

YOUTH AGRI-SKILLING FOR DECENT EMPLOYMENT (YADE)

Horticulture Agroecological Production Manual



May 2021

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Production Manual

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INCOME GENERATING ACTIVITY - SELECTION, PLANNING AND MANAGEMENT Training Manual

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About YADE Project

1.1 Introduction

Uganda made impressive economic development in the last three decades. Poverty headcount declined from 56% in 1992 to 27% in 2018 and 33% of the total population belongs to the middle class. However, the rosy economic growth is marred by inequalities and social exclusion. Youth; majority of the total population have largely not benefited from the jobless economic growth. There are few employment opportunities for young people, who enter in thousands into the labour market every year. While in the last decades the labour force grew annually with 390,000 new job seekers, only 8,120 jobs were created each year. Two-thirds of all jobs created in 2001 - 2011 were confined to only six out of the 112 districts and mainly in central Uganda. Rural areas contribute 96% to national poverty. This has resulted into a steady increase in unemployment rates from 1.9% in 2009 to 9.4% in 2016. The majority (64%) of unemployed people is the youth and especially female youth. It is worrying, that at the current population growth rate and public-private sector absorption capacity, it will likely take one generation before the majority of the labour force has a non-farm salary job. This situation is due to: Lack of relevant and marketable skills and limited access to business finance. To address, AFARD secured a 3-year funding from Medicor Foundation and Dka Austria through HORIZONT3000 to implement Youth Agri-skilling for Decent Employment (YADE). YADE seeks to improve youth employment through “a holistic and bundled-package approach that improves youth employability with agri-skilling, business start-up kits, and business development services” so that the youth (15-30 years) can join the world of work in sustainable and viable agribusinesses (targeting the ready local markets) that can lift them out of poverty. Below is a summary of the project.

| | |
|---|--|
| Duration 3 years (01.04.2021 – 31.03.2024) | Overall objective: To contribute to sustainable poverty reduction among youth through agri-enterprise development |
| Geographical area Wadelai Sub county, Nebbi District, West Nile, Uganda | Specific objective: To increase access to gainful agricultural employment opportunities for 500 youth in Pakwach district through marketable non-formal vocational and complementary skills training by 2024 |
| Beneficiaries 5,100 people (500 youth direct and 4,600 indirect): 02 Sub county local governments will gain from produce tax; 3,000 smallholder farmers will use animal traction services; at least 05 market vendors will buy youth products; and at least 100 youth who will be wage employee | Expected results: R1: To establish and strengthen 24 agribusiness youth investment groups (a-YIGs) with functional VSLA by 2024 R2: To improve the employability of 500 youth through entrepreneurship, financial literacy, collective marketing and non-formal vocational skills training by 2024 R3: To increase the ownership and growth of 500 youth agribusinesses for self-employment by 2024 To achieve this goal, the project will: (i) Mobilize 500 youth (60% females) into 24 Agribusiness Youth Investment Groups (a-YIGs) using a youth-led Village Savings and Loan Associations (VSLAs) ; (ii) Improve youth employability skills through trainings in entrepreneurship and life skills, financial literacy and collective marketing together with non-formal agri-vocational skills training in niche agribusinesses (animal traction, horticulture, cage fish farming, bakery, catering, agroforestry, and food processing); (iii) Provide start-up kits together with training in good agricultural and agribusiness practices (GAAP); and (iv) Offer business coaching and market linkages with agro-input dealers and produce buyers. With increased productivity, the youth will achieve increased incomes to: a) grow their agribusinesses, b) increase their average savings and c) acquire and own more productive assets. |
| Implementing entity Agency for Accelerated Regional Development (AFARD) | |
| Budget UGX1,123,688,000 (Euro 280,922) | |
| Funding Medicor Foundation and Dka Austria through HORIZONT3000 | |

1.2 About the Manual

The training is based on elements of the FFS approach and adult learning theories. The following elements are important:

- The training should be conducted in a participatory and highly interactive way because involvement and learning are enhanced when participants contribute to the discussion. It is therefore essential that participants are encouraged to share their own experiences before the theoretical material is brought to them.
- Similarly, practical exercises, where participants apply what they learn directly in a demonstration field, will enhance learning.
- The demonstration field should be located on the farm of one of the participants (host farm). All training sessions will take place in this field. The host farmer must look after the field between training sessions.
- The training plan must follow the cropping calendar for the product concerned, so that the farmer can apply what he has learned directly at home (see the proposed training calendar

below). Ideally, the participants should meet every week or second week on a learning cycle comprising 8-10 meetings.

- Where appropriate, encourage participants to try different things and make small “experiments”, either at home or on the demonstration field (for example, applying different types of fertilizer) and observe the effect these treatments can have on the crop.
- If possible, the facilitator should visit farmers in their fields to give them feedback on how they implement their crop at home and help them find solutions to the problems they face.

The participatory method and learning-by-doing will create a direct link between the training and the challenges farmers face when implementing new techniques at home. This will enable them to develop their observation and innovation skills and to find solutions on their own to the problems they may face. It is recommended to start each training session with the practical part, before the facilitator gives technical advice at the end of the training sessions.

Recommended structure of a training session:

1. Welcome
2. A look back at what has happened since the last meeting. (10-20 minutes)

In the participant fields: Take a few minutes to ask participants what they have been able to apply at home since the last session and with what results. Allow participants to share their experiences with each other, highlight their successes and ask questions if they have any.

In the demonstration field: Also take a few minutes to observe with the participants what has happened in the demonstration field since the last session. What has changed, how have the plants grown? What disease problems can be seen? Do they find insects, other organisms? How is the soil, the humidity, etc.? Facilitators can ask the participants to focus on aspects related to the topic of the day.

3. Introduction of the topic of the day and short brainstorming to identify what the participants know already about this topic. (10-20 minutes). For each chapter, some guiding questions are proposed to stimulate the discussion.
4. Exercises in the field (2 hours). Practical aspects of the topic of the day are directly applied in the field by the participants, with the support of the facilitator. The participants shall then apply these techniques at home as well.
5. Summary (20-30 minutes): the facilitator summarizes important aspects of what has been learned during the sessions and give some more technical advice if necessary.

Recommended training program

It is important that the training units are delivered at a time that is appropriate to the crop production schedule, so that participants are then able to apply the new knowledge gained directly at home.

Where appropriate, some training units may be combined (e.g., common varieties and nursery establishment). Other units may also be offered in two separate sessions to address or deepen different aspects (e.g., pest and disease management).

| Topic | Duration | Timing |
|---|-----------------------|------------------------------|
| 1. Importance of growing horticulture | 1.5 hours | 4 weeks before planting time |
| 2. Land selection and preparation | 2.5 hours | 4 weeks before planting time |
| 3. Nursery establishment and management | 3 hours | 4-6 weeks before planting |
| 4. Transplanting | 3 hours | Day of planting |
| 5. Weeding | 3 hours | 3-4 weeks after planting |
| 6. Pests and diseases management | 2 sessions of 3 hours | 5-10 weeks after planting |
| 7. Harvesting | 3 hours | Week 17-20 after planting |

Introduction to Agroecological farming

Agroecology is farming that aims at feeding a growing population while conserving and nurturing the natural resource base. Agroecological farmers want to improve food yields for balanced nutrition, strengthen fair markets for their production, enhance healthy ecosystems, and build on traditional knowledge and customs. Their objective is to create stable food production systems that are resilient to environmental perturbations such as climate change and disease.

Agroecology views farmland as an ecosystem – a complex network in which every living and nonliving component of the system is important and affects every other component, either directly or indirectly. Since farmland provides many services to us humans (such as food production, clean water or biodiversity) we have to take care of it. Key principles of agroecological farming therefore include:

- Protect the environment and use natural resources efficiently and sustainably;
- Reduce the use of chemicals as far as possible;
- Make use of organic/biological measures and resources, and try to recycle what you can;
- Rather prevent problems (such as pests and diseases) than having to treat them;
- Let nature help you;
- Practice agriculture for the good of people and the environment.

Topics in which agroecological farming differs particularly from conventional farming are especially soil fertility management and pest and disease management¹.

¹and efficient irrigation, sustainable water use

Introduction to soil Management

Learning objectives:

After completing this module, participants will:

- understand soil types, fertility test, and how soils can be made and kept healthy and fertile in agroecological farming.
- know how to produce an apply compost
- know how to manage and apply farm animal manure

Duration: 2-4 hours

Learning aids

- material and tool to produce compost with the group
- farm yard manure

Activities and exercises

- Brainstorming on the importance of soil
- Practically demonstrate how to make compost
- Establish a field trial to compare crop growth with and without compost

Content

Soil is what plants grow in and people cannot survive without soil. For that reason, knowledge of the soil is one of the most important requirements for farmers. It is the surface layer of the earth's crust which is capable of supporting life.

There are 3 main soil types in Uganda: Clay, Sand and Loam.

- If a soil is referred to as a "clay" soil then this usually indicates that clay is the major constituent in that soil.
- Most soils contain a mixture of minerals. Soil mixtures are often referred to as loams. A soil made up of a mixture of sand, silt and clay with the properties of no one group dominating is called a loam. A "medium loam" would be made up of 50% clay and 50% silt. If the soil has a large amount of clay it may be called a "heavy loam" while a soil with a large amount of sand (50%+) may be called a "sandy loam"

Soil types and their characteristics

| Soil type | characteristic |
|--------------------|---|
| Sandy soils | <ul style="list-style-type: none">• Contain mostly sand• Do not hold water very well• Most sand is small pieces of stone |
| Clay soils | <ul style="list-style-type: none">• Holds water very well• Lacks pores, has few plant roots and is hard to dig |
| Loam | <ul style="list-style-type: none">• Made of gravel, sand, clay with good/high organic matter content• Loam has a dark colour• Has many roots and earthworm channels |

Soil Composition

Fertile soil is generally composed of mineral matter, organic matter, water and air.

- Mineral Matter (45%) can be composed of; gravel (large pebbles and stones, sand, silt, clay particles and mineral salts (usually in solution).
- Water (25%) is found in the spaces between soil particles called pores.
- Air (25%) is also found in the spaces between soil particles called pores.
- Organic Matter (5%) can be composed of plant roots, dead leaves and twigs, humus (a product of the breakdown of organic matter), microorganisms (bacteria, fungi, yeast) and macro-organisms/small animals such as earthworms.

Soil fertility

Instead of simply using chemical fertilizers to boost crop growth, agroecological soil fertility management considers crop rotations or intercropping with legumes (that can fix nitrogen from the air, the use manure and compost, and beneficial organic matter management to keep soils healthy and fertile. Reducing tillage operations and protecting the soil with a permanent cover helps maintaining the soil fertile and healthy. Some practical guidelines on how to prepare and use soil fertility amendments are given in a separate leaflet.

Soil fertility experiments

| Experiment | Materials and method | Observation |
|---|---|---|
| Determine the soil water holding capacity. | <ul style="list-style-type: none">Three soil samples; clay, loam and sandWaterPaper filterEmpty water bottle Method: Three empty water bottles are cut A paper filter is placed on each bottle, holding a soil sample Water is poured through the soil sample and the rate of water infiltration determined | Water infiltrates fast through sand, then moderately through loam soil, then slowly through clay. Conclusion: loam soils have a good water infiltration rate therefore better to crop production |
| Determining the organic matter content of the soil. | <ul style="list-style-type: none">Three soil samples; clay, loam and sandWaterUsed water bottle Method: Soil samples are put into three empty water bottles. Water is added, and the bottle shaken Allow to stand | Loam soil has a bigger layer of organic matter followed by sandy soil and then clay soil. Conclusion: The organic matter in loam soil is good for crop production |
| Determining soil acidity | <ul style="list-style-type: none">Three soil samples; clay, loam and sandBaking powderWater Method: Three samples of soil are put into three containers A small quantity of water is added to wet the samples Baking powder is added The samples are put close to the ear to hear any sound made | The soil sample that gives the most hissing sound due to release of hydrogen gas is the most acidic |
| Determining soil alkalinity | <ul style="list-style-type: none">Three soil samples; clay, loam and sandVinegar Method: Vinegar is added to the three samples of soil in three containers | The sample that gives the biggest hissing sound, was more alkaline |

Soil fertility management in agroecological farming

As mentioned in the introduction on “What is agroecological farming?” agroecological soil fertility management not only consists of adding nutrients as (chemical) fertilizers to your plot. A healthy and productive soil provides plants with nutrients (“plant food”), water and air. Organic matter in the soil (“humus”) is important that the soil can fulfill these tasks. In agroecological farming we aim at nurturing the soil so that it enables our crops to grow well. We therefore try to provide our soil not only with nutrients (to be used by the plants) but also with organic matter. Recycling organic material from the farm (such as crop residues, weeds or manure) and the household (e.g. waste from cooking and cleaning) allows for reducing wastage of valuable substances and making use of nutrients and organic matter for soil fertility improvement. By producing quality compost, such material is converted into great food for the soil and our crops.

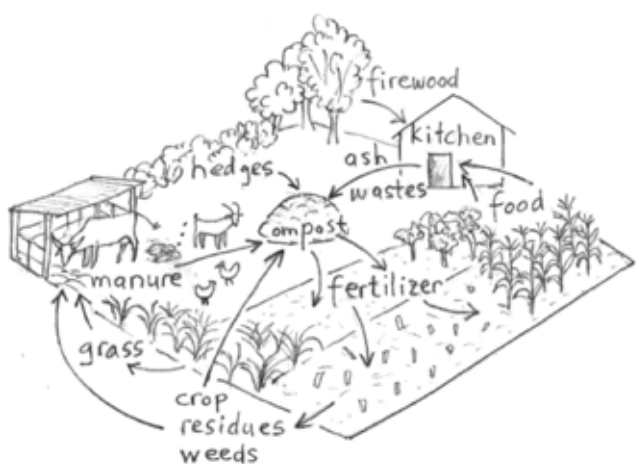
Nature can help us in agroecological soil fertility management: leguminous plants can capture nitrogen, one of the most important crop nutrients, from the air and make it available in the soil for our crops. Crop rotations or intercropping with such legumes not only increases soil fertility but is also preventing a lot of pests and diseases. Furthermore, a permanent soil cover of living or dead plants (or plant parts) protects the soil because braking up the soil and leaving it open exposes it to wind and water erosion, and organic matter is decomposed, what not only reduces soil fertility but also releases CO₂ to the atmosphere and thus contributes to climate change.

In the following we explain how you can recycle organic material from your farm and household and turn it into compost to feed your soil and crops. Compost is great for soil fertility management because it adds nutrients and organic matter to the soil and thus helps holding water and nutrient in the soil, allows for adequate soil aeration, and improves the soil's structure favoring root growth, seedling emergence and soil life, and reducing soil erosion and compaction. It allows improving the value of animal manure, may suppress soil-borne pests and diseases, and can raise the pH value of the soil.

1. Making compost

By composting we accelerate the natural decomposition and transformation of organic material to humus so that we can use it as a soil amendment. We provide the bacteria, which perform this decomposition, a favorable environment so that they can do their job effectively. The decomposition process requires oxygen and some water. If the decomposition is fast it produces heat that destroys risky material such as weed seeds or pathogens (e.g. fungal diseases), pests and parasites.

A compost site is a central place where all organic materials from the farm are collected, broken down, and made available for plant nutrition when brought back into the nutrient cycle as fertilizer and soil amendment. (picture: Infonet Biovision)



The composting site should be close to where organic material accrues, if possible close to where the compost will be used (e.g. the garden), close to a source of water, in the shade (e.g. under a tree, banana plants, or some kind of roof), protected from heavy rain, and on relatively level ground but not where rainwater will collect/stagnate. The compost heap should not be placed too close to houses as the heap may attract rats, snakes and termites etc., and sometimes a bad odor cannot be avoided.



Locate the compost heap where organic material accrues and/or where it will be used, but not too close to the house (picture: HDRA 1998)

Material Organic material that can be used to make compost

- Plant materials, both dry and green:
 - Weeds, grasses and any other plant materials cut from inside and around fields, in clearing paths, in weeding, etc.
 - Wastes from cleaning grain, cooking and cleaning the house and compound, making food and drinks.
 - Crop residues: stems, leaves, straw and chaff of all field and horticultural crops or from threshing grounds.
 - Garden wastes – old leaves, dead flowers, hedge trimmings, grass cuttings, etc.
 - Dry grass, hay and straw left over from feeding and bedding animals. Animal bedding is very useful because it has been mixed with the urine and droppings of the animals.
 - Dropped leaves and stems from almost any trees and bushes except plants which have tough leaves, or leaves and stems with a strong smell or liquid when crushed. (Stems of cactus, such as prickly pear, can be used if they are crushed or chopped up. They are also a good source of moisture for making compost in dry areas.)
- Animal materials:
 - Dung and droppings from all types of domestic animals, from night pens and shelters, or collected from fields. (Chicken droppings are very valuable because they are rich in nitrogen.)
 - Urine from cattle and people: Provide your animals with a bedding of dry plant material in their shelter or paddock; the bedding will soak the urine (and dung). You can also catch urine in a container from animals when they wake up and start moving around in the morning, and provide a container in the toilet or latrine where people can pass or put their urine.
- **DO NOT USE:** Meat scraps (they attract rats and other pests, dogs, wild animals) and any non-organic materials like plastic or metal!

There are two different ways to make compost:

1.1. Continuously fed systems (“the easy way”):

All organic wastes are deposited on the heap continuously, as they are produced and obtained during

the year. Just throw any organic material you have onto one heap. In these heaps, temperature does not rise up as much as in a heap which is set up at once (see 2.2 Batch fed system), and the process of decomposition is therefore slower.

Turn, mix and shift the heap only once, then leave it there until you need it for fertilizing. A good time to turn the heap is around two or three months before the beginning of the next rainy season. Do not add any new/fresh material when turning the heap. After you turned the heap, cover it and leave it to mature. Then the compost will be ready when you need it for planting. From now on, new organic material is collected on a new heap. You can use the spot or pit from which you removed the first heap when you turned it.



If you have a lot of material, turn and move the heap when it is around one meter high. Then start a new heap. If this one also reaches one meter, turn the material onto the first heap, cover it all up and start collecting again. In this way, you will always have compost ready for use.

If you keep animals (cows, goats, sheep, rabbits, chicken) in sheds or enclosures where droppings are concentrated, the compost heap should be close-by. It is advisable to add new bedding (maize stalks, weeds, leaves etc.) for the animals at least once a week to soak up all the urine and manure. Feed residues, beddings, droppings and urine are all added to the compost regularly when using the “easy way” system. Collect all organic material in one pit or heap until it reaches one meter, then mix and turn it to another pit beneath the first one. In any case, turn the heap two or three months before planting and let it rest to mature, while you start to fill the first pit again.

1.2. Batch fed system (“the best way”):

The organic material is collected separately, then mixed and the compost heap set up at once. This system leads to a hot composting process. The compost is ready within a shorter time and a high quality product is obtained. Its advantages are reduced nutrient loss and destruction of diseases and weed seeds as a result of the high temperature (FAO 2015).

There are many ways to produce such compost. A very effective one is presented in the following. (pictures: FiBL 2012)

1. Collecting the material

Collect material like kitchen wastes and animal manure regularly and keep it separately. It is good to keep them dry, cool and covered, for example with banana leaves or a grass thatch to prevent water and nutrient loss before the heap is constructed. Soil, crop residues and green vegetative matter may be collected on the day of building the heap.



