School Demonstration Farm

Agriculture Guide

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1. School Demonstration Farm Site Selection

Factors to consider when choosing your garden site:

Water	Locate the garden as close as possible to a natural water source, such as a well or stream. The closer your garden is to the water source = the less labor to carry it.
Traffic Patterns	Put the garden in a spot near the school and where people can easily see it, so it can be monitored and students and staff can easily access it. Create an entrance/exit and paths to accommodate many people at once.
Security	Consider erecting a barrier around the garden, such as a fence, to repel animals and deter theft or vandalism. Establish a schedule for students, staff, and community members to monitor the garden, especially during school breaks.
Topography	Gardens on flat land are easier to start and maintain than gardens on sloped land. If the garden is on a slope, use techniques such as level beds or ridging reduce soil erosion and water runoff. If you are using flat land make sure that it does not flood in the rainy season.
Ownership	Ask parents, staff, and community members to donate land, tools, seeds, and/or their time so they feel like they are a part of the garden.
Safety	Analyze the site for potential hazards that could cause injury, such as an uncovered well or near a busy road. Minimize hazards, such as covering the well, and establish safety protocols for people working in the garden. Avoid leaving dangerous tools such as cutlasses and rakes laying on the ground so that students do not step on them and injure themselves.
Sun	The site needs at least 6 hours of sunlight per day to be productive and grow most vegetables. Some plants do better in the shade, though, so some light shade may be desired.

Ideas for working with nature:

- Poor soil can be improved by adding mulch and compost. Ridges and mounds also capture organic matter that is carried by the wind and rain.
- Old buildings can be used to support vine crops
- Bushes can produce food and be used as a fence
- Wet areas can be managed with raised beds

TAKE TIME TO OBSERVE YOUR POSSIBLE SITES

Work with nature instead of trying to work against it.
Observe patterns of the sun throughout the day, how water flows when it rains, human traffic patterns, and if plants are already growing there (indicating good soil).

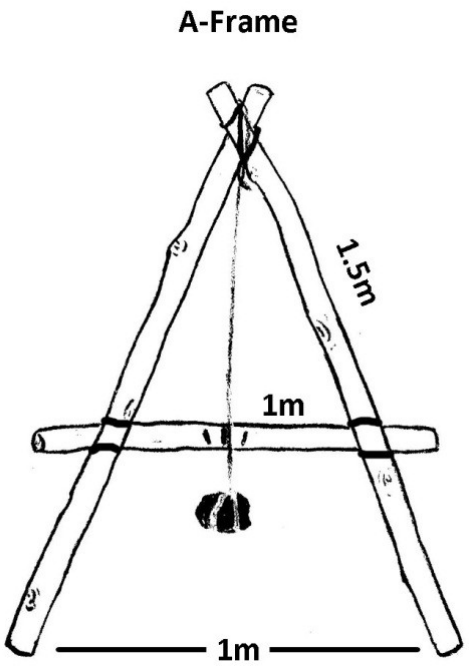
A productive garden takes time—learn from failures to improve.

2. A-Frame Construction and Use

Materials to build one A-frame:

Items	Length/Size	Quantity
Sticks	1.5m	2pcs
Sticks	1m	1pc
Twine rope	1.5m (total of 6m)	4pcs
Rock	Fist sized	1pc

How to build an A-frame:



1. Place the two 1.5m sticks such that the tops are crossing and the feet are 1m apart on the ground. These sticks will now be called the "legs."
2. Use one piece of twine rope to lash the legs together until they are tight and do not wiggle
3. Place the 1m stick against the legs horizontally about 2/3 of the way from the feet. This horizontal stick will now be called the "cross bar."
4. Use the second piece of twine rope to lash the cross bar tightly to one of the legs
5. Re-measure the distance between the feet and make sure that it is still 1m
6. Use the third piece of twine rope to lash the crossbar to the second leg until it is tight and does not wiggle
7. Test the overall strength of the three pieces. The A-frame should be rigid and unable to move.
8. Tie one end of the fourth twine rope to the rock so that it is secure
9. Tie the other end of the twine rope to the lashing where the two legs cross at the top of the A-frame. This should be tied very loose around the center of the lashing (not around the legs) such that it swings freely and cannot get stuck.
10. Place the feet on two visibly unlevel points

