



A GUIDE TO COMMERCIAL CHILLI CULTIVATION IN MALAWI



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Foreword

This material has been developed by the Corporate Institute of Horticulture (CIH) on behalf of and with support from Gesellschaft für Internationale Zusammenarbeit (GIZ) commissioned by the Federal Ministry for Economic Cooperation and Development (BMZ) in the global project 'Employment in rural areas with a focus on youth' (RYE). In Malawi, the project is implemented by Agriculture and Finance Consultants (AFC) called 'Empowering Youth in Agribusiness!' (EYA!).

This manual is a tool for Agricultural Field Officers to effectively train and advise farmers on Recommended Production Practices and Integrated Pest and Disease Management (IPM) for chillies. The Corporate Institute of Horticulture is grateful to GIZ and the EYA project team for bestowing it with not only the responsibility but also investing the trust in the institution to develop the training material.

CIH is specifically indebted for the valuable support received throughout the period of working on the document. Finally, CIH is sincerely appreciative to the Agwenda staff in Nkhotakota, the chilli growing groups, and anyone we contacted in relation to this work.

ACRONYMS

AFC	Agriculture and Finance Consultants
CIH	Corporate Institute of Horticulture
CMD	Cassava Mosaic Virus
EC	Emulsifiable Concentrates
DP	Dusting Powder
EYA	Empowering Youth in Agribusiness
FC	Flip Chart
GIZ	Gesellschaft für Internationale Zusammenarbeit
IPM	Integrated Pest Management
SC	Suspension Concentrates
SP	Soluble Powders
TMV	Tobacco Mosaic Virus
WP	Wettable Powders
WHO	World Health Organization
WS	Water Dispersible Powders

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HOW TO USE THE MANUAL

This manual is divided into modules. If the modules are very extensive, they are subdivided into topics. The topics each comprise training sessions of different duration.

Module or topic structure

- a) A table that states
 - Objectives/learning outcomes
 - Learning materials
 - Duration of the training session

The contents of the table will be introduced at the beginning of each training session.

Where applicable, a recapitulation of a previous training session and lessons learned in the meantime should be conducted.

In addition, expectations of participants are collected at least at the beginning of each module.

- b) One or several activities to get involved in the topic of the training session, to collect all the relevant facts already known by the participants and to share experiences.
 - The trainer will add any technical content that was not mentioned during the group presentations or plenary activities at the beginning of the session in a brief presentation based on the *Information Sheet*
- c) An information sheet that provides information about the technical content of the training session.
 - The trainer uses the *Information Sheet* as reference
 - Participants may use the information sheet to review after the training or to prepare for the next training session
- d) An activity to practice all the information collected and presented.
- e) An activity to summarize what has been learned and practiced.
- f) Outlook on the next training session and possibly a task to further practice the newly acquired technical content.
 - Trainers will need to set aside time at the beginning of the next session to review the results or observe the progress of the assignments

Role of trainer

In this training guide, the trainer takes on the role of a facilitator. The aim is to ensure that participants actively engage in the training and receive support from the facilitator to acquire new skills and knowledge. Each training session starts with a collection of all relevant facts already known by the participants and their experiences related to the topic of the session. The trainer then does not give a full presentation or lecture, but merely fills in missing technical content or corrects incorrect information.

This is a demanding task and requires that the trainer knows the training content of the session well. Consequently, the trainer needs to prepare the session in advance and ensure that he/she knows the entire content of the information sheet.

The trainer in the role of facilitator also ensures that all necessary materials for practical activities, as well as the location and time, are prepared and communicated.

As new skills and knowledge are practiced during the training sessions, special attention must be paid to the choice of venue. Whenever possible, training should take place on participants' farms or demonstration fields.

Activities to get involved into the topic of the training session

a) Usual procedure

Activity I: Group discussion and experience sharing (25 minutes)



- Organize participants into smaller groups of four to six people depending on the number of available participants.
- Instruct the participants to brainstorm on the topic of training (encourage the participants to use as much personal experience as possible).
- Advise the participants to write their points clearly on the provided flip charts, which they will present afterwards. At the beginning of their group work, they shall assign a presenter.

Activity II: Group presentations (20 minutes)



- Invite a representative from each group to present on behalf of the group what they had discussed during group work about the importance of growing vegetables.
- Allow members from other groups to ask questions or seek clarification from the points raised by the presenting group (members of the group and not necessarily the presenter should respond and/or provide clarification on the questions asked by the participants in plenary).

Activity III: Plenary session (up to 40 minutes, depending on the extent of information to be added)



- After listening to the presentations of all groups, add facts that were not mentioned or correct misinformation. The Information Sheet is your reference.
- Allow for further contributions and questions of participants.
- Do not expand this part to more than 40 minutes.

b) Alternative procedure

Sometimes it may be more efficient to collect the participants' knowledge about the topic of the session in plenary:

- If a demonstration site or specialized farm is visited (see chapter **farm visits** below),
- A guest speaker or expert is invited,
- The topic is unknown to more than half of the participants.

Under these circumstances, the collection of prior knowledge on the topic of the session will be conducted as a plenary session.

Activity I: Plenary session to collect prior knowledge on the topic of the session



- Ask participants to share any information and experiences they have gathered related to the topic of the session. Encourage all participants to actively contribute
- The trainer takes notes on flipchart if practicable
- After the collection is concluded, add facts that were not mentioned or correct misinformation. The information sheet is your reference
- Allow for further contributions and questions of participants
- Do not expand this part to more than 45 - 60 minutes

Variations and additional information for the trainer

Farm visits

Visits to specialized farms or demonstration sites enrich the training sessions. After welcoming the owner or manager, they should first be given the opportunity to introduce themselves and the farm or demonstration site and to take a tour.

Then the session continues with the usual collection of all relevant facts already known to the participants and their experiences related to the topic of the session. This time it is done in plenary and in addition, the participants' observations on the farm or demonstration site are added. The trainer takes notes, if possible, on flipcharts.

Instead of adding to the collected knowledge himself, the trainer may ask the owner or manager to fill in missing information or explain the farming activities step by step. In the latter case, it is advisable to hold a preparatory meeting with the owner or manager and show or hand out a copy of the information sheet.

The rest of the session, with practical activities, summarizing the skills and knowledge acquired, and giving assignments, proceeds as usual.

Instead of the trainer adding up on the collected knowledge, she or he could ask the owner or manager to present missing information or to explain farming activities step by step. In the latter case, it is advisable to have a preparatory meeting with the owner or manager and to show or hand out a copy of the information sheet.

Practical training or practical exercises

All training should be as practical as possible. All newly acquired knowledge has to be applied in practice and the skills are to be practiced either during the training or between the trainings on the own farm or on a farm of a relative.

If practicable, the training should be carried out in the participants' farms, in specialized farms or at demonstration sites. However, this requires preparation:

- Is there enough space for the participants?
- Are all materials available?
- Are tools available or do the participants have to bring along their own?

Case studies

Sometimes case studies are helpful to get involved in a topic or to practice newly acquired skills.

If the case study is to be used to engage the participants with the topic of the session, then it will be analysed and worked on in-group setting at the beginning. The rest of the session proceeds as usual. Case studies may also be used to apply newly acquired knowledge. Then the case study and related tasks are carried out instead of the practical activity.

At the beginning of a new series of training sessions

If the trainer starts a new training series with participants he has not yet trained, then she/he should follow these steps:

a) Climate setting (5 minutes)

- One of the trainers greets the participants and asks them how they feel about being participants of the training. Trainers should be relaxed and friendly. All trainers should be visible at this time
- Arrange seating plan into a "U" shape and remove the tables
- Set up the Flip Chart (FC) stand and all other materials that will be used
- Ask participants some introductory questions:
 - As an example, what is your interest in vegetable production?
 - Also, ask the participants what they expect to happen during training session
 - Ask the participants if they personally know each other as well as the members of the training team

b) Trainer and participants Introduction (20 – 30 minutes)

- First, trainers introduce themselves. The introduction should cover the first name, surname, family background, home and home district, duty station, official responsibilities and life goal. The introduction should be informal and friendly
- Let the participants' pair up and arrange to introduce each other

c) Clarification of expectations (30 minutes)

Expectations of participants are collected at least at the beginning of each module.

Ask participants to write on one card or piece of paper provided what they expect to achieve at the end of the training course. These are called expectations. The participants should not list more than five expectations. The facilitators should not collect the cards.

- Ask one participant to write her/his expectations directly on a Flip Chart (FC). Afterwards ask the second participant to add what is not already on flip chart in writing and to make a check mark beside those expectations he/she has listed as well
 - This takes less time than one might expect since the expectations of the last participant will be included in those listed by the first part of the group.
- Be frank with participants about expectations, all of them may not be met during the training program
- Give a brief overview of topics that will be covered
 - Keep the flipchart paper and check from time to time, what has been covered and what could be integrated in the upcoming training sessions
 - Collecting expectations helps the trainer to find out what the participants had in mind when they came to the training
 - At this stage of the course, it is important to encourage participants to take part in order to establish the interactive mode that will continue throughout the course

Expectations may also be collected at the beginning of a new topic or session. In this case, the collection should take place in a short plenary session.

d) Training rules and regulations - norms (10 minutes)

- Explain that norms are behaviours that participants agree upon to regulate their activities for the success of the training
 - The key to a successful norm is that it is agreed upon by the group and not imposed by the trainers. No norm should be “finalized” without discussion and agreement
- Examples of norms:
 - Putting phones on silent mode
 - Do not disturb others by making noises
 - Punctuality
 - Active participation
 - No side meetings
- Ask participants to propose norms for the training and let them discuss and agree to them by themselves
- Once agreed, write the norm on the flip chart
- Keep the flip chart paper and take it along to the other following sessions. If necessary, remind participants of the set norms

INTRODUCTION

Basic information

- **Common name:** Chillies
- **Scientific names:** *Capsicum annum* and *Capsicum frutescens*
- **Family:** *Solanaceae*
- Other crop members of the family: Egg plants, tomato, tobacco, potato among others.
- **Common use:** Consumed fresh, dried or in a processed form as a table vegetable or spice.
- **Growth habit:** Perennial sub shrub living two to three years, erect growing to a height of 0.5 to 1.5 m, much branched with a strong tap root and is both self and cross-pollinated.
- **Nutritive value:** Chilli fruits are a rich source of Vitamin A and C, B6, and high in K, Mg and Fe.

Common varieties

1. **Bird's eye or Mphiripiri:** Small and slender with a pointed tip, extremely pungent (Scoville scale), fruits born upright.



Figure 1: Birds Eye variety

2. **Red cayenne:** Large and long with pointed or blunt tip, moderately pungent, pendantly born fruits.



Figure 2: Red Cayenne variety

3. **Kambuzi:** Small and round, very pungent and highly flavoured, fruits born upright.



Figure 3: Kambuzi variety

4. **Other varieties of chilli**

- Anaheim
- Fresno
- Jalapeno
- Rocket
- Short Bullet

Why should the youth be involved in chilli growing?

Growing of chillies would be a good source of income that can transform the lives of many youths in Malawi.

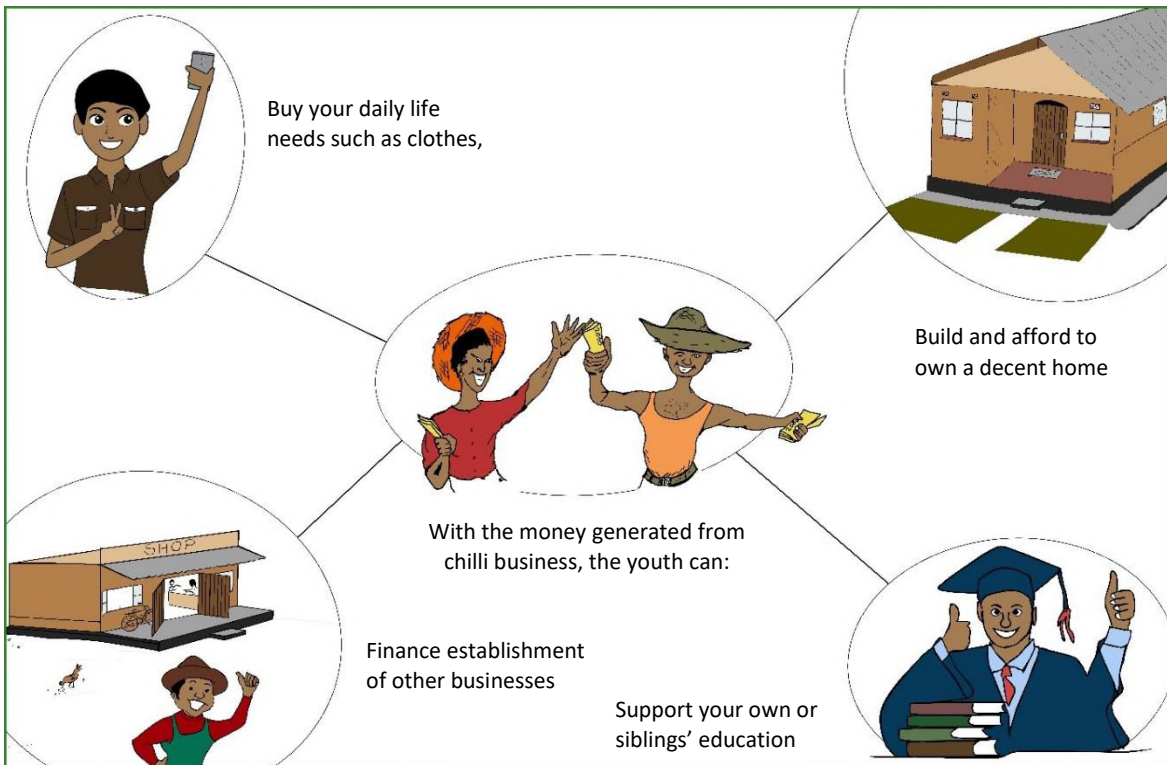


Figure 4: Benefits of chilli cultivation

MODULE 1: PLANNING TO START A CHILLI PRODUCTION BUSINESS

ITEM	CONTENT
Objectives	<p>By the end of this topic participants will be able to:</p> <ul style="list-style-type: none"> - State the importance of production planning - Explain factors to be considered in production planning - Prepare an effective plan for their chilli producing business
Training materials	Flip charts, markers, masking tapes, flip chart stand and ballpoint pens note books
Training duration	115 minutes

Activity I: Group discussion and experience sharing (20 minutes)



- Organize participants into groups of five people
- Instruct the participants to brainstorm on the key considerations in planning to start a chilli production business
- Advise the participants to write their points clearly on the provided flip charts, which they will present afterwards. At the beginning of their group work, they shall assign a presenter

Activity II: Group presentations (25 minutes)



- Call the participants back for the presentation of their discussion outcomes
- Invite a representative from each group to present on behalf of the group what they had discussed during group work on meaning, importance and the challenges of vegetable growing in Malawi
- Allow members from other groups to ask questions or seek clarification from the points raised by the presenting group (members of the group and not necessarily the presenter should respond and/or provide clarification on the questions asked by the participants)

Activity III: Plenary session (40 minutes)



- After listening to all groups' presentations, facilitate a plenary session on the importance of planning chilli production
- The trainer should build the plenary session on the experience and knowledge shared by all groups in their presentations
- Ensure that the session broadens the discussion and covers all the details given in the information sheet, e.g. the main business planning factors summarized as MITES (Market, Investment capacity, Technology, Expertise and Site)

INFORMATION SHEET

Farmers must plan farming activities properly for a good yield. Planning requires good record keeping. If you do not keep records, you cannot plan in detail. It is critical to consider the market- and/or the consumer demands in the plan because it is of no use to grow chillies that will not be liked by the customers as being the market outlets. Planning involves paper work and in planning, the following must be considered.

Production calendar for chillie crop

Table 1: Chillies production calendar

No.	Activity	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
1.0	Nursery establishment												
1.1	Site selection for nursery and field												
1.2	Bush clearing												
1.3	Tilling												
1.4	Harrowing												
1.5	Making nursery beds												
1.6	Sterilizing nursery beds												
1.7	Making ridges in the field												
1.8	Seed sourcing												
1.9	Sowing seed												
2.0	Nursery management												
2.1	Watering												
2.2	Mulching												
2.3	Weeding												
2.4	Pests and disease control												
2.5	Hardening off												
3.0	Transplanting of seedlings												
4.0	Field management												
4.1	Irrigation												
4.2	Manure application												
4.3	Weeding												
5.0	Pest and disease management												
6.0	Harvesting												
7.0	Post-harvest handling												
7.1	Drying												
7.2	Grading												
7.3	Packaging												
7.4	Storage												

Planning to start a chilli production business

Chillies production must be a well-planned initiative in order to generate profits and fulfil one's aspirations. Remember, this is a business and every business aims at making profits!

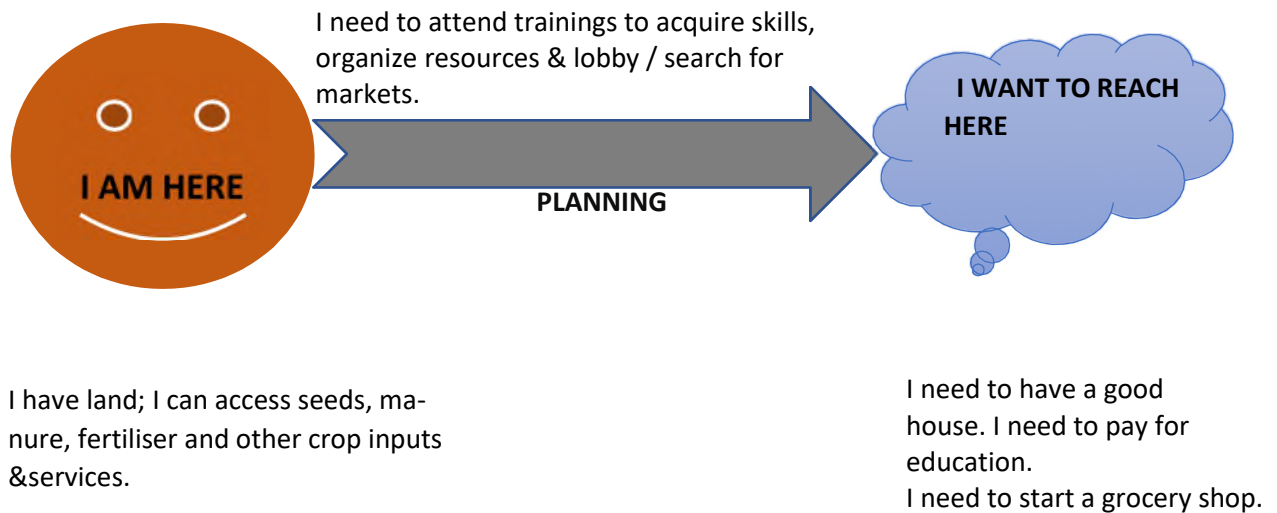


Figure 5: An illustration of the importance of planning for a successful chilli growing business

The big five

For a successful chillies production business, five key considerations have to be made. These have been named as the Big Five with the acronym **MITES!** Let us look at them in summary.