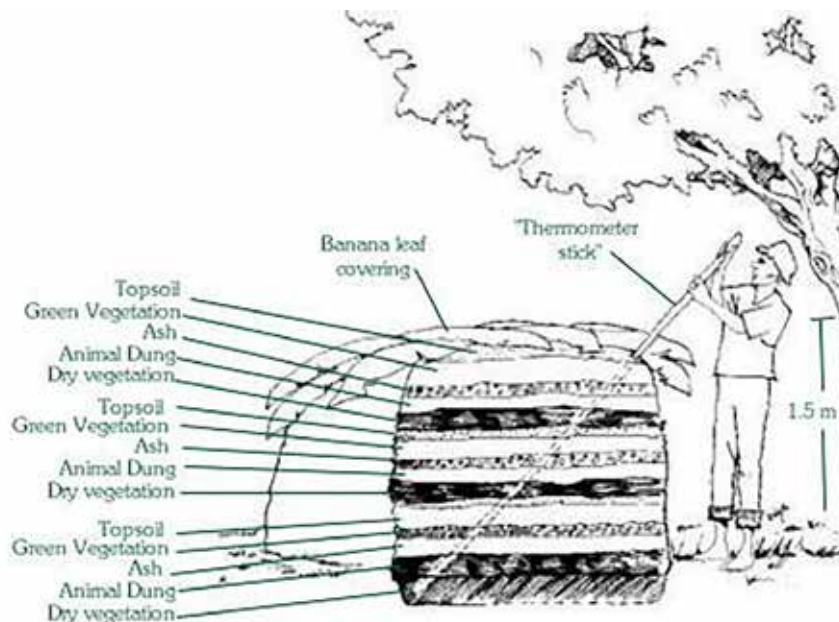
2. Prepare the foundation for the heap

- Dig a shallow trench/pit 1 to 2 m wide, 3 to 6 m long and 20 to 40 cm deep (if the heap is under a tree, move 2 m away from the tree presence of roots in the soil). Put the soil on one side, you will need it later.
- Put a 30 cm layer of twigs and branches (or possibly old straw, stalks of maize and sorghum, or old cabbage stalks, rose and hedge trimmings from gardens) at the bottom to allow good drainage of excess water. Sprinkle some water on this layer.



3. Setting up the heap

- Prepare the composting material well: chop coarse, especially woody, material to encourage its decomposition.
- Above the layer with twigs and branches make a second layer of dry vegetation, hedge cuttings or grass. This layer should be about 15 cm thick (6 inches). Sprinkle water on this layer too.
- Put on a third layer of animal manure. The manure contains micro-organisms which are vital for decomposition.
- Sprinkle some ash or dust on this layer. The ashes contain valuable minerals including potassium, phosphorus, calcium and magnesium. The ashes also neutralizes the acids produced during decomposition, especially by the animal manure.
- The next layer should be green leaves, possibly from high-protein leguminous trees like Calliandra, Leucaena and Sesbania. You can also use hedge cuttings of plants like Tithonia.
- Sprinkle on a little topsoil or old compost. The topsoil contains bacteria which are useful in the decomposition process.
- Add more layers in turn, starting with dry vegetative materials, then animal manure or biogas slurry, followed by wood ash, green vegetation and topsoil. Remember to sprinkle water on every layer. Build the pile up to 1.5 m (5 feet) high. A well-made pile has almost vertical sides and a flat top.
- To complete the pile, cover it all over with a layer of topsoil about 10 cm (4 inches) thick. This layer prevents plant nutrients from escaping from the compost pile. Lastly, cover the whole with 10 cm straw, grass, banana leaves or the like to protect it from drying out.



Piling up a compost heap in alternating layers of coarse dry material, manure, ash, fresh green material and soil (or old compost). Picture: IIRR 1998)

The ideal material mix

Decomposition of dry crop residues and woody parts is faster when enough easily decomposable material like fresh green plant material or fresh animal dung is mixed into the compost. An ideal mixture would be:

- one third fine nitrogen-rich material, such as fresh green vegetation, fresh leaves, weeds, household wastes and animal manure. Micro-organisms need this nitrogen to multiply and break down the other material.
- one third medium to fine material with lower nitrogen content (fine dry crop residues, dry leaves, straw etc.).
- one third bulky material like chopped branches, tree bark, coarse crop residues. This material guarantees that there is enough air inside the heap.

4. Composting in pits

When little water is available (in dry areas or during the dry season), composting in pits may be more appropriate than building heaps since humidity is better conserved in pits. In such cases it is recommended that the heap stands with more than half of its height in the ground. Be careful to locate the pit in a place than cannot be flooded. Do not use pits in wet areas, as the compost may become waterlogged.

If possible, make the compost immediately at the end of the rainy season while there are still green and moist plant materials (and ample other organic material) available. In the dry season and in dry areas it is particularly important to make the pit near a place where water can be added, e.g. next to the home compound where waste water and urine can be thrown on the compost, or near another water point. Also shading and covering the compost is important to prevent drying out. In dry areas, the «Bangalore-pit-method» is most appropriate. (IFOAM 2003; very detailed information you find in Edwards and Araya 2011)

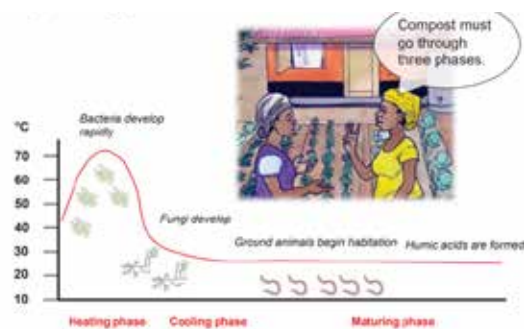
The composting process comprises three phases: heating, cooling, maturing (FiBL 2012)

5. Management of your compost heap

The composting process – 3 Phases

Compost goes through three phases until it is ready to be used:

- **Heating phase:** Within three days after setting up the compost heap, temperature in the center of the heap rises to about 60 °C to 70°C. You can feel that by driving a pointed (possibly metal) stick into the compost heap, withdrawing it and feeling its temperature. This heating phase lasts for about 2-3 weeks. The bacteria that decompose the material are using energy which produces the heat. This heat is crucial for good-quality compost and to destroy pests and diseases, weed roots and seeds.
- You should test the temperature of the heap from time to time using the stick method. During the heat phase the stick should feel slightly too hot to touch when removed. If it is still at ambient temperature decomposition may not have started yet. In this case, more air or water may be needed, or the heap may just need to be left for a while longer. If the heap is very hot, decomposition is happening but the excessive heat may kill or scare away the microorganisms. In this case, the supply of air will need to be reduced and more water added to cool it down.
- **Cooling phase:** After decomposition of the green plants by the bacteria, the temperature will decline to about 25°C to 45°C. By controlling the temperature with your (metal) “thermometer” stick you can observe the temperature decrease. Now, fungi start with the decomposition of straw, fibers and wooden material.
- **Maturing phase:** During this phase, red compost worms and other soil organisms start to become active. At the end of this phase, the compost has lost about half of its original volume. The color is dark and the compost smells like fertile soil.



The composting process comprises three phases: heating, cooling, maturing (FiBL 2012)

Turning the heap

If you want to accelerate the composting process you can turn the heap after two to three weeks when the hot phase is over and the heap will have decreased to about half its original size (your thermometer stick is cold when you pull it out, or if it has a white substance on it; this shows that decomposition has stopped). Turning the compost helps to accelerate the decomposition process, but it is not essential if the heap has been set up properly and kept moist. However, with turning the heap you achieve better quality compost (more homogenous decomposition, better destruction of pathogens). Turning of the heap will replace the oxygen and will ensure that the material on the outside decomposes as well. To turn, the heap needs to be taken apart. Then the ingredients can be mixed, and the heap is rebuilt. If the heap is dry, water should be added. If the heap is wet, organic matter is added. (picture: IIRR 1998) You may turn the heap a second time about 3 weeks to two months later. A third turning may be necessary before all the material, other than twigs and thick stems, has decomposed. The compost is ready about 2 to 4 months after the heap has been set up. The compost is mature as soon as none of the original



Turn the pile after 2-3 weeks

material is recognizable anymore and has turned into a blackish brown color with a pleasant smell. Be sure to protect the mature compost from rain and sun; the compost should stay moist but not wet. To check whether your compost is mature take some compost in your hands and check the moisture content. An ideal moisture content means that the compost keeps its form without dripping. If compost falls apart it is too dry. If the compost smears or drips, the compost is too wet.



Checking the moisture content of the compost (FIBL 2012)

What's wrong with my compost?

If the compost material gets dusty white, this is a sign that fungi are developing too much. The material is too dry and too loose. In this case, you have to add water and mix in nitrogen rich material (fresh green material, urine, fresh cow dung) and keep the heap moist. If the material gets blackish-greenish and has a foul smell, this is a sign that the material is too wet and that air and structure are missing. Loosen the heap or best set it up again, mix coarse woody dry material into it and protect it from rain. (TOF 2010a)

How to make enriched compost in just 14 days (CTA 2007)

A more rapid method of making compost has been developed in Asia. The decomposition process is speeded-up by adding large amounts of fresh animal manure and by frequently turning the heap. Chicken manure is superior to other manures.

Do this:

1. Chop the plant waste materials (dry or green or both).
2. Thoroughly mix these with equal amounts of fresh animal manure.
3. Pile the mixture into a heap at least 1m high and 1m wide and allow a similar sized area to turn the heap.
4. Cover the heap with banana leaves or old sacks to reduce heat loss.
5. By the third or fourth day, the inside of the heap should be hot. If not, add more manure and mix with the other materials.
6. From the third or fourth day onwards, turn the heap every two days so that the materials from the sides and top are moved to the centre.
7. In 14 to 18 days, the compost should be ready for use.

Application of compost

The main use of compost is to increase and maintain crop yields by improving the ability of the soil to hold water and nutrients, by adding nutrients to the soil, by amending soil structure (and thus enhancing rainwater infiltration and reducing soil erosion), and by keeping the soil healthy.

Compost can be used as soon as the original composting material has changed into an unrecognizable crumbly, dark mass with a pleasant smell. Twigs and thick stems do not decompose completely and can still be seen. How long it takes until this stage is reached depends on the used materials, the outside temperature and moisture content of the heap. It can take one month only, or up to three or four months after turning the heap.

Immature compost should be spread out as mulch; it will continue to mature on the ground, suppresses weed growth, and animals in the soil will draw it into the soil where it will decompose further. When using compost as a mulch it should be covered with a thin layer of straw; this will avoid loss of nutrients due to direct exposure to sunlight and heat.

Ripe compost can be worked into the soil superficially (down to max 10 cm). It is best to use compost near to or directly in the root zone of plants. Mix a few handfuls into the planting hole before or at planting. If you prepare a seedbed or beds for transplanting, use about two large hoofuls per square meter, or enough to cover the ground with a layer of 1 cm thickness.



Spreading compost around the base of plants suppresses weed growth and improves soil structure (picture: HDRA 1998)

Compost is a scarce and valuable soil amendment. Usually it is just not possible to produce sufficient amounts for fertilizing all fields. It should therefore be applied where it is most beneficial:

- in nurseries for seedlings;
- in seedbeds;
- in your kitchen garden;
- into planting holes or pits.

(TOF 2010a; for the nutrient contents of composts, please refer to the TOF 2010b)

Final remarks

Compost making relies on materials that are available on the farm and does not require any special equipment, making it a cheap method. But compost production requires a lot of labor and demands regular attention. Collecting the composting materials, setting up the heap, regular watering and repeated turning of the heap, when not mechanized, make composting a labor intensive activity. Nevertheless, in view of the value of compost as a soil amendment it is worth to invest these efforts for compost preparation (FiBL 2012).

Using animal manure for soil fertilization

Animal manure is very valuable fertilizer containing large amounts of nutrients and organic matter: adding manure to soils enhances soil fertility and soil health that leads to increased agricultural productivity, improved soil structure and biodiversity.

However, adding fresh manure as a fertilizer can harm (burn) our crops, and it contains pathogens dangerous for humans and possibly viable weed seeds (Rosen and Bierman). Therefore, manure should be collected and stored for a while. But if manure is stored inadequately (e.g. if it is just dried), it loses its value as a fertilizer (volatilization of N, possibly leaching of N and other nutrients by rainwater).

The best fertilizer quality we achieve if we use manure in composting, i.e. if we add it to a compost heap or pit. Else we should mix the manure with dry plant material (straw, grass, crop residues, leaves etc.) or sawdust for storage. The best option is that the dry plant material is used as bedding material for the animals and thus can soak both dung and urine; this gives a well-balanced source of plant nutrients which is of similar or even better quality than chemical fertilizer.

As compost, stored farmyard manure should be protected from sun, wind and rain. Water logging, as well as drying out should be avoided, so as to avoid nutrient losses. The storage site should be impermeable and have a slight slope. Ideally, a trench collects the liquid from the manure heap and the urine from the stable. A dam around the heap prevents uncontrolled in- and outflow of urine and water.

Storing manure in pits is particularly suitable for dry areas and dry seasons. Storage in pits reduces the risk of drying out and the need to water the pile. However, there is greater risk of waterlogging and more effort is required as the pit needs to be dug out. For this method, a 90 cm deep pit is dug with a slight slope at the bottom. The bottom is compressed and then first covered with straw. The pit is filled with layers of manure about 30 cm thick and each layer compressed and covered with a thin layer of earth. The pit is filled up until it stands about 30 cm above ground and then covered with 10 cm of soil. (FAO 2015)

Collect animal dung, urine and bedding materials daily and add to your heap or pit. It is possible to enrich the manure by adding ash (potassium), natural phosphate, glumes and other material (Agrisud 2010). A heap should get at least 1m high and 1m wide. The temperature of the fresh manure can rise up to 70°C within 1 to 3 weeks. It is advised to turn the heap over when temperature reaches 60°C (stick method or putting hand inside the manure feels hot); this may be necessary two to three times (JICA 2016).

After collecting the manure (dung together with bedding materials) for up to 2 months, let it remain further up to 2 months without putting other manures over it so that it can mature. Make sure to cover it with leaves, straw or plastic sheet during this period. Afterwards, the manure is ready to be used. Well decomposed animal manure is a great fertilizer and soil amendment, and free from weed seeds, plant pathogenic fungi, bacteria and parasites.

If possible, animal manure should be incorporated into the soil during or immediately after spreading to minimize open air exposure and prevent nutrients (mostly N) from getting lost prior to uptake by crops (Teenstra et al. 2015).

ONION PRODUCTION



1. Importance of Onion growing and common varieties in Uganda

Learning objectives:

After completing this module, participants will:

- Understand the importance of onion growing for income and nutrition
- Have reflected on the reasons why they would like to grow onions
- Know the characteristics of different varieties of onions commonly grown in Uganda and be able to choose varieties adapted to the growing conditions of their farm and production objectives.

Duration: 1.5 hours

Learning aids

- Flip charts
- Marker pens
- Masking tape
- Training manual
- Different varieties of onions (if available) or pictures of these varieties

Activities and exercises

- Discuss why is it important for you to grow onions
- Show samples of onion varieties available in the community and what are their advantages and disadvantages.

Content

1.1 The importance of growing onions.

Onion is a vegetable grown as an annual crop. Onions require both a small amount of initial capital and land to produce. It takes a relatively short time to mature.

Onion are mainly grown because of the following reasons.

- For food – they form an important ingredient of various dishes as sauce or salads
- For generating income- they are high income crops and easy to sell

1.2 Qualities of a good seedling for transplanting

The facilitator should emphasize that if seedlings is not properly managed in the nursery bed, they may not be very good for transplant, the trainer should emphasize the key qualities to consider when one is buying or selecting good seedlings for transplanting.

- Healthy and disease-free seedling
- Vigorous growth
- Have 4-6 true leaves
- Pencil thickness
- Free from physical deformities

It is recommended to purchase seed/seedling from a reputable supplier/stockist. Seedlings sourced from unreliable suppliers may affect production through the following:





- Varsity not true to type
- Uneven bulb size
- Bulbs ripening at different time
- Reduced yields level
- High persistence of pests and diseases

1.3 Selected varieties of onions commonly grown in Uganda

Which variety to choose depends on local conditions and the purpose of growing and intended use (self-consumption, selling in the village, on supermarket, for hotels, processing). Therefore, it is important to think about the intended use of the onion you will cultivate, the market preferences, and to choose the varieties accordingly

The common onion varieties grown in Uganda are Bombay red and Red Creole. These varieties have only medium yield potentials, but they are very popular. Other onion varieties are the hybrids Jambar F1, Red Passion F1, Red Pinoy and Early Red Max.

Table 1: The main onion varieties grown in Uganda

| Variety | Maturity | Yield | Attributes |
|--|------------------------------|-----------------------|---|
| Red Creole  | 150 days after transplanting | 16,000 kg per acre | <ul style="list-style-type: none"> • A popular variety which produces red, flat-round, globular bulbs • It has very pungent taste • Excellent in storage |
| Bombay Red  | 150 days from transplanting | 16,000 kg per acre | <ul style="list-style-type: none"> • Variety for dry and warmer conditions • Produces small to medium sized bulbs, which are globe shaped, deep purple red color. • Good storage capability and transport |
| Red Passion F1  | 120 days | 25'000 kg per acre | <ul style="list-style-type: none"> • Deep red hybrid onion • Very good drying and keeping quality • Tolerant to pink rot disease • Produces good grade onions • Uniform maturity • Can store for up to 6 month • Plant spacing 30×10 |
| Red Pinoy  | 90 days from transplanting | 25'000-30'000 kg/acre | <ul style="list-style-type: none"> □ Well adapted to rainfed and irrigation □ Strong pungency □ Long shelf life of up to 6 months at room temperature • Deep red attractive bulbs with a high market demand. |

2. Land selection and land preparation for onion planting

Learning objectives:

After completing this module, participants will:

- Understand the factors to consider in selecting a suitable site for onion production
- Understand how onion plants interact with other plants and how to plan crop rotation considering spatial and temporal arrangement of onion plants.
- Learn the best practices of land preparation for onion production.

Duration: 3 hours

Learning aids

- Land where the onion plot will be implemented
- Tools for land preparation such as Hoes, Pangas, Slashers, Axes

Activities and exercises

- Discuss what group members would consider to choose an appropriate site for growing your onions
- Practically prepare the land for onion plantation.

Content

Land selection for onion growing

- Onions grow well in sandy loam soils with good fertility. Fertility can be seen from the vegetation growing in the area.
- Soils with small gravels are suitable for onion production.
- The land should not be prone to flooding and it should have a gentle slope to facilitate drainage.
- There should not be many trees as they will lead to lots of shade in the field and yet shade affects the development of onions.
- The land should not have been used for production of onions or garlic in the last 1 year. This will help minimize pests and diseases build up.

Crop rotation is essential to minimize pest and diseases!

- Crop rotation is a major component of organic farming, affecting both soil conditions and pest cycles.
- Wait 3-4 years before planting onions again at the same location
- A rotation with non-solanaceous crops for 3-6 years will avoid pest problems in onions.

Land preparation for onion growing

- The land must be dug and allowed to rest for at least one month. During this period, there is also decomposition of the trash/rubbish to manure for improved soil fertility.
- Deep ploughing by use of hand hoes or tractors is recommended to remove most of the weed roots and soften the soil for easy movement of water and air in the soil, but also make it easy for bulb formation and expansion.
- Second tillage is then done to produce a fine bed. This will improve crop establishment and growth.
- Apply mulch to conserve soil and water and reduce evaporation.
- If you are planning to plant in the second rains, open your land (1st digging) at the end of the 1st rains. This will enable you to have the land ready for planting by the time the second rains start.

3. Nursery establishment and management

Learning objectives:

After completing this module, participants will:

- Understand the factors to consider in selecting a suitable site for onion production
- Understand how onion plants interact with other plants and how to plan crop rotation considering spatial and temporal arrangement of onion plants.
- Learn the best practices of land preparation for onion production.

Duration: 3 hours

Learning aids

- Seed
- Watering can
- Spray pump
- Panga
- Hoes, Poles
- Dry grass
- Tying materials

Activities and exercises

- In the demonstration field ask members to observe what has happened since the last session.
- Recap the last lesson and skills learnt
- Although some people plant ready seedlings that is very expensive, discuss why it is important to have an onion nursery
- Also discuss what are attributes of a good nursery site
- Practically demonstrate how to site and set up and manage a nursery

Content

- A nursery bed is a prepared plot of land for raising seedlings. It acts as a temporary home for young plants until they are eventually planted in a main garden.
- A poorly constructed and managed nursery bed will lead to poor germination or diseased seedlings, the seedlings may fail to grow when transplanted.

The purpose of the nursery is therefore to grow seedlings:

- Of the right variety and in sufficient quantities.
- Of the right size, health and strength at the beginning of the planting season.