11. Wait for the rock to stop swinging and mark the point where it rests against the cross-bar
12. Have two helpers place their fingers on the ground next to the feet of the A-frame
13. Rotate the A-frame 180 degrees so that the feet are where the helper's fingers are. The helpers need to keep their fingers stationary until the A-frame is turned!
14. Wait for the rock to stop swinging and mark the second point where it rests against the cross-bar.
15. Make a third marking exactly half-way between the two marks. This is your level point!

Maintenance: If the joints become loose with use, they must be tightened and the marks must be re-cut to ensure that the A-frame is leveling correctly. Using an A-frame with loose joints can result in inaccurate leveling.

How to use an A-frame:

- Leveling: Stand the two legs of the A-frame on a plot of soil and let the rock dangle freely. If the string attached to the rock stops near the center mark on the crossbar, then the plot is level or nearly level.
- Measuring distance: The feet of the A-frame are 1m apart.
    1. To measure distance across a field, start at your starting point and walk the A-frame in a straight line (or as straight as possible) to your end point.
    2. Count each rotation to get the total number of meters between the two points.
    3. To measure distance between ridges or mounds, or to measure the width of a garden bed, the feet of the A-frame can also be used as they are 1m apart.

- <u>Measuring ridge and mound height/width:</u>
    - *Width*--
        1. Use a measuring tape to mark the appropriate ridge/mound width on the A-frame cross-bar
        2. Once the ridge/mound is completed, lay the A-frame flat on top of the ridge/mound and use the markings on the cross-bar to determine if it is the correct width
    - *Height*--
        1. Use a measuring tape to mark the appropriate height of the mound/ridge on the legs of the A-frame
        2. Stand the A-frame so that it straddles the mound/ridge and look to see if the top is at the level of the markings

3. Composting

Compost is created by combining organic materials to make a natural fertilizer. It is easy and costs nothing but can make a big difference in how well your garden produces.

The decay of leaves, plant stalks, grasses, fruits and vegetables creates a nutrient-rich compost. When you add this compost to your garden you reintroduce required nutrients. It is important that all of these essential ingredients be present in compost:

Air + Water + Carbon + Nitrogen + Microorganisms + Moisture = Compost

Microorganisms such as fungi and bacteria make the materials decompose. After the microbes begin the decomposition, larger organisms such as worms and insects also help to break down the organic materials.

From the organic compost materials, the microbes use the carbon (C) for food and the nitrogen (N) to build proteins. Without both types of materials (such as dung that is high in nitrogen and dried grass that is high in carbon), the microbes cannot do their job, and the compost process will be slow.

Compost Materials	
"Green Materials" **High in Nitrogen** **Comes from things that are green or relatively fresh.**	**"Brown Materials"** **High in Carbon** **Comes from things that are brown or drying up.**
Green Leaves Green Grass Green Weeds Manure (chicken, goat, sheep but not pig) Food Scraps Old Fish Banana Peels Banana/Plantain/Pawpaw Fresh Leaves Snails (shells are a good source of calcium) Egg Shells	Dry Banana Leaves Dry Leaves Dry Grass Peanut Hay/Shells Old Roofing Thatch Rice Hay/Bran/Hulls Carton

Materials <u>NOT</u> to compost:

While anything that was once alive can be composted, you should not put everything in your pile. These items are **<u>NOT</u>** good for the compost:

- wood or large stick; they take too long to break down
- protein such as large amounts of meat scraps and bones; they will attract unwanted animals
- cat, dog, pig, or human dung; it may contain disease
- any plants that have noticeable disease or pest problems

Different ways to make compost:

Making Lazy Compost		
<u>Pile:</u> pile up organic materials and allow it to decompose	OR	<u>Pit:</u> dig a hole, place in organic materials, and allow it to decompose
1. At the time of brushing gather up as much organic material as possible (grass, leaves, vines, etc.) 2. Place them in a big pile 3. Let sit until the end of the rainy season 4. Remove any undecomposed material from the outside of the pile. You now have lazy compost! 5. Remember, even bad compost is still compost! But, if you want to make better compost, try making simple or super compost (directions follow).		
Making Simple Compost		
<u>Pile:</u> pile up organic materials and allow them to decompose	OR	<u>Pit:</u> dig a hole, place in organic materials, and allow them to decompose
1. Place a thick layer of brown/high carbon materials first (you only need to use 1 of the brown materials listed previously) 2. Water until everything is damp 3. Add a layer of green/high nitrogen materials (you only need to use 1 of the green materials listed previously) 4. Repeat the process until the pile is 1 meter at the base and 1 meter high or the 1 meter by 1 meter pit is filled – if the pile is too small, it will not get hot enough to kill seeds and diseases		

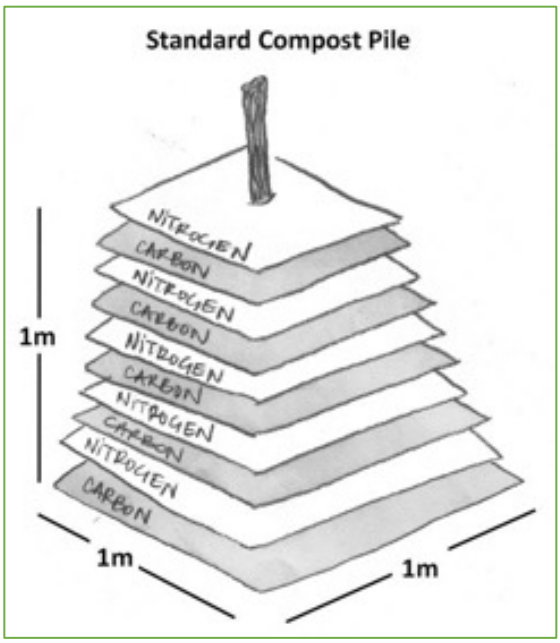
5. Cover the pile in a thick layer of dry carbon materials like leaves or grass to help lock in heat and moisture
6. Turn over every 2 weeks for 6 to 8 weeks. Add water as necessary to keep the pile damp. Make sure to place the less decomposed material from the outside on the bottom center when you are turning.
7. Remember, even OK compost is still compost! But, if you want to make the best compost possible, try making super compost (directions below).

Making Super Compost

Pile: pile up organic materials and allow it to decompose	OR	Pit: dig a hole, place in organic materials, and allow it to decompose

1. Place a thick layer of brown/high carbon materials first (see the *Compost Materials* table for brown materials)
2. Add water until damp if necessary
3. Add a layer of green/high nitrogen materials (see the *Compost Materials* table for green materials)
4. Add water until damp if necessary
5. Sprinkle with clean wood ash to help balance the acidity
6. Add a few full shovels of finished compost (to introduce microbes)
7. Place a thick layer of brown/high carbon materials first (see the *Compost Materials* table for brown materials)
8. Add water until damp if necessary
9. Add a layer of green/high nitrogen materials (see the *Compost Materials* table for green materials)
10. Repeat the process until the pile is 1 meter at the base and 1 meter high or the 1 meter by 1 meter pit is filled – if the pile is too small, it will not get hot enough to kill seeds and diseases
11. Cover the pile in a thick layer of dry carbon materials like leaves or grass to help lock in heat and moisture.
12. Turn over repeatedly after 1-2 weeks and monitor temperature and moisture level

NOTE: Clean wood ash means organics only—wood, crop residues, straw, leaves, etc.—and NO plastic.



You may want to make several compost pits or piles so that you have compost at different stages and have fertilizer ready for when you need it. If so:

1. Use compost from one pile/pit to start another in order to have compost ready at different times
2. Make a new pile every 2 weeks at the time of turning to ensure a constant source of compost

4. Seed Germination Test

A germination test helps you see if seeds are viable. When you know how viable your seeds are you can make the most of them by planting more if the germination rate is low or less if the rate is high to help increase the productivity of your garden.