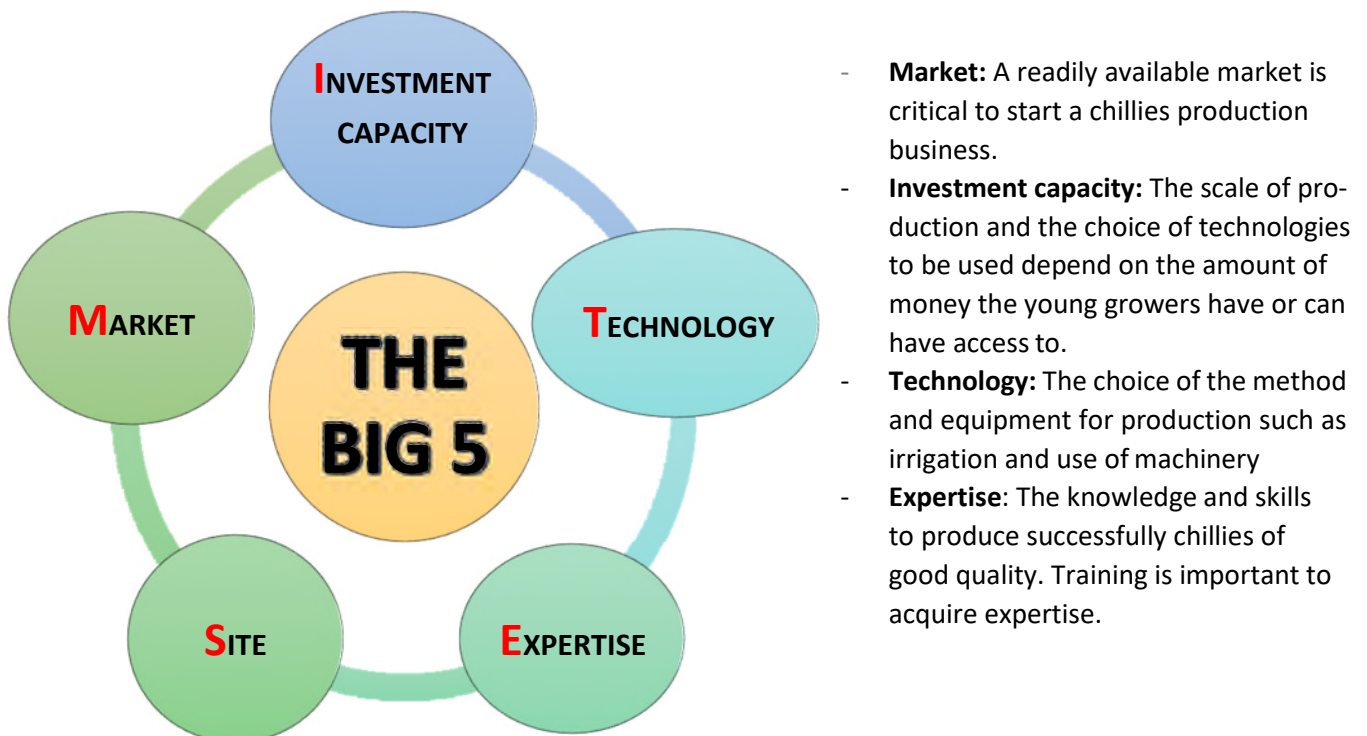


Figure 6: The five main factors considered when planning a chilli production enterprise

Note

The big five while discussed as guiding principles for planning a chilli growing business are not a complete picture of what it takes to have a successful chilli enterprise. Several other important factors such as availability and source of quality seed and availability of infrastructure such as roads to facilitate easy movement have to be considered together with the big five for a complete picture.

Activity IV: Quality assurance and course assessment (15 minutes)



- Use different techniques to assess how the participants understood the lesson. Ensure that this is as participatory as possible. Techniques could be:
 - o Allow participants to state their key take away points and lessons from the session
 - o Provide an opportunity for pairs or individuals to facilitate a recap of the lesson
 - o Ask specific questions from the content of the lesson allowing all participants to take part in responding to the questions

Activity VI: Course feedback and planning for the next session (15 minutes)



- Discuss the way forward/upcoming activities with participants:
 - o Date, venue, time, topic of next session and activities to take place before the next meeting
 - o Encourage all participants to prepare, arrive on time and be present for the entire session
- Obtain feedback from participants on the concluded training session by thanking all participants for coming to the training

MODULE 2: COMPOST MAKING

ITEM	CONTENT
Objectives	By the end of this topic farmers are able to: <ol style="list-style-type: none"> 1. Identify the best method of making compost for their commercial chilli production 2. Prepare various types of compost
Training materials & tools	<p>Training materials: Flip charts, markers, masking tapes, notebooks, ballpoints and flip chart stand</p> <p>Compost materials: Grasses, leaves, straw, garbage, green leaves, maize bran, farm manure, ash, anthill soil and water</p> <p>Compost making tools: Hoes, rake, shovel, watering can, panga knives, pegs, tape, strings, sacks and black plastic paper</p>
Training duration	270 minutes

Activity I: Group discussion and experience sharing (20 minutes)



- Organize participants into smaller groups of four to six people depending on the number of available participants
- Instruct them to brainstorm and share experiences on the materials and procedures for making compost
- Advise the participants to write their points clearly on the provided flip charts, which they will present afterwards. At the beginning of their group work, they shall assign a presenter

Activity II: Group presentations (30 minutes)



- Call the participants back for the presentation of their discussion outcomes
- Invite a representative from each group to present what they had discussed during group work
- Allow members from other groups to ask questions or seek clarification from the points raised by the presenting group (members of the group and not necessarily the presenter should respond and/or provide clarification on the questions asked by the participants)

Activity III: Plenary session (40 minutes)



- After listening to presentations from all groups, in present the materials and procedure for making compost
- Build your presentation on the points and experiences presented by the participants
- Inform the participants that all details will be addressed further during the practical exercise

INFORMATION SHEET

Compost is well-decomposed organic matter capable of releasing nutrients to the plant and improving soil fertility and structure.



Figure 7: A well-decomposed compost

Soil consists of two parts, animate (living) section called humus and inanimate (non-living) section comprising sand, and clay. Humus consists of millions of organisms, which are so small that they cannot be seen by the naked eye. They are called microorganisms, and they live on organic material such as manure, plant matter (grass, leaves, etc.), animal matter (bones), eggshells and sawdust. These microbes die when the organic material changes into compost. The dead microorganisms are good food for plants.

Compost requirements

The microorganisms function well if the following requirements are met:

a) Air

There must be enough air in the compost. Organic material must therefore not be squashed together too much or be full of water.

b) Water

The organic material must be kept moist and not be allowed to dry out.

c) Warmth

The organic material can either be kept warm by making it in a hole in the ground, or if it is above ground, by covering it with plastic sheets.

d) Food

Make sure that the organic material has enough carbon **C** and nitrogen **N**. Carbon is found in grass, hay, stems and branches. Nitrogen is found in manure, urine and chemical fertilizers.

1. Importance of compost

- Compost provides crops with plant nutrients
- Improve topsoil structure through supply of organic matter, hence: -improving root penetration, improving permeability, improving water retention, improving resistance to erosion, improving aeration in the soil
- Reduces leaching of the soil nutrients
- Improves soil microbial activity
- Supplies nutrients even in succeeding years after application

2. Problems associated with compost

- High labour demand
- The quality is variable, hence nutrient content in particular manure is not known
- Large volumes of water are needed to make manure
- Material is bulky and needs to be transported to the field if not made in the fields

3. Types of compost manure

- Pit compost
- Chinese compost (Changu method)
- Chimato compost
- Wooden frame compost
- Windrow compost
- Bokashi compost

4. Compost manure making

4.1 Pit method

It is made in a pit hence its name. Usually, it is not recommended during the rainy season unless an overhead protective roof is constructed to avoid excessive water entering into the pit that may stop the decomposition process.

Composting materials required

- Grass
- Crop residues
- Maize stover
- Leaves of various plants
- Booster with high nitrogen content, e.g. khola manure or previously made compost manure, decomposed matter from garbage pits. The booster provides microbes, which are required to speed up the decomposition process of the composting materials
- Green fresh matter and leguminous leaves
- Water

Equipment and tools

- Bucket or watering can
- Measuring stick
- Hoes
- Shovels & Panga

Note

Chop the composting materials to at least less than 10 cm long to increase the surface area necessary for rapid decomposition.

Site selection

Preferably, the site should be:

- Near a garden where the manure will be used to ease transport problems. If it is made in the garden, it is better to site it on the edge of the garden in order not to disrupt cultivation operations in the middle of the garden
- The site should preferably be under shade in order to maintain moisture in the pit
- Select a fairly flat ground for even distribution of organic material and water
- The site should be convenient for collection of materials and water

Procedure

- Clear the surface of the ground in at least 2.0 m diameter for easy marking
- Measure out a square of 1.5 m by 1.5 m
- Dig a pit 1.5 m square. The depth should be 1.0 m. Below 1.0 m, there is a reduction in the number of microbes, which are necessary in decomposing the composting materials. Separate topsoil from subsoil since topsoil may be re-used when piling the pit



Figure 8: A standard pit for compost manure making at CIH in Salima

- Water the whole pit adequately. It is important because subsequent watering may not be required
- Spread the booster to a depth of 3 to 5 cm to provide nitrogen to microbes in the pit
- Water the manure adequately until it is completely saturated
- Pile the bulk of composting materials to a depth of about 30 cm
- Water adequately to induce the decomposition process
- Put manure again to a depth of 3 to 5 cm to provide nitrogen
- Repeat the procedure of alternating the composting material and manure until the pit is full
- Cover the pit with topsoil of about 8 cm thick
- After three to four days, check for warmth by inserting a stick to see if decomposition has started. Normally, the stick will feel warm

Note

If the pit is not under shade, cover the top with grass or leaves to conserve moisture. Turning is not required.

Signs of maturity

- The materials become dark or grey in colour
- The pit sinks to almost half its original size
- The materials become unrecognizable

Duration to maturity

The manure will be ready in about two to three months' time depending on type of composting materials used.

4.2 Chinese type (Changu)

The organic materials decompose relatively fast hence the name 'Changu'. Site selection is the same as that for Pit compost but in addition, the site should be away from dwelling houses and behind windbreaks. The composting materials are the same as in pit compost.

Procedure

1. Clear the ground for easy marking.
2. Mark 1.5 to 2 m diameter circle by using a string and a peg.
3. Heap 20 to 30 cm thick layer of composting materials. This will form the base of the compost heap
4. Water the heap adequately until water just oozes out when material is squeezed between the fingers
5. Add booster on top to a height of 3-5 cm thick
6. Water the booster layer adequately
7. Repeat the procedures outlined in steps 3 to 6 with each subsequent layer's diameter decreasing until the heap reaches a height of 1.5 m, thereby forming a conical shape
8. If the heap is not under shade, cover it with grass to conserve moisture



Figure 9: Chinese (Changu) compost manure heaps at CIH in Salima

Procedure in turning

1. After two to three days, the heap will have formed three distinct layers. The outer layer A, the middle layer B, and the inner layer C
2. Turn the heap every 5 days to speed up decomposition
3. During turning, remove the outer layer A from the heap and separate the middle layer B from the inner layer C
4. Put layer A at the bottom as illustrated below:



Figure 10: Procedure for turning compost

5. Water adequately
6. Put layer C in the middle
7. Water adequately
8. Lastly put layer B on top/outside the heap
9. Water and cover the heap with grass if necessary

Note

The conditions are most suitable for decomposition at the middle of the heap. The heap will mature in about 30 to 40 days. The softer and greener the material the faster it will decompose.



Figure 11: A matured heap of Chinese compost

4.3 Chimato compost

Chimato is a form of compost that is made as a heap on the ground. When the heap is complete, it is smeared on the outside with mud and requires no turning and additional water.

Site selection and materials required are the same as for those already discussed in pit and Chinese.

Procedure

There are two ways by which Chimato compost can be made. The dimensions of the conical type of Chimato are the same as that of the Chinese compost. The major difference is that in the Chimato compost two cross poles are fixed when making the compost. The third pole is fixed at the center. These three poles are later removed leaving holes that will act as air vents.

The piling of the compost materials is exactly the same as in Chinese compost.

- Watering is done after heaping each layer.
- Smear the outside with mud leaving the vents open.
- Cover the heap with grass or plastic paper to maintain moisture.

1. The second type of Chimato compost has the following dimensions:
Length: 1.5 m
Width: 1.5 m
Height: 1.5 m
2. Arrange the logs, bricks, stones in pairs at 10 cm apart creating a gap for air vents.
3. Set three air vents at 60 cm apart.
4. Lay down maize stover or twigs on logs to create a bed.
5. Fix a pole in the middle of the created bed. When the compost heap has been completed, the pole will be removed leaving a hole that will become an air vent for aeration in the compost heap.
6. Pile the chopped composting materials and manure in exactly the same way as in the Chinese compost.
7. Water every layer adequately, until it oozes when the composting materials are squeezed.
8. Add a booster on top to a height of 3 to 5 cm thick.
9. Water again on top of the booster till it is saturated.
10. Repeat the above process of 20 to 30 cm layer of watered composting materials topped by a 3 to 5 cm of booster material up to a height of 1.5 m.
11. As the heap grows, shake the pole to ensure that there is an open hole.
12. When the compost has attained the required height, smear the heap with mud leaving the air vents open.
13. Cover the heap with grass or plastic paper to maintain moisture.
14. After one day remove the ventilation pole fixed in the middle.
15. After two to three days, close the top vent to retain warmth in the heap.



Figure 12: Chimato compost heap at CIH in Salima

Duration to maturity

The manure will be ready in about 40 to 60 days depending on type of composting materials used.

4.4 Windrow composting method

Windrow composting consists of placing the mixture of raw materials in long narrow piles called wind- rows that are agitated or turned-on regular basis (NRAES, 1992).

Windrow will help promote mass production of compost as preparation is done in large quantities.

Materials

- Dry stalks and leaves of maize (chopped)
- Soya or/and groundnuts residues
- Cattle/goat dung
- Virgin soils
- Wood ash

Composting materials required

- Grass
- Crop residues
- Maize stover
- Leaves of various plants
- Booster with high nitrogen content, e.g. khola manure or previously made compost manure, decomposed matter from garbage pits. The booster provides microbes, which are required to speed up the decomposition process of the composting materials
- Green fresh matter and leguminous leaves
- Water

Equipment and tools

- Bucket or watering can
- Brushwood of about 2 m long
- Measuring stick/tape
- Hoe
- Shovel
- Panga

Note

Chop the composting materials to at least less than 10 cm long to increase the surface area that is necessary for rapid decomposition.

Site selection

Site selection factors are same as pit compost.

Procedure

- Chop the crop residues/leaves preferably to 10 cm or less
- Clear the surface of the ground at least 2 m wide for easy marking; the length of the cleared area should be dictated by the amount of composting material but should be in multiples of 1.5 m
- On the cleared surface, mark a rectangle of width 1.5 m and length of 8 m. The length could be extended in multiples of 8 m if one has adequate composting material
- Water the surface until the surface is just moist; do not create a muddy condition
- Insert the brushwood along the perimeter of the windrow at 20 to 30 cm apart to a height of 1.5 m
- Spread a layer of booster evenly to a thickness of 2 to 3 cm to provide a source of nitrogen to microbes in the compost
- Pile a layer of about 30 cm of composting material on top of the booster
- Water adequately to induce the decomposition process
- Pile another layer of 20 to 30 cm of composting material on top of the first layer followed by a layer of booster and water adequately
- Repeat the procedure of alternating the composting material and manure until the roll reaches a height of 1.5 m
- Cover the compost roll with preferably black plastic paper to induce anaerobic decomposition
- Cover the roll with about 8 cm thick moist topsoil
- After seven to fourteen days, check for warmth by inserting a stick to see if decomposition has started



Figure 13: Windrow ready for covering



Figure 14: A covered heap of windrow manure at CIH

4.5 Bokashi composting method

Bokashi is a product of fermented mixed organic fertilizer materials such as plant residues or compost that fully utilize the ability of aerobic microorganisms. Ash is also added, hence the name Bokashi. Bokashi manure is used for basal dressing and is of higher nutrient value than other types of manure

Composting materials required

- Crop residues such as maize stover or groundnuts straws/Grass/ Leaves of various plants
- Fermented gaga
- Booster with high nitrogen content, e.g. khola manure or previously made compost manure, decomposed matter from garbage pits. The booster provides microbes, which are required to speed up the decomposition process of the composting materials
- Wood ash
- Water

Equipment and tools

- Watering can or bucket
- Measuring stick
- Hoe
- Shovel
- Panga

Site selection

Same as factors for other types of compost explained above.

Procedure

- Clear the surface of the ground in at least 2 m diameter
- Mark a circle of 1 m diameter
- Water the surface until the surface is just moist; do not create a muddy condition
- Chop the crop residues/leaves preferably to 10 cm or less
- Mix five to eight wheel burrows of chopped crop residues/grass/leaves with three to four wheelbarrows chopped soya or groundnut haulms and 20 to 30 shovels of cattle/goat/chicken dung, three to five shovels wood ash and half (1/2) shovels fermented gaga
- Apply water while turning the mixture thoroughly such that water is evenly distributed into the mixture. Water until the mixture is just moist
- Mark a circle of 1 m diameter
- At the centre of the circle, insert a stick to a height of 1 m
- Pile the mixture around the stick to a height of half (1/2) m
- Cover the mixture with a plastic sheet, preferably black
- Cover the heap with a thin layer of soil or stones so that the plastic sheet shall not be blown off by wind
- After five to seven days, check for warmth by inserting a stick to see if decomposition has started

Table 2: Benefits, problems and application rate for the different types of manure

METHOD	BENEFITS	PROBLEMS	RATE
Pit	- No turning required -No subsequent watering - Pit can be reused	- More labour to dig the pit - More labour to lift the compost from the pit - Difficult to make during the rainy season	10 pits per 0.4 ha
Chiese (Changu)	- Can be ready in 40 days at most - Possible to throughout the year	Labour-intensive during turning	15 heaps per 0.4 ha
Chimato	- No turning required - Possible to make throughout the year	- Requires shelter during the rainy season	10 heaps per 0.4 ha

5. Method of application

Two handfuls per planting station for cereals is the most recommended. The two handfuls weigh about 250 grams. At this rate, the amount of manure applied is 3.5 tons per hectare. When farmers have adequate manure, they can apply manure in the furrows. The recommended amount is one 20-l tin/bucket spread an along 8 m-long furrow. They can also apply using binding and broadcasting.