Qualities of a good nursery bed:

- A gentle slope fertile and well drained piece of land
- Close to water source for irrigation of the seedlings
- Should never be put in a water logged area
- Located in less weed infested area
- In areas with a lot of water, raise the nursery bed 10-15 cm above the ground
- The soil should be dug deeply
- Not neighboring onion or ginger gardens
- Should be near the main garden to avoid damage of seedlings at transplanting

Nursery bed preparation, sowing and watering

The following steps should be followed when implementing a nursery:

1. Choose a good location with a good drainage.
 2. Clear the land.
- Measure 1.2 metre wide of any length, dig it well, ensuring that stones and roots lying underneath are dug out and thrown outside the nursery
 - Construct the bed by heaping the soil to a height of 15 cm above the ground. The top of the

constructed bed should be 1 metre wide with sliding sides.

- The soil should then be mixed thoroughly with farm yard manure where applicable
- Charcoal dust and ashes can also be mixed in the bed to correct the acidity of the soil and keep away worms

Sowing seeds in the nursery beds

Planting and planting depth

- The bed should be watered thoroughly on the evening before sowing.
- Spacing: 30cm x 10cm or at spacing of 15cm between rows (1 plant per hole).
- Cover the seeds lightly and mulch the bed with dry grass.
- Gaps fill within 1 week of transplanting for even growth.
- Onion should be transplanted at a depth of 2.5-3 cm deep when its already pencil size
- Add water to the planting hole before planting for better establishment

Maintenance of nursery bed

- Mulch the seed bed after sowing until germination
- Provide enough shade to the seedlings after germination, 1 metre above the bed
- Thin the seedlings properly, remove weak or disease seedlings and keep the bed weed-free
- Provide enough water to the seedlings.



Fig1: shows well managed onion seedlings in the nursery bed ready for transplanting

Weeds, Pest and disease management in nursery bed

- Before watering, it is important to gently pull any weeds that are growing in the nursery bed. Such weeds compete with the seedlings for nutrients and water in the soil.
- One of the most common diseases of onions in the nursery is damping off, which causes the stem to rot at the crown, leading to seedling death.
- To avoid damping off, one week after germination, a spray with mancozeb or Dithane M45 is possible (but not recommended in agroecological production).
- Mix 1 tea spoon in 5 litres of water. On the day of spraying, ensure you water first and then spray after watering so that the chemical is not washed off the seedlings during watering. If there are signs of rain, do not spray. Spraying should be done at least 3 hours before or after any rain.

4. Transplanting

Learning objectives:

After completing this module, participants will:

- Select good seedlings for onion planting.
- Plant onions with the correct spacing.
- Plant onions according to the recommended practices.

Duration: 3-4 hours

Learning aids

- Group demonstration field
- Hoes
- Onions seedlings
- Watering cans
- Strings and Pegs

Activities and exercises

- In the demonstration field observe with the participants what has changed with plants grown
- Discuss how to select quality seedlings
- Practically demonstrate how to transplant

Content

Timing of seedling transplant

- Age of the seedling is important for establishment and higher bulb yield, this should be done when 3-4 true leaves emerge, before the bulb formation starts. Transplant seedling after 45-55days
- If seedlings overstay in nursery bed for 60 days after sowing bulb formation starts and potential for bulb size development reduced with consequent significant yield reduction.
- Harden the crop by removing shade a week before transplanting as this gives the seedling chances to get used to direct sun.
- Transplant at recommended spacing per crop early in the morning or late in the evening from (6:00am to 10:00am or 4:00 to 6:00pm)
- Plants should receive water as soon as transplanting is done.

Steps in Transplanting Seedlings

- **Step 1:** The day before transplanting gently water the seedbeds heavily, to loosen the soil for easy pulling and reduced root damage. Do not water on the day you transplant.
- **Step 2:** Use the correct in-row and between-row spacing and mark and dig all planting holes to be transplanted the same day.
- **Step 3:** Remove the seedlings from the seed bed with as much moist soil around its roots as possible. Hold the seedling very close to the root crown as you pull. This minimizes leaf damage during pulling.
- **Step 4:** Place the seedlings carefully in a bucket, basket or bowl and transport them immediately to the planting site
- **Step 5:** Quickly plant the seedling in its planting hole without bending its roots.
- **Step 6:** Hold the seedling in one hand and using two fingers of the other hand make a hole 3-5cm deep at a marked position. Carefully place the seedling in the planting hole with the roots pointing downwards.
- **Step 7:** Place the soil firmly around the root collar of the seedling with your fingers to keep it upright and to expel any trapped air.
- **Step 8:** Gently water the seedlings and then shade them with leaf twigs or arched dried grass to protect it from the heat of the sun
- **Step 9:** Continue transplanting, watering and shading until all the planting holes are filled.
- **Step 10:** Mulch the shaded seedlings.
- **Step 11:** Any excess seedlings may be sold except for a few which should remain to replace the ones that may die.
- **Step 12:** After a week remove the shading twigs or grass and water twice a week
- **Step 13:** Keep a diary to record all the activities you are doing each day and the dates as well.

5. Weeding

Learning objectives:

After completing this module, participants will:

- know when and how to do weeding, pruning, and staking.
- understand the effects of weeds on the yields of onions.
- Be able to apply the different methods of weed control in the onions.

Duration: 3 hours

Learning aids

- Demonstration field Tools for weeding

Activities and exercises

- In the demonstration field observe with the participants what has changed with the plants grown
- Discuss what is a weed and why we must weed
- Practically select a weed and demonstrate how weeding and pesticide making and spraying are done and ask trainees to do the same on their fields

Content

Effects of weeds on onion plants

- Weeds directly compete with plants for growth factors like sunlight, water, nutrients, space, and this makes the crop weak and susceptible to attack by pathogens.
- Weeds greatly reduce crop yield as well as its general performance.
- Weeds harbor pests and diseases.
- Some weeds can damage the crop by producing toxic substances.
- Weeds cause harvesting problems, especially those that develop late in the crop season.



**A well managed onion garden
kept free from weeds**

Weed Management

- Onions develop slower and weed competition can result in yield losses.
- Weeds can be controlled successfully if done at the right time, using the right methods.
- Care should be taken to avoid damage to the bulbs when mechanical weed control measures are used.
- Frequent weeding is encouraged as it does not only kill the weeds but also loosens the soil which helps in bulb expansion.
- Generally, 3 hand weeding are given at 1-month interval after transplanting.
- Weeding will greatly help curb pests and diseases.
- Apart from using a hoe, weeds in onions can also be controlled using the following:
 - Mulching
 - Crop rotation
 - Hand pulling/uprooting the weeds

In addition, the following factors are important for a good onion production

- High temperature favors bulb formation and development, however if temperature exceeds that required for bulb formation, maturity is hastened and bulbs do not grow to maximum size. This lowers yield.
- Fertile well drained soil is also important for onion production
- Bulbs development stage needs substantial amount of moisture during the growing season
- Avoid application of fresh manure as the plants will develop thick necks and too much leaf at the expense of bulb formation.

6. Pest and disease management

Learning objectives:

After completing this module, participants will:

- Know the common pests and diseases affecting onions and their effects.
- Recognize the signs and symptoms of different pests and disease attack in onions.
- Apply the Integrated Pest and Disease management approaches in onion production.
- Understand the critical stages of growth of different pests to target control in onion production.

Duration: 3-4 hours

Learning aids

- Demonstration garden
- Insect bottle
- Stationery
- Knapsack sprayer
- Jerrycan
- Basin soap
- Pesticides

Activities and exercises

- In the field, identify any pest and diseases affecting onions
- Let trainees list whatever pest and diseases they have experienced
- Discuss the various pest and diseases – their symptoms and prevention measure to avoid attacks
- Practically demonstrate organic treatment measures – see section after Eggplant





Content

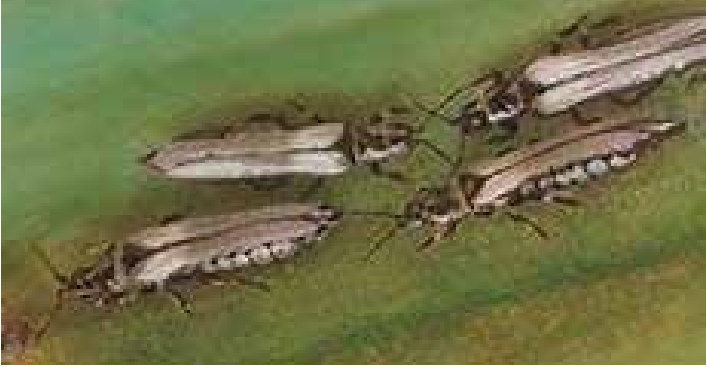




General pest and disease management practices








Onions are not attacked by so many pests and diseases as other horticultural crops. This is because of their smell which repels some of the pests and disease vectors. It is however not completely immune to attack. It is recommended that control starts even before the pests or disease symptoms are seen. Prevention measures should also be put in place. In principle, the following practices will greatly reduce pest and disease incidences in the field.

1. Crop rotation – this breaks the pest lifecycle.
2. Early planting – your crop escapes by the time pest/disease incidences rise, you are harvesting.
3. Use of resistant varieties – they resist damage even when the crop is attacked (see Table 1 to identify which variety is resistant to which diseases).
4. Weed control – weeds affect crop vigor which is related to damage. Weaker crops are more damaged (see previous chapter).
5. Scouting – To spot pests/diseases early and control them in time.
6. Correct identification of pest or disease to use the right control strategy.
7. When irrigating, do not wet the leaves. Otherwise, it will help fungal diseases to develop.
8. Mulching– reduces contact of soil and the plant parts.
9. Remove affected plant parts

Common onion pest and diseases and their control methods

| What they are | | Signs | Controls |
|---|--|--|---|
| Onion thrips  |  | <ul style="list-style-type: none">• They are tiny (1 mm in length), slender and very mobile insects.• Distortion of leaves and bulbs• Result into white and silvery patches on the leaves | <ul style="list-style-type: none">• Remove weeds. Thrips build up on them.• Remove heavily infested plants.• Crop rotation• Timely planting• Spray with organic pests or cypermethrin |
| Onion fly (<i>Delia antiqua</i>)  |  | <p>The most damaging stage of this pest is the larva, called the onion maggot</p> <p>It is white-cream in colour and it damages onions by:</p> <p>Eat the lateral roots system and bore into the base of the stem.</p> <p>Attacked leaves wilt and turn bluish, with the plants becoming shrivelled and later wilting.</p> | <ul style="list-style-type: none">• Where manure is used, it should have broken down properly before it is used to cut of attraction to the onion fly.• Avoid planting in soil with high un decomposed organic matter. This attracts adults to lay eggs in soil• Powdered hot pepper or powdered ginger placed around the stems helps when the onion fly population is moderate.• Practice rotation with crops not related to onions, do not plant in fields affected with crops in the same family• Neem-based products have a deterrent effect on the adult flies |

| What they are | Signs | Controls |
|---|---|---|
| <p>Onion crickets</p>  | <p>They cause serious damage to the crop particularly at the beginning of the season, both in the nursery bed and after transplanting in the main field. They cut and feed on the seedlings killing them instantly.</p> | <p>Field hygiene by timely weeding especially immediately after transplanting</p> |
| <p>Cutworms</p>  |  <p>They are caterpillars that live in the soil, and eat the stems of young seedlings and transplants of all garden crops.</p> <p>The seedlings or transplants may be entirely eaten, or may be felled like tiny trees at soil level, in most cases, overnight.</p> | <ul style="list-style-type: none"> • Field hygiene as the cutworms tend to hide among debris in the field • Spray with organic pesticides • Proper timing of planting to avoid water stress in the early stages of crop growth as this leads to more extensive activity by the pest and damage to the crops. • Maintain weed-free plots |
| <p>Purple blotch (<i>Alternaria porri</i>)</p>  |  <p>Small white sunken spots developed on the leaves. These enlarge and under moist condition turn purple with a yellowish border and are covered with a sooty deposit of spores, after 3-4 weeks the leaves turn yellow and collapse.</p> <p>Bulbs may be attacked, mainly at the neck. This can be seen as a yellow to reddish watery rot.</p> | <ul style="list-style-type: none"> • Crop rotation, • use disease free seedlings, • sprays every seven days with a fungicide when signs of infection appear. Spray with Mancozeb or Dithane M45. |

| What they are | | Signs | Controls |
|-------------------------|---|---|---|
| Downy mildew |   | <ul style="list-style-type: none"> □ Lesions form near tips of old leaves (elongated yellowish patches) □ Leaves die back and this extends to younger leaves | <ul style="list-style-type: none"> □ Crop rotation, □ use clean propagules, □ spray every seven days with a fungicide when signs of infection appear using mancozeb or Dithane M45 (not recommended in agroecological production). |
| Yellow dwarf |   | This is a viral disease transmitted by aphids; symptoms appear as short yellow streaks at the base of the first leaves as they emerge through the neck of the bulb. | Timely planting, improved field hygiene and sanitation |
| Storage diseases | | | |
| Neck rot |  | Neck rot symptoms usually appear in storage; however, it may start immediately before harvest. As the disease progresses, the tissue becomes greyish and a grey mold may also develop | healthy seeds, proper drying, leave at least 4 cm stem length at neck during topping, |
| Soft rot disease |  | Severe discoloration with soft rotting and water soaking of one or more of the inner fleshy scales. Foul odour may ooze from the bulb when squeezed | Proper drying, harvest only at right maturity, reduce doses of nitrogenous fertilizers |
| Brown rot |  | Dark brown discoloration on bulb scale; Rotting starts from inner scales and spreads to outer scales; Bulbs seems to be healthy, but when pressed, white ooze comes from the neck. | Proper drying and leave at least 4 cm stem length at neck during topping |

7. Onion Harvesting and drying

Learning objectives:

After completing this module, participants will:

- be able to identify signs of maturity and ripening in the onion crop
- know when to harvest onions
- know the different methods and practices of harvesting and drying onions

Duration: 3-4 hours

Learning aids

- Tarpaulins
- Containers/wooden boxes
- Demonstration garden

Activities and exercises

- In the participant fields ask participants to observe what has changed with the crop
- Discuss signs of maturity and ripening in the onion crop for the correct stage of harvesting
- Discuss the common mistakes farmers make during harvesting and drying of onions
- Practically harvest the onions with trainees

Content

Signs of maturity and harvesting of onions

Onions take 165- 170 days (5 – 6 months) to mature including days in the nursery bed. Maturity signs include:

- Bulb necks become thin
- Leaves bend over/droop
- Leaf bending can be done by the farmer during the last month of maturity (to fasten ripening)
- The tops of the onions turn brown or yellow and fall over

Methods and practice of harvesting onion

Pull the onions early in the morning on a sunny dry day, Shake off excess soil.

Proper harvesting of onions starts with a preparation phase called curing. Curing is a process intended to dry off the necks and outer leaves of bulbs. The main objective is to prolong shelf life by preventing moisture loss and attack by diseases

Field Curing - Curing can be done in the field if the maturity and harvesting coincides with dry months. It involves:

- Placing the harvested onions in rows with leaves partially covering the bulbs to prevent sunburn or greening
- The onions are then left in the field until the outer leaves and neck are completely dry and papery. This takes 2 – 3 weeks depending on the environmental condition

Protected Curing - is where the drying of onions is done in a protected environment, in a warm, dry and well-ventilated location protected from direct sunlight and rain

The process involves the following:

- Removal of excess soil
- Trimming of foliage leaving 2.5cm of section of stem at neck
- Placing onions in single layer in large flat tray

Onions can also be cured by tying tops of bulbs in bunches and hanging on a horizontal pole in well ventilated shade

Drying and storage of onion after harvest

- Dry in open sided bands or under tree shade on a raised platform that allows air circulation from the bottom of the heap, protected from sunshine to avoid scorching the bulbs
- Delayed drying after harvest can cause rotting
- Store in good houses, well ventilated for further curing.
- Tie bunches by the leaves and hang in an onion store well ventilated cool and dry
- Skin colour should be typical of the cultivar if it is to be stored
- Do not mixed varieties in the same package
- Remove all damaged, diseased and thick necked bulbs during sorting before storage

Annex

| Weeks | Growth stage | Activities | Recommendation |
|-----------------------------|---|--|--|
| 8weeks before transplanting | Nursery bed management Germination after 5-8days | <ul style="list-style-type: none"> • Prepare the nursery bed • Sowing (4 – 5 weeks before intended transplanting date) • Watering • Raise the shade • Thinning • Pest and disease management and (Hardening) | <ul style="list-style-type: none"> • Soil sterilization • Fence the nursery bed after sowing • Water twice morning and evening) • Slant the shade west-east to a height of 1m by 1/2m immediately after germination • Reduce watering gradually • Remove the shade |
| 1 | Pencil thick | <ul style="list-style-type: none"> • Transplant and mulch immediately after transplanting. • Take care not to mulch with materials having viable seeds. These will become weeds | <ul style="list-style-type: none"> • Use clean material for carrying the seedling Sort seedlings and plant uniform size seedlings • Transplant in the evening |
| 2 | | <ul style="list-style-type: none"> • Gap fill | <ul style="list-style-type: none"> • Keep the field free of weeds all the time • Select more vigorous seedlings for faster growth to catch up with those planted earlier. • Do it within a week after transplanting to avoid big differences in growth |
| 3 | The fourth and fifth leaves emerge | <ul style="list-style-type: none"> • First weeding • Monitoring for pests (cutworms and crickets) | <ul style="list-style-type: none"> • Remove the weeds from the field, taking care not to injure the plants |
| 4 | Vegetative growth | <ul style="list-style-type: none"> • Monitoring for pests and diseases (cutworms, aphids, bacterial wilt) | <ul style="list-style-type: none"> • Spray with organic pesticides/ Pyrethroid and dimethoate derivatives • Fungicides (mancozeb, dithane M45) • Phyto sanitation |

| | | | |
|----|---|---|--|
| 5 | Vegetative growth continues | <ul style="list-style-type: none"> • Second weeding • Monitoring for pests and diseases (mole crickets, downy mildew, onion thrips)) • Do earthing-up | <ul style="list-style-type: none"> • Phyto sanitation • Reduce movement in the field |
| 6 | Bulbing starts | <ul style="list-style-type: none"> • Monitoring for pests and diseases (mole crickets, downy mildew, onion thrips) • Do earthing-up | <ul style="list-style-type: none"> • Spray with dimethoate • Phyto sanitation • Minimize movements in the garden • Start constructing a store for curing |
| 7 | Bulbing continues | <ul style="list-style-type: none"> • Weeding continues • Monitoring for pests and diseases (mole crickets, downy mildew, onion thrips)) • Earthing-up continues | <ul style="list-style-type: none"> • Minimize movements in the garden |
| 8 | Bulb expansions increase in size | <ul style="list-style-type: none"> • Field monitoring to check for exposed bulbs • Earthing-up exposed bulbs | <ul style="list-style-type: none"> • Reduce movement in the field • Phytosanitation • Avoid foreigners from accessing the field |
| 9 | Bulb expansion continues | <ul style="list-style-type: none"> • Weeding continues • Monitoring for pests and diseases (mole crickets, downy mildew, onion thrips)) • Earthing-up for exposed tubers continues | <ul style="list-style-type: none"> • Guard against thieves • Avoid movements in the garden • Phyto sanitation |
| 10 | Physiological maturity signs appear (10% maturity) | <ul style="list-style-type: none"> • Field monitoring for exposed bulbs • Earthing-up for exposed tubers continues | <ul style="list-style-type: none"> • Guard against intruders (thieves) • Reduce movement in the field phyto sanitation • Organize the items used during harvesting and drying |
| 11 | Physiological maturity signs intensify (50% maturity) | <ul style="list-style-type: none"> • Field monitoring for theft | <ul style="list-style-type: none"> • Bend the leaves to fasten maturity |
| 12 | Maturity continues (70%) | <ul style="list-style-type: none"> • Start selective harvest incase bending wasn't done | <ul style="list-style-type: none"> • Guard against theft |
| 13 | Maturity continues (70%) | <ul style="list-style-type: none"> • Start selective harvest incase bending wasn't done | <ul style="list-style-type: none"> • Guard against theft |
| 14 | Harvesting | <ul style="list-style-type: none"> • Lifting the bulbs | <ul style="list-style-type: none"> • Take care to avoid bulb injury |
| 15 | Post-harvest handling | <ul style="list-style-type: none"> • Drying/ Curing • storage | <ul style="list-style-type: none"> • Cure under shade • Well ventilated stores |

TOMATO PRODUCTION



1. Importance of tomato growing and common varieties in Uganda

Learning objectives:

After completing this module, participants will:

- Understand the importance of tomato growing for income and nutrition
- Have reflected on the reasons why they would like to grow tomatoes
- Know the characteristics of different varieties of tomatoes commonly grown in Uganda and be able to choose varieties adapted to the growing conditions of their farm and production objectives

Duration: 2-3 hours

Learning aids

- Flip charts
- Marker pens
- Masking tape
- Training manual
- Different varieties of tomatoes (if available) or pictures of these varieties

Activities and exercises

- Discuss why is it important for you to grow tomato
- Show samples of tomato varieties available in the community and what are their advantages and disadvantages.