Materials for a germination test:

Items	Quantity
Seeds	Minimum of 20 of the same seeds
Clean cloth	2pcs
Clean water	
Paper and pencil/pen	

How to do a germination test:

1. Select the type of seed you want to test. If you obtain seeds from different sources, be sure to label them and keep them separate to conduct separate germination tests on each group of seeds.
2. Soak the pieces of clean cloth in clean water. Wring out the cloths so they do not drip.
3. Place 20 seeds in organized rows on one of the cloths. Cover the seed with the second piece of cloth and loosely roll up the cloths. Repeat the test for other types of seeds or the same types of seeds from different sources.
4. Label each roll of cloth with the type of plant, source of the seeds and the date.
5. Place the rolled cloth in shade for 5-7 days. Unroll the cloth and examine the germination. Most seeds that are viable will have germinated by then. Count the number of seeds tested (e.g., 20). Count the number of seeds that germinated (e.g., 14).

6. Calculate the germination rate (GR)--Count the number of seeds that have germinated and divide that number by the number you first tested. This is your germination rate. If the germination rate is less than 85%, you should plant extra seeds. The lower the GR, the more (extra) seeds you must plant to ensure that the beds are fully planted. For example, if you want four squash plants but the germination rate was only 70%, you will need to plant enough seeds for five or six plants. See example in the box.
7. Record the germination rate.

Seed Germination Formula:

$$\frac{\text{Number of Seeds Germinated}}{\text{Number of Seeds Planted}} \times 100 = \text{\% of Germination Rate}$$

Example:

$$\frac{\text{14 Seeds Germinated}}{\text{20 Seeds Planted}} \times 100 = \text{70\% Germination Rate}$$

5. Elevated Nursery Construction

Materials to build one, 3 meter by 1 meter elevated nursery bed and shade:

Item	Length/Size	Quantity
Short forks – Nursery Legs (Thick Bamboo)	110cm	6pcs
Long forks – Shade Cover Legs (Thick Bamboo)	7.5ft	3pcs
Long forks – Shade Cover Legs (Thick Bamboo)	7ft	3pcs
Cross Bars (Thin Bamboo)	3m	8pcs
Crosses – for slats (Medium Bamboo)	1.2m	35pcs
Crosses (Medium Bamboo)	1.2m	8pcs
Holes	30cm deep	6
Plain Thatch	-	20pcs
Twine	Roll	1

How to build an elevated nursery:

1. Dig 6 holes to a depth of 30cm. The holes should be 1m apart at the width, and 1.5 meters between holes on the sides.
2. Cut all pieces to the height listed in the material list
3. Cut forks no more than 10cm above the bamboo node to ensure that the pieces do not split down the length of the legs
4. Place the short forks in the holes. If constructing the nursery on sloped land, remove earth from the holes on the up-slope sides until the forks are all the same height.
5. Place the cross bars in the forks, running the length of each side
6. Cut the 1m crosses into slats and place across the width of the cross bars
7. Tie the slats down using the 3m cross bars to hold them into place

8. Place the long forks in the holes to the sides of the short forks making sure to use the longer ones on the same side so that the roof slopes to one side
9. After all forks have been placed, fill and pack the soil around the forks
10. Place the cross bars on each of the long forks, running along the sides, to frame the roof
11. Place more slats across the width of the roof and tie down to support the thatch
12. Place vines or grass on the bottom of the planting bed and cover with topsoil
13. Place thatch over the slats on the roof and tie down

6. Vegetable Nursery Preparation

Some plants, such as such as tomato, pepper, and okra, do best when seeds are started in a nursery and then transplanted into the garden (see table below).

