- The GMB, Delta; stock feed producers, NGOs and private millers are the major buyers of sorghum.
- Sorghum is also grown under contract farming arrangements in Zimbabwe.
- Zimbabwe does not export grain but exporting is allowed.

ANNEXES

Annex 1: Sorghum gross margin budget

Sorghum Budget per ha - Dryland					
Gross Yield		2000	kgs		
Producer Price		\$0.30	per kg		
Recovery Rate		100%	of Gross Yield		
Gross Income GI (US)		\$600.00			
VARIABLE COSTS					
Inputs	Item	Unit	Quantity	Unit Cost (USD)	Cost (USD)
Land Preparation	Ripping	ha	1	22	22
Seed	Seed	kg	10	2	20
Fertilizers	Compound D	kg	200	0.6	120
	Lime	kg	500	0.12	60
	Ammonium Nitrate	kg	100	0.66	66
	Transport				40.5
Herbicides	Glyphosate	litres	2	9	18
	Basagran	kg	1.5	15	22.5
Pesticides	Trichlorfon (Dipterex)	kg	3	5	15
	Carbaryl	kg	1	10	10
Packaging	50kg sacks	units	40	0.5	20
Transport		Ton	2	20	40
Labor contracted		Ld	10	3.5	35
Total Variable costs - TVC					489
Returns					
Gross Margin (profit/loss)			111		
Cost per kg			0.25		
Break even yield (kg)			1 630		