Content

1.1 Reasons for growing tomatoes

Tomatoes are grown for different reasons including:

- Household consumption: Tomatoes are an important ingredient in various dishes such as sauces and salads. They contribute to a healthy diet because they are rich in minerals, vitamins, essential amino acids, sugars and dietary fibres. They contain vitamin B and C, iron and phosphorus.
- As a source of income: Tomatoes are a high-income crop that is easy to sell. They have a short production cycle (90 days) and require small amounts of initial investment capital.
- Tomatoes can be processed into purées, juices and ketchup. Canned and dried tomatoes are economically important processed products.

1.2 Types of tomato plants

Tomato is an annual plant, which can reach a height of over two metres. Three different types of tomato plants can be distinguished:

- tall or indeterminate type
- semi-bush or semi-indeterminate type
- bush or determinate type




The tall varieties are the best choice for a long harvest period. They keep growing after flowering. This feature is called indeterminate. The plants generally have more foliage. This will keep the temperature lower within the crop and the fruits grow in the shade of the leaves. Because they are covered, the sun does not damage the fruits and they ripen more slowly. Slower ripening and a high leaf/fruit ratio improve the taste of the fruits and in particular the sweetness. The tall types have to be staked, caged or trellised.







Bush types usually support themselves and need no staking. Determinate types stop growing after flowering. They require less labour, so they are popular for commercial cultivation. They have a relatively concentrated fruit set which lasts only two or three weeks and the fruits ripen much faster than those from indeterminate types.

1.3. Selected varieties of Tomato commonly grown in Uganda

- Which variety to choose depends on local conditions and the purpose of growing and intended use ((self-consumption, selling in the village, on supermarket, for hotels, processing into dry tomato, tomato puree other products). Therefore, it is important to think about the intended use of the tomato you will cultivate, the market preferences, and to choose the varieties accordingly
- Local varieties (land-races) and improved (or commercial) varieties can be distinguished. They are the result of a continuous process of selection of plants. Selection criteria are based on characteristics such as type of fruit, shape of plant, vitality and resistance to pests and diseases, yield, Duration of production cycle but also on factors related to climate and management. Farmers select varieties that perform best under the local conditions.
- Hybrid and non-hybrid varieties can be distinguished. Tomato breeding companies have produced F1-hybrids. These grow from seeds that have been produced by controlled hand pollination of male and female parent lines. These hybrids combine high yield, disease resistance and other plant and fruit characteristics. When using hybrids, new seeds should be purchased each season. This may cost more money, but the resistance against diseases of hybrids means the tomato plants need less spraying with pesticides. The yields are also higher, creating more opportunity to bring tomatoes to the market.

Table 1 Many tomato varieties grown in Uganda and their characteristics

| Variety | Maturity | Yield | Attributes |
|---|-------------------------------|---------------------------------------|--|
| Rio grande  edenbrothers.com | 75 days from transplanting | 15-17 tons/acre | <ul style="list-style-type: none"> • Determinate open pollinated variety. • Excellent keeping quality. • Firm elongated fruits with excellent transport qualities. • Tolerance to verticillium wilt and tomato leaf curl. • Plant spacing: 60 by 45cm • Well suited for processing into sauces, ketchups and for dry fruits |
| Kilele F1  Syngenta.com | 80 days from transplanting | 70-80 tons/acre under good practices. | <ul style="list-style-type: none"> • Determinate hybrid variety • Over 21 days shelf life. • Tolerant to Bacterial wilt. • Difference between the varieties regarding yield 10 – 80 tons per ha. • However, does not do well in the W. Nile region. • Plant spacing: 60cm by 60cm. • Firm elongated oval fruit to suit market preference. • Well suited for fresh consume. |
|  Improved Nouvelle F1 | 80-85 days from transplanting | 35 tons/acre | <ul style="list-style-type: none"> • Semi-determinate hybrid variety. • Very good shelf life and transport quality. • High bacterial wilt tolerance, verticillium wilt and fusarium wilt. • Spacing: 60cm by 60cm. • Well suited for fresh consume. |

| | | | |
|---|--|-----------------|---|
| New Fortune maker F1  | 70-75 days from transplanting | 30-35 tons/acre | <ul style="list-style-type: none"> • Determinate hybrid variety. • Shelf life of over 21 days and good transportability. • Tolerant to bacterial wilt, verticillium wilt and fusarium wilt. • Spacing: 60cm by 60cm • Well suited for fresh consume |
| Money maker  Edebrothers.com | 90 days from transplanting | 25 tons/acre | <ul style="list-style-type: none"> • Indeterminate and open pollinated. • Pinkish and hard skin. • Requires staking. • Delicate in transportation. • No specific diseases tolerance. • Spacing is 60cm by 60cm. • Well suited for fresh consume. |
|  Cal J Shambaza.com | 75-85 days from planting | 10-12 tons/acre | <ul style="list-style-type: none"> • Determinate and open pollinated. • Does not require staking. • Good yielder. • Can be transported easily to far markets but it is delicate, losses should be considered. • Sweet tasting deep red fruits. • Tolerant to verticillium wilt and fusarium wilt • Spacing: 60cm by 60cm • Well suited for both fresh consume and processing. |
| Maglobe  | 90-95 days after transplanting. | 20-25tons/acre | <ul style="list-style-type: none"> • Widely adapted, hardy tomato variety. Semi-determinate with long fruit bearing period. • Does well in humid climates. Fruit weight 160-175gm and resistant to fusarium |
| Roma VFN  | 90-95days after transplanting | 20-25tones/acre | <ul style="list-style-type: none"> • Determinate, very productive variety. Widely marketable. • Fruit weight 60-70gm with pear shape appearance with moderate firmness. Resistant to fusarium and verticillium |
| Heinz 1370  | Maturity 80-85 days after transplanting. | 20tones/acre. | <ul style="list-style-type: none"> • Determinate variety bearing medium-sized firm fruits. • Very adaptable with fruit bearing period. Fruit is deep oblate, with average weight 120-140gm. Resistant to fusarium |

2. Land selection and preparation for tomato growing

Learning objectives:

After completing this module, participants will:

- Understand the factors to consider in selecting a suitable site for tomato production
- Understand how tomato plants interact with other plants and how to plan crop rotation considering spatial and temporal arrangement of tomato plants.
- Learn the best practices of land preparation for tomato production
- Know how to manage soil fertility
- How soil fertility should be managed and how to prepare compost and manage manure

Duration: 2-3 hours

Learning aids

- Land where the onion plot will be implemented
- Tools for land preparation such as Hoes, Pangs, Slashers, Axes

Activities and exercises

- Discuss what group members would consider to choose an appropriate site for growing your tomato
- Practically prepare the land for tomato plantation.

Content

Land selection for tomato growing

The land selected should fulfill the growing requirements of tomato and shows the following characteristics:

Growth requirements of tomatoes

- Tomato grows well on most mineral soils that have proper water holding capacity and aeration, and are free of salt but prefer Sandy loam soils with good fertility and high organic matter content. Soil fertility can be assessed by looking at yields of other crops or by analyzing the vegetation type in the growing area. (The facilitator can ask the participants to mention different vegetation species indicating good soil fertility).
- Avoid soils with a very high content of clay.
- Tomato is moderately tolerant to a wide range of pH (level of acidity), but grows well in soils with a pH of 5.5 – 6.8 with adequate nutrient supply and availability.
- Sufficient moisture must be maintained on the land to establish the plant successfully and carry it through to fruit production. A simple rule of thumb can be used to determine whether local water supplies are sufficient for growing tomato. If there are herbaceous plants (plants with many thin leaves) growing in the natural environment, it will be possible to grow tomato. You should be able to count on at least three months of rain. Water stress and long dry periods will cause buds and flowers to drop off, and the fruits to split.
- However, if rains are too heavy and humidity is too high, the growth of mould will increase and the fruit will rot. Cloudy skies will slow down the ripening of tomatoes. However, adapted cultivars are available. Seed companies have special tomato varieties for hot-humid climates.
- On a gentle slope to facilitate drainage and to avoid flooding. Soil depth should be 60 cm or more.
- Light and rainfall should be evenly distributed throughout the year. Very wet weather and little sunshine encourages excessive vegetative growth at the expense of fruit formation.
- Good air drainage (i.e. well ventilated, but not strong wind!) will reduce the risk of foliar disease.
- Few trees as they will lead to lot of shade in the field affecting proper tomato growth.
- Not recently used for production of tomatoes, egg plants, pepper, Irish potatoes, pumpkins,

tobacco or watermelon in the last 3-6 years to minimize pests and diseases transmission risks.

- The climate of the site must be adapted: The optimum temperature for most varieties lies between 21 and 24 °C. The plants can survive a range of temperatures, but the plant tissues are damaged below 10 °C and above 38 °C (Table 2)
- In tropical lowlands, the minimum temperature at night is also important. Temperatures below 21 °C can cause fruit abortion

Table 2: Temperature requirements for different stages of tomato (source: Agrodok 17)

| Stages | Temperature (° C) | | |
|------------------------|-------------------|---------------|------|
| | Min. | Optimum range | Max. |
| Seed germination | 11 | 16-29 | 34 |
| Seedling growth | 18 | 21-24 | 32 |
| Fruit set | 18 | 20-24 | 30 |
| Red colour development | 10 | 20-24 | 30 |

Crop rotation

Crop rotation is the practice of growing a series of different types of crops in the same area in a sequence

Advantages or benefits of crop rotation include: It improves the soil structure and reduces depletion/ erosion, It increases soil fertility. It helps control weeds, pests and diseases hence reduce reliance on chemicals

- Crop rotation is a major component of organic farming, affecting both soil conditions and pest cycles.
- A rotation with non-solanaceous crops for 3-6 years will avoid pest problems in tomatoes.
- Tomato followed by cereals and millet reduces the incidence of disease in tomatoes.
- Beans, marigold, cowpea and green leafy vegetables are common crops that are mixed to avoid the incidence of pests and diseases on tomatoes.

Land preparation for tomato growing

- The land must be prepared 4-6 weeks before transplanting and manure should be applied early enough to rest for at least one month for proper decomposition (see section on soil fertility).
- Deep ploughing by use of hand hoes or tractors is recommended to remove most of the weed roots and soften the soil for easy movement of water and air in the soil. It is also important to make it easy for tomato roots to grow by penetrating properly in the soil.
- A second tillage is then done to produce a fine bed. This will improve crop establishment and growth.
- Applying mulch can be positive to conserve soil and water and reduce evaporation.
- Sources of mulching material are: weeds or cover crops, crop residues, pruning material from trees, cuttings from hedges, waste from agricultural processing or from forestry.

3. Nursery establishment and management

Learning objectives:

After completing this module, participants will:

- Understand the factors to consider in selecting a suitable site for tomato production
- Understand how tomato plants interact with other plants and how to plan crop rotation considering spatial and temporal arrangement of onion plants.
- Learn the best practices of land preparation for tomato production.

Duration: 2-3 hours

Learning aids

- Land where the onion plot will be implemented
- Tools for land preparation such as Hoes, Pangas, Slashers, Axes

Activities and exercises

- Discuss what group members would consider to choose an appropriate site for growing your onions
- Practically prepare the land for tomato planting.

Content

- Tomatoes can be direct-seeded in the field, but it is expensive many seeds are required (about 500 to 1000g of seeds/ ha) and adds about four weeks of weeding labour to growing costs.
- Raising the young transplants in a nursery enables seedling uniformity, requires smaller quantity of seed and saves on weeding costs.
- A nursery is an area where young plants can grow with special care and protection. Tomato seedlings are first raised in nurseries because the seedlings are always needed in large numbers and seeds have more difficulties to germinate and survive when planted direct in the field.
- The seedlings are raised in beds until transplanting time when the seedlings are uprooted and planted in another prepared garden.

The purpose of the nursery is therefore to grow seedlings:

- Of the right variety and in sufficient quantities.
- Of the right size, health and strength at the beginning of the planting season.

Qualities of a good nursery bed:

- A flat, fertile, and well drained piece of land.
- Close to a water source (borehole or running stream are the best as stagnant water tends to have disease causing organisms).
- Located area not infested with weeds.
- The soil should be tilled deeply.
- Not bordering other tomato gardens, or gardens planted with Irish potatoes, egg plants or pepper to avoid diseases transmission.
- Not grown with these species during the last years

Nursery bed preparation, sowing and watering

The following steps should be implemented to implement a nursery:

1. Choose an high location with good drainage
2. Remove clods of earth, stubble and perennial weeds. The seedbed should be 1m wide and 20-25 cm high. The length depends on the number of seedlings wanted. To raise a sufficient amount of plants for one hectare, 150-200 g seeds should be sown on 250 m² of seedbed.
3. Sterilize the soil by burning the top of the bed for about 10 minutes using dried vegetation. The

procedures for sterilizing the bed using the direct heat method are:

- Sprinkle water on to the bed to make it moist.
 - Heap a lot of grass on top of the bed.
 - Set it on fire starting at the end away from the driving wind. This will slow down the speed of burning.
 - Keep on adding grass for about 10 minutes. This method sterilizes the first 5 cm of the soil.
4. Allow the bed to rest for between 3 - 5 days.
 5. Mix well decomposed manure and fine sand with the soil if is available and possible. Bring the seedbed to fine tilth.
 6. Sow in drills 5-15 cm apart at 0.5 cm deep and cover lightly with soil. Than cover the whole bed with dry grass (mulch).
 7. Shade the beds moderately with the shades slanting east at 1 meter height. This procedure is important to avoid sun and heat stress to tomato seedlings so that they grow well.
 8. Water twice a day in the morning and evenings only.
 9. Seeds germinate 5-8 days after sowing. Immediately seedlings start germinating remove the grass and put on top of the shade.
 10. Start reducing the watering frequency after germination, control pests and diseases and keep seedlings free of weeds.
 11. Stop watering completely one week before transplanting.
 12. Hardening off the seedlings: after two weeks: exposure to sun light
 13. After 3 weeks: seedling ready for transplanting

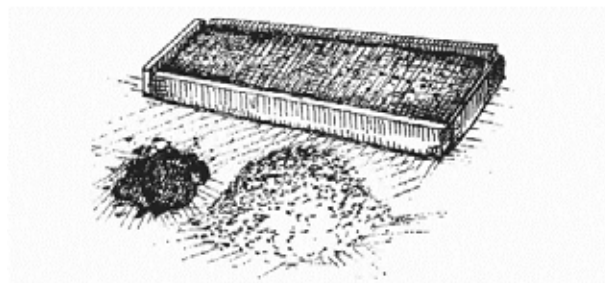


Figure 1: a seed box prepared with a mixture of one-part well-rotted manure (cow dung) and two-part sands

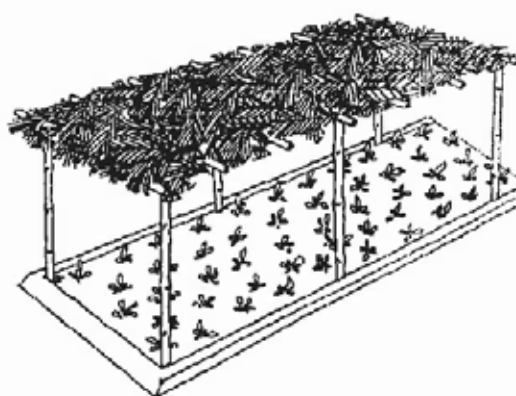


Figure 2: seed bed with shade

Weeding, pests, and disease control in the tomato nursery

Before watering, it is important to gently pull any weeds that are growing in the nursery bed. Such weeds compete with the seedlings for nutrients and water in the soil. One of the most common diseases of tomatoes in the nursery is damping off (Figure 3), which causes the stem to rot at the crown, leading to seedling death. Damping off is caused by different fungi that live in the soil (see also chapter on pest and diseases). It normally occurs in damp wet soils. Tomatoes seedlings are less susceptible to infection of damping off diseases caused by *Pythium* or *Rhizoctonia* when reach the 2- or 3-leaf stage. However, *Phytophthora* damping off disease infects tomato plants at any stage. An organic control to avoid tomato damping off in tomato nurseries, cinnamon (*Cinnamomum verum*), moringa (*Moringa oleifera*) and clove (*Syzygium aromaticum*) can be applied as extracts or powder.



Figure 3: Tomato seedling affected from damping off disease.



Figure 4: Tomato seedlings affected by damping off

4. Transplanting

| | |
|---|---|
| Learning objectives: After completing this module, participants will: <ul style="list-style-type: none">• select good seedlings for tomato planting.• plant tomatoes with the correct spacing.• plant tomato according to the recommended practices. | Duration: 2-3 hours Learning aids <ul style="list-style-type: none">• Group demonstration field• Hoes• Tomato seedlings• Watering cans• Strings and pegs |
| Activities and exercises <ul style="list-style-type: none">• In the demonstration field observe with the participants what has changed with plants grown• Discuss how to select quality seedlings• Practically demonstrate how to transplant | |

Content

Transplanting, mulching, and gap filling

When properly managed in the nursery bed, seedlings are ready for transplanting 4-5 weeks after germination.

- The seedlings should not have been watered in the nursery for at least 7 days before transplanting to strengthen them.
- Water the bed heavily on the day of pulling (12-14 hours before seedlings are taken out of the seedbed) to ease lifting of seedlings and reduce injury to them. Prick out the seedlings and transplant into the main garden in the evening to avoid long day heat stress. When removing the seedlings, keep a large clump of soil attached to the roots to prevent them from being damaged.
- The seedlings are positioned in the holes. Make the holes for the plants deep enough so that the lowest leaves are at ground level. Press the soil firmly around the root, and water around the base of the plant to settle the soil.
- Spacing: 60cm x 45cm or 60cm x 60cm depending on the variety (1 plant per hole).
- Use vigorous seedlings for faster growth.
- Add water to the planting hole before planting. Water the plants immediately once they have been transplanted.
- Mulching should be done to conserve water in the soil. It should be done immediately after transplantation of the seedling. The mulch will also help to protect the fruits from being spoiled in case of rain.
- Care should be taken not to wet the lowest leaves, as this can stimulate the growth of mould.
- Eventually fill gaps (died seedlings) within 1 week of transplanting for even growth.
- The transplanted plants should be protected from heat during the first five days, e.g. by covering them with large leaves.

5. Weeding, pruning, mulching and staking

Learning objectives:

After completing this module, participants will:

- know when and how to do weeding, pruning, and staking.
- understand the effects of weeds on the yields of tomatoes.
- be able to apply the different methods of weed control in the tomatoes.

Duration: 2-3 hours

Learning aids

- Demonstration field
- Staking poles/sticks
- Pruning knife

Activities and exercises

- In the demonstration field observe with the participants what has changed with plants grown
- Discuss how to select quality seedlings
- Practically demonstrate how to weed, prune, mulch and stake

Content

Weeding

- The crop stand should be kept free of weeds at all time, because weeds compete for light, nutrients and water
- Weeds may be vectors for diseases and provide shelter for organisms that cause tomato diseases such as Tomato Yellow Leaf Curl Virus (TYLCV), and reduce the yield.
- Hand weeding is recommended.
- The following integrated practices are useful for controlling weeds effectively:
 - o Remove the previous crop residues and use sanitation practices to avoid introducing weed seeds.
 - o Deep cultivation and exposing soil to sunlight before transplanting help to destroy the weed seeds.
 - o It is important to keep the field weed free for 4-5 weeks after transplanting. It is during this period that weed competition must be suppressed to avoid reduction in yield.
 - o Weeds growing between crop rows are the easiest to control. Shallow ploughing (up to a depth of 15-20 cm) or using mulch usually removes them.