How to start seeds in a nursery for transplanting:

1. Soil: Mix 1 part garden soil with 1 part compost nursery soil. Sterilize soil so it is free of disease organisms by covering in coal or wood and burning for several hours
2. Placement: Make rows 15 centimeters apart and 0.5 centimeters deep across the nursery planting bed. Sow 2 seeds per 1 centimeter in the row.
3. Planting: Cover seed with the soil no deeper than twice their thickness. Press lightly. Water gently with a watering can or spray lightly over a palm leaf. Take care not to water with a strong stream or you may erode the soil and seeds away.
4. Thinning: When seedlings emerge, you must thin them to allow enough room for a healthy transplant to grow. Whether in the garden or containers in a raised nursery, this means 1 seedling every 2 centimeters. Larger seedlings may need additional thinning. Overcrowded plants will look thin and spindly and will be less healthy.
5. Watering: Watering should be done as gently as possible. Even a normal watering-can can be too rough if used from too great a height. Especially when plants are very young, you should inspect your nursery to make sure the seedlings are not bent over and stuck in the soil. If they are, gently free them without damaging the roots or stems.

Best for transplanting seedlings	
Vegetable	**Seedlings ready for transplant**
cabbage	3 - 5 weeks
eggplant	4 - 6 weeks
kale	3 - 5 weeks
okra	4 - 6 weeks
onion	3 - 6 weeks
pepper (green and red)	5 - 6 weeks
tomato	4 - 6 weeks

6. Before Transplanting: Reduce watering and expose the containers to a little more sun each day for a week before transplanting. This will toughen the plants and reduce the shock of transplanting.

Nursery space in the garden bed protection and maintenance:

- Mesh cloth – Cover your garden bed nursery with mesh cloth to provide shade for your young plants and protect them from insects.
- Wood ash – Can deter insects
- Weeding – Weed as needed to ensure sun, water, and nutrients get to seedlings

7. Garden Bed Preparation

How to prepare a garden bed using the dig-dig method:

1. Use the feet of the A-frame (1m wide) to mark out the edges of your garden bed to the desired length (use twine rope if you would prefer perfectly straight garden beds)
2. Once the garden bed is marked out, remove the topsoil from the bed and place to the side
3. Use diggers, hoes, and shovels to loosen the sub-soil as deeply as possible (a minimum of 20-50cm)
4. Use a rake to roughly re-level the subsoil, then use the A-frame to make sure that the sub-soil is roughly level in all directions
5. Once the subsoil is level, replace the topsoil and rake until it is roughly level
6. Add soil amendments evenly over the surface of the bed (compost or manure, wood ash, charcoal powder as available) and cut in with a shovel so as to keep a uniform distribution of amendments in the topsoil
7. Rake very smooth and use the A-frame to ensure that the bed is as level as possible

Maintaining the benefits of dig-dig:

The dig-dig process is a lot of work, especially when digging a bed in soil that has not been cultivated before. The last thing you want to do is re-compact your soil after spending so much time and energy making it soft. Here is a list of dos and don'ts that will help you maintain the benefits of double digging:

<u>DO</u>

- Use a watering can (factory or homemade) when watering to reduce the water's impact on the soil
- Mulch the garden beds so that the surface is not continually drying in the sun and then remoistening when it is watered which leads to surface crusting and prevents future water penetration

DON’T

- Step in the garden beds. Ever! This is the easiest way to compact the soil, damage existing root systems, and reduce the water-holding capacity.
- Use a bucket to water the beds. Watering roughly leads to soil compaction almost as quickly as walking on it.
- Leave the surface of the soil exposed to the sun and wind longer than is absolutely necessary. As soon as plants are large enough to have mulch around them, the beds should be mulched thoroughly.