Broadcasting is common in rice fields.

Generally, the soil colour becomes darker with subsequent application of manure due to increase in organic matter levels.

Activity IV: Practical on making compost (120 minutes)



- Give an opportunity to the participants to practice making of composts of your choice or their choice depending on the available materials
- For the selected type of compost, follow the procedures laid out above ensuring that all participants actively participate in the processes
- Ensure that participants are involved in every activity including collection of the materials

Tips for trainer

- For an effective delivery of the practical, ensure that you arrange for the practical area well in advance inspecting where the compost will be made
- Ensure that all the materials for making the compost are sourced and made available on the training day
- The procedure of the practical provided in the description is comprehensive. Trainers will select the steps from the procedure depending on their situation

Activity V: Quality assurance and course assessment (20 minutes)



- Use different techniques to assess how the participants understood the lesson. Ensure that this is as participatory as possible. Techniques could be:
 - o Allow participants to state their key take away points and lessons from the session
 - o Provide an opportunity for pairs or individuals to facilitate a recap of the lesson
 - o Ask specific questions from the content of the lesson allowing all participants to take part in responding to the questions

Processing questions

- * What were the main steps/activities and/or considerations in making compost?
- * Which were the easiest and the most difficult steps in the practical?
- * What skill stands out for you?

Generalization questions

- * What conclusion would you draw from this practical?
- * Which step if not followed would result in poor quality compost?

Application questions

- * Will you be comfortable to prepare compost on your own?
- * What alternatives are there to achieve in making compost in the absence of other equipment or materials used in this demo?

Activity VI: Assignment (10 minutes)



- Inform the participants that they have the task of making their own compost
- The trainer should make it clear to all participants that they are being visited to check that they have made compost and followed the correct procedure
- In addition, farmers should check each other and see if they are all using the correct technique in compost making

Activity VII: Course feedback and planning for the next session (10 minutes)



- Discuss the way forward/upcoming activities with participants:
 - o Date, venue, time, topic of next session and activities to take place before the next meeting
 - o Encourage all participants to prepare, arrive on time and be present for the entire session
- Obtain feedback from participants on the concluded training session
- End the session by thanking all participants for coming to the training

MODULE 3: NURSERY ESTABLISHMENT

Topic 1: Seed sourcing and site selection

ITEM	CONTENT
Objectives	By the end of this topic, participants will be able to: <ul style="list-style-type: none"> - Describe factors to consider in the selection of a nursery site - Select a nursery site - Select clean, healthy and viable seeds for the chilli nursery - Identify various sources of quality seed for commercial chilli production
Training materials	Flip charts, markers, masking tapes, flip chart stand and ballpoint pens notebooks
Training duration	90 minutes

Activity I: Group discussion (20 minutes)



- Organize participants into groups of four to six people depending on the number of participants
- Instruct them to brainstorm and share experiences on the following:
 - o Key factors that are considered when selecting a site for a chilli nursery
 - o Important factors to consider in sourcing chilli seed
 - o Options for accessing quality chilli seed
- Advise the participants to write their points clearly on the provided flip charts, which they will present afterwards. At the beginning of their group work, they shall assign a presenter

Activity II: Group presentations (20 minutes)



- Call the participants back for the presentation of their discussion outcomes
- Invite a representative from each group to present what they had discussed during group work
- Allow members from other groups to ask questions or seek clarification from the points raised by the presenting group (members of the group and not necessarily the presenter should respond and/or provide clarification on the questions asked by the participants)

Activity III: Plenary session (20 minutes)



- After listening to groups' presentations, summarize the major factors to consider when selecting a suitable site for chillies nursery establishment
- The trainer should build the plenary session on the experience and knowledge shared by all groups in their presentations
- Inform the participants that all details will be addressed further during the practical exercise

INFORMATION SHEET

Site selection for chilli nursery and chilli production

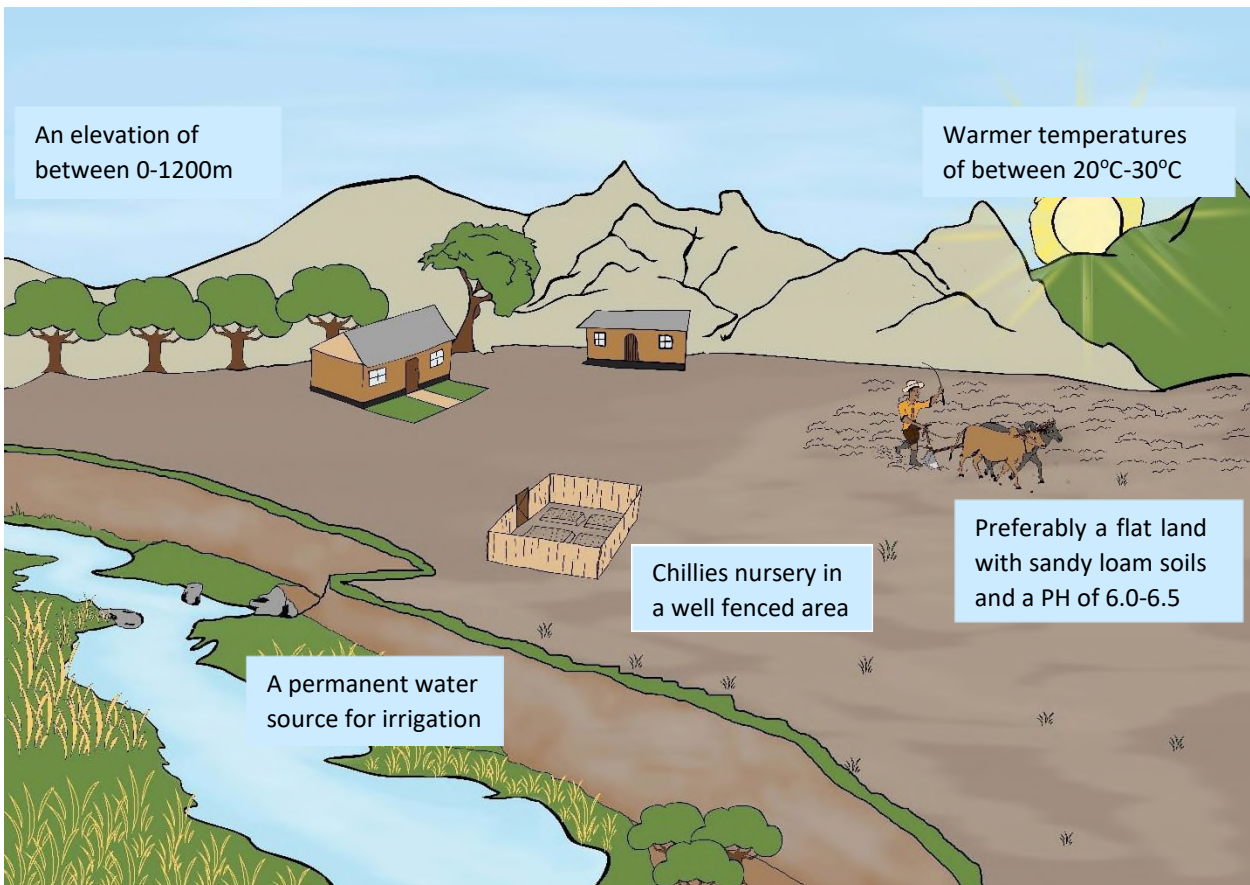


Figure 15: Factors for site selection for both chillies nursery and field establishment

- The nursery has to be sited close to a permanent water source, if available
- The closer the nursery is to the home, the more secure it is from both stealing and damage by animals
- Where animals on free-range system are prominent, it is always important to consider erecting a simple fence (e.g. Thorn-bush branches)
- The site should be in an open area (not under shade) to allow sunlight to reach the plants for photosynthesis
- The site should have a gentle slope to drain the excess water away
- *A site with rich, well drained, friable/crumbled soils without history of any member of the Solanaceae family such as tomato, tobacco, potato and eggplant, grown there for the past three years*

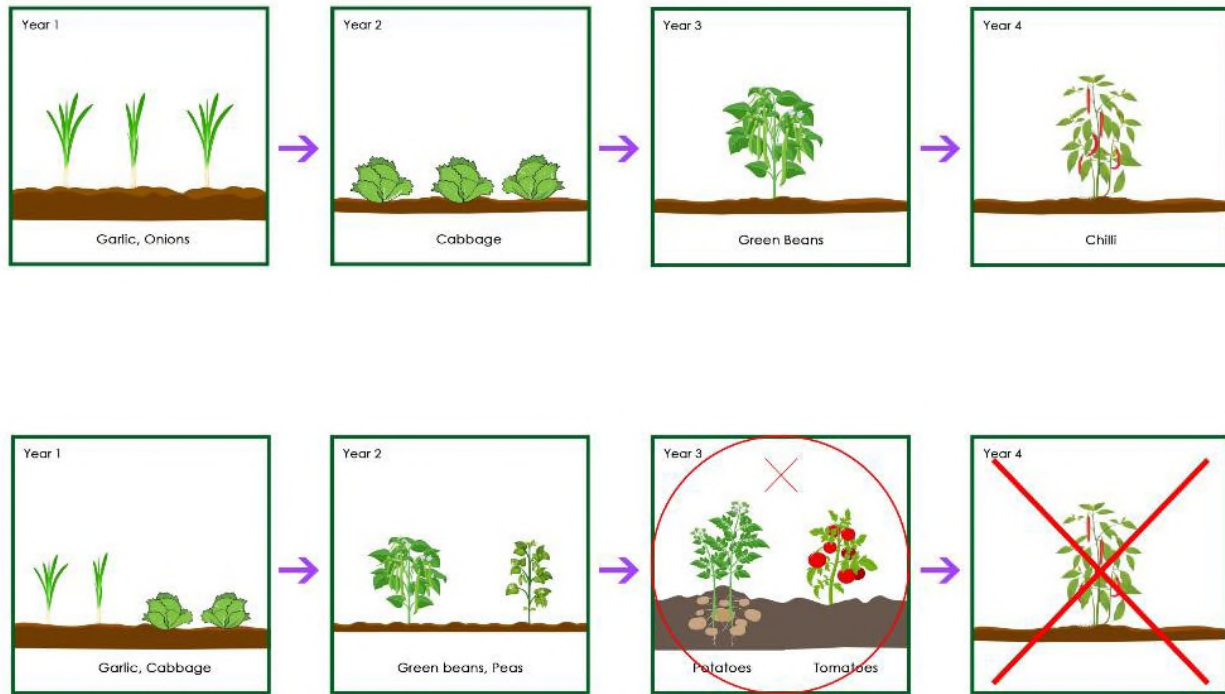


Figure 16: A sample of a rotation plan

Avoid

- X Soils which cakes, compacts or crusts such heavy clay soils. These soils keep a lot of water causing a damping-off disease
- X Distinct dry and rainy weather is important to facilitate effective drying
- X Temperatures and day lengths are important for flowering, fruit set and colour development during ripening which affect quality of the crop
- X Growing chillies in the right environment promotes good and healthy growth reducing infestation of pests and diseases

Sourcing clean, healthy and viable seeds



Figure 17: Chilli pepper seeds

- The success of any chilli enterprise begins with healthy, clean and viable seeds
- For a long time and even now, access to certified, clean and quality chillies seed remains a key production challenge in Malawi
- Currently growers are using recycled/retained seed, which is collected through field selection. The procedure for selecting seeds from the field is as follows:
 - Mark or tag healthy and vigorous chillies plants in the field
 - Harvest healthy and big pods from the marked plants and keep them separately for drying
 - Split open the pods to collect the seeds
 - Keep the seeds for use in the next growing season

Caution

Many years of recycling/retaining seeds may cause degeneration of the seed genetics and germination strength

Activity IV: Quality assurance and course assessment (15 minutes)



- Use different techniques to assess how the participants understood the lesson. Ensure that this is as participatory as possible. Techniques could be:
 - Allow participants to state their key take away points and lessons from the session
 - Provide an opportunity for pairs or individuals to facilitate a recap of the lesson
 - Ask specific questions from the content of the lesson allowing all participants to take part in responding to the questions

Activity V: Assignment/individual work (10 minutes)



- Inform the participants that they have the task to select a suitable site where they will establish their chilli nursery
- The trainer should make it clear to all participants that the chosen sites will be inspected before the day of the next training and before anyone begins to establish their nurseries

Activity VI: Course feedback and planning for the next session (10 minutes)



- Discuss the way forward and upcoming activities with the participants:
 - Date, venue, time, topic of next session and activities to take place before the next meeting
- Encourage all participants to prepare, arrive on time and be present for the entire session
- Obtain feedback from participants on the concluded training session
- Close the session by thanking all participants for coming to the training

Topic 2: Land preparation

ITEM	CONTENT
Objectives	By the end of this topic, participants will be able to: <ul style="list-style-type: none"> - Describe the steps involved in land preparation - Prepare land for the chilli nursery and field planting - Prepare a nursery bed
Training materials & tools	Flip charts, markers, masking tapes, flip chart stand, slashers, pangas, axes, hoes, shovels, tapes, pegs, strings, hammer and manure
Training duration	210 minutes

Activity I: Group discussion (20 minutes)



- Organize participants into groups of four to six people depending on the number of participants
- Instruct them to brainstorm and share experiences on the best practices in land preparation for a chilli nursery and chilli fields
- Advise the participants to write their points clearly on the provided flip charts, which they will present afterwards. At the beginning of their group work, they shall assign a presenter

Activity II: Group presentations (20 minutes)



- Call the participants back for the presentation of their discussion outcomes
- Invite a representative from each group to present what they had discussed during group work
- Allow members from other groups to ask questions or seek clarification from the points raised by the presenting group (members of the group and not necessarily the presenter should respond and/or provide clarification on the questions asked by the participants)

Activity III: Plenary session (20 minutes)



- After listening to groups' presentations, summarize the best practices in preparing land for chilli nursery establishment and field production
- The trainer should build the plenary session on the experience and knowledge shared by all groups in their presentations
- Inform the participants that all details will be addressed further during the practical exercise

INFORMATION SHEET – including practical exercise

Land preparation

- Land preparation, in general, involves clearing, tilling (ploughing) and harrowing when land preparation draft animal power or machinery is used
- For the nursery, bed making and sterilization are done while for the field, ridges are made
- Land clearing should be done by slashing or hoeing and not burning the bush to prevent killing beneficial microorganisms
- Soil must be tilled/ploughed to a depth of between 25 to 30 cm before beds are made in the nursery or ridges are made in the field. Tilling helps to loosen the soil and it also exposes harmful pests to sunlight hence killing them
- Tilling the land is done manually using a hoe while ploughing can be done by draft animal power or machinery if available



Figure 18: Land preparation (slashing and tilling)

Activity IV: Group Practical: Land clearing, ploughing and bed making (60 minutes)



Step 1: Land clearing and tilling (45 minutes)

This practical will be done in one group as a demonstration with all the participants. Suggested below are some of the steps that a trainer should consider for an effective demonstration:

- Allow the participants to be in their small groups as divided earlier on
- Take them to the demonstration site
- Arrange them in such a manner that they have a clear view of the demonstration area
- State the objectives of the demonstration clearly explaining the skills that will be acquired
- The trainer should display and describe all the materials to be used during demonstration
- Participants should then be allowed to practice land clearing, tilling and breaking of clods to make fine tilth as explained above

Information for the trainer

- o Ensure that all the materials required for the practical are in place
- o Also, ensure that there is a clear guide for the practical
- o Ensure that all the participants are taking part
- o Continue to provide guidance at every step to ensure that skills are taught

Step 2: Nursery bed construction demonstration

The aim of this practical is to make participants understand the steps to be followed in making a nursery bed for raising chillies seedlings.

Many farmers use seedbeds to raise their seedling since this is a cheap method. The seedbeds either could be sunken or raised. The sunken seedbeds are used in the dry season or in areas where rainfall is low. These beds conserve moisture. The raised beds on the other hand are ideal in the rainy season in order to avoid waterlogging conditions on the seedbed. These beds are also widely used in areas of high rainfall areas. The beds are usually 1 m wide and of any desirable length.



Figure 19: Sunken seedbeds

The trainer facilitates a demonstration on the construction of a nursery bed with all the participants involved.