Pruning

- Pruning is important for tomatoes, especially for thick bush and indeterminate types. It improves the light penetration and air circulation. The need for pruning depends on the type of plant and the size and quality of the fruit. If plants are not pruned, they will grow at random and fruit will be smaller.
- Pruning the side-shoots is called nipping. Pruning the tops of the stem is called heading.
- Nipping: The lower side-shoots should be removed by pinching them out with the fingers and only one main stem should remain. If they are allowed to grow they will produce masses of foliage but few tomatoes. Nipping enhances quality and size of the fruits.



Figure 5: nipping of side-shoots should be done regularly

- Heading: The tip of the main stem of the tall type is pinched off when 3 to 5 leaves are fully grown. The shoots that grow out of the top 2 to 4 buds are left to grow. In this way 2 to 4 side-shoots will grow as main stems, supported by sticks (see Figure). When these stems are 1 - 1.25 m long, the tops should also be pinched off. New side-shoots should be removed regularly by nipping them. Usually, 3 to 4 fruit clusters grow along each stem.
- To avoid the spread of diseases from plant to plant, do not use knives for pruning 'Pinch out' the side-shoots instead using your thumb and forefinger.
- Trimming leaves: old, yellow or sick leaves should be removed from tomato plants to control the spread of diseases. It is very easy to spread disease via your hands or any tools that are used, so avoid sick plants. Clean tools regularly. It is best to prune in the morning on a sunny day so that the wounds can dry quickly. It is advisable to burn or bury the infected leaves to avoid disease infections.
- Bush varieties require no pruning for most of the season. Remove any yellow or decaying foliage as soon as possible to avoid the spread of disease. If plants become too large to support themselves, either trim out a few major branches or add more support canes. The side branches can be tied on to the additional support canes.
- After formation of the first fruit cluster of mature green tomatoes, remove all the lower older leaves to allow for ventilation and disperse food to the fruits.
- When the plant has developed 6-7 branches with tomatoes, stop the plant from growing further by breaking off the growing tip. If more than seven branches of tomatoes begin to develop, pinch extra branches out to encourage the plant to produce good quality tomatoes rather than an abundance of low-quality late-maturing fruits.
- Flowers should be pruned to 5-6 per cluster for medium- large sized fruits.

Mulching

Should be done to reduce soil temperature, conserve soil moisture, and prevent soil erosion. Different materials like dry grass/non seeded weeds can be used to cover the soil. This is especially important where no staking is done. Tomatoes are very sensitive and once not mulched and staked, soil bacteria can cause diseases to the fruits. It is advisable to mulch after first weeding.

Staking



Figure 7: staking in tomatoes

- Staking or trellising tomato plants with bamboo poles, wood stakes, or other sturdy material provides support and keeps the fruit and foliage off the ground. Staking will increase fruit yield and size, reduce fruit rot, and make spraying and harvesting easier.
- Staking is usually done early – three weeks after transplanting – to minimize plant damage
- Indeterminate varieties should be staked to facilitate pruning, pinching, harvesting and other cultivation practices.
- Determinate varieties should be staked in the wet season to prevent fruit contact with the soil.
- Rice straw, plastic strips, horticultural fixing tape or other materials can be used for fixing. Fixing should be done to support fruit clusters. Tie a string lightly on the tomato and then gently twine the string around the plant to avoid snapping the stem.

6. Pests and diseases management in tomatoes

Learning objectives:

After completing this module, participants will:

- Know the common pests and diseases affecting tomatoes and their effects.
- Recognize the signs and symptoms of different pests and disease attack in tomatoes.
- Apply the Integrated Pest and Disease management approaches in tomato production.
- Understand the critical stages of growth of different pests to target control in tomato production.

Duration: 2-3 hours

Learning aids

- Demonstration garden
- Insect bottle
- Stationery
- Knapsack sprayer
- Jerrycan
- Basin soap
- Pesticides

Activities and exercises

- In the demonstration field observe with the participants what has changed with the plants grown
- Discuss what is a weed and why we must weed
- Practically select a weed and demonstrate how weeding and pesticide making and spraying are done and ask trainees to do the same on their fields

Content

General pest and disease management practices

Tomato is a crop that suffers a lot of pest and disease attack. It is recommended that control starts even before the pests or disease symptoms are seen. Prevention measures should also be put in place. In principle, the following practices will greatly reduce pest and disease incidences in the field.


- a. Crop rotation – this breaks the pest lifecycle.
- b. Early planting – your crop escapes by the time pest/disease incidences rise, you are harvesting.
- c. Use of resistant varieties – they resist damage even when the crop is attacked (see Table 1 to identify which variety is resistant to which diseases).
- d. Weed control – weeds affect crop vigor which is related to damage. Weaker crops are more damaged (see previous chapter).
- e. Scouting – To spot pests/diseases early and control them in time.
- f. Correct identification of pest or disease to use the right control strategy.
- g. When irrigating, do not wet the leaves. Otherwise, it will help fungal diseases to develop.
- h. Mulching and staking – reduces contact of soil and the plant parts. Most tomato diseases are soil borne. Staking also improves crop coverage during spraying.
- i. Remove affected plant parts


Common tomato pests and their control


oinsects can help to control harmful pests. Some examples of natural predators:

- Ladybird beetle controls whitefly.
- Green lacewings control aphids and whitefly.
- Hover flies (Syrphidae) control aphid eggs.
- Trichogramma wasps control codling moth.
- Bacillus thuringiensis against Army worm.

| Causes | Descriptions | Signs/Symptoms | Control |
|--|--|---|--|
| <p>Common pests</p> <p>Nematodes</p>  | <ul style="list-style-type: none"> <input type="checkbox"/> Are very small worms (invisible to our naked eyes) living in the soil that feed on plant roots. <input type="checkbox"/> Spread via: via infected plant material, tools, rainwater and irrigation water, strong winds (which carry infested soil particles), and contaminated soil carried on shoes, or animal feet. Nematodes will survive in soil as long as it stays moist. | <ul style="list-style-type: none"> <input type="checkbox"/> Some nematodes feed from the outside of plants, others enter the plant. All feed on the plant's sap, which can reduce the plant's productive capacity. <input type="checkbox"/> Even greater damage can occur if viruses or fungi enter the plant as a result of the injuries caused by the nematodes, and then proceed to make the plant sick, and eventually die. <input type="checkbox"/> Root-knot nematodes are of major importance in tomato cultivation. They cause galls (infected swellings) on plant roots (see Figure 11). Three common types of root-knot nematodes are: <i>Meloidogyne incognita</i>, <i>M. javanica</i> and <i>M. arenaria</i>. <input type="checkbox"/> Affected plants remain small. Nematodes cause yield losses of about 30% in tomato in the tropics. <input type="checkbox"/> If you discover an area in the cultivated field where part of the crop is clearly lagging behind in growth, the plants are lighter in colour, and their leaves are abnormally shaped but do not show signs of a mosaic pattern, then you may well have a nematode infestation. It usually begins in a small, limited part of the cultivated area, and spreads slowly throughout the plantation. | <ul style="list-style-type: none"> <input type="checkbox"/> Rotate tomato with other crops such as cereals, cabbage, onion, ground nut, cassava, sesame, etc. Do not rotate with Solanaceae. It is not advisable to rotate with crops of the Cucurbitaceae family (e.g., cucumber or pumpkin) or papaya either, as these can also cause the transmission of diseases. <input type="checkbox"/> Remove weeds and plant remains (rotten leaves and fruit). <input type="checkbox"/> Interplant with plants that emit substances via their roots which nematodes do not like or which kill them, such as sesame or African marigold (<i>Tagetes erecta</i> and other related varieties). <input type="checkbox"/> Expose the soil to sun and wind. Plough the soil several times. The nematodes will be ploughed up to the surface of the soil and will be exposed to the sun and high temperatures, which kill them. <input type="checkbox"/> Chemical pesticides (nematicides) and soil sterilants (including steam treatment) are effective but costly control methods. They should only be used at last resort. |



| Causes | | Descriptions | | Signs/Symptoms | Control |
|------------------|---|---|---|---|---------|
| Aphids |  | <input type="checkbox"/> Aphids are soft, oblong insects about 2.5 mm in length (Figure 13). <input type="checkbox"/> There are aphids with and without wings. | <input type="checkbox"/> Direct damage occurs when they attack the crop in large numbers, especially the youngest leaves and stems. <input type="checkbox"/> Aphids also transmit several viruses. | <input type="checkbox"/> Remove old crop debris before sowing new crop. <input type="checkbox"/> Intercrop with other crops. <input type="checkbox"/> Use nitrogen fertiliser in moderate amounts; apply organic fertilisers. <input type="checkbox"/> Spray a solution of soap, cow urine or extract (Azadirachta indica). <input type="checkbox"/> Cover the ground with grey plastic sheeting, which repels the aphids by reflecting sunlight. | |
| Thrips |  | Thrips are very small insects, only 0.5 to 2 mm long. You have to look carefully to spot them. They usually have wings. | <input type="checkbox"/> Thrips lay their eggs on the leaf. The larvae appear after about 10 days. The larvae and adult thrips suck the leaf sap, causing silvery spots on the leaf surface. <input type="checkbox"/> The adult thrips also leave their excreta on the leaf as small black dots. <input type="checkbox"/> A few thrips species are vectors of Tomato Spotted Wilt Virus (TSWV). | <input type="checkbox"/> Cover the ground with plastic sheeting to prevent the thrips from passing into the soil for their cocoon stage. <input type="checkbox"/> Plough well, so that cocoons are brought to the surface where they will dry up and die. <input type="checkbox"/> Remove crop debris. <input type="checkbox"/> Spray plants with a solution of soap or neem extract (Azadirachta indica). This will not affect the cocoons in the soil so repeat spraying regularly to kill the aboveground adults. | |
| White fly |  | The adult fly is white in colour and 1-2 mm long. It feeds, just like the larvae, on the leaf sap. | <input type="checkbox"/> When plant leaves are turned over, a whole swarm of whitefly may fly up. They lay eggs on the underside of the leaves. <input type="checkbox"/> Whitefly are especially a problem in the dry season. Once the wet season starts they disappear. | <input type="checkbox"/> Encourage the presence of natural predators of whitefly, by planting shrubs or other plants between the crop rows (interplanting) or along pathways between borders. <input type="checkbox"/> Use resistant cultivars (hairy leaves make it difficult for the whitefly to lay its eggs). <input type="checkbox"/> Spray a solution of kerosene and soap to control whitefly. | |

| Causes | Descriptions | Signs/Symptoms | Control |
|--|--|--|---|
| <p>Butterflies and moths (Lepidoptera)</p>  | <ul style="list-style-type: none"> <input type="checkbox"/> Butterflies and moths are common pests in tomato crops. <input type="checkbox"/> They lay green or brown eggs on young leaves, flowers and fruit. <input type="checkbox"/> The hatched larvae (caterpillars, Figure 15) feed on leaves, flowers, fruit and even the roots. <input type="checkbox"/> While feeding, the caterpillars grow in size, passing through a number of larval stages. Eventually they form cocoons in the soil. A few weeks later these hatch and the adult butterflies fly out and disperse. | <p>Depending on the species, different parts of the plants (fruit, leave, root) may be affected.</p> | <ul style="list-style-type: none"> <input type="checkbox"/> Remove weeds regularly. <input type="checkbox"/> Plough one month before sowing or transplanting. <input type="checkbox"/> Remove and destroy the infected fruits. <input type="checkbox"/> Use crop rotation. <input type="checkbox"/> Check regularly for the presence of eggs and then take measures to control the young larvae. <input type="checkbox"/> Use light traps that attract moths at night, preventing them from laying their eggs on the plants. <input type="checkbox"/> Apply wood ash, wood chips or shavings and/or calcium on the seedbeds. <input type="checkbox"/> Intercrop with cabbage. <input type="checkbox"/> Spray <i>Bacillus thuringiensis</i>, a biological insecticide. <input type="checkbox"/> Spray with a neem solution (<i>Azadirachta indica</i>) or other locally used natural pesticides. |



| Causes | | Descriptions | | Signs/Symptoms | Control |
|--|--|--|---|--|---------|
| Bacterial diseases | | | | | |
| <div><div><div><div><div><div><u>Bacterial wilt</u> (caused by <i>Ralstonia solanacearum</i>)</div><div></div></div></div><div></div></div></div></div> | | <div><div><div><div><div><input type="checkbox"/> Soil born disease</div><div><input type="checkbox"/> Bacterial wilt is one of the major diseases of tomato.</div><div><input type="checkbox"/> The pathogen can also cause the bacterial wilt in several major crops such as eggplant, pepper and potato.</div><div><input type="checkbox"/> The bacteria survive in the soil and enter roots of young plants through wounds made by transplanting, cultivation, insects or certain nematodes.</div></div></div><div><div><div>The bacteria are spread through irrigation water, soil movement, or moving infected plants (e.g. when transplanting).</div></div></div></div></div> | <div><div><div><div><input type="checkbox"/> Rapid wilting of the youngest leaves at the ends of the branches without yellowing or spotting leaves during the hottest part of the day.</div><div><input type="checkbox"/> During its early stages, only one or half a leaflet may wilt, and plants may appear to recover at night, when the temperatures are cooler.</div><div><input type="checkbox"/> The entire plant may wilt quickly and desiccate although dried leaves remain green leading to general wilting and yellowing of foliage and eventually the plant dies.</div></div></div></div> | <div><div><div><div><input type="checkbox"/> Use of resistant varieties.</div><div><input type="checkbox"/> Crop rotation.</div><div><input type="checkbox"/> Avoid infested fields. Once the soil has been infected, do not grow Solanaceae for at least 7 years. Rotate with cereal crops.</div><div><input type="checkbox"/> Do not injure roots or leaves, so be careful during transplantation and prune as little as possible.</div><div><input type="checkbox"/> Make sure the field is well drained.</div></div></div><div>If necessary, sterilise the soil (see Agrodok 9: Vegetable gardening in the tropics).</div></div> | |

| Causes | | Descriptions | | Signs/Symptoms | Control |
|---|---|--|---|----------------|---------|
| <u>Bacterial canker</u> (caused by <i>Clavibacter michiganensis</i>)  | <ul style="list-style-type: none"><input type="checkbox"/> Economically important tomato disease that occurs worldwide.<input type="checkbox"/> Spread via seed or the soil or infected via injured stems or roots.<input type="checkbox"/> The bacteria can survive in plant debris. | <ul style="list-style-type: none"><input type="checkbox"/> Damage may be severe when root-knot nematodes are present.<input type="checkbox"/> Symptoms may be noted on leaves, stems, and inside fruits.<input type="checkbox"/> Areas of leaves above the second or third cluster may show dull green, yellow and water-soaked areas.<input type="checkbox"/> Wilting progresses until the plant dies.<input type="checkbox"/> Long, brown stripes, which can split open, appear on the stem. Adventitious roots may develop on the stems.<input type="checkbox"/> Stems may also display cankers under some conditions. Internally, the vascular tissues of the stems display light yellow to brown streaks.<input type="checkbox"/> 'Bird's eyes', round slightly raised spots with a red dot surrounded by a white ring, appear on fruits. These do not always occur, but are a helpful diagnostic aid when present. | <ul style="list-style-type: none"><input type="checkbox"/> Use diseases-free seeds or transplants.<input type="checkbox"/> Soak seeds for 30 minutes in water at 56°C, or 5 hours in a 5% solution of hydrochloric acid to ensure disinfection.<input type="checkbox"/> Plant into a clean field.<input type="checkbox"/> Disinfect pruning tools before each use and clean them well after use.<input type="checkbox"/> Remove and burn crop debris.<input type="checkbox"/> Rotate tomatoes with a non-host crop. | | |
| <u>Fungal diseases</u> Early blight (caused by <i>Alternaria solani</i>)  | <ul style="list-style-type: none"><input type="checkbox"/> Early blight is a fungus caused tomato disease.<input type="checkbox"/> spread via seed, wind, rain and infected plant remains.<input type="checkbox"/> Plants that have been damaged are more susceptible to this fungus. | <ul style="list-style-type: none"><input type="checkbox"/> Lower leaves show brown or black spots with dark edges, almost like a target.<input type="checkbox"/> Stem ends of fruits may be attacked, showing large, sunken black areas with concentric rings.<input type="checkbox"/> This fungus strikes after plants set fruits.<input type="checkbox"/> Flowers and small fruit fall off. | <ul style="list-style-type: none"><input type="checkbox"/> Crop rotation: Avoid to grow tomato on the same location as egg plants, potato and pepper for 4-6 years.<input type="checkbox"/> Do not plant young plants near older plants.<input type="checkbox"/> Make sure the plants have enough water but avoid excessively moisture or humidity on the tomato field.<input type="checkbox"/> Use tolerant varieties.<input type="checkbox"/> Remove and burn damaged plant parts.<input type="checkbox"/> Weed regularly and thoroughly.<input type="checkbox"/> Use pathogen-free seeds.<input type="checkbox"/> Apply effective fungicides if available | | |

| Causes | Descriptions | Signs/Symptoms | Control |
|--|--|---|---|
| <p><u>Late blight</u></p>  | <p>The disease is very common particularly during the rainy season but also when there is excess of moisture or humidity.</p> | <ul style="list-style-type: none"> <input type="checkbox"/> It can spread very fast wiping away plants within a short time and it also affects fruits. <input type="checkbox"/> Irregular greenish or water-soaked lesions on the leaves, stems, and fruits. <input type="checkbox"/> Leaves develop bluish-grey patches, turn brown, wither but stay attached to the plant. <input type="checkbox"/> Fruits develop watery spots which develop on upper half of fruit. <input type="checkbox"/> Rapid death of the entire plant. | <ul style="list-style-type: none"> <input type="checkbox"/> Remove and destroy the infected leaves (be sure to wash your hands afterwards to avoid other plants contamination). <input type="checkbox"/> The best control measure for late blight is prevention avoiding excessively moisture and humidity on the field. |
| <p>Fusarium and verticillium wilt (caused by <i>F. oxysporum</i>)</p>  | <p>These wilt diseases are caused by fungi in the soil that enter through young plants, then begin to plug the vessels that move water to the roots and stems of the plants.</p> | <ul style="list-style-type: none"> <input type="checkbox"/> Without enough water, the plants begin wilting on sunny days, although they will appear to recover at night. <input type="checkbox"/> Tomato wilt may first appear in the top or lower leaves of the plant, causing them to lose color and turn yellow, then die back from the tips. <input type="checkbox"/> The plant may wilt on only one side or on a leaf, while the other half or rest of the plant remains healthy for a long time. <input type="checkbox"/> The process continues until the entire plant is affected. <input type="checkbox"/> A brown stain can be seen if the stem or roots are cut. <input type="checkbox"/> Pink fungus fluff is found on dead plant parts. | <ul style="list-style-type: none"> <input type="checkbox"/> Use resistant tomato varieties <input type="checkbox"/> Minimise the watering schedule. To prevent the soil drying out apply mulch on the seedbed. <input type="checkbox"/> Remove and destroy all affected plants. <input type="checkbox"/> Avoid using location for tomato, egg plants, potato and pepper for 4-6 years, because the fungi that cause the wilt can remain in the soil that long without a host to infect. <input type="checkbox"/> Decrease the acidity of the soil by applying calcium or marl. |

| Causes | Descriptions | Signs/Symptoms | Control |
|---|--|---|---|
| <p>Anthraxnose (caused by <i>Colletotrichum coccodes</i>)</p>  | <p>The disease spreads quickly in humid weather, and when it is hot and humid.</p> | <ul style="list-style-type: none"> □ Signs of infection by this disease are grey-brown spots (dents) on the fruit and, in humid weather, salmon-pink spores. | <ul style="list-style-type: none"> □ Transmission is most common via infected plant material (especially the fruit). Therefore, measures relating to crop hygiene are very important. □ Choose resistant plant varieties. □ Do not compost infected fruits, leaves or stems and clean up the garden after harvest, to reduce overwintering of fungal spores. □ Use of organic fungicide like Neem oil spray |
|  <p>Septoria leaf spot</p> | | <ul style="list-style-type: none"> □ Small black spots may show up in the center. □ The affected leaves turn yellow, wither, and fall off. | <ul style="list-style-type: none"> □ Correct spacing between tomato plants. □ When watering tomatoes, water at the base of the plants. |