Steps in nursery bed construction (60 minutes)

- Mark out the bed-dimensions of 1 m wide and 3 m long
- Raise the loose soil to a 15 cm height to make the nursery bed
- Flatten and level the top of the bed. It is important to have a well levelled bed because it:
 - o Prevents water from running towards one side of the bed during watering
 - o Manure and fertilizer do not accumulate on one side
 - o Result in non-uniform growth of seedlings
 - o May also result in damping-off of seedlings on the side where water settles because the fungus that causes this disease thrives well in wet conditions

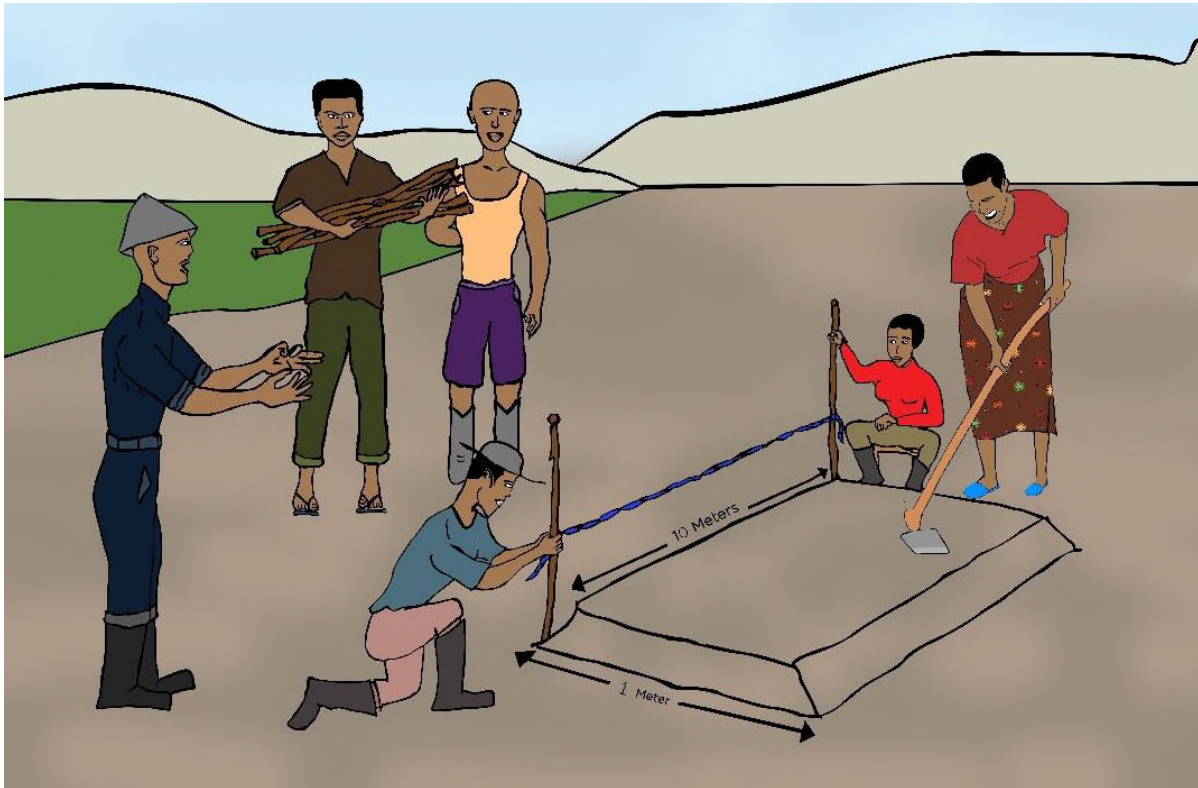


Figure 20: Demonstration on the construction of a vegetable nursery bed

After the bed construction is done, facilitate a demonstration of **manure application** on the bed using the following guide:

- Work into top 15 cm, 10 to 15kgs of well-decomposed manure applied to 1m²
- Evenly broadcast the manure on a nursery bed
- Incorporate the manure in the bed using a rake
- After applying manure, water the bed to activate the growth of weeds and reappearance of other harmful soil pests and soil-borne diseases in preparation for sterilization



Figure 21: Applying manure to a chilli plant

Activity V: Quality assurance and course assessment (20 minutes)



- Use different techniques to assess how the participants understood the lesson. Ensure that this is as participatory as possible. Techniques could be:
 - o Allow participants to state their key take away points and lessons from the session
 - o Provide an opportunity for pairs or individuals to facilitate a recap of the lesson
 - o Ask specific questions from the content of the lesson allowing all participants to take part in responding to the questions

Processing questions

- * What were the main steps in land preparation, making nursery beds and manuring?
- * Which steps were the easiest and most difficult in the practical?
- * What skill stands out for you?

Generalization questions

- * What conclusion would you draw from this practical?
- * Which step if not followed would result in poor vegetable seedling's growth?

Application questions

- * Will you be comfortable making a nursery bed at your farm?
- * What alternatives are there to achieve raising quality vegetable seedlings in the absence of other equipment or materials used in this demo?

Activity VI: Assignment (10 minutes)



- Inform all the participants that each one of them has to prepare the land, make nursery beds and apply manure according to the knowledge and skills gained in this training session
- Explain also that this activity will be inspected before the next training as a means of verifying adherence to standards

Activity VII: Course feedback and planning for the next session (10 minutes)



- Discuss the way forward/upcoming activities with participants:
 - o Date, venue, time, topic of next session and activities to take place before the next meeting
 - o Encourage all participants to prepare, arrive on time and be present for the entire session
- Obtain feedback from participants on the concluded training session
- Close the session by thanking all participants for coming to the training

Topic 3: Sterilizing nursery beds

ITEM	CONTENT
Objective	By the end this topic, farmers are able to sterilize nursery beds for vegetable seedling production
Training materials & tools	Flip charts, markers, masking tapes, flip chart stand, maize stalks or grass, strings, black plastic paper, watering cans, water, pegs, panga knives, hoes, rake and matches
Training duration	150 minutes

Activity I: Group discussion and experience sharing (25 minutes)



- Organize participants into groups of four to six people depending on the number of participants
- Instruct them to brainstorm and share experiences on the reasons and procedure for sterilizing a vegetable nursery bed and vegetable fields
- Advise the participants to write their points clearly on the provided flip charts, which they will present afterwards. At the beginning of their group work, they shall assign a presenter

Activity II: Group presentations (20 minutes)



- Call the participants back for the presentation of their discussion outcomes
- Invite a representative from each group to present what they had discussed during group work
- Allow members from other groups to ask questions or seek clarification from the points raised by the presenting group (members of the group and not necessarily the presenter should respond and/or provide clarification on the questions asked by the participants).

Activity III: Plenary session (20 minutes)



- After listening to presentations from all groups, summarize procedure in sterilization of nursery beds and vegetable fields
- Build your presentation on the points and experiences presented by the participants
- Inform the participants that all details will be addressed further during the practical exercise

INFORMATION SHEET - INCLUDING PRACTICAL EXERCISE

Sterilization of nursery beds

The aim of bed sterilization is to kill pathogens that cause damping-off disease, nematodes, harmful insects, weeds, weed seeds and soil-borne diseases.

Water is used as a heating medium to achieve sterilization while avoiding direct heating which could cause loss of nitrogen and other nutrients in the form of gas.

Procedure

- Apply water on the bed to field capacity
- Heap/pile a stack of dry maize stalks, husks, bush wood or grass to a height of about 1 m on a seedbed
- Set fire to burn the stalks or grass to sterilize the bed

Activity IV: Practical demonstration on sterilizing of nursery beds and chilli production beds (45 minutes)



Facilitate a practical on bed sterilization using the following steps:

- Ask the participants to water the bed to field capacity
- Ask the other group of participants to collect maize stalks or grass enough to sterilize the bed
- Instruct them to pile the maize stalks or grass on the bed to a height of 1 m
- Ensure that the participants completely cover the bed with maize stalks or grass for effective sterilization. After stacking the maize stalks or grass on the bed, ask participants to burn them
- Burn against wind direction to allow slow burning of the grass for effective sterilization



Figure 22: Sterilization burning of maize stalks

Solarisation

This is the method of heating the soil with clear plastic sheets using the sunlight and the solar energy, which radiates into the soil to kill pathogens.

Procedure for solarisation is as follows:

- Cover the beds with clear plastic and
- Seal the edges with soil and
- Leave in direct sunlight for three weeks.

Materials required for solarisation include:

- Clear heavy-duty plastic sheet
- Wheelbarrow
- Hoes and
- Shovel

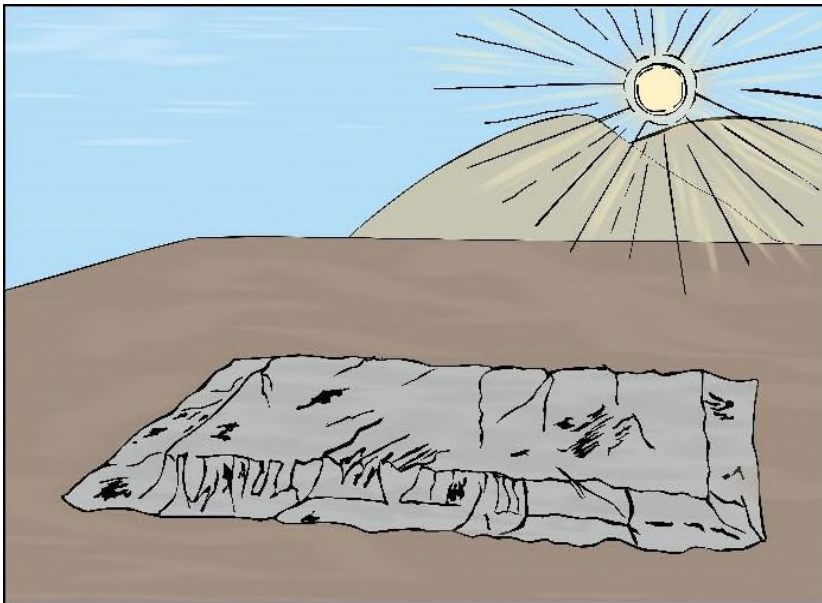


Figure 23: Solar sterilization

Activity V: Quality assurance and course assessment (20 minutes)



- Use different techniques to assess how the participants understood the lesson. Ensure that this is as participatory as possible. Techniques could be:
 - o Allow participants to state their key take away points and lessons from the session
 - o Provide an opportunity for pairs or individuals to facilitate a recap of the lesson
 - o Ask specific questions from the content of the lesson allowing all participants to take part in responding to the questions

Processing questions

- * What were the main steps in sterilizing the beds?
- * Which steps were the easiest and the most difficult in the practical?
- * What skill stands out for you?

Generalization questions

- * What conclusion would you draw from this practical?
- * Which step if not followed would result in poor growth of vegetable seedlings?

Application questions

- * Will you be comfortable sterilizing nursery beds at your farm using the methods discussed in this lesson?
- * What alternatives are there to achieve quality vegetable seedlings in the nursery in the absence of equipment or materials used in this demo?

Activity VI: Assignment (10 minutes)



- Inform all the participants that each one of them will be required to sterilize their nursery beds according to the knowledge and skills gained in this training session
- Explain to all the participants that the sterilized beds will be inspected before the next training

Activity VII: Course feedback and planning for the next session (10 minutes)



- Discuss the way forward/upcoming activities with participants:
 - o Date, venue, time, topic of next session and activities to take place before the next meeting
 - o Encourage all participants to prepare, arrive on time and be present for the entire session
- Obtain feedback from participants on the concluded training session
- Close the session by thanking all participants for coming to the training

Topic 4: Sowing of chilli seeds

ITEM	CONTENT
Objective	By the end of this topic, farmers will be able to sow the chilli seeds for a commercial production
Training materials & tools	Flip charts, markers, masking tapes, flip chart stand, ruler, dibber (a pointed hand tool for sowing seed), water, watering cans and seeds
Training duration	150 minutes

Activity I: Group discussion and experience sharing (20 minutes)



- Organize participants into groups of four to six people depending on the number of participants
- Instruct them to discuss and share experiences on the procedure of sowing chilli seeds in a nursery
- Advise the participants to write their points clearly on the provided flip charts, which they will present afterwards. At the beginning of their group work, they shall assign a presenter

Activity II: Group presentations (20 minutes)



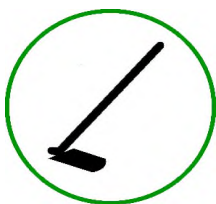
- Call the participants back for the presentation of their discussion outcomes
- Invite a representative from each group to present what they had discussed during group work
- Allow members from other groups to ask questions or seek clarification from the points raised by the presenting group (members of the group and not necessarily the presenter should respond and/or provide clarification on the questions asked by the participants)

Activity III: Plenary session (15 minutes)



- After listening to presentations from all groups, summarize procedure in sowing of seeds in a nursery or gettable fields
- Build your presentation on the points and experiences presented by the participants
- Inform the participants that all details will be addressed further during the practical exercise

Activity IV: Practical on sowing of vegetable seeds (60 minutes)



- Inform the participants that they have the task of sowing seeds on the beds they prepared and sterilized earlier on at least two days after beds have been sterilized in order to allow the beds to cool
- In sowing seeds, participants should follow the procedure described below

INFORMATION SHEET

Sowing chilli seeds

Procedure for sowing chilli and other vegetable seeds:

- Firstly, they must apply water to the seedbeds in order to soften the soil for easy grooving
- They must make grooves of half a fingernail (0.5 cm for smaller seeds and a bit more for bigger seeds) deep and one full hand apart, which is about 15 cm
- They must thinly and uniformly spread the seeds in the furrows
- Let the participants sow seeds as well on a second bed using the broadcasting technique. In this technique, the seeds are spread thinly and evenly on the bed without following any proper pattern. When small seeds are sown, the farmers should mix the seeds with sand to facilitate even distribution of the seeds on the bed

After sowing seeds:

- They must cover the seeds lightly with sand to enhance germination
- They must immediately mulch the seedbeds with grass to keep them moist and keep the beds cool on hot days. The participants must ensure that the grass they use for mulching is free from seeds, diseases and insects
- The mulch should be spread evenly and ensure that all bed shoulders are covered properly
- The participants should make sure that half of the mulch is removed as soon as most of the seedlings have germinated
- As grass mulch can attract white ants (termites), the participants must regularly check the mulch
- After mulching beds, they must irrigate the bed



Figure 24: A dibber used for seed sowing



Note

The trainer must emphasize to the participants that mulching and watering are crucial nursery management activities, which start immediately after sowing.

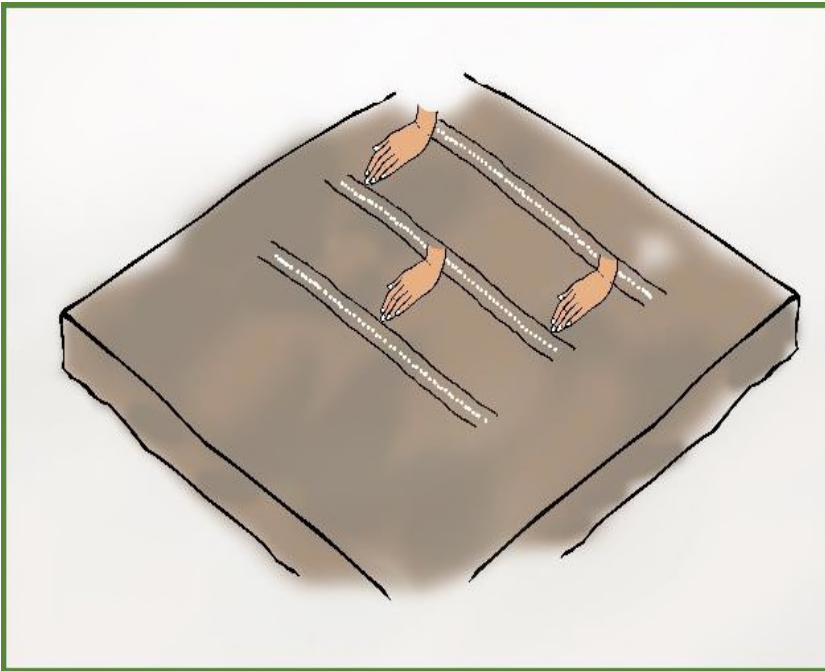


Figure 25: Sowing grooves made one full hand apart



Figure 26: Mulching and watering soon after sowing

Activity V: Quality assurance and course assessment (15 minutes)



- Use different techniques to assess how the participants understood the lesson. Ensure that this is as participatory as possible. Techniques could be:
 - o Allow participants to state their key take away points and lessons from the session
 - o Provide an opportunity for pairs or individuals to facilitate a recap of the lesson
 - o Ask specific questions from the content of the lesson allowing all participants to take part in responding to the questions

Processing questions

- * What were the main steps and considerations in the sowing of seeds?
- * Which were the easiest and the most difficult steps in the practical?

Generalization questions

- * What conclusion would you draw from this practical?
- * Which step if not followed would result in poor chilli seedling growth?

Application questions

- * Will you be comfortable sow chilli seeds at your farm?
- * What alternatives are there to achieve a good chillies nursery crop in the absence of equipment or materials used in this demo?

Activity VI: Assignment (10 minutes)



- Inform the participants will need to go and sow seeds in their nursery beds according to the knowledge and skills gained during the training
- The trainer should make it clear to all the farmers that their sowing work will be inspected before the next training
- Emphasize on all the crucial steps in seed sowing discussed in the session (half finger deep grooves, grooves spaced at one full hand apart, thinly spreading seed, covering with sand after sowing, mulching and watering)

Activity VII: Course feedback and planning for the next session (10 minutes)



- Discuss the way forward/upcoming activities with participants:
 - o Date, venue, time, topic of next session and activities to take place before the next meeting
 - o Encourage all participants to prepare, arrive on time and be present for the entire session
- Obtain feedback from participants on the concluded training session
- Close the session by thanking all participants for coming to the training

MODULE 4: NURSERY MANAGEMENT

Topic 1: Mulching, weeding and water management

ITEM	CONTENT
Objective	By the end of this topic, farmers will be able to mulch, weed and manage effective water regimes on a chilli nursery
Training materials & tools	Flip charts, markers, masking tapes, flip chart stand, panga, sticks, grass, water and watering cans, prepared nursery beds
Training duration	150 minutes

Activity I: Group discussion (20 minutes)



- Organize participants into groups of four to six people depending on the number of participants
- Instruct them to discuss and share experiences on the following practices in the nursery:
 - o Procedure and importance of mulching on a nursery bed
 - o Methods/procedure of watering in the nursery
 - o Common weeds in a nursery
 - o Weed control methods in the nursery that are currently being used by the farmers
- Advise the participants to write their points clearly on the provided flip charts, which they will present afterwards. At the beginning of their group work, they shall assign a presenter

Activity II: Group presentations & feedback (25 minutes)



- Invite the participants back for the presentation of their discussion outcomes
- Invite a representative from each group to present what they had discussed during group work
- Allow members from other groups to ask questions or seek clarification from the points raised by the presenting group (members of the group and not necessarily the presenter should respond and/or provide clarification on the questions asked by the participants)

Activity III: Plenary session (25 minutes)



- After listening to presentations from all the groups, facilitate a plenary discussion on the importance of mulching, watering, erection procedure and importance of a raised mulch
- Build your presentation on the points and experiences presented by the participants
- Inform the participants that all details will be addressed further during the practical exercise

INFORMATION SHEET

Mulching

Advantages of mulching

- Support the soil structure
- Protects the soil surface from rain or overhead irrigation and so prevents capping
- Reduces compaction because there is a cushioning effect and as such, any weight is spread over a large area
- Adds organic matter, which is eventually mixed with the soil and forms humus and releases nutrients
- Reduces direct evaporation and therefore the soil is moister under mulch. This is especially important in establishing fruit trees
- Smothers or prevents weed growth so that there is no competition for water and nutrients
- Reduces likelihood of soil erosion by preventing capping
- Mulching affects soil temperature because it acts as an insulating layer and is therefore reducing daily fluctuation

When explaining the importance of erecting a raised mulch, the following points must be emphasized:

- To help conserve/retain moisture for germination of seeds not yet germinated
- To provide protection to the young seedlings during very hot weather periods. Young seedlings would easily wilt and die
- To prevent breakage of seedling due to water force during irrigation

This means that a raised mulch would protect the young seedlings even in rather cool weather.

Ensure that the raised mulch is very light and allows sunlight to penetrate. Your young seedlings need light as well



Figure 27: Mulching and watering

Weeding

Weeding is performed to:

- Eliminate competition for space, water, light and nutrients between plants and weeds
- Weeding therefore promotes seedling growth
- Make the bed and the surroundings clean, free of pests, rodents and diseases that could attack and destroy seedlings
- Ease operations like pulling seedlings for transplanting which would have otherwise been interfered by weeds
- Avoids bush fire, which would destroy the seedlings

Procedure for weeding in the nursery

- Pull weeds out from the nursery beds by hand
- Avoid pulling together with seedlings
- Light hoeing can also be done around the nursery area
- Slash the surrounding area

Water management

Advantages of watering

- Water is a media for transporting plant nutrients
- It improves plant quality
- It increases chilli yield
- It determines the bearing time



Figure 28: Watering seedlings on a raised mulch

Enlighten the participants that overwatering the plants in the nursery may cause damping-off disease!

- Too much watering will also cause the growth of tall and weak seedlings while too little water will make seedlings grow too slow and be stunted
- Use watering cans with a fine shower rose and make sure that seedbeds are evenly watered
- Frequently scratch the soil surface to break the hard pan

The following watering schedule can be followed up at and after the time of sowing into the nursery seedbed:

- From seeding, to complete germination (eight to fourteen days) lightly water the seedbeds three times a day
- In week 3, water the seedbeds once a day
- In week 4, water the seedbed one time every three days
- In weeks 5 to 6, water only when seedlings show signs of wilting. This is called hardening off of the seedlings

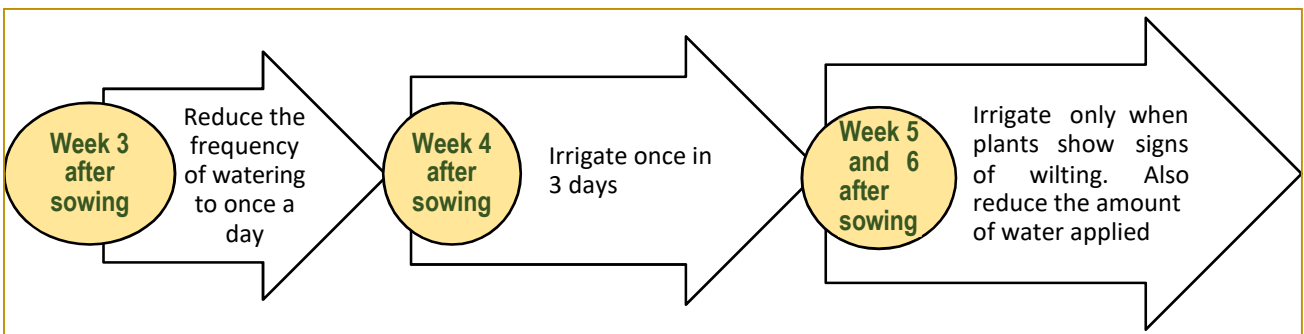


Figure 29: Illustrating hardening off process of the seedlings on a nursery bed

Activity IV: Practical on mulching, weeding and watering (45 minutes)



- Facilitate a demonstration on mounting a raised mulch. This can be done at the usual demo plot or at one of the participants' nurseries
- Ensure that all participants are involved during the practical and follow the given procedures

Suggested procedure

- o Ask the participants to collect supporting sticks between 25-40 mm in diameter (the trainer can arrange to bring these in advance in order to save time)
- o Fix these around the bed at a height of 30 to 45 cm and place cross-sticks to support the mulch
- o Spread the mulch thinly over the raised platform, leaving some space for sunlight to penetrate. Remember that these small seedlings need light
- o Use a watering can to apply water after checking the moisture content
- o A few days after weeds begin to emerge, bring back the farmers and demonstrate weeding on the nursery bed

Activity V: Quality assurance and course assessment (15 minutes)



- Use different techniques to assess how the participants understood the lesson. Ensure that this is as participatory as possible. Techniques could be:
 - o Allow participants to state their key take away points and lessons from the session
 - o Provide an opportunity for pairs or individuals to facilitate a recap of the lesson
 - o Ask specific questions from the content of the lesson allowing all participants to take part in responding to questions

Activity VI: Assignment (10 minutes)



- Ask participants to construct a raised mulch and implement a watering schedule on their nursery beds according to the knowledge and skills gained during this training once the seedlings have emerged
- Explain to all the participants that their nursery beds will be inspected during the next training
- Emphasize on the reasons for constructing a raised mulch and decision making on watering frequency

Activity VII: Feedback and planning for the next session (10 minutes)



- Discuss the way forward/upcoming activities with participants:
 - o Date, venue, time, topic of next session and activities to take place before the next meeting
 - o Encourage all participants to prepare, arrive on time and be present for the entire session
- Obtain feedback from participants on the concluded training session
- Close the session by thanking all participants for coming to the training

Topic 2: Pest and disease management in the nursery

ITEM	CONTENT
Objectives	By the end of this topic participants will be able to: <ul style="list-style-type: none"> - Identify pests and diseases - Apply the most effective control measures
Training materials & tools	Flip charts, markers, masking tapes, flip chart stand, knapsack sprayer and pesticides
Training duration	180 minutes

Activity I: Group discussion (20 minutes)



- Organize participants into smaller groups of four to six people depending on the number of participants
- Instruct the participants to brainstorm and share experiences about:
 - o Common pests and diseases in the chilli nursery
 - o Pest and diseases control methods in the nursery that are currently being used by farmers
- Advise the participants to write their points clearly on the provided flip charts, which they will present afterwards. At the beginning of their group work, they shall assign a presenter

Activity II: Group presentations & feedback (25 minutes)



- Call the participants back for the presentation of their discussion outcomes
- Invite a representative from each group to present what they had discussed during group work
- Allow members from other groups to ask questions or seek clarification from the points raised by the presenting group (members of the group and not necessarily the presenter should respond and/or provide clarification on the questions asked by the participants)

Activity III: Plenary session (30 minutes)



- After listening to presentations from all the groups, facilitate a plenary discussion on pest and disease control in chilli nurseries
- Build your presentation on the points and experiences presented by the participants
- Inform the participants that all details will be addressed further during the practical exercise

INFORMATION SHEET

Scheduled scouting is an effective way to monitor pest and disease attacks in the nursery and determine an effective way of control.

Scouting means systematic checking of pest and disease occurrence either in the nursery or in the field. It also involves careful study of the levels and types of damage caused in order to determine when and how to control them.



Figure 30: Scouting for pests and diseases

Table 3: Pest and disease scouting sheet for chilli nursery and fields

NAME OF MONITOR/SCOUTER _____						
DATE	BLOCK NUMBER	ROW NUMBER	PLANT NUMBER	PEST NAME	NUMBER OF THIS PEST OBSERVED	GENERAL INFORMATION OR NOTES
EXAMPLE 16/03/2022	2	1	15 from right	Mealy bug	Too many to count	A lot of ants visible to the eye, but no mealy bug

IMPORTANT NOTE:

Chemical application should be the last resolution to control pests and diseases after the common controls have been exhausted. These include:

- Nursery hygiene and soil sterilization
- Starting with clean and healthy seeds
- Correct irrigation levels
- Proper site selection
- Use of predators
- Crop rotation

When chemicals are to be used, the correct type, concentration and application methods have to be employed. Source the chemicals from a reputable agro-dealer e.g. Agwenda.

Please also refer to module 5 for further information on chemical use.

Proper mixing of pesticides

- Before mixing, test the sprayer with water to see if it leaks and is working properly
- Read the label to determine the proper mixture
- Wear PPE while mixing pesticides
- Mix in a grassy area. Do not mix on concrete or hard surfaces
- Only use water unless directed by the label to use another liquid
- Fill the sprayer with two-thirds of the water needed. Then add the proper amount of pesticide. Then add the remaining one-third of water
- Mix only the amount necessary to do the job



Figure 31: Incorrect way of mixing chemicals



Figure 32: The right way of mixing chemicals

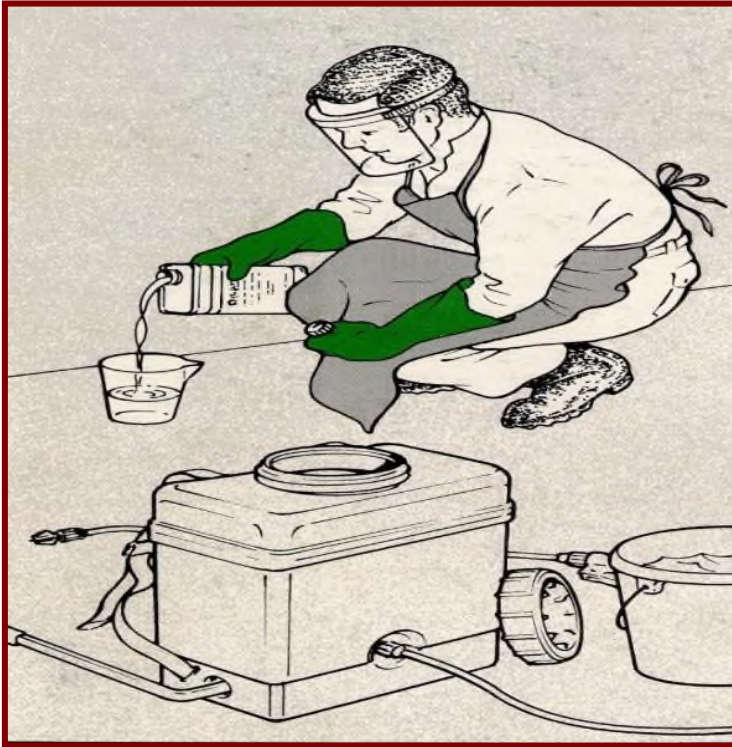


Figure 33: Wear PPE while mixing

Neem leaves can be used as alternatives to chemicals for the control of pests like cutworms and thrips.

Using neem leaves



Figure 34: Neem leaves

What are neem leaves used for?

Neem leaves contains a high concentration of the active ingredient Azadiractrin that repels and kill many common pests. Because of its ability to affect many types of bugs, neem is considered a medium to broad-spectrum pesticide.

Neem also works well as a miticide (acting against mites) and fungicide such as Powderly mildew. Whilst it is used to combat already-infected plants, neem is safe and effective to use as a preventive measure too.

How does neem work?

Neem works in many ways, making it effective against several pests.

1. In small sucking insects such as spider mites, aphids and white flies, neem restricts breathing by forming a layer of oil on breathing pores.
2. The oil coats, softens and dissolve the exoskeletons of some pests causing desiccation and death
3. The active ingredient in neem interferes with several physiological processes such as:
 - Preventing larvae from maturing. This helps to control population growth
 - Feeding and mating behaviour

How to prepare a neem pesticide?

To use neem leaves on your infected plants:

- Pluck neem leaves and pound them in a mortar while still fresh



Figure 35: Fresh pounded neem leaves

- Soak the leaves in water mixed with soap (preferably soap made from vegetable oil) and leave it to stand overnight (other ingredients such as chilli powder can be added). Soap helps the oil in the leaves to mix well with the water and stop it from floating (apply half handful in a 20litres bucket)



Figure 36: Pounded neem leaves soaked in a bowl



Figure 37: Example of powder soap to add to neem

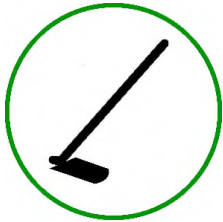
- When working with neem, put on garden gloves. This is because neem oil may cause an allergic reaction in some people.



Figure 38: Examples of garden gloves to be worn when working with neem

- Shake before using/spraying, as neem oil may separate from its mix
- Spray affected plant stems and leaves thoroughly until the solution drips from the leaves. This includes the undersides of the leaves where pests may hide
- Reapply once a week until pests are eliminated. (Note that it may take some time for pests to reduce in numbers visibly)
- For severe cases, also use the same mixture as a soil drench

Activity IV: Practical on pest and disease management (60 minutes)



- The demo practical on pest and disease control will take many forms including scouting (checking), pest and disease identification, deciding on chemical application and applying the chemicals to the seedlings to control available pests and diseases
- To ensure the effectiveness of this exercise, the trainer should visit the farmers' nurseries and choose a training site where pests and diseases are present

Facilitate a demo practical using the following procedure

- Building on the experience shared by the participants, identify the major chilli nursery pests like aphids, cutworms, caterpillars and the major diseases as damping-off
 - o During preparation for the training, prepare clear pictures of the pests and diseases so that participants can appreciate them. This will enhance their skill of identification of pests and diseases in the field
 - o This skill of identification will be practiced during the demo practical
- Instruct the participants to line up along the nursery bed and identify any pests and diseases that they are able to see on the bed
- Instruct them to collect all the pests aside for easy identification and do the same with diseases in case they have attacked the leaves
- Instruct the participants to use the knowledge from the plenary session and their own presentations to identify the pests and diseases, the damage they cause and the most appropriate ways of controlling them
- Let them document this and share it with other members
- After this is done and the best way identified is a chemical application, demonstrate the most appropriate way of spraying chemicals in the field
 - o Putting on of PPE, calibrating the sprayer, diluting the chemicals, filling the chemicals into the sprayer and spraying not against the wind
- After the demonstration, allow the participants to practice

Activity V: Quality assurance and course assessment (20 minutes)



- Use different to assess how the participants understood the lesson. Ensure that this is as participatory as possible. Techniques could be:
 - o Allow participants to state their key take away points and lessons from the session
 - o Provide an opportunity for pairs or individuals to facilitate a recap of the lesson
 - o Ask specific questions from the content of the lesson allowing all participants to take part in responding

Processing questions

- * What were the main steps/activities and considerations in the pest and disease management program for the nursery?
- * Which were the easiest and the most difficult steps in the practical?
- * What skill stands out for you?

Generalization questions

- * What conclusion would you draw from this practical?
- * Which step if not followed would result in poor chilli seedling growth?

Application questions

- * Will you be comfortable drawing up a pest and disease control program at your farm?
- * What alternatives are there to achieve a good chillies nursery crop in the absence of other equipment or materials used in this demo?

Activity VI: Assignment (10 minutes)



- Ask participants to inspect their nurseries and implement a pest and disease management program utilizing the knowledge and skills gained during this training
- The trainer should make it clear to all the farmers that their nurseries will be inspected before the next training

Activity VII: Feedback and planning for the next session (10 minutes)



- Discuss the way forward/upcoming activities with participants:
 - o Date, venue, time, topic of next session and activities to take place before the next meeting
 - o Encourage all participants to prepare, arrive on time and be present for the entire session
- Obtain feedback from participants on the concluded training session
- Close the session by thanking all participants for coming to the training

MODULE 5: TRANSPLANTING AND IRRIGATION OF CHILLI SEEDLINGS

ITEM	CONTENT
Objective	By the end of this topic participants will be able to transplant and irrigate chilli seedlings correctly
Training materials & tools	Flip charts, markers, masking tapes, flip chart stand, hand forks or trowels, hoes, baskets, empty sacks and seedlings in the nursery
Training duration	120 minutes

Activity I: Group discussion (20 minutes)



- Organize the participants into groups of four to six people depending on the number of participants
- Instruct them to brainstorm and share experiences on the procedures used to transplant chilli seedlings:
 - o What preparations need to be made before transplanting the seedlings?
 - o What is the correct spacing for chilli seedlings?
 - o What is the best time to transplant the seedlings?
 - o How to handle the seedlings when transplanting
 - o Irrigation decision making after transplanting
 - o Methods and procedure for irrigation for transplanted seedlings
- Advise the participants to write their points clearly on the provided flip charts, which they will present afterwards. At the beginning of their group work, they shall assign a presenter

Tip for the trainer

During this discussion, tell the participants that they can apply knowledge from transplanting other crops, like transplanting cabbage seedlings.

Activity II: Group presentations & feedback (25 minutes)



- Call the participants back for the presentation of their discussion outcomes
- Invite a representative from each group to present what they had discussed during group work
- Allow members from other groups to ask questions or seek clarification from the points raised by the presenting group (members of the group and not necessarily the presenter should respond and/or provide clarification on the questions asked by the participants)

Activity III: Plenary session (15 minutes)



- After listening to presentations from all groups, summarize best practices on establishment and management practices of a vegetable field
- Build your presentation on the points and experiences presented
- Inform the participants that all details will be addressed further during the practical exercise

INFORMATION SHEET

Transplanting seedlings

- Seedlings are ready for transplanting when they are 5–6 weeks old and approximately 15 cm high
- The night before transplanting, water seedbeds
- Carefully lift the seedlings from the nursery bed and keep as much soil around the root system as possible
- When lifting the seedling make sure, you go as deep as possible to avoid damaging the roots. This can be achieved by using a hand fork
- Transplanting must be done at the beginning of the rainy season to give seedlings a good start
- Transplant seedlings when temperatures are low usually on a cloudy or rainy day or in the late afternoon or early in the morning
- Loosen up the soil on the bed using a fork or a hoe
- The planting depth must be the same (at collar mark) as it was lifted out of the seedbed
- Sort the seedlings according to size and ensure that seedlings of the same size are planted in the same ridges
- Avoid bending the roots during transplanting
- Seedlings must be watered immediately after transplanting
- Transplant only clean, straight healthy plants with long internodes
- Discard weak seedlings or those that are chlorotic and those with twisted roots
- Chillies are transplanted at a spacing (in-row) of two full feet or 30 to 60 cm
- Manure can be applied on the planting station before transplanting of seedlings
- Fertilizers can be applied a week or two weeks after planting

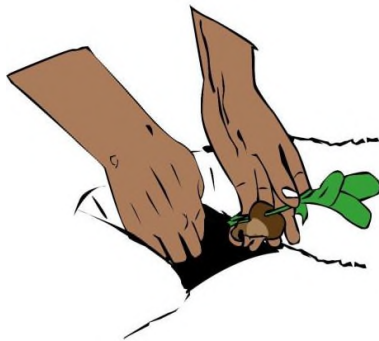


Figure 39: Transplanting chilli seedlings

Watering of young chilli plants

Importance of water

- Water is a media for transporting plant nutrients
- It improves plant quality
- It increases chilli yield
- It determines the bearing time

Watering of chillies

- Chillies must be watered regularly, at least once a week depending on the weather
- Areas that receive below 600 mm of rain per year needs supplementary irrigation
- Three weeks after planting, water plants daily if there are no rains
- Reduce watering schedule to two to three days per week, but this will depend on the weather
- Five to six mm of water is sufficient for the chilli plants
- Dry conditions result in premature small sized fruit set which can lead to low yield
- Heavy rainfall results in poor fruit set and rotting of the fruits
- Avoid over-watering because this may lead to plants being susceptible to diseases
- Any water stress during flowering may result in blossoms and immature fruit drop off

Note

Farmers can also construct swalleys, box ridges, basins or contour ridges for water harvest and also practice conservation agriculture.