| Causes | Descriptions | Signs/Symptoms | Control |
|---|---|---|---|
|  <p><u>Damping off</u></p> | <input type="checkbox"/> Damping off is a fungal disease that causes sudden collapse of seedlings or failure to germinate. | <input type="checkbox"/> Seedlings fail to emerge from the soil resulting in patches that appear to have germinated poorly. Alternatively, seedlings may emerge but fall over and die some time afterwards. <input type="checkbox"/> First leaves appear water soaked and mushy. <input type="checkbox"/> Very thin stems that become wet and brown | <input type="checkbox"/> Do not site seedbed on a field previously planted with eggplants, pepper, potatoes or tomatoes. <input type="checkbox"/> Use clean land, if reusing the old plots, it is important to sterilize them. <input type="checkbox"/> Use certified disease-free seeds. If it is farmer-saved seed, it can be given hot water treatment. <input type="checkbox"/> Plant seeds when soil is at optimum temperature. <input type="checkbox"/> Pre-soak seeds to speed germination. <input type="checkbox"/> Remove all infected seedlings immediately. <input type="checkbox"/> Avoid excessive watering. Allow the soil to dry between watering. |
| <p>Common tomato virus diseases</p> <p><u>Mosaic virus</u></p>  | <input type="checkbox"/> Mosaic virus attacks many kinds of plants and is common in tomatoes. While mosaic disease does not kill the plant, it diminishes the number and quality of fruits. <input type="checkbox"/> Seeds transmit the virus. | <input type="checkbox"/> yellow-green spotted leaves, rolled-up leaves, stunted growth and discolouration of fruits and internal browning under the skin | <input type="checkbox"/> The virus enters through cuts in leaves and stems, so avoid handling the plant as much as possible. <input type="checkbox"/> wash hands thoroughly with soap first entering the field. never smoke tobacco near the plants - even cigarette ash can transmit infection. <input type="checkbox"/> Planting resistant varieties. <input type="checkbox"/> Crop rotation. Do not grow other Solanaceae near the field. <input type="checkbox"/> Use pathogen-free seed and destroy infected plants. |

| Causes | | Descriptions | | Signs/Symptoms | Control |
|------------------------|---|--|--|---|---|
| Other problems | | | | | |
| <u>Blossom-End Rot</u> |  | This disease is caused by a lack of calcium, most often brought on by fluctuating water or a result of too much salt in the soil, which is caused by the use of saline water, or irrigating with too little water during the dry season. | | <ul style="list-style-type: none"> □ It appears as a sunken, dead area opposite the stem (the blossom-end of the fruit). □ The area will expand as the fruit matures. | <ul style="list-style-type: none"> □ Water plants regularly to maintain moist, but not waterlogged soil. □ Spread a 2-inch thick layer of mulch around plants to conserve soil moisture. □ Prevent calcium deficiency in the soil. □ Reduce salt in the by flushing it out with salt-free irrigation water (normally during the rainy season), making sure that there is good drainage. |
| <u>Sunscauld</u> |  | essentially a sunburn on a tomato fruit | | Sunscauld cause a section of the fruit to become soft, light in color and dry. | It is important to maintain enough foliage to shade fruits from strong sunlight. |

6. Pests and diseases management in tomatoes

Learning objectives:

After completing this module, participants will:

- be able to identify signs of maturity and ripening in the tomato crop
- know when to harvest tomatoes
- know the different methods and practices of harvesting of tomatoes

Duration: 2-3 hours

Learning aids

- Tarpaulins
- Containers/wooden boxes
- Demonstration garden

Activities and exercises

- In the participant fields ask participants to observe what has changed with the crop
- Discuss signs of maturity and ripening in the tomato crop for the correct stage of harvesting
- Discuss the common mistakes farmers make during harvesting of tomato
- Practically harvest the tomato with trainees

Content

Harvest management practices

- Tomatoes take around 90 days to mature (including days in the nursery bed).
- It will be necessary to harvest several times as the fruit of tomato plants do not all ripen at the same time the harvesting continues for up to 2 months.
- Important considerations during harvest practices are the proper stage of fruits maturity, the way the fruit is detached from the tree and the time of harvesting.

Harvest maturity

- Quality tomatoes are firm and are uniform in colour.
- Tomatoes are ready for harvest as soon as they are mature but still green.
- If the tomatoes are to be used for the production of, for example, ketchup, chutney, purée or juice, the fruit must be picked when it is red and completely ripe.
- If the tomatoes are to be sold as vegetables on the market, they can be harvested while still green. Green tomatoes can be ripened after picking, until they are red. A few red, ripe tomatoes will speed up the ripening process. One disadvantage of early picking is that the nutritional value of the tomatoes is lower. One advantage is that green tomatoes are less likely to get damaged or to rot.
- Tomatoes can be classified in four stages of maturity:
 - **Stage 1:** Seed are white in colour (immature) and can be cut when the tomato is sliced. There is no juice inside the tomato.
 - **Stage 2:** Seeds have a tan colour (mature) and some juice present.
 - **Stage 3:** Seeds are pushed aside when cut. The colour inside is still green.
 - **Stage 4:** Juice becomes red in colour.
- Tomatoes that are harvested at the first stage of maturity will ripen into poor-quality tomatoes. Tomatoes harvested at third and fourth stages of maturity will ripen into good-quality tomatoes.
- Representative samples of green mature fruits are cut crosswise and if the seeds slide without being cut, then the tomatoes of the same variety can be considered mature.
- Immature fruits when picked, fail to develop full color and flavor and deteriorate easily.



Time of harvesting

- Pick tomatoes during the cooler part of the day.
- It is recommended to harvest up to noontime and to keep the harvested fruits in a shaded area soon after picking. A rise in fruit temperature occurs when the fruits are left exposed to the sun. Heating up will result in accelerated ripening of fruits.

Harvesting method

- Harvesters should observe good personal hygiene during harvesting.
- Harvest tomato carefully by hand picking. Mature fruit is best removed by a “lift, twist and pull” technique.
- Harvested tomatoes should be placed in clean collecting containers such as plastic pails with smooth inside finish and then transferred to field containers like the wooden boxes with smooth lining.
- While harvesting, avoid throwing tomatoes into the container, dropping, and dragging of containers during hauling causing fruits to bump against each other must be prevented. These poor handling practices will result in both visible and non-visible damages like internal bruising. Visible injuries can be in the form of cuts, punctures or abrasion. Internal damage will appear later as brown or black discoloration in the seed area or manifested as faster ripening and increased susceptibility to decay.
- Picking containers should never be too full.



Figure 20: proper way of harvesting tomatoes (Agrodok 17)

6. Pests and diseases management in tomatoes

Learning objectives:

After completing this module, participants will:

- know the different stages of post-harvest handling in tomatoes
- be able to identify common mistakes during post harvesting and handling that affect quality and quantity in tomato production
- be able to apply basic technologies of post-harvest handling for tomatoes

Duration: 2-3 hours

Learning aids

- Stationery
- Packaging boxes
- Tomato fruits

Activities and exercises

- Discuss how tomatoes are handled after harvesting
- Practically demonstrate how to pay attention to post harvest handling

Content

Post-harvest handling of tomatoes

Proper post-harvest handling is important in maintaining the quality and ensuring safety of tomatoes at all handling stages. In many cases farmers pay keen attention on good agronomic practices of tomato production but pay less attention to post-harvest handling and end up with a lot of post-harvest losses in terms of quality and quantity.

Post-harvest handling operations

Post-harvest operations refer to activities done to the fresh produce in preparation for marketing. These operations can be done in the field, in collection centers or in a packing house. The packing area should provide adequate protection from sun and rain, kept always clean, and pet animals should be kept away from the packing area. After harvesting ripe tomatoes, they should be stored in a cool place if they are not sold immediately. It is essentially to avoid to let the ripen tomatoes under sunshine to avoid the bursting of the fruits.

Cleaning/washing

In places where tomatoes are not staked and grown during the rainy season, soil particles may adhere on the fruit. Soil-borne decay-causing microorganisms can cause fruit rots thus the need to clean them prior to marketing. Fruits should be dried properly prior to packaging.

Tomatoes can also be cleaned by wiping them with moist cloth. Ensure however, that the water and the cloth used in wiping the fruit are clean to prevent contaminating the fruit.

Sorting/grading



Figure 21 sorting and grading tomatoes

Good quality tomatoes are generally preferred by buyers; thus sorting/grading of fruits is a necessary operation. Sorting is the grouping of tomatoes based on the criteria of the one classifying and there is no definite set of standards followed.

Good quality and safe tomato fruits are mature, clean, well-formed, free from insect and disease damage, free from mechanical damage such as cuts, abrasion, and punctures, free from microbial, chemical, and physical contamination.

Because the harvesting time of tomatoes continues at intervals for up to two months it is important to pick fruits as they ripe and according to your market demand.

Tomato fruits with the following defects, on the other hand, are most likely to be rejected:

- Insect-and disease-damaged.
- Mechanically-damaged such as cuts, punctures, abrasion, compression.
- With preharvest defects such as deformation and cracks. physical contamination.

Packaging

Proper packaging is essential in maintaining product quality during transport and subsequent handling.

Packaging materials

Rigid containers such as plastic crates and wooden boxes with smooth linings are highly recommended for tomatoes since they provide adequate protection against compression damage. They have smooth inside finish and can be easily cleaned. They are also stackable and reusable/returnable.



Figure 22: Wooden boxes for tomatoes transportation



Figure 23: Packaging of tomatoes in crates

Considerations in the use of wooden boxes

- Hygiene – should be thoroughly cleaned with soap/detergent after use.
- Handling – handle with care during loading, stacking, and unloading; do not drop.
- Do not use the boxes as seats when sorting.
- Storage – store them in a clean area free of insects and rodents.
- Store separately from chemicals and farm machinery to prevent contamination.
- Do not use as storage container for chemicals (fertilizers and pesticides) if used for fresh produce.

Transport

The main objective in transport is to ensure that tomatoes will arrive in top quality condition to the final market. This includes movement from the garden to the homestead and later to the market.

In all the post-harvest and handling stages, it is important to follow proper transport practices:

- Handle containers/boxes gently; they should not be dropped or thrown on to each other.
- Do not sit on top of packed tomatoes during field transport.
- Do not expose tomatoes to the sun during transport.
- Allow air to circulate in the stacks or piles of produce by providing space in between stacks

9. Tomato seed production

| | |
|--|---|
| <p>Learning objectives: After completing this module, participants will:</p> <ul style="list-style-type: none"> • Know the right ripe stage to produce tomato seeds • be able to extract and store tomato seeds for the next crop generation | <p>Duration: 2-3 hours</p> <p>Learning aids</p> <ul style="list-style-type: none"> • Ripe tomatoes or a tomato fields with the right ripening stage of fruits • Containers • Knives • Teaspoons |
| <p>Activities and exercises</p> <ul style="list-style-type: none"> • Discuss how trainees secure or preserve seeds • Explain how to select the right tomato ripening stage for extracting seeds • Demonstrate practically how to extract seeds aware that after the extraction the seeds need a fermentation time of 2-3 days. | |



Content

For own seed production, it is not recommended to use hybrid (F1) varieties

Hybrids are plants that are a result of artificial cross-pollination. The first crop from hybrid seeds will produce well, but it is not advisable to use second-generation seed for planting. The chance that you will get plants with inferior characteristics is high. New seed must be bought and used for each crop.

If you want to produce your own seeds, you need to work with non-hybrid varieties!

Table 3: steps to produce seeds from tomato

| | |
|---|--|
|  <p>Step 1</p> | <ul style="list-style-type: none"> – The plot where to choose the tomato to extract seeds should not previously have had tomatoes planted recently. – Choose ripe fruits only from robust and disease and pest-free plants. – Wash the tomato fruit. – Cut the tomato in two pieces. The best is if the cut is done halfway between the top and bottom of the tomato to expose the maximum number of seeds. |
|  <p>Step 2 (Source : A.A. Seif, icipe)</p> | <ul style="list-style-type: none"> – Extract the seeds may using a teaspoon. Put the seeds into a container including the liquid surrounding the seeds. A small amount of the harder tomato flesh may also be included but do not worry about it. – You can also simply squeeze the tomato halves to extract the seeds but at this stage they are very soft and easily damaged, so pay attention! – We do not recommend to add water at this point. |



Step 3

- Cover the top of the container with cling film cutting a couple of slits in it or cover it with cloth or paper. This is useful to keep away dirt and other possible contaminants.
- Place the container in a warm, dry and shaded position. Let the seeds stand for 2 to 3 days.
- Stir the seeds daily to ensure uniform fermentation and to prevent seed discoloration.

Step 4



- Wash the fermented seeds with clean water well until the liquid is clean.
- Any seeds that float during washing should be discarded because they are either not fully ripened or filled properly.
- Dry the seeds in indirect light and in well-ventilated places. The seeds could be spread out over a clean manila sack to dry.



Step 5

(Source : A.A. Seif, icipe)

- In case the tomato seeds cannot be sown immediately, they should be stored well. A waterproof container (transparent plastic bag, non-colored glass bottle) are good storing possibilities.
- Store the seeds in a cool place, as dry as possible.
- Check the seeds regularly once a week, if mould develops dry the seeds again.

Annex

Summary of tomato growing weekly activity plan

| Week | Growth stage | Critical activities | Recommendations |
|--|---|---|---|
| 4-6 weeks before trans-planting | Nursery bed preparation Germination after 5-8 days | <ul style="list-style-type: none"> • Prepare the nursery bed • Monitoring • Sowing (4 – 5 weeks before intended transplanting date) • Watering • Raise the shade • Thinning • Pest and disease management • Hardening | <ul style="list-style-type: none"> • Soil sterilization • Fence the nursery bed after sowing • Water twice (morning and evening) • Slant the shade west-east to a height of 1m by 1/2m immediately after germination • Reduce watering gradually • Remove the shade gradually |
| 0 | Pencil thick | <ul style="list-style-type: none"> • Transplant and mulch • immediately after transplanting. | <ul style="list-style-type: none"> • Use clean material for carrying the seedlings • Transplant in the evening • Take care not to mulch with materials having viable seeds as these will become weeds |
| 1 | | <ul style="list-style-type: none"> • Gap fill | <ul style="list-style-type: none"> • Keep the field free of weeds all the time • Use vigorous seedlings for faster growth |
| 2 and 3 | The fourth and fifth leaves emerge | <ul style="list-style-type: none"> • First weeding • Monitoring for pests (cutworms and crickets) | <ul style="list-style-type: none"> • Remove the weeds from the field, taking care not to injure the plants |
| 4 | Vegetative growth | <ul style="list-style-type: none"> • Monitoring for pests and diseases cutworms, aphids, bacterial wilt) • Staking starts | <ul style="list-style-type: none"> • Spray with organic concoctions/ • Pyrethroid and dimethoate derivatives • Fungicides (mancozeb, dithane M45) • Phytosanitation |
| 5 | Flowering starts and production of suckers (Explain what suckers Are) | <ul style="list-style-type: none"> • Monitoring for pests and diseases (aphids, thrips, late blight, bacterial wilt) • Pruning should start | <ul style="list-style-type: none"> • Phytosanitation • Reduce movement in the field |

| Week | Growth stage | Critical activities | Recommendations |
|--------------|--|---|---|
| 6 | Flowering | <ul style="list-style-type: none"> • Monitoring for pests and diseases (Bacterial wilt, Late blight) • More pruning - with care to avoid flower damage) | <ul style="list-style-type: none"> • Spray with organic concoctions/ • Pyrethroid and dimethoate derivatives • Phytosanitation • Avoid movements in the garden |
| 7 | Fruit formation starts | <ul style="list-style-type: none"> • Second weeding starts • During second weeding, • Monitoring for pests and diseases (Late blight) | <ul style="list-style-type: none"> • Move carefully in the garden • Fungicides (mancozeb, dithane M45) |
| 8 | Fruits increase in size | <ul style="list-style-type: none"> • Field monitoring to check for diseases/ pests (Boll worms, fruit canker) | <ul style="list-style-type: none"> • Limit movements in the field, and where necessary, move carefully in the garden |
| 9 | Physiological maturity signs appear(10% maturity) | <ul style="list-style-type: none"> • Field monitoring for diseases/pests | <ul style="list-style-type: none"> • Guard against intruders (thieves) • Reduce movement in the field • Phytosanitation • Organize the items used during harvesting |
| 11-20 | Harvesting | <ul style="list-style-type: none"> • Field monitoring for theft | <ul style="list-style-type: none"> • Guard against intruders (thieves) |
| 11-22 | Post-harvest handling | <ul style="list-style-type: none"> • Follow the recommended PHH practices | <ul style="list-style-type: none"> • Guard against intruders (thieves) |

EGG PLANT **PRODUCTION**



Importance of eggplant growing and common varieties in Uganda

Learning objectives:

After completing this module, participants will:

- Understand the importance of eggplant growing for income and nutrition
- Have reflected on the reasons why they would like to grow eggplants
- Know the characteristics of different varieties of eggplants commonly grown in Uganda and be able to choose varieties adapted to the growing conditions of their farm and production objectives

Duration: 2-3 hours

Learning aids

- Flip charts
- Marker pens
- Masking tape
- Training manual
- Different varieties of eggplants (if available) or pictures of these varieties

Activities and exercises

- Discuss why is it important for you to grow eggplant
- Show samples of eggplant varieties available in the community and what are their advantages and disadvantages.

Content





1.1 Reasons for growing eggplants

Eggplant is a member of the Solanaceae family which includes Tomato, Potato, Black Nightshade, Sweet Pepper and Chili. It is a perennial crop but grown commercially as annual.

- The unripe fruit is consumed as cooked vegetable. It is low in calories and fats, and a good source of Vitamins and minerals. The fruit is a good source of vitamin A and C, potassium, phosphorous and calcium. They may be roasted, fried, stuffed, cooked as curry or pickled. Cooking for prolonged periods will destroy most of the vitamins. The fruits of the white varieties have medicinal value for diabetics.
- As a source of income: Eggplants are a high-income crop that is easy to sell and require small amounts of initial investment capital. Eggplant has a 2-cropping period of 4-7 months.

1.2. Selected varieties of Eggplant commonly grown in Uganda

Table 1 Eggplant varieties grown in Uganda and their characteristics

| Variety | Maturity | Attributes |
|---|----------------------------------|--|
|  <p>Black Beauty</p> | 100 days after transplanting | <p>Oval to heart-shaped glossy purple fruits which are almost black</p> <p>Fruit size is about 10 x 8 cm.</p> <p>It has a good shelf life. It is unsuitable in cold wet areas.</p> |
|  <p>Florida High Bush</p> | 70 – 80 days after transplanting | <p>Early maturing, tall growing & high yielding</p> <p>Fruit has an elongated shape & dark purple</p> <p>Fruit size is about 11 x 5 cm.</p> <p>It is unsuitable for cold wet areas</p> |
|  <p>Ravaya</p> | 85 days after transplanting | <p>Produces very large, dark purple and egg shaped fruits</p> <p>Fruit shape is elongate oval. Fruit size is about 15 x 8 cm.</p> <p>It is unsuitable for cold wet areas.</p> |
|  <p>Ravaya</p> | 80 days after transplanting | <p>Early maturing & high yielding variety</p> <p>The fruits are slender, purple-coloured and borne in bunches of 3-4.</p> <p>This variety is popular for fresh export market.</p> |

Land selection and preparation for eggplant growing

Learning objectives:

After completing this module, participants will:

- Understand the factors to consider in selecting a suitable site for eggplant production
- Learn the best practices of land preparation for eggplant production
- Know how to manage soil fertility
- How soil fertility should be managed and how to prepare compost and manage manure

Duration: 2-3 hours

Learning aids

- Land where the onion plot will be implemented
- Tools for land preparation such as Hoes, Pangas, Slashers, Axes

Activities and exercises

- Discuss what group members would consider to choose an appropriate site for growing your eggplant Practically
- prepare the land for eggplant plantation.