Figure 40: Practicing conservation agriculture through the planting of vetiver and covering the soil using maize stalks



Figure 41: A constructed and maintained swalley for conserving water



Figure 42: Ridges constructed on contour lines to control water movement

Activity IV: Practical on transplanting and irrigation (40 minutes)



- Facilitate a practical on transplanting and irrigation of young chilli plants allowing the participants to apply the knowledge gained during the session
- Observe how the participants will prick out the seedlings, carry them to the transplanting field, select them and finally plant and water them
- Ensure that all participants are involved during the practical and follow the given procedures

Facilitate a demo practical using the following procedure

- o Divide the participants into teams according to activities i.e. pricking out, watering, seedling sorting, planting station marking, planting and irrigation
- o Explain clearly the role of each team and what they will need to follow according to the information provided during the plenary session
- o Instruct the teams to start the operation beginning with the team that will do the watering of the nursery bed
- o Throughout the exercise, continue to walk around to check and ensure that participants are following the correct procedures

Activity V: Quality assurance and course assessment (10 minutes)



- Use techniques to assess how the participants understood the lesson
Ensure that this is as participatory as possible. Techniques could be:
 - o Allow participants to state their key take away points and lessons from the session
 - o Provide an opportunity for pairs or individuals to facilitate a recap of the lesson
 - o Ask specific questions from the content of the lesson allowing all participants to take part in responding to the questions

Processing questions

- * What were the main steps/activities and considerations in transplanting and irrigation of young chilli seedlings from the nursery?
- * Which were the easiest and the most difficult steps in the practical?
- * What skill stands out for you?

Generalization questions

- * What conclusion would you draw from this practical?
- * Which step if not followed would result in poor chilli seedling growth?

Application questions

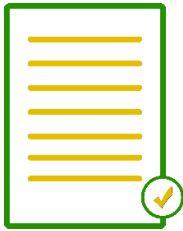
- * Will you be comfortable transplanting seedlings correctly at your farm?
- * What were the main steps/activities and considerations in applying water to the plants?
- * What alternatives are there to achieve a good chillies nursery crop in the absence of other equipment or materials used in this demo?
- * How can the skills gained in this practical be applied in the production of other crops?

Activity VI: Assignment (10 minutes)



- Ask participants to go to their fields and utilize the knowledge and skills gained during this training.
- Explain to all the participants that the sterilized beds will be inspected before the next training

Activity VII: Planning for the next session (10 minutes)



- Discuss the way forward/upcoming activities with participants:
 - o Date, venue, time, topic of next session and activities to take place before the next meeting
 - o Encourage all participants to prepare, arrive on time and be present for the entire session
- Obtain feedback from participants on the concluded training session
- Close the session by thanking all participants for coming to the training

MODULE 6: FIELD MANAGEMENT

Weeding and manure/fertilizer application

ITEM	CONTENT
Objective	By the end of this topic participants will be able to weed and correctly apply manure/fertilizer in a chilli field
Training materials & tools	Flip charts, markers, masking tapes, flip chart stand and hoes, demonstration plot
Training duration	120 minutes

Activity I: Group discussion (20 minutes)



- Organize participants into groups of four to six people depending on the number of participants
- Instruct them to brainstorm and share experiences on weeding and manure/fertilizer application in a chilli field
- Advise the participants to write their points clearly on the provided flip charts, which they will present afterwards. At the beginning of their group work, they shall assign a presenter

Activity II: Group presentations & feedback (20 minutes)



- Call the participants back for the presentation of their discussion outcomes
- Invite a representative from each group to present what they had discussed during group work
- Allow members from other groups to ask questions or seek clarification from the points raised by the presenting group (members of the group and not necessarily the presenter should respond and/or provide clarification on the questions asked by the participants)

Activity III: Plenary session (15 minutes)



- After listening to presentations from all groups, summarize best weeding practices in a vegetable field
- Build your presentation on the points and experiences presented by the participants
- Inform the participants that all details will be addressed further during the practical exercise

INFORMATION SHEET

The key management practices after successful transplanting of chilli seedlings include the following:

- Weeding
- Mulching
- Fertilizer application, watering
- Pest and disease control
- Staking and
- Fruit thinning

Weeding in the field

Weeding in the field is done to:

- Eliminate competition of space, water, light and nutrients between the chilli plants and the weeds
- Promote the healthy growth of the chilli plants in the production field
- Keep the field clean, free of pests, rodents and diseases that could attack and weaken the chilli plants

Procedure for weeding

1. Physical/mechanical weeding

This includes hand weeding, hoeing, mulching and slashing. Hoeing is the most commonly method used in weeding chilli fields. Avoid damaging roots when hoeing. Mulching will suppress weeds and therefore reduce the need for cultivation.

2. Chemical weeding

The use of herbicides is not so common in chilli production, but it is the most effective method, which can be used. However, herbicides are very expensive. The three types of basic weed killers are contact, translocated and residual. Commonly used herbicides are glyphosate and paraquat.

Farmers should weed as many times as weeds continue emerging in the field.



Figure 43: Hoe weeding in chilli field



Figure 44: Weeding with a bush knife

Manure/fertilizer application Importance of manure:

- Improves soil structure
- Maintains good soil condition
- Improves the water holding capacity of the soil
- Supplies plant nutrients including the trace elements

Note that the common types of manure are compost, farmyard manure, animal manure and green compost.



Figure 45: A heap of compost manure



Figure 46: Farmyard manure



Figure 47: Animal manure



Figure 48: Green composting



Figure 49: Application of manure

Importance of fertilizers

- Promote optimal growth of chilli plants
- Increase yield and enhances the quality chilli fruits
- Improve soil fertility and add trace elements
- Ensures sustainable production of chillies

The commonly used fertilizers in chillies are Calcium Ammonium Nitrate (CAN) and urea.



Figure 50: Demonstrating fertilizer application in a tomato field

- Emphasize that a good soil nutrition program is essential for an increased and quality chilli production
- Soil nutrition affects growth vigour, flowering and fruit set, pod size and good colour of the pods during ripening
- Both manure and synthetic fertilizers are important in the production process of chillies.

Provide a general soil nutrition guide for the chillies as follows:

- Apply manure at 25 tons per hectare or two handful (equivalent to 250 grams) per planting station before transplanting
- In addition to the manure, apply 75 kg per hectare of CAN two weeks after transplanting at 10 cm away from seedlings
- Make a second application of CAN at 75 kg/ha when flowers first appear
- In the ratoon crop, make the first application of CAN at the beginning of rains
- If soil tests indicate the need for P, K & S apply P at 110 to 170 kg P₂O₅/ha, Potassium at 110 to 170 kg K₂O/ha, and Sulphur at 17 to 22 kg/ha

Activity IV: Practical on weeding and manure/fertilizer application (40 minutes)



- If there are weeds in the demonstration plot, bring the participants together to identify the weeds and carefully remove them all
- Later on, facilitate a practical on manure/fertilizer application allowing all participants to participate in the practical
- Ensure that all participants are involved during the practical and follow the given procedures
- If the weeds are not available, participants will use the knowledge gained in this session to carry out effective weeding at their own chilli fields

Activity V: Quality assurance and course assessment (10 minutes)



- Use different techniques to assess how the participants understood the lesson. Ensure that this is as participatory as possible. Techniques could be:
 - o Allow participants to state their key take away points and lessons from the session
 - o Provide an opportunity for pairs or individuals to facilitate a recap of the lesson
 - o Ask specific questions from the content of the lesson allowing all participants to take part in responding to the questions

Activity VI: Assignment (10 minutes)



- Ask participants to inspect their fields for any weeds and implement a weeding program immediately utilizing the knowledge and skills gained during this training
- The trainer should make it clear to all the participants that their fields will be inspected before the next training
- Emphasize that weeding will have to be done as many times as weeds appear in the field

Activity VII: Feedback and planning for the next session (10 minutes)



- Discuss the way forward/upcoming activities with participants:
 - o Date, venue, time, topic of next session and activities to take place before the next meeting
 - o Encourage all participants to prepare, arrive on time and be present for the entire session
- Obtain feedback from participants on the concluded training session
- Close the session by thanking all participants for coming to the training up visits to check the management of weeds in each of the selected farmers' fields (all of them if possible)

MODULE 7: PEST AND DISEASE MANAGEMENT

Topic 1: Scouting of insect pests and diseases in vegetable field

ITEM	CONTENT
Objectives	By the end of this topic, farmers will be able to: <ul style="list-style-type: none"> - Identify various methods of scouting for insect pests and diseases - Carry out scouting for pests and diseases in their vegetable production
Training materials	Flip charts, markers, masking tapes, flip chart stand and ballpoint pens note books, data sheet, magnifying lens, PPE, Insect sticky traps, pheromones
Training duration	150 minutes

Activity I: Group discussion and experience sharing (25 minutes)



- Organize participants into smaller groups of four to six people depending on the number of participants
- Instruct the participants to brainstorm on different methods of scouting for pests and diseases in chilli fields (encourage the participants to use as much personal experience as possible)
- Advise the participants to write their points clearly on the provided flip charts, which they will present afterwards. At the beginning of their group work, they shall assign a presenter

Activity II: Group presentations (25 minutes)



- Call the participants back for the presentation of their discussion outcomes
- Invite a representative from each group to present what they had discussed during group work
- Allow members from other groups to ask questions or seek clarification from the points raised by the presenting group (members of the group and not necessarily the presenter should respond and/or provide clarification on the questions asked by the participants)

Activity III: Plenary session (30 minutes)



- After listening to presentations from all groups, summarize most common pests and diseases and scouting activities
- Build your presentation on the points and experiences presented by the participants
- Inform the participants that all details will be addressed further during the practical exercise

INFORMATION SHEET

Scouting for insect pests and diseases

Scouting is a physical check for the presence of insect pest and diseases in a vegetable nursery and field.

Scouting helps a farmer to make appropriate decision on the best control measure for pest or diseases. It is an effective system of insect and disease identification in order to effectively monitor and control both insect pests and diseases.

Procedure of scouting



Figure 51: Demonstration scouting in an okra field

Strategically divide the vegetable gardens using any of the following methods:

1. Scouting diagonally (X) assuming the field is square or rectangle.
2. Scouting following W.
3. Scouting following Y.
4. Zigzag scouting: one walks in a zigzag way going across the field while checking and taking note of the presence of pest and disease.
5. Random scouting: one selects beds randomly (20% of the shed) and check for the presence of pests or diseases and record on the checklist.

Activity IV: Practical on scouting (60 minutes)



- Facilitate a practical on scouting allowing the participants to apply the knowledge and skills gained from the session above.
- Observe how the participants carry out the activities and the recording.
- Offer any guidance throughout the practical to ensure that the participants are doing the right thing.

Activity V: Quality assurance and course assessment (10 minutes)



- Use different techniques to assess how the participants understood the lesson. Ensure that this is as participatory as possible. Techniques could be:
 - o Allow participants to state their key take away points and lessons from the session
 - o Provide an opportunity for pairs or individuals to facilitate a recap of the lesson
 - o Ask specific questions from the content of the lesson allowing all participants to take part in responding to the questions

Activity VI: Course feedback and planning for the next session (10 minutes)



- Discuss the way forward/upcoming activities with participants:
 - o Date, venue, time, topic of next session and activities to take place before the next meeting
 - o Encourage all participants to prepare, arrive on time and be present for the entire session
- Obtain feedback from participants on the concluded training session
- Close the session by thanking all participants for coming to the training

Topic 2: Integrated pest and disease management (IPM)

ITEM	CONTENT
Objectives	By the end of this topic, farmers will be able to: <ol style="list-style-type: none"> 1. Identify integrated pest and disease management practices and applications in chilli production in Malawi 2. Implement an effective integrated pest and disease management program in their commercial chilli production
Training materials	Flip charts, markers, masking tapes, flip chart stand and ballpoint pens notebooks
Training duration	135 minutes

Activity I: Group discussion and experience sharing (20 minutes)



- Organize participants into smaller groups of four to six people depending on the number of participants
- Instruct the participants to brainstorm on integrated pest management as a way of controlling pests and diseases (encourage the participants to use as much personal experience as possible)
- Advise the participants to write their points clearly on the provided flip charts, which they will present afterwards. At the beginning of their group work, they shall assign a presenter

Activity II: Group presentations (20 minutes)



- Call the participants back for the presentation of their discussion outcomes
- Invite a representative from each group to present what they had discussed during group work
- Allow members from other groups to ask questions or seek clarification from the points raised by the presenting group (members of the group and not necessarily the presenter should respond and/or provide clarification on the questions asked by the participants)

Activity III: Plenary session (25 minutes)



- After listening to the presentations from all the groups, facilitate a plenary session on IPM
- Build your presentation on the points and experiences presented by the participants
- Inform the participants that all details will be addressed further during the practical exercise

INFORMATION SHEET

Integrated pest management (IPM)

- Integrated Pest Management (IPM) is the use of all available pest control tactics in the design of a program to manage but not eradicate pest populations, so that economic damage and harmful side effects are avoided
- The cornerstone of an IPM program is the use of economic injury levels and pest monitoring as a basis for the judicious application of pesticides or other control tactics
- It is in contrast to the prophylactic or calendar spray approach where pesticides are applied routinely (or haphazardly), irrespective of pest levels
- IPM program does not eliminate the use of pesticides but reduces sole reliance on them
- It is a decision-making process to determine if, when, where and what strategy and mix of tactics should be used
- The basic requirements for developing IPM include an understanding of the biology and ecology of the key pests, economic information about the crop, pest damage and control measures, and the availability of environmentally acceptable control strategies
- This requires the inspection of each vegetable field on a regular basis (usually weekly) year in and year out

IPM programs combine management approaches for greater effectiveness. The most effective, long-term way to manage pests and diseases is by using a combination of methods that work better together than separately

Approaches for managing pests and diseases in IPM program are often as follows:

Seed sources

Buy seeds from reputable source, which are free from seed borne diseases. Use resistant varieties

- Use varieties that are known to be tolerant or resistant to insect pests and diseases. For example: Sugar loaf cabbage variety is resistant to black rot
- Sterilize seedbeds soil
- Sterilize the seedbeds soil in which you are going to raise your seedlings
- Transplant only pest and disease-free seedlings
- Be sure that the seedling being transplanted are healthy and free from pests and diseases
- Do not overcrowd plants
- Close planting causes the air beneath the leaves to stay wet. This encourages fungal diseases, especially damping off
- Space the plants so that air can move between them
- Plant into soil that drains well
- Diseases such as damping off and root rot occur in soils that do not drain well. Plant your vegetables in deep, well -drained soil. Organic matter and mulch will help the soil to drain quickly
- Keep the plants healthy. Healthy plants normally withstand pests and diseases better than weak plants. Grow your vegetables in fertile soil, water them regularly and mulch them to keep the soil moist

Check plants for pests or diseases

Disease and pest surveillance should be a routine exercise. Control pests and diseases as soon as you notice them. Remove and bury all plants that show signs of viral infections that you cannot control. This stops vectors from carrying the disease to healthy plants



Figure 52: Burying infected plants

Encourage the natural enemies of pests



Many insects eat plant-eating insects. These insect eating other insects called 'natural enemies' help to keep pest numbers down. You should encourage these natural enemies of pests by not spraying with chemical pesticides. Examples of insects that eat pest insects are ladybird beetles and larvae, praying mantises, spiders, wasps and some fly larvae. Some wasps lay their eggs into the larvae of pest insects.

Use clean tools



Figure 54: Disinfecting tools using methylated spirit (95%)

Tools can carry diseases from sick to healthy plants. If you handle tools such as knives used on diseased plants, clean them before using them on healthy plants. Dip the tools into a disinfectant (a liquid that kills microorganisms) such as household bleach (Jik or Javel), 95% methylated spirit, and vinegar or Jeyes fluid. You can keep a mixture of the disinfectant and water in a closed container for cleaning your tools.



Figure 55: Control of aphids

Use pest control methods to control the vectors of viral diseases. Viral diseases cannot be cured. Dig up and bury any plants that have a viral disease to stop vectors from spreading the disease. Remove all alternative hosts from around the nursery and the field.

Mechanically or physically remove pests off the plants



Figure 56: Physical control of pests

Pick large pests such as grasshoppers, snails and beetles off plants and kill them. When faced with a substantial pest population, it is advisable to employ a bucket of water to efficiently eliminate them through drowning.

Remove all debris from the field

Some plant diseases may over-winter in plant debris and these should be carefully disposed of.

Chemical control

IMPORTANT NOTE

To promote sustainable and environmentally friendly agricultural practices, it is essential to minimize the use of chemical pesticides. Instead, farmers can adopt a variety of alternative strategies (as shown above) to protect their crops and maintain soil health. Use of chemical pesticides should be avoided whenever possible!

By reducing reliance on chemical pesticides, we can safeguard our ecosystems, protect human health, and support a more sustainable and resilient agricultural system for generations to come.



Figure 57: Demonstrating spraying against aphids in a bean field – to be avoided if possible

Chemical control is the use of pesticides and the last resort. In IPM, pesticides are used only when needed and in combination with other approaches for more effective, long-term control. Pesticides are selected and applied in a way that minimizes their possible harm to people, non-target organisms, and the environment. With IPM you will use the most selective pesticide that will do the job and be the safest for other organisms and for air, soil, and water quality; use pesticides in bait stations rather than sprays; or spot-spray a few weeds instead of an entire area.

The above IPM principles and practices are combined to create *IPM programs*. While each situation is different, six major components are common to all IPM programs:

1. Pest identification (monitoring or scouting).
2. Monitoring and assessing pest numbers and damage (Use of thresholds).
3. Guidelines for when management action is needed.
4. Preventing pest problems.
5. Using a combination of biological, cultural, physical/mechanical and chemical management tools etc.
6. After action is taken, assessing the effect of pest management.