Content

Eggplants does well in middle to sandy soils with proper aeration and drainage. It normally has greater drought tolerance due to its deep roots. The optimum pH levels range from 6 to 7.

Optimum day temperatures for eggplant are in the range of 20-30°C and night temperatures from 20-27°C. Eggplant is more susceptible to low temperatures and does not tolerate frost. It is tolerant to drought and excessive rainfall, but struggles where water logging occurs. When temperature and humidity are high, eggplant becomes more vegetative.

Eggplant does best in well-drained, sandy loam soils. When grown at altitudes above 800 m, growth is retarded and yields reduced.

Land preparation

- The land must be prepared 4-6 weeks before transplanting and manure should be applied early enough to rest for at least one month for proper decomposition.
- Plow well to improve soil aeration and drainage and to removes rocks and other undesirable materials from the soil. One week later, many apply a pre-planting fertilizer or manure.
- Deep ploughing by use of hand hoes or tractors is recommended to remove most of the weed roots and soften the soil for easy movement of water and air in the soil. It is also important to make it easy for tomato roots to grow by penetrating properly in the soil.
- A second tillage is then done to produce a fine bed. This will improve crop establishment and growth.
- Applying mulch can be positive to conserve soil and water and reduce evaporation.
- Sources of mulching material are: weeds or cover crops, crop residues, pruning material from trees, cuttings from hedges, waste from agricultural processing of from forestry.
- The manure/compost should be broadcasted (6 tons per acre) then worked into the soil (incorporated) preferably using a hoe. Manure/compost should be applied 1 – 2 weeks before transplanting the Eggplant and incorporated into the soil

Nursery establishment and management

Learning objectives:

After completing this module, participants will:

- Understand the factors to consider in selecting a suitable site for eggplant production
- Understand how eggplant plants interact with other plants and how to plan crop rotation considering spatial and temporal arrangement of onion plants.
- Learn the best practices of land preparation for eggplant production.

Duration: 2-3 hours

Learning aids

- Land where the onion plot will be implemented
- Tools for land preparation such as Hoes, Pangas, Slashers, Axes

Activities and exercises

- Discuss what group members would consider to choose an appropriate site for growing your onions
- Practically prepare the land for eggplant planting.

Content

Eggplant is normally propagated by seed. Soaking the seeds in water for 24 hours speeds up germination. No treatment is needed when sowing fresh, vigorous seed in sterilized soil. Otherwise, soak seeds in warm water (50°C) for 30 minutes, rinse them in cold water, and dry them before sowing.

Nursery preparation

- Before sowing an application of 3 - 5 kg of good compost per m² into the nursery seedbed.
- Sow seeds 200g per acre in a well-prepared raised seedbed in rows 10 cm apart.
- Space the seeds well to make transplanting easier.
- Site should also be away from shade, should be flat or gently sloping
- Prepare a seedbed of 1 m width and a convenient length
- Seeds are sown thinly on rows spaced at 15 cm apart
- Shade is erected above the nursery to protect young seedlings
- The seedlings emerge after 8-17 days depending on the weather and soil conditions. In areas with hot weather during spring, producers may sow the seeds directly in the field. Although this is a cost-effective method, it generally results in greater problems later, as the crop matures.
- Avoid making nursery (and transplanting) in areas where the following crops were grown for the last 3 years: tomato, pepper, potato to prevent a recurrence of the same pests and disease pathogens.
- Rotate eggplants with other crops like onions, cereals or legumes. Planting eggplant after rice reduces the incidence of bacterial wilt and nematodes.

Nursery Management

- Water the nursery regularly
- Harden the seedlings 1 – 2 weeks before transplanting by reducing the frequency of watering and gradually exposing the seedlings to direct sunlight
- Seed beds are kept free of weeds
- Insects can be blocked from reaching the seedlings by using an insect proof net



Transplanting, Weeding, Pruning, mulching and staking

Learning objectives:

After completing this module, participants will:

- select good seedlings for eggplant planting.
- plant eggplants with the correct spacing.
- plant eggplant according to the recommended practices.
- know when and how to do weeding, pruning, and staking.
- understand the effects of weeds on the yields of eggplants.
- be able to apply the different methods of weed control in the eggplants.

Duration: 2-3 hours

Learning aids

- Group demonstration field
- Hoes
- Eggplant seedlings
- Watering cans
- Strings and pegs
- Staking poles/sticks
- Pruning knife

Activities and exercises

- In the demonstration field observe with the participants what has changed with plants grown
- Discuss how to select quality seedlings
- Practically demonstrate how to transplant, weed, prune, mulch and stake

Content

Transplanting

- As you plan for transplanting, 7 days before make compost tea. Leave the mixture for one week. Strain and spray on seedlings to control fungal pathogens and prevent infection.
 - » Harden plants by withholding water 6 to 9 days before transplanting to reduce shock.
 - » Water seedlings 12 to 14 hours before transplanting to the field.
 - » Before transplanting place well-rotted farmyard manure in the planting furrows or planting holes and mixed with the soil.
- Seedlings are transplanted 3 – 4 weeks after sowing at which the height of seedling is about 10 – 15 cm
- It is recommended that transplanting should be done either early in the morning or late in the evening or on a cloudy day.
 - » Seedlings should have 3 - 4 true leaves, disease-free, and without flower buds.
 - » Transplant seedlings by digging a hole deep enough to bury a plant so that its first true leaf is just above the soil surface. Press the soil firmly around the root.
 - » Water the newly transplanted plants with compost tea (mix 1 part of compost with 6 parts of water).
 - » Transplanting will most probably fail, unless the soil temperature is above 20°C.

Recommended Spacing

| Between rows (cm) | Between plants (cm) | | | | | |
|-------------------|---------------------|--------|--------|--------|--------|--------|
| | 20 | 25 | 30 | 35 | 40 | 50 |
| 150 | 33,000 | 26,400 | 22,000 | 19,000 | 16,500 | 13,200 |
| 175 | 28,500 | 22,800 | 19,000 | 16,300 | 14,285 | 11,400 |
| 200 | 25,000 | 20,000 | 16,700 | 14,300 | 12,400 | 10,000 |
| 225 | 22,000 | 17,600 | 14,600 | 12,700 | 11,000 | 8,800 |
| 250 | 20,000 | 16,000 | 13,300 | 11,400 | 10,000 | 8,000 |

Fertilizer Application Rates

- Apply 2 bottle tops (10g) of Triple Super Phosphate (TSP) per hill (80kg/acre)
- Excess “P” leads to fruits with too many seeds reducing the quality
- Eggplant crop should be fertilized with organic fertilizers to produce high yields
- Top-dressing fertilizer such as CAN should be applied in 2 splits at 40 kg & 80 kg per acre at 4 and 8 weeks after transplanting
- Inadequate top-dressing can result into physiological disorders:
 - » Hollow cavities and poor taste in fruits due to potassium deficiency
 - » Blossom-end rot due to an imbalance between Nitrogen, Calcium and soil moisture

Stacking

- It is important to stack eggplants in order to prevent foliage and fruits from touching the ground and to provide ample space for aeration. Stacking also makes harvesting become much easier.
- Start stacking when eggplants have reached a height of 40 cm (16 inches).
- Tie every plant with wooden stakes 0.5cm (1 inch) thick and 1-1.5m (50-60 inches) long.

Pruning

In exceptional cases, you can prune eggplants by removing most of the peripheral stems of the plant when it has 3-4 stems and retain the two v-shaped main stems. This provides proper aeration and protects the plant from humidity favored infections.

Mulching

Should be done to reduce soil temperature, conserve soil moisture, and prevent soil erosion. Different materials like dry grass/non seeded weeds can be used to cover the soil. This is especially important where no staking is done. Tomatoes are very sensitive and once not mulched and staked, soil bacteria can cause diseases to the fruits. It is advisable to mulch after first weeding.

Pests and diseases management in eggplants

Learning objectives:

After completing this module, participants will:

- Know the common pests and diseases affecting eggplants and their effects.
- Recognize the signs and symptoms of different pests and disease attack in eggplants.
- Apply the Integrated Pest and Disease management approaches in eggplant production.
- Understand the critical stages of growth of different pests to target control in eggplant production.

Duration: 2-3 hours

Learning aids

- Demonstration garden
- Insect bottle
- Stationery
- Knapsack sprayer
- Jerrycan
- Basin soap
- Pesticides

Activities and exercises


- In the demonstration field observe with the participants what has changed with the plants grown
- Discuss what is a weed and why we must weed
- Practically select a weed and demonstrate how weeding and pesticide making and spraying are done and ask trainees to do the same on their fields



Content


General pest and disease management practices



Eggplant is a crop that suffers a lot of pest and disease attack. It is recommended that control starts even before the pests or disease symptoms are seen. Prevention measures should also be put in place. In principle, the following practices will greatly reduce pest and disease incidences in the field.



- j) Crop rotation – this breaks the pest lifecycle.
- k) Early planting – your crop escapes by the time pest/disease incidences rise, you are harvesting.
- l) Use of resistant varieties – they resist damage even when the crop is attacked (see Table 1 to identify which variety is resistant to which diseases).
- m) Weed control – weeds affect crop vigor which is related to damage. Weaker crops are more damaged (see previous chapter).
- n) Scouting – To spot pests/diseases early and control them in time.
- o) Correct identification of pest or disease to use the right control strategy.
- p) When irrigating, do not wet the leaves. Otherwise, it will help fungal diseases to develop.
- q) Mulching and staking – reduces contact of soil and the plant parts. Most eggplant diseases are soil borne. Staking also improves crop coverage during spraying.
- r) Remove affected plant parts



| Causes | Descriptions, Signs/Symptoms | Control |
|--|--|---|
| <p>Cutworms (Agrotis spp.)</p>  | <p>These caterpillars are serious pests particularly in nurseries and of newly transplanted plants. They attack eggplants and many other plants at night. They cut seedlings and usually drag them down into the soil leaving the clean-cut stem. They cannot cut older plants. Large ground beetles, frogs, and birds prey cutworm.</p> | <p>Plough and harrow the field prior to transplanting. This exposes cutworms to natural enemies and desiccation and helps destroy plant residue that could harbour cutworms.</p> <p>Make barriers to protect the transplanted seedlings. Barriers can be made by wrapping paper, aluminium foil, thin cardboard or similar materials around the base of transplant stems. Toilet rolls are handy as cutworm collars since they are readily available and will biodegrade into the soil.</p> <p>Dig near damaged seedlings and destroy cutworms.</p> <p>Conserve natural enemies. Parasitic wasps and ants are important in natural control of cutworms.</p> |
| <p>Budworm (Scrobipalpa blapsigona)</p>  <p>Parasitic wasp emerged from caterpillar.</p> | <p>It is reported as one of the major pests of eggplants in Ghana. The small brown caterpillars of the budworm bore into flower buds and feed inside the flowers. This causes the flowers to drop off. Budworm damage is often overlooked, but it can be serious, leading to very low fruit set (Youdeowei, 2002).</p> | <p>Conserve natural enemies. Caterpillars are usually parasitised by wasps.</p> <p>Practise crop rotation.</p> <p>Avoid growing eggplant two years in succession.</p> |
| <p>Whiteflies (Bemisia tabaci)</p>  | <p>Whiteflies feed on leaves of eggplant sucking plant sap. Whiteflies are vectors of the mosaic virus reported to occasionally affect eggplant in West Africa.</p> | <p>Apply neem products. Neem products have given control of the tobacco whitefly on eggplant. In the Caribbean, weekly sprays of neem seed powder (50g/l), and 2% neem oil gave good protection against this pest (Ostermann and Dreyer, 1995).</p> <p>In Sudan, commercial neem products and home-made products (neem seed water extract 50g/l) reduced the populations of Bemisia tabaci on eggplant and potato (El Shafie, 2001).</p> |


| Causes | Descriptions, Signs/Symptoms | Control |
|---|--|---|
| <p>Root-knot nematodes (Meloidogyne spp.)</p>  | <p>Eggplant is highly susceptible to root-knot nematodes, especially on sandy soils. Symptoms of infestation by root-knot nematodes are similar in all crops: wilting of plants and if infested plants are pulled from the soil the roots can be seen to be distorted, swollen and bearing knots. The infested roots eventually rot and affected plants die.</p> | <p>Use resistant varieties, if available. Practise crop rotation. Practise mixed cropping. Two weeks after incorporating plant material into the soil a new crop can be planted or sown (phytotoxic effects are usual if the crop is planted before two weeks). Use bioproducts (e.g. neem extracts). Use biofumigation where possible. Maintain high levels of organic matter in the soil (manure or compost).</p> |
| <p>Weeds (Striga)</p>  | <p>Eggplant is slow to become established and cannot compete with aggressive weeds. Weeds also harbour insect pests and diseases.</p> | <p>Remove weeds by hand regularly. Cultivate the land. Only shallow cultivation is necessary. Mulch plants. Black plastic mulch effectively controls weeds and reduces labour needs. Natural organic mulches such as rice straw help conserving moisture and add organic matter to the soil.</p> |


| Causes | Descriptions, Signs/Symptoms | Control |
|---|------------------------------|--|
| <p>Mole crickets, Tobacco Cricket (Brachytrupes spp.)</p>  | | <p>Mole crickets are a local sporadic pest. They have been reported as major pests of eggplants seedlings.</p> <p>Mole crickets live in the soil, feeding on the roots. They leave their burrows at night to cut and forage for seedlings and drag them down into the soil or leave them wilting on the surface for a few days before being taken into the burrow. Their underground burrows reaching a depth of 60-80 cm. They prefer mainly sandy soils where the adults can easily burrow.</p> <p>The adult is fat and 5 cm long, the adult female will live 3-4 months and lay over 300 eggs.</p> <p>Male mole crickets sing by stridulating, always underground, to attract females.</p> <p>Are small insects which have pure white wings and prominent hind legs</p> <p>They occur in groups on underside of leaves</p> <p>Large populations cause leaves to turn yellow and may fall off the plants</p> <ul style="list-style-type: none"> • Keep Eggplant fields weed-free • Use of yellow sticky traps to monitor their levels • Water sprays • Avoid use of broad spectrum insecticides since they reduce natural enemies • Use of neem products to reduce populations • Spray Thiocloprid (CALYPSO SC480®) • Hand pick adults from their burrows. • Sprinkle wood ash in nursery. • Plough deep to destroy burrows. <p>Expose insects to predators. Large ground beetles, frogs and birds prey on mole crickets.</p> <p>A few 1-cm-wide openings may be found around the damaged plants. The mole crickets can be forced into the open and captured when water is poured into the burrows.</p> |


| Causes | Descriptions, Signs/Symptoms | Control |
|---|--|---|
| <p>Thrips (Thrips spp and Frankliniella spp.)</p>  | <p>Thrips are small (1.5 mm long), slender, brown insects with pale yellow hind wings that appear as a yellow line down the back of the body when the insect is at rest. Adult thrips have characteristic wings; the transparent wings have a fringe of hairs around the outside edge standing out in the same plane as the wing.</p> <p>Thrips attack eggplant mostly during the dry season. They cause browning of leaves, especially on the lower leaf surface. In severe cases, the entire leaf dries. Thrips feeding on fruits causes scarring, irregular discolouration and deformation, which reduce the market value of fruits.</p> | <ul style="list-style-type: none"> Monitor the crop regularly for early detection of the pest and signs of infestation. Conserve natural enemies. Anthocorid bugs and predatory mites are important natural enemies of thrips. Avoid use of pesticides that kill natural enemies. Whenever necessary spray the crop with botanicals or other <u>biopesticides</u>. Some plant extracts (e.g. garlic, rotenone, neem, pyrethrum, and a mixture of garlic and pepper) are reported to control thrips. Spinosad, a bacterial derivative, is effective in controlling thrips. |
| <p>Cotton leafhoppers or jassids</p>  | <p>They are small insects (1-3 mm long), green in colour with slender tapered bodies.</p> <p>Leafhoppers are very mobile. The adults hop away when disturbed. Nymphs resemble adults, but have no wings, and run sideways when disturbed. The eggs are inserted in the leaf tissue on the underside of leaflets. They feed mainly on the underside of eggplant leaves, causing small yellow patches on leaves. Infested leaves curl upwards along the margin. Under heavy attack, leaves turn yellow and then brown and dry, giving a burned appearance. Fruit setting may be very low. Leafhoppers multiply rapidly during dry spells and can cause extensive damage.</p> | <ul style="list-style-type: none"> Spray neem products. Commercial and simple (home-made) neem products give control of leafhoppers on eggplants (10g/l at 10 days interval). |


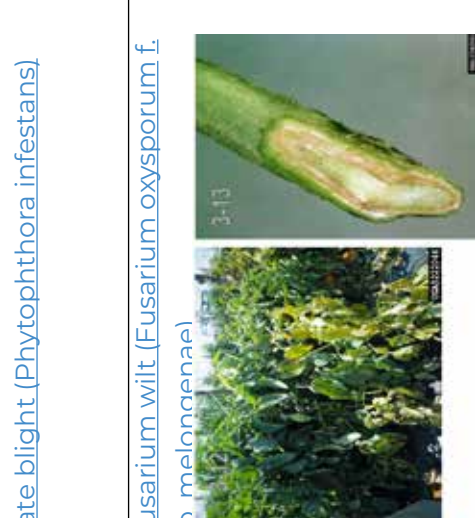

| Causes | Descriptions, Signs/Symptoms | Control |
|---|--|---|
| <p>Aphids (Aphis gossypii)</p>  | <p>Aphids are found in groups on the under surface of young leaves. When numbers increase they can move to upper leaf surfaces, stems and flowers. Aphids, in particular the cotton aphid, can become important pests in the cool dry season.</p> | <p>Spray neem products. They have a repellent effect and have been effective in reducing numbers of the cotton aphid on eggplants. Effective treatments included foliar sprays with aqueous extracts of neem seeds, kernel and neem cake at concentrations of 10 to 50 g/l, and 3% neem oil applied at 10 days intervals. Bare root dipping with 50g/l aqueous neem kernel seed extract, 3% neem oil and a 10 g/l aqueous neem cake extract have also been effective (Ostermann & Dreyer,1995).</p> |
| <p>Spider mites (Tetranychus spp.)</p>  | <p>Spider mites may become serious pests of eggplant during the dry season. Attacked leaves show a stippled appearance (white specks), and their surface covered with a fine web. Continuous infestation causes the leaves to dry-up. The plants are stunted and yields reduced.</p> | <p>Conserve natural enemies. Predatory mites and anthocorid bugs are important in natural control of mites.</p> <p>Avoid use of broad-spectrum pesticides. They may kill natural enemies and may lead to mite outbreaks.</p> <p>Provide good growing conditions for plants. Healthy plants are more likely to withstand mite attack.</p> <p>Adequate irrigation is particularly important. Apply mulch and incorporate organic matter into the soil to improve the water holding capacity and reduce evaporation.</p> |

| Causes | Descriptions, Signs/Symptoms | Control |
|--|---|---|
| <p>Epilachna beetles (Epilachna spp.)</p>  | <p>The adult beetle is oval in shape, about 6 mm in length and reddish brown in colour with black spots on their backs. They look very similar to the beneficial ladybird beetles (predators), but the body of this pest ladybird beetle is covered with short, light coloured hairs, which give them a non-glossy or matt appearance. The larvae are pale yellow and covered with branched spines.</p> <p>They feed on the leaves of eggplants by scraping the surface and eating the leaf tissue between the veins. Attacked leaves may be completely stripped to the mid-veins to skeletons. They may also feed on fruits causing small shallow hollows on the fruit surface. High numbers of these beetles can cause considerable damage.</p> | <p>Hand pick and destroy adults and larvae. This is feasible in small plots.</p> <p>Spray neem products. Neem extracts have repellent effects on these beetles. For instance, sprays with an aqueous neem seed extract (10g/l) at 10 days intervals showed repellent effect on Epilachna beetles in India (Ostermann and Dreyer, 1995).</p> |
| <p>Eggplant lace bug (Urentius hystricellus)</p>  | <p>It is a small bug (about 3 mm in length), brownish in colour. Its body is covered with spines and the wings show a distinct lace-like appearance. Nymphs resemble adults, but are initially wingless, developing wings as they grow. Both adults and nymphs are usually found in groups on the underside of leaves. They suck sap from the leaves causing whitish to yellowish mottled patches on the leaves. In case of serious infestations the leaves turn entirely yellow and drop off. Attacked leaves are speckled with small black shiny spots, which are the faeces of the bugs.</p> | <p>Spray neem products. They have given effective control of lace bugs on eggplants. The lace bug (Urentius sp.) was repelled from eggplant plots treated with neem oil (5, 10 and 20%). However, concentrations of 10 and 20% showed phytotoxic effects.</p> <p>Weekly sprays of an aqueous neem seed extract (50 g/l) and 2% neem oil gave good results against another species of lace bug (Corythaica cyathicollis) attacking eggplant in the Caribbean (Ostermann and Dreyer, 1995).</p> |