Advantages of integrated pest management

- Decision making process (When, where, what)
- Does not eliminate use of pesticides
- Flexible and offers variety of options
- Saves on time, chemicals
- Reduced environmental pollution
- Reduced exposure to chemicals

Activity IV: Practical on IPM (45 minutes)



- Facilitate a practical session on IPM. Allow participants to work in groups
- Each group should select one of the IPM approaches mentioned above such as burying infected crops, disinfecting tools and mechanical or physical removal of pests
- Observe how the participants carry out the activities
- Offer any guidance throughout the practical to ensure that the participants are doing the right thing

Activity V: Quality assurance and course assessment (15minutes)



- Use different techniques to assess how the participants understood the lesson. Ensure that this is as participatory as possible. Techniques could be:
 - Allow participants to state their key take away points and lessons from the session
 - Provide an opportunity for pairs or individuals to facilitate a recap of the lesson
 - Ask specific questions from the content of the lesson allowing all participants to take part in responding to the questions

Activity VI: Course feedback and planning for the next session (10 minutes)



- Discuss the way forward/upcoming activities with participants:
 - Date, venue, time, topic of next session and activities to take place before the next meeting
 - Encourage all participants to prepare, arrive on time and be present for the entire session
- Obtain feedback from participants on the concluded training session
- Close the session by thanking all participants for coming to the training

Topic 3: General guidelines for safe and effective use of pesticides

ITEM	CONTENT
Objectives	By the end of this topic, farmers will be able to: <ul style="list-style-type: none"> - Use pesticides safely - Apply pesticides efficiently in their commercial vegetable production
Training materials	Flip charts, markers, masking tapes, flip chart stand and ballpoint pens notebooks, chemicals, knapsack sprayers, measuring cylinder, spare nozzles, and cleaning containers
Training duration	150 minutes

Activity I: Group discussion and experience sharing (20 minutes)



- Organize participants into smaller groups of four to six people depending on the number of participants
- Instruct the participants to brainstorm on how spraying of chemicals should be done in the vegetable field (encourage the participants to use as much personal experience as possible)
- Advise the participants to write their points clearly on the provided flip charts, which they will present afterwards. At the beginning of their group work, they shall assign a presenter

Activity II: Group presentations (25 minutes)



- Call the participants back for the presentation of their discussion outcomes
- Invite a representative from each group to present what they had discussed during group work
- Allow members from other groups to ask questions or seek clarification from the points raised by the presenting group (members of the group and not necessarily the presenter should respond and/or provide clarification on the questions asked by the participants)

Activity III: Plenary session (30 minutes)






- After listening to the presentations from all the groups, facilitate a plenary session on spraying of chemicals
- Build your presentation on the points and experiences presented by the participants
- Inform the participants that all details will be addressed further during the practical exercise

INFORMATION SHEET

Pesticide is the general name used for the group of agricultural chemical products that principally includes insecticides, nematicides, bactericides, fungicides and herbicides. Pesticides contain hazardous chemicals; as such, they must be mixed and sprayed safely. All workers who mix and spray pesticides must be properly trained to ensure their safety and that of other people and the environment.

Pesticides are formulated as liquids presented as Emulsifiable Concentrates (EC), Suspension Concentrates (SC) and Flowable Composite (FC); also, as powders presented as Wettable Powders (WP), Soluble Powders (SP), Water Dispersible Powders (WS) and Dusting Powders (DP); then as Granules (GR) and Water Dispersible Granules (WG) (Table 5). These pesticides according to WHO have colours to indicate their danger (Figure 58). Red indicates extremely toxic, red indicating toxic, yellow indicating moderately hazardous and blue indicating slightly hazardous and green indicating acute hazard unlikely in normal use.

Table 5: Characteristics of pesticides formulations

FORMULATION	CHARACTERISTICS
<p>Liquids</p> 	<p>Pour easily; easily contaminate skin; fumes – inhaled and extremely toxic if swallowed.</p>
<p>Powders</p> 	<p>Produce dust; inhalation poisoning and also dangerous on skin or swallowed.</p>
<p>Granules</p> 	<p>Easier to work with, less risk of personal or environmental contamination and poisoning - inhalation, skin contact or swallowing.</p>

Protect biodiversity on the vegetable garden by reducing the use of group 1 and 2 pesticides as shown in the figure below.

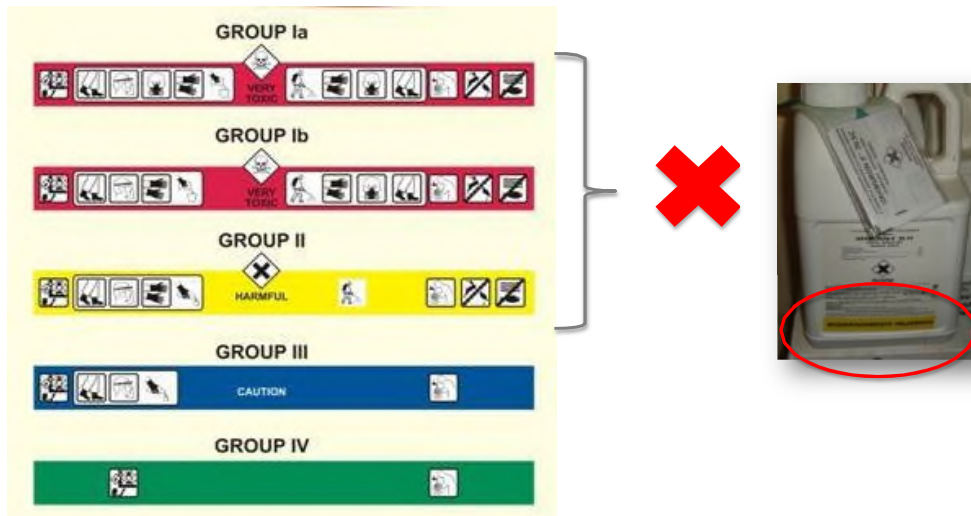


Figure 58: WHO classification of chemicals

While use of pesticides is increasing operational aspects that require respect should be given special consideration otherwise it may be hazardous to man or crop or ineffective and uneconomical. Various factors should be considered to attain both safety and effectiveness.

Choice of chemicals

- Use fungicides to control fungal diseases, insecticides to control insect pests and nematicides to control nematodes
- Buy the correct product
- The pest must be identified
- Check for the recommended pesticide(s)
- Know the dose rate, dilutions, timing and frequency
- Identify the method of application
- Know precaution to be taken
- Know cost per unit are

Purchase and storage of pesticides

- Buy the correct product
- Do not buy damaged packs and without original labels
- Do not store pesticides with food or animal feed
- Never use food or drink containers for storage of pesticides
- Packages should be inspected for signs of damage and leaks regularly

Proper mixing of pesticides

- Before mixing, test the sprayer with water to see if it leaks and is working properly
- Read the label to determine the proper mixture
- Wear PPE while mixing pesticides
- Mix in a grassy area. Do not mix on concrete or hard surfaces
- Only use water unless directed by the label to use another liquid
- Fill the sprayer with two-thirds of the water needed. Then add the proper amount of pesticide. Then add the remaining one-third of water
- Mix only the amount necessary to do the job



Figure 59: Incorrect way of mixing chemicals

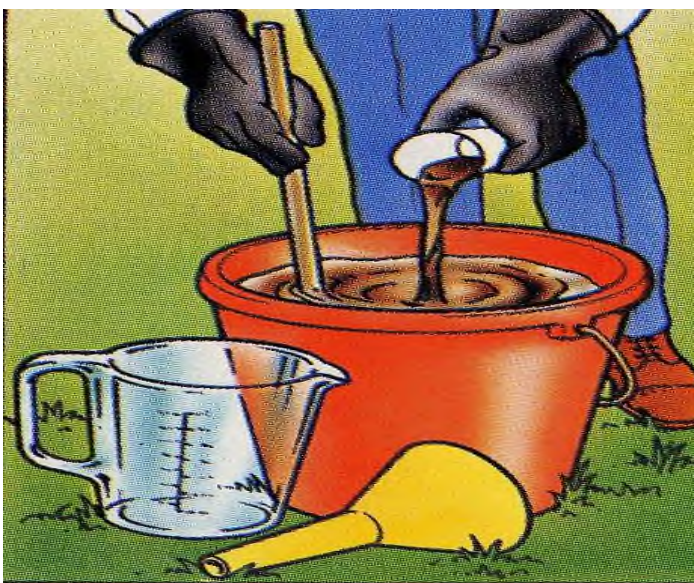


Figure 60: The right way of mixing chemicals

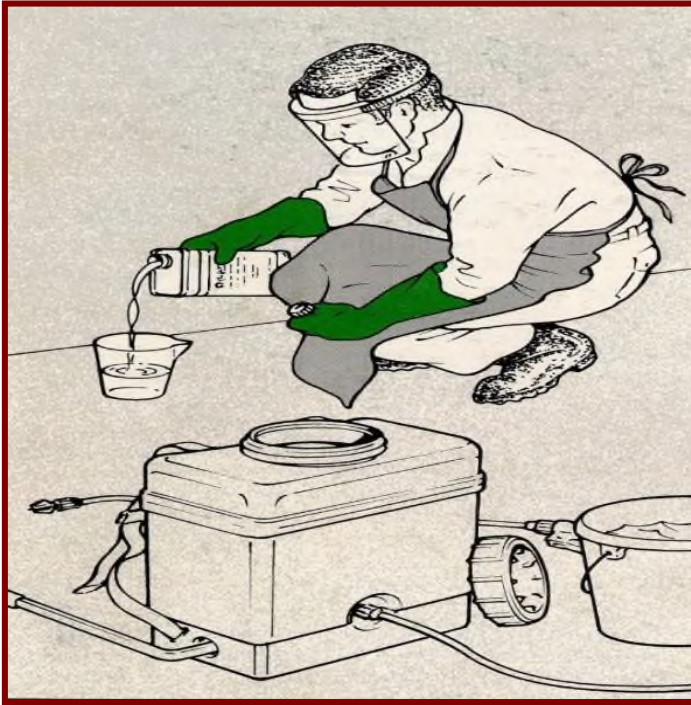


Figure 61: Wear PPE while mixing

Application equipment and pesticide use

- Check equipment before each day's operations. Residual pesticides may cause corrosion and clogging
- Do not use leaky or defective equipment
- Always read the product label and follow instructions
- Do not contaminate the environment by misuse of pesticides
- Always wear protective clothing to cover as much of the body as possible
- Wash all clothing and equipment after use
- Do not blow out clogged nozzles with the mouth - use water or a soft probe
- Pesticides and dirty equipment should never leave unattended
- Wash hands and face before eating, drinking or smoking
- Clean and check equipment after use

Proper spraying of pesticides

- Spray so that other workers or persons are not exposed
- Other workers and persons must not enter the area where a pesticide is being sprayed
- Be aware of wind direction as it can cause the pesticide to drift to areas not chosen for spraying
- If possible, spray early in the morning or in late afternoon. High humidity will lessen the chance of drifting
- Wear PPE while spraying
- All workers must be notified in advance of where spraying is to occur
- All workers must have immediate access to water, soap, and towels for routine washing and emergency decontamination

Medical issues

- Anyone exposed to a pesticide must be taken to a medical facility. Tell medical personnel the type of pesticide being used
- All workers must be informed of pesticide label requirements. Central posting of recent applications is required

Clean up and proper disposal of pesticide containers

- Rinse all equipment with water in a grassy area. Never clean up on a hard surface
- Never flush pesticide residue into a storm drain or any type of drain
- Always wash with soap and water before you eat, drink, smoke, or go to the bathroom
- Clothing worn during spraying should be washed separately
- Before discarding an empty container:
 - Fill it half full of water
 - Shake it to rinse
 - Empty the rinse water into the sprayer
 - Spray in a grassy area
 - Do this three times
 - This process will also clean the sprayer bottle and hose
- Once the container has been completely rinsed punch a hole in the bottom
- Do not burn empty containers
- Do not recycle containers

The dangers of pesticides

Pesticides can get into water. Rain washes pesticides off plants and then moves into rivers and dams. The pesticides in the water kill fish and other water animals. Water birds that eat the poisoned fish can also be poisoned. Water for drinking and washing will contain pesticides.

Pests become resistant

Usually after a grower has sprayed pesticides a few times, the pests are no longer killed by the pesticide. This is because there are always a few survivors, which are not killed by the pesticide. These survivors are stronger than the ones that were killed. This stronger type breeds so that fewer and fewer die after each spraying. We say the pests have become resistant to the pesticide and the grower must use a new stronger pesticide to kill the pests. With time, the pests will also become resistant to the new pesticide.

Dangers to humans

Chemicals are poisons and can affect humans and animals directly or indirectly as he continues to use them, either by direct poisoning or through affecting the genetic system. Allergies have also been associated with some chemicals.

Non-selectivity in action

Some chemicals are broad-spectrum and as such are capable of upsetting the natural balance that exists in the natural environment, such that beneficial organisms, which help to keep pest populations down, are also killed.

Activity IV: Practical-identifying and familiarizing with various chemicals (45 minutes)



- Arrange a variety of common chemicals in a spacious place where all participants can see them clearly (this can be on a table or raised platform)
- Explain to the participants the names, uses and methods of application of the different chemicals in the display
- In their groups, participants should choose one of the chemicals and practice mixing and diluting it according to the procedure discussed in a plenary session or shown on the container. (If there is no need to spray any vegetables, use water and black tea instead of chemicals to practice mixing or diluting)
- Once mixed, participants should practice spraying in the field. (If there is no need to spray, use water and black tea instead of chemicals to practice mixing, diluting and spraying)
- Allow enough time for the participants to familiarize themselves with the chemicals so that they can easily identify them when they go to buy them in the shops

Activity V: Quality assurance and course assessment (15 minutes)



- Use different techniques to assess how the participants understood the lesson. Ensure that this is as participatory as possible. Techniques could be:
 - o Allow participants to state their key take away points and lessons from the session
 - o Provide an opportunity for pairs or individuals to facilitate a recap of the lesson
 - o Ask specific questions from the content of the lesson allowing all participants to take part in responding to the questions

Activity VI: Course feedback and planning for the next session (10 minutes)



- Discuss the way forward/upcoming activities with participants:
 - o Date, venue, time, topic of next session and activities to take place before the next meeting
 - o Encourage all participants to prepare, arrive on time and be present for the entire session
- Obtain feedback from participants on the concluded training session
- Close the session by thanking all participants for coming to the training

Topic 4: Pest and disease management in chilli production

ITEM	CONTENT
Objective	By the end of this topic, farmers will be able to: <ul style="list-style-type: none"> - Identify most common pests and diseases that affect chilli - Control pests and diseases in their commercial chilli production
Training materials & tools	Flip charts, markers, masking tapes, flip chart stand, pest samples, pictures of diseases and cabbage heads
Training duration	180 minutes

Activity I: Group discussion and experience sharing (25 minutes)



- Organize participants into smaller groups of four to six people depending on the number of available participants
- Instruct the participants to discuss and share any general information/knowledge about the various pests and diseases that attack chilli and their control methods
- Advise the participants to write their points clearly on the provided flip charts, which they will present afterwards. At the beginning of their group work, they shall assign a presenter

Activity II: Group presentations (25 minutes)



- Call the participants back for the presentation of their discussion outcomes
- Invite a representative from each group to present what they had discussed during group work
- Allow members from other groups to ask questions or seek clarification from the points raised by the presenting group (members of the group and not necessarily the presenter should respond and/or provide clarification on the questions asked by the participants)

Activity III: Plenary session (30 minutes)



- After listening to presentations from all groups, present about the various pests and diseases that attack chilli and their control methods
- Build your presentation on the points and experiences presented by the participants
- The information sheet below may be helpful, but use of other sources to generate more information is encouraged

INFORMATION SHEET

A. Common pests of chillies

1. Cutworms (Mphuzi)

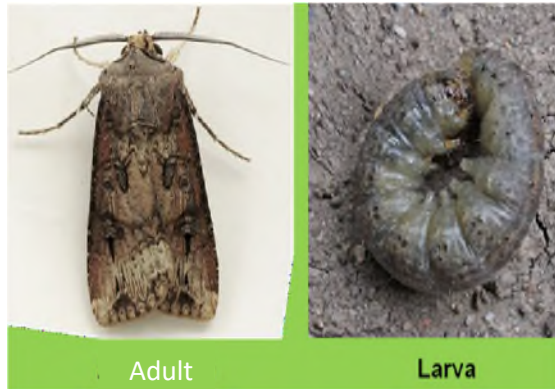


Figure 62: Cutworms

Description and damage caused

- They are larvae of some nocturnal moths
- Damage to chillies is done by their larvae, which cut seedlings
- Female moths lay their eggs singly or in small groups on moist soil, weeds or stems and lower leaves of host plants or on low-growing vegetation
- Newly hatched larvae then burrow into the soil
- They come out at night to cut down seedlings or climb the plants to eat leaves

Control

- Handpick and remove the cutworms
- Avoiding weeds in or around the field because the moths lay eggs on them
- When you see 5% of the plants are cut by these worms, drench the soil with Chlorpyrifos 480 EC or Dursban 480 EC at 2ml/l of water or by drenching with a pyrethroid like cypermethrin 20% EC at 1 ml in 10 litres (l) of water

2. Aphids (Nsabwe or Chinoni)



Figure 63: Aphids

Description and damage caused

- These are tiny oval- and soft-bodied insects
- They usually live in colonies on leaves and shoots of their host plants
- They suck sap from stems and leaves of the plants, causing distortion of shoots, stunted growth, which reduces yield significantly if not controlled

Control

- Keep your chilli fields and its surrounding free of weeds and alternative host plants
- Apply Dimethoate 40 EC at a rate of 0.8ml/l of water or Confidor 70 WG at 0.3g / l of water or Acetamiprid 225 EC at 1ml/l of water

3. Whiteflies (Ntchentche zoyera)



Description and damage caused

- They are small white insects that belong to the bug group
- Normally they live on the undersides of the leaves of their host plants
- Suck sap from the leaves of the host plant

Figure 64: Whiteflies

Control

- Set yellow sticky traps to catch and kill them
- Spray any of the following insecticides: Cypermethrin EC, Deltamethrin EC, Prosper EC and Polytrin C 44 EC

4. Red Spider Mites (Kangaude wofira)



Top surface of the leaf



Underside of the leaf

Description and damage caused

- They are small spider-like mites
- They attack leaves and fruits of chilli
- They suck sap from fruits and leaves
- Adult females are 0.5 mm long, oval, orange-red with an indistinct dark blotch on each side of the body

Figure 65: Red spider mites

Control

- Spray neem leaf extract (prepared by soaking 1 kg of fresh neem leaves in water overnight) or spray synthetic insecticides such as Polytrin C 44 EC at 1.2 ml/l of water
- Ensure thorough spray, specifically on the underside of the leaves for effective control

5 Nematode (Mandolo)



Figure 66: Nematodes

Description and damage caused

- *Meloidogynae species* are common nematodes affecting chillies
- Nematode's infestation can lead to huge economic loss in chilli production
- They feed on the roots of the plant

Control

- Practice crop rotation with non-host crops such as maize or other grass crops, and cabbages or other brassicas
- Use of farm yard manure, ploughing the field deeply to expose and kill eggs and by fumigating the fields