| Causes | Descriptions, Signs/Symptoms | Control |
|---|--|---|
| <p>Shoot and fruit borer (Leucinodes orbonalis)</p>  | <p>It is a major pest of eggplant. The adult is a small moth, with a wingspan of 18-24 mm, white in colour with a pink and bluish tinge, and a few brown spots on its wings. Moths lay creamy white single eggs on leaf undersides, stems, flower buds, or the base of fruits. Upon hatching the caterpillars (white in colour) bore into the top section of fruits and tender shoots. Caterpillars develop inside fruits and stems reaching a length of 15-18 mm. When fully-grown, caterpillars make a small hole in the fruit or shoot and drop to the soil and pupate among fallen debris.</p> <p>When plants start bearing fruits, most caterpillars prefer to feed on the tender fruits. The damage to the shoots is not seen until they droop as a result of the caterpillar feeding inside them. Recently damaged fruits are not easy to detect. The first indication of damage to the fruit is a small hole just below the calyx where the insect has entered. Fruits are filled with frass. They change colour and taste; they drop off and are unmarketable. Caterpillars are difficult to control with pesticides. Within hours of hatching from eggs, caterpillars enter the shoots or fruits, and are not reached by contact pesticides.</p> | <p>Conserve natural enemies. Predatory ants are the main natural enemies of the shoot and fruit borer. Other natural enemies include: ladybird beetles, praying mantis, earwigs, predatory bugs and spiders. Destroy old eggplant plants and stubble (burn or bury them) immediately after harvest. Pupae can survive in the stubble for several weeks, infesting the new crop. Use healthy, pest-free seedlings. Raise seedlings far away from sources of infestation (old eggplant fields, eggplant stubble)</p> <p>Grow seedlings under nylon netting to prevent moths from laying eggs on the plants.</p> <p>Remove and destroy infested shoots (readily visible as dry tip of branches). Burn, shred into tiny pieces or bury attacked shoots at least 20 cm in the soil. If this is done by all farmers in a community, especially before fruiting, pest infestation and damage can be drastically reduced. Continue cutting attacked shoots at least once a week until the final harvest.</p> <p>Destroy infested fruits found during harvest.</p> |

| Causes | Descriptions, Signs/Symptoms | Control |
|---|---|---|
| <p>Bacterial wilt (<i>Ralstonia solanacearum</i>)</p>  | <p>This disease occurs with bad drainage, especially in the hot, wet season and is often combined with symptoms of root-knot nematodes. Plants wilt and die suddenly. When newly infected stems are cut crosswise and placed in water, a greyish or yellowish ooze appears from the cut stem. The pathogen is soil-borne with a wide host range. Root-knot nematode infestation aggravates the disease development.</p> <p>The first visible symptom on foliage is a wilting of the leaves at the ends of the branches during the heat of the day with recovery at night. As the disease develops, a streaky brown discoloration of the stem may be observed on stems 2.5 cm or more above the soil line, and the leaves develop a bronze tint.</p> | <p>Use resistant varieties, if available. Use certified disease-free seeds. Remove infected plants from fields and destroy affected plants. Rotate with non-solanaceous crops (e.g. maize or beans). Use raised beds for improved drainage. Graft plants onto resistant rootstocks.</p> |
| <p>Powdery mildew (<i>Leveillula taurica</i>)</p> | <p>Symptoms appear as yellowish spots on the leaves. On the lower surface of affected leaves the spots are covered by a whitish growth constituting spores of the fungus. Affected leaves eventually dry up but do not fall off. The fungus is endophytic (grows within the leaf contrary to other powdery mildew fungi that are grow on surface of the leaves). It has a wide host range. It is not seed-borne but it survives on herbaceous weeds and other susceptible hosts. Temperatures slightly above 20 degC, dry conditions and fairly high relative humidity favour disease infection. However, fungal dispersal takes place mainly at low humidity.</p> | <p>Use of resistant varieties, if available. Use overhead irrigation. Use sulphur sprays.</p> |

| Causes | Descriptions, Signs/Symptoms | Control |
|--|---|--|
| <p>Anthracnose (Colletotrichum melo)</p>  | <p>Spots of fruits are sunken. When weather is moist, the spots get tan-coloured (growth of fungal spores). There may be several spots on affected fruit and they may join up and cover the whole fruit. Severely affected fruits drop. Eventually, affected fruits dry and become black. Most often, soft-rot bacteria invade affected fruits and cause a soft watery decay. The fungus usually attacks fruits on plants that are weakened or over-ripe. Infection is favoured by relative humidity close to 100% and temperatures between 21 and 30degC.</p> | <p>Use resistant varieties, if available. Use certified disease-free seeds. Practise crop rotation. Destroy infected crop residues</p> |
| <p>Phytophthora fruit rot (Phytophthora parasitica)</p> | <p>The fungus is soil-borne. It is spread in the field by run-off water and farm implements. The disease is favoured by prolonged periods of high moisture and temperatures near 30deg C.</p> <p>Phytophthora fruit rot fungus can cause damping-off in seedbeds, leaf spotting and collar rot on the main stem final resulting in plant death. The fungus may attack fruit at any growth stage and any part of the fruit. Spots on the fruit are dark brown, water-soaked and may have a light-coloured border. A whitish mould develops on the spots when wet conditions prevail. The spots are neither sunken nor exhibit concentric rings (zonation). Infected fruits drop prematurely.</p> | <p>Avoid dense planting. Remove and destroy diseased fruit and plants. Plough deep because Phytophthora would not survive. Practise crop rotation with non-solanaceous crops such as tomato, potato and peppers. Where practical, add copper sulphate to irrigation water.</p> |

| Causes | Descriptions, Signs/Symptoms | Control |
|---|---|---|
|  <p>Late blight (Phytophthora infestans)</p> | <p>The late blight fungus affects tomatoes, potatoes and eggplants but not pepper. Its symptoms consist of brown spots with purplish tinge and they can develop on leaves, stems, branches and both green and ripe fruits. In moist weather it can cause complete defoliation and rotting of fruits.</p> | <p>Use resistant varieties, if available Practise rotation with non-solanaceous crops (e.g. tomato, potato, peppers etc) for 3 to 4 years. However, this will only be effective if it is done in cooperation with neighbouring farmers since the fungal spores can travel quite large distances by wind. In wet weather, copper fungicides, could be applied as soon as the disease is observed or as soon as local experience suggests that the weather conditions are favourable for disease development.</p> |
| <p>Fusarium wilt (Fusarium oxysporum f. sp. melongenae)</p>  | <p>Affected plants show yellowing of leaves that progressively wilt and die from bottom upwards. Woody stem and root tissue of diseased plants turn brown. This fungus does not affect tomatoes. Optimum temperature for its growth on eggplants is 27.8 degC</p> | <p>Use resistant varieties, if available Amend soils with organic matter (e.g. compost) Practice crop rotation</p> |
| <p>Early blight Early blight or Alternaria leaf and fruit spots (Alternaria spp.)</p>  | <p>They cause leaf spotting and fruit rots. They produce leaf spots with concentric rings. The spots are mostly irregular, 4 to 8 mm in diameter and may enlarge and cover a large area of the leaf blade. Severely infected leaves drop off prematurely resulting in the reduction of yield. Fruit spots are circular, brown, dry and hard</p> | <p>Observe proper field sanitation. Use certified disease-free seed. Own seed should be water heat treated</p> |

10. Eggplant harvesting

Learning objectives:

After completing this module, participants will:

- be able to identify signs of maturity and ripening in the eggplant crop
- know when to harvest eggplants
- know the different methods and practices of harvesting of eggplant

Duration: 2-3 hours

Learning aids

- Tarpaulins
- Containers/wooden boxes
- Demonstration garden

Activities and exercises

- In the participant fields ask participants to observe what has changed with the crop
- Discuss signs of maturity and ripening in the eggplant crop for the correct stage of harvesting
- Discuss the common mistakes farmers make during harvesting of eggplant
- Practically harvest the eggplant with trainees

Content

- Maturity: Harvesting starts 60 – 90 days after transplanting depending on variety
- Harvest immature fruits before seeds begin to enlarge and harden. Harvest fruits when they are about two-thirds of their maximum size.
- Fruits should have shiny glossy appearance
- Over mature fruits are bitter. Harvest eggplants before their seeds turn brown.
- Harvesting is done once or twice a week for 3-4 weeks.
- Fruits should be harvested early in the morning when it is cool since the fruit temperature is low
- Eggplants are harvested by hand
- Secateur or any other tool is used to harvest fruits
- When picking, 2.5 – 5 cm fruit stalk is left attached to the fruit i.e. cut the fruit from the stem and leaving a short piece of stem on the fruit.
- Harvested fruit should be kept in a cool, shaded and ventilated area in order to minimize heat that causes potential weight loss.
- Yields: vary from 8,000 – 10,000kg per acre depending on the variety and crop husbandry
- For seed production, harvest only fully mature fruits from healthy and productive plants.

ORGANIC PESTICIDES

Learning objectives:

After completing this module, participants will:

- Understand the importance of organic pesticides
- Understand the reasons why they should avoid inorganic pesticides
- Know how to make organic pesticides using locally available materials

Duration: 2-3 hours

Learning aids

- Flip charts
- Marker pens
- Masking tape
- Training manual

Assorted local materials - Hot pepper, Garlic/ onion bulbs, Warm water, Strainer, utensil, Cow Urine and dung, Bucket, Gunny cloth, Marigold flowers and plant, soap, neem fruits, and plants like Lantana, Artemesia, Stinging nettle, black jack

Activities and exercises

- Discuss why is it important to treat plant pest and diseases
- Demonstrate practically on how to make the various organic pesticides.

NB: Since a number of days will be required to fully have the pesticide ready, this topic can also be done at the very start of the unit e.g., nursery management

1. Garlic/Onion + Hot Pepper Extract

Materials

- Hot pepper
- Garlic/ onion bulbs
- Warm water
- Strainer

Procedure

- Combine 0.5 kg of hot pepper with 1kg of garlic/onion bulbs, pound the two together to form a thick paste in a container.
- Add the vegetable paste to 4 liters of warm water and thoroughly mix the ingredients together.
- Pour the solution into a plastic container and allow it sit for 24 hours in a relatively warm place.
- Strain the solution and put the filtrate in a clean container. And this is your pesticides.
- Pour the pesticides in a squirt bottle that has been thoroughly well cleaned to get rid of other contaminants
- Mix the extract with water in a ratio of 1:4-5 liters and add 1 table spoon of liquid soap and apply.



2. Garlic brew

Materials:

- Garlic
- Cow Urine
- Bucket
- Gunny cloth
- Strainer

Procedure

- Crush or grind the garlic (1kg) into a paste and put into the bucket (10 liter) containing cattle urine (10 liter)
- Stir the materials for 5-10 min and cover with a gunny cloth or cotton cloth which can provide sufficient aeration
- Allow the material to ferment for 5-7 days
- After 7 days sieve the solution before spraying to avoid the nozzle of the sprayer
- The solution is diluted 10 times with water and sprayed on the foliage in the evening hours.
- Care should be taken that the concentrated solution should not be sprayed in the crop/vegetables about to be harvested.



Garlic



Cow urine



Crushed garlic mixed with cow urine in a bucket

3. Marigold Extract Marigold (*Tagetes* sp.)

It is an excellent pest repellent for most of the pests. When these plants are planted along with the main crop especially in vegetables, due to the allelopathic effect, they help in managing soil borne insects, pathogens and nematodes.

Materials required

- Marigold flowers along with the entire plant
- soap

Method

- Take 5 kg of Marigold plants along with the flowers. Grind into fine paste.
- Add 100 litres of water and allow it for fermentation for 7 days.
- Add 100 grams of soap nut powder on the day of spraying which acts as emulsifier.
- Stir for 15 minutes and spray during evening hours.

4. Garlic Decoction

This spray can be prepared if there is a sudden incidence of pest and no sprays are available with the farmer to manage the pest.

Materials required

- Garlic- 1 kg
- Water – 10 litres
-

Method

- Boil 1 kg of garlic in 10 litres of water separately.
- Allow the solution to cool and sieve the solution with a muslin cloth.
- Dilute one part of the solution with 10 parts of water and spray on the crop during evening hours.

| | |
|---|--|
|  |  |
| Garlic | Garlic boiled in water |
|  |  |
| Filtering cooled solution with a cloth | The filtered garlic decoction |

5. Neem extract

Watery extracts from seeds and leaves are excellent against beetle larvae and caterpillars, and good against stalk borers and adult beetles

Procedure:

- Collect fallen neem fruits from underneath the trees.
- Remove the flesh from the seeds and wash away any remaining shreds.
- Dry the seeds in bags or baskets. Avoid mould formation.
- For the preparation of extract, shell the seeds.
- Grind 500 g of neem seed kernels in a mill or pound them in a mortar or grate them finely. Mix the crushed neem seed with 5 to 10 litres of water. Soak them overnight.
- Strain the liquid before use.
- Application of neem water extracts - Spray the neem water directly onto the plants using a sprayer or straw brush. - Neem works fastest during hot weather.
- Heavy rains may wash off the protective cover of neem on plants.
- Repeat the treatment if pest infestation is high. - Neem water will remain effective for 3 to 6 days if it is kept in the dark. All neem preparations lose their power rapidly when exposed to sunlight.

Precautions during preparation of neem extracts Leaf or seed

Although they are almost non-toxic to mammals, seeds or seed extracts are poisonous when consumed. Take the following precautions:

- Place the neem extract out of reach of children and pets while preparing, using and storing it
- Avoid direct contact with the crude extract at any time
- Do not use utensils and containers for food preparation and for drinking for the preparation of neem extract.
- Clean all the utensils properly before and after use.
- Wash your hands after handling the plant extract.
- Always test the plant extract on a few infested plants first before going into large scale spraying.
- Use protective clothing when applying the solution.

MANURES

1.Liquid manure for pest management

A variety of plants (weeds) which have pesticidal value can be used. Plants which have strong disagreeable odour are ideal for making this preparation

Materials required

- Plants like Lantana, Artemesia, Stinging nettle, black jack - 3 kg
- Cattle dung - 3 kg
- 20 litre capacity plastic bucket
- Water – 20 litres

Procedure:

- Chop the plants into small pieces
- Mix with 3 kgs of cow dung
- Put in a gunny bag, tie the bag and hang in a bucket of 20 liters water for 5-7 days.
- Dilute 1 cup of solution to 10 cups of water



Cutting the plant material



Pouring water into the bucket



Removing the gunny bag after 5-7 days



The liquid manure solution

2.Dung Brew

It is a fermented solution of cow dung and provides nutrition to the crops.

Materials required

- Cattle dung - 5 kg
- Cattle urine – 15 litres
- Plastic bucket of 20 litres capacity

Method

- Add 5 kg of cattle dung and 15 litres of cattle urine in a bucket and mix it well.
- Cover the bucket with a gunny sack or any material that provides sufficient aeration.
- Stir the materials every alternate day for 15 days.
- The dung brew is ready for spray after 15 days and can be stored for 2 months.

Pest and disease management

To reduce the use of chemicals as far as possible, agroecological pest and disease management applies many practices to prevent pests and diseases from building up and creating losses:

- Cropping patterns such as crop rotations, intercropping, or trap/catch/push crops can break pest and disease cycles (and provide numerous other benefits), while anti-parasite crops may scare away (repel) or trap certain pests;
- Use resistant and tolerant varieties (quality seed, seed treatments, ...);
- Strong plants are less susceptible to pests and diseases (soil fertility, micro-climate, weeding, nurseries, effective micro-organisms and the like, ...);
- Introduce and nurture beneficial organisms (habitat, e.g. agroforestry, to enhance diversity);
- Adequate fertilization and irrigation (not too much N or humidity);
- Physical control: traps, enclosures/netting, by hand, scaring away, removing diseased plants;
- Organic pesticides: produced by farmers, small businesses;
- Go regularly to the field and observe thoroughly.

Some recipes and guidelines to produce and use such measures are explained further-on or in a separate leaflet.

11. Gross Margin Analysis

Learning objectives:

After completing this module, participants will:

- Be aware of the importance of record keeping and be able to record costs and income of the target crop.
- Know how to calculate the gross margin in order to assess the profitability of a crop and find out ways of potential improvements.

Duration: 2-3 hours

Learning aids

- Flip charts,
- markers,
- calculator.

Activities and exercises

The trainer will introduce the topic of the day. He will stimulate the discussion by asking the following questions:

- Do you know how much profit you generate with the target crop the last season?
- Do you know which expenditures are most important in the production?
- Do you know if your costs were higher or lower than your income?
- Practically conduct with trainees the cost benefit analysis. Where prices of inputs are not known conduct a market survey

Practical exercise

1. The facilitator asks the group to list all the expenses and costs (means of production and labour) they had for the target crop during the last crop year (or other crop). Producers are invited to mention them from memory. Do not forget the value of family labour and the costs of paid labour. The facilitator records the costs mentioned by the producers in the table below (on a flip chart).

2. Once the production costs are listed, the facilitator asks the group about the income: What have you done with the harvest product? Did you sell the entire production or only part of it? How much did you earn from the sales? Do you still have a remaining stock, how many bags/kg? The facilitator writes the cash income or the value of the production (in case of no cash value) in the table under part B. Income.

3. The facilitator explains how to compute the gross margin, which is total income minus the total costs. Then he asks the group whether the production of this crop is profitable or not (see if the gross margin is positive or negative).

4. The facilitator asks who wants to try to keep a record for the target crop during this season. The facilitator distributes the above table to the participants. The latter should write down their expenses (materials and labor). At each session, the host farmer could present his data (or in turn). It could serve as starting point for a group discussion on the similarities and differences in the record keeping among the participants. And report on the difficulties faced in filling the table.

Table for the calculation of the costs and income for a crop

| | | | |
|--|------------|-------------------|--------------|
| Name of farmer: | | Village/district: | |
| Date of calculation: | | | |
| Time period (season from/to): | | | |
| Crop: | | | |
| Total field area (ha): | | | |
| Total yield (kg): | | | |
| | Quantity | Unit cost (Ushs) | Total (Ushs) |
| A. Production costs (input) | | | |
| Materials | | | |
| Seed | 3 bags | 600 | 1800 |
| Organic fertilizers: | | | |
| – Manure | | | |
| – Compost | | | |
| Mineral fertilizers: | | | |
| – NPK | | | |
| | | | |
| Pesticides: | | | |
| | | | |
| | | | |
| Packaging bags | | | |
| Labor (Person-days) | | | |
| Soil preparation | 2 man days | 2000 | 4000 |
| Manure application | | | |
| Planting | | | |
| Weeding/ Hilling up 1 | | | |
| Weeding/ Hilling up 2 | | | |
| Dehaulming | | | |
| Harvesting | | | |
| Threshing | | | |
| Transport | | | |
| Total production costs (a) | | | |
| B. Income (output) | | | |
| Sales | | | |
| Home consumption* | | | |
| Remaining (storage)* | | | |
| Others* | | | |
| Total income (b) | | | |
| Gross margin (b - a) | | | |
| Profit per acre (Gross margin divided by field area) | | | |

***Convert in monetary: kg multiplied by market price.**