B. Common diseases of chillies

1. Anthracnose (Nthomba)



Figure 67: Anthracnose on chilli pods

Description and damage caused

- This is a fungal disease that attacks the leaves, stems and fruits
- A fungus called *Colletotrichum capsici* causes it
- Small, circular spots are seen on the skin of the fruit and expanded in the direction of long axis of the fruit
- The fruits with many spots drop off prematurely resulting in heavy loss of yield

Control

- Start with clean/pathogen free seed
- Practice crop rotation
- Use fungicides such as Benlate

2. Bacterial wilt (Kafota)



Figure 68: Bacterial wilt

Description and damage caused

- This is a vascular system disease caused by soil and water-borne bacteria called *Ralstonia solanacearum*
- The bacterium can survive in soil for extended periods without a host plant and in crop debris
- There is abrupt wilting of plants in the field without yellowing
- Wilting happens quickly starting from the top of the plants and moves downwards
- Wilting takes place despite presence of enough moisture in the soil

Control

- Use disease-free seedlings
- Avoid irrigating chilli with water from areas known to have the disease
- Uproot and burn any diseased plant (Do not bury it!)
- Wash hands after handling infected plants and sterilize any gardening tool that could have been used in infected soil
- Practice crop rotation with non-solanaceous crops

3. Late blight (Chiwawu)



Figure 69: Late blight

Description and damage caused

- It is a foliar disease caused by a fungus-like microorganism called *Phytophthora capsica*
- Leaves first show small dark green spots that enlarge and become bleached, as if scalded
- The lesions develop white molds in humid weather and eventually leaves drop

Control

- Plant new chilli fields away from old ones
- Apply fungicides such as Ridomil Gold and Dithane M45
- Remove and destroy all chilli residues after harvesting
- Practice crop rotation

4. Virus diseases (Matenda obwera chifukwa cha virus)



Figure 70: Viral diseases

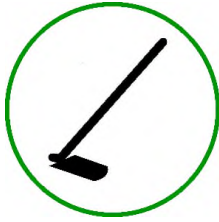
Description and damage caused

- There are a number of them including Tobacco Mosaic Virus (TMV), Bushy Top, Potato Virus X & Y and Cassava Mosaic Virus (CMD)

Control

- Use of good, clean seed
- Crop sanitation
- Practice crop rotation
- Vector control (e.g. insects which transmit the disease pathogens)
- Elimination and destroy affected plants

Activity IV: Practical on pest and disease management (75 minutes)



- Facilitate a practical on pest and disease control that covers several aspects including scouting (checking), pests and diseases identification, decision on pest and disease treatment, chemical application and applying the chemicals to the field to control available pest and/or diseases
- For effectiveness of this practical, the trainer should inspect the fields of the farmers and choose where there are pests and diseases
- Allow enough time to ensure that all participants are able to identify the various pests and diseases in the field
- Make sure that the participants closely watch and actively participate in the entire activity
- Allow each participant to practice
-

Facilitate a demo practical using the following procedure

Having explained and exposed the participants to the identification of economic pests and diseases of chillies, take the participants through a practical scouting, identifying pests and diseases by using the following procedure:

- Instruct the participants to enter the demo plot and identify any pests and diseases that they are able to see
- Instruct them to collect all the pests for easy identification while in a group after scouting. They can do the same with diseases in case they have attacked the leaves, dry or dead plants or any sign of a disorder
- Instruct the participants to use the knowledge from the plenary session and their own presentations to identify the pests, the damage they cause and suggest the most appropriate ways of controlling them
- Let them document this and share with other members
- After this is done and the best pest/disease control method identified is chemical application, demonstrate the most appropriate way of spraying chemicals in the field
 - How to put on PPE, how to dilute the chemicals, how to fill the chemicals into the sprayer and how not to spray into the wind
 - Allow participants to practise spraying chemicals after the demonstration
- Take time to emphasize to the participants that while this practical may seem to have been done during nursery management, field pest and disease management is done on a bigger scale and may have more pests and diseases hence needs other skills and knowledge
- Therefore, invite all participants to be attentive and participate throughout

Activity V: Quality assurance and course assessment (15 minutes)



- Use different techniques to assess how the participants understood the lesson. Ensure that this is as participatory as possible. Techniques could be:
 - o Allow participants to state their key take away points and lessons from the session
 - o Provide an opportunity for pairs or individuals to facilitate a recap of the lesson
 - o Ask specific questions from the content of the lesson allowing all participants to take part in responding to the questions

Processing questions

- * What were the main steps/activities and considerations in the pest and disease management program for the chilli production?
- * Which were the easiest and the most difficult steps in the practical?
- * What skill stands out for you?

Generalization questions

- * What conclusion would you draw from this practical?
- * Which step if not followed would result in poor chilli production?

Application questions

- * Will you be comfortable implementing a pest and disease control program at your farm?
- * What alternatives are there to achieve a good crop in the absence of equipment or materials used in this training?
- * How can the skills gained in this practical be applied in the production of other crops?

Activity VI: Assignment (10 minutes)



- Ask participants to inspect their fields for any pests and diseases and implement a pest and disease management program utilizing the knowledge and skills gained during this training
- The trainer should make it clear to all participants that their chilli fields will be inspected before the next training

Activity VII: Feedback and planning for the next session (10 minutes)



- Follow Discuss the way forward/upcoming activities with participants:
 - o Date, venue, time, topic of next session and activities to take place before the next meeting
 - o Encourage all participants to prepare, arrive on time and be present for the entire session
- Obtain feedback from participants on the concluded training session
- Close the session by thanking all participants for coming to the training

MODULE 8: HARVESTING

ITEM	CONTENT
Objectives	By the end of this topic participants will be able to: <ol style="list-style-type: none"> 1. Describe maturity indicators of chillies at harvesting stage 2. Explain the appropriate method of harvesting chillies 3. Harvest chilli fruits correctly
Training materials & tools	Flip charts, markers, masking tapes and flip chart stand, sacks, baskets, mature chillies fruits, gloves, and masks
Training duration	150 minutes

Activity I: Group discussion (20 minutes)



- Organize participants into smaller groups of four to six people depending on the number of available participants
- Instruct the participants to discuss and share information/knowledge about maturity indices and harvesting procedure of chilli fruits
- Advise the participants to write their points clearly on the provided flip charts, which they will present afterwards. At the beginning of their group work, they shall assign a presenter

Activity II: Group presentations & feedback (20 minutes)



- Call the participants back for the presentation of their discussion outcomes
- Invite a representative from each group to present what they had discussed during group work
- Allow members from other groups to ask questions or seek clarification from the points raised by the presenting group (members of the group and not necessarily the presenter should respond and/or provide clarification on the questions asked by the participants)

Activity III: Plenary session (15 minutes)



- After listening to all the groups' presentations, facilitate a plenary discussion on harvesting of chillies
- Build your presentation on the points and experiences presented by the participants
- Inform the participants that all details will be addressed further during the practical exercise

INFORMATION SHEET

- Fruits are ready for harvesting when they are red
- Handpick the chilli pods as quickly as possible as birds may eat them thereby reducing yield
- Harvesting should be done very carefully so that only those fruits with a full red colour are picked
- Detach fruit stalks while picking. This must be a point of emphasis as observation shows most chilli growers harvest their chillies with the stalk intact
- Put the harvested chillies in sack or baskets
- Chilli can yield from 1 to 3 tons/ha dry weight
- The key points in harvesting are summarized as the do the five: mask up, put on the gloves, pick the containers, prey on the reds and shy the stalks
- Do not use plastic containers in harvesting and handling of chilli plastics as these promote condensation which will cause fruit rot
- Always use weaved baskets or hessian sacks



Figure 711: Harvesting chillies

Activity IV: Practical on harvesting (45 minutes)



- Facilitate a practical on harvesting of chillies
- Offer any guidance throughout the practical to ensure that the participants are following the right procedures
- Make sure that the participants closely watch and actively participate in the entire activity
- Allow each participant to practice

Activity V: Quality assurance and course assessment (15 minutes)



- Use different techniques to assess how the participants understood the lesson. Ensure that this is as participatory as possible. Techniques could be:
 - o Allow participants to state their key take away points and lessons from the session
 - o Provide an opportunity for pairs or individuals to facilitate a recap of the lesson
 - o Ask specific questions from the content of the lesson allowing all participants to take part in responding to the questions

Activity VI: Assignment (10 minutes)



- Ask participants to plan for harvesting of their chillies in the field listing the materials they will need and how they will source them
- Explain also that this activity will be inspected before the next training as a means of verifying adherence to standards

Activity VII: Feedback and planning for the next session (10 minutes)



- Follow Discuss the way forward/upcoming activities with participants:
 - o Date, venue, time, topic of next session and activities to take place before the next meeting
 - o Encourage all participants to prepare, arrive on time and be present for the entire session
- Obtain feedback from participants on the concluded training session
- Close the session by thanking all participants for coming to the training

MODULE 9: POST-HARVEST HANDLING

Topic 1: Drying

ITEM	CONTENT
Objectives	By the end of this topic participants will be able to: <ol style="list-style-type: none"> 1. Identify the appropriate drying method for chilli fruits 2. Dry chilli fruits
Training materials & tools	Flip charts, markers, masking tapes and flip chart stand, sacks, mask, ripe chilli fruits, reed mats and racks
Training duration	180 minutes

Activity I: Group discussion (20 minutes)



- Organize participants into smaller groups of four to six people depending on the number of participants
- Instruct the participants to brainstorm and share experiences on drying of chilli fruits
- Advise the participants to write their points clearly on the provided flip charts, which they will present afterwards. At the beginning of their group work, they shall assign a presenter

Activity II: Group presentations & feedback (20 minutes)



- Call the participants back for the presentation of their discussion outcomes
- Invite a representative from each group to present what they had discussed during group work
- Allow members from other groups to ask questions or seek clarification from the points raised by the presenting group (members of the group and not necessarily the presenter should respond and/or provide clarification on the questions asked by the participants)

Activity III: Plenary session (20 minutes)



- After listening to all the groups' presentations, facilitate a plenary discussion on drying process of chillies
- Build your presentation on the points and experiences presented by the participants
- Inform the participants that all details will be addressed further during the practical exercise

INFORMATION SHEET

Drying of chilli is essential to extend the usable shelf life, prevent them from rotting and improve their quality. When kept wet, chillies will easily develop molds and produce an awful odour thereby decreasing the quality and market value. Chillies will also have to be dried in order to enhance their processing characteristics.

Procedure

- Construct a drying rack about 1 to 1.5 m wide and 1 m high from the ground on a space, which receives full sunlight
- Place clean reed mats or use hessian sacks on the racks
- Spread the chilli thinly on the mat in a layer of one fruit thickness and regularly, especially in the beginning, turn the chilli gently
- Dry the chilli to a marketable moisture content of 8 to 10%.

Proceed carefully:

- ✗ Do not dry your chilli on plastic or mats, use plastics on the drying racks or use plastic containers to carry/store the chilli because plastics promote condensation, which will cause fruit rot
- ✗ Do not dry your chilli in the shade. It will cause slow drying, promote molds (fungi) development and rotting
- ✗ Do not handle harvested chilli pods roughly causing physical (bruising) damages. It will reduce quality and you will be losing value and revenue
- ✗ Do not over dry your chilli



Figure 722: Drying of chillies on a rack

Activity IV: Practical on drying (90 minutes)



- The practical for this training session may include construction of a drying rack and spreading harvested chilli fruits on the rack
- Offer any guidance throughout the practical to ensure that the participants are following the right procedures
- Make sure that the participants closely watch and actively participate in the entire activity
- Allow each participant to practice

Tips for the trainer

For effective delivery of the practical, ensure that you arrange the practical venue well in advance inspecting where the drying rack will be constructed considering the dos and don'ts

Ensure that all the materials for constructing the rack are sourced and made available on the day of the training

Facilitate the practical session as follows:

- o Invite the participants to clear the identified place where the drying rack will be constructed
- o Bring together all the materials and equipment for the construction
- o Mark the dimensions of the rack depending on the preferred size
- o Set out the structure by marking points where holes will be dug
- o Dig the holes on the marked points
- o Fix the poles in the marked points
- o Continue to fix the cross poles and tying with strings until the rack is completely erected
- o Lay on the rack a woven mat, hessian sack or shed net. Make sure it is tied to the rack to prevent it from being blown off
- o Put the harvested chillies on the rack
- o Spread it thinly to a layer of one pod to facilitate quick drying and prevent growing of fungus

Activity V: Quality assurance and course assessment (15 minutes)



- Use different techniques to assess how the participants understood the lesson. Ensure that this is as participatory as possible. Techniques could be:
 - o Allow participants to state their key take away points and lessons from the session
 - o Provide an opportunity for pairs or individuals to facilitate a recap of the lesson
 - o Ask specific questions from the content of the lesson allowing all participants to take part in responding to the questions

Processing questions

- * What were the main steps/activities and considerations in drying chillies?
- * Which were the easiest and the most difficult steps in the practical?

Generalization questions

- * What conclusion would you draw from this practical?
- * Which step if not followed would result in poor quality of the chilli product?

Application questions

- * Will you be comfortable constructing a drying rack on your own and following the correct drying process for your chillies?
- * What alternatives are there to achieve a good chilli crop in the absence of equipment or materials used in this training?
- * How can the skills gained in this practical be applied in the production of other crops?

Activity VI: Assignment (10 minutes)



- Inform the participants that they have to construct their own drying racks
- The trainer should make it clear to all the participants that they will be visited to inspect and verify that they have their racks constructed correctly

Activity VII: Planning for the next session (10 minutes)



- Discuss the way forward/upcoming activities with participants:
 - o Date, venue, time, topic of next session and activities to take place before the next meeting
 - o Encourage all participants to prepare, arrive on time and be present for the entire session
- Obtain feedback from participants on the concluded training session
- Close the session by thanking all participants for coming to the training

Topic 2: Grading, packaging and storage

ITEM	CONTENT
Objectives	By the end of this topic participants will be able to: <ol style="list-style-type: none"> 1. Correctly grade chilli 2. Explain the procedure of packing and storing chillies 3. Pack and store chilli fruits correctly
Training materials & tools	Flip charts, markers, masking tapes and flip chart stand, chillies, gloves, masks, sacks and mats
Training duration	90 minutes

Activity I: Group discussion (20 minutes)



- Organize the participants into smaller groups of four to six people depending on the number of participants
- Instruct the participants to brainstorm and share experiences on grading, packing and storing chilli fruits
- Advise the participants to write their points clearly on the provided flip charts, which they will present afterwards. At the beginning of their group work, they shall assign

Activity II: Group presentations & feedback (15 minutes)



- Call the participants back for the presentation of their discussion outcomes
- Invite a representative from each group to present what they had discussed during group work
- Allow members from other groups to ask questions or seek clarification from the points raised by the presenting group (members of the group and not necessarily the presenter should respond and/or provide clarification on the questions asked by the participants).

Activity III: Plenary session (10 minutes)



- After listening to all the groups' presentations, facilitate a plenary discussion on the packaging process of chillies
- Build your presentation on the information and experiences presented by the participants
- Inform the participants that all details will be addressed further during the practical exercise discussion on these topics

INFORMATION SHEET

Grading

- Get rid of all foreign matter and impurities
- Remove black and rotten chillies
- Isolate discoloured pods
- Sort your pods by size

Remember: Always mask up and wear gloves when touching and handling the pods.

Grades of chillies

Grade A: Clean, well-dried and undamaged chillies with shiny red to deep red in colour.

Grade B: All remaining chillies fall under this grade (dull- red colour usually appearing more of yellow than red).

Packaging

Pack dried chillies in hessian sacks because they limit exposure to light, allow passage of air to prevent creating damp conditions, reduce dust problems and allow pods to maintain good moisture content.

Storage

- Store dried chillies in hessian sacks
- Keep the storeroom dry at lower temperatures of 0oC to 4oC
- Storage rooms should be free from objectionable odours (do not store together with e.g. agricultural chemicals, fuels, etc.)
- Do not allow insects and vermin to enter
- When conditions are dry, open the windows for air circulation, on the other hand, when damp conditions prevail the storage unit should be closed
- Inspect the storeroom frequently to avoid the build-up of moisture, moulds, insects, and rodents
- When stored for a long time, take the chillies out in the sun to prevent the growing of moulds and rotting



Figure 73: Packaging chillies in clean sacks

Activity IV: Practical on grading, packaging and storage (30 minutes)



- The practical for this training session includes the actual grading, packaging process to show good packaging materials and storage environment for the chillies
- Offer any guidance throughout the practical to ensure that the participants are following the right procedures
- Make sure that the participants closely watch and actively participate in the entire activity
- Allow each participant to practice

Activity V: Quality assurance and course assessment (10 minutes)



- Use different techniques to assess how the participants understood the lesson. Ensure that this is as participatory as possible. Techniques could be:
 - o Allow participants to state their key take away points and lessons from the session
 - o Provide an opportunity for pairs or individuals to facilitate a recap of the lesson
 - o Ask specific questions from the content of the lesson allowing all participants to take part in responding to the questions

Activity VI: Assignment (5 minutes)



- Inform the participants that they have the task to package and store their chillies as shown during this training
- The trainer should make it clear to all participants that they would be visited to check that chillies are stored correctly

Activity VII: Feedback and planning for the next session (5 minutes)



- Follow Discuss the way forward/upcoming activities with participants:
 - o Date, venue, time, topic of next session and activities to take place before the next meeting
 - o Encourage all participants to prepare, arrive on time and be present for the entire session
- Obtain feedback from participants on the concluded training session
- Close the session by thanking all participants for coming to the training

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Additional resources

The *Access Agriculture* website provides access to locally produced videos on various agricultural topics in English and local languages such as Chichewa. These can be used to supplement training.

<https://www.accessagriculture.org/>

Appendix 2: Template for chilli production calendar

No.	Activity	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May	Jun	Jul
1.0	Site selection for nursery and field												
2.0	LAND PREPARATION												
2.1	Bush clearing												
2.2	Tilling												
2.3	Harrowing												
2.4	Making nursery beds												
2.4	Making ridges in the field												
3.0	Sowing seed												
4.0	NURSERY MANAGEMENT												
4.1	Watering												
4.2	Weeding												
4.3	Pests and disease control												
4.4	Hardening off												
5.0	Transplanting												
6.0	FIELD MANAGEMENT												
6.1	Irrigation												
6.2	Fertilizing												
6.3	Weeding												
6.4	Pests and disease control												
6.5	Harvesting												
6.7	Grading												
6.8	Packaging												
6.9	Storage												
6.10	Marketing												