8. Transplanting

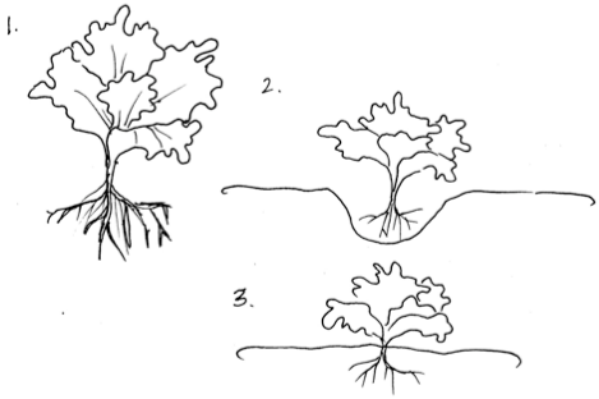
Have the garden soil ready before you transplant. Transplant in late afternoon or early evening; this will give the tender young transplant the night and early morning to recover and it will be less likely to wilt before being exposed to the full sun.

How to transplant seedlings from a nursery:

1. Dig a hole large enough to hold the transplant roots. Add a handful or two of compost to the transplant hole to help seedlings get off to a good start. Fill the hole with water and allow it to drain. This will ensure that the soil surrounding the transplant will have adequate moisture.

2. Transplant only the most healthy and vigorous seedlings. This means the seedlings must have good roots and at least two sets of well-developed, true leaves.

Lettuce and Cabbage Transplants



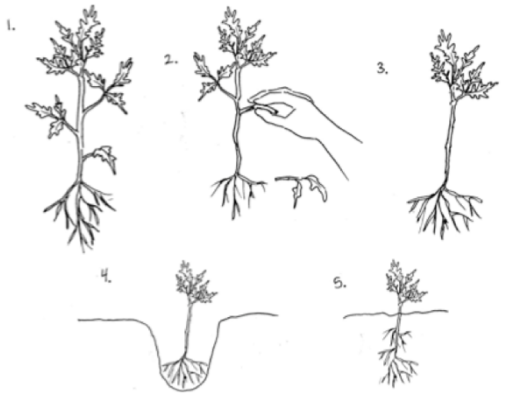
1. Gently remove the transplant from the nursery.
2. Place the transplant in the planting hole just up to the root collar. Pinch off the largest leaves.
3. Fill in the planting hole and gently press down the soil around the root zone.

3. Take special care to handle the transplants. <u>To avoid damaging the roots or stems, you should handle them gently by the leaves, not the stem.</u> Remove the seedlings with a trowel, taking along a good size root and soil ball. This will help minimize the "transplant shock" to the seedling.

4. Transplant quickly!

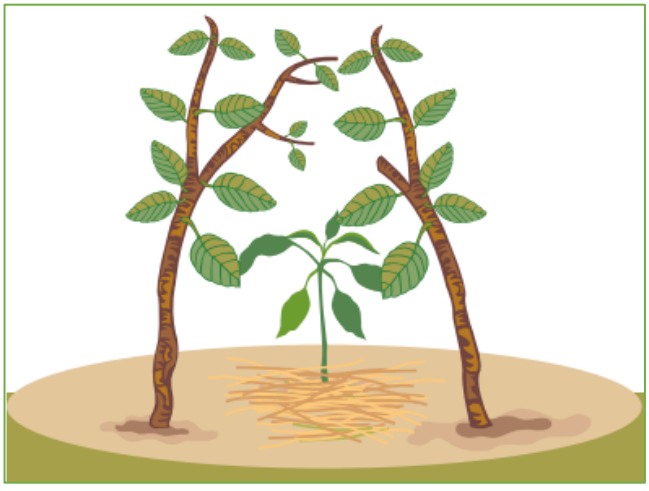
5. Except for tomatoes, replant all seedlings at a depth that matches their depth in the seedling container. Tomatoes are an exception to this and can be planted 4 cm. or so deeper than they were in the seedling bed. Tomatoes will spout new roots from the stem and have a stronger, deeper root system. Space the plants appropriately.

Tomato Transplants



1. Gently remove the transplant from the nursery.
2. Pinch off the lowest leaves.
3. Leave the top-most 2-4 leaves.
4. Transplant to a depth covering most of the stem
5. While holding the transplant by the leaves, pour water in the hole and fill it with soil. Press down gently to ensure the root system is in contact with the soil.

6. Press soil firmly around the roots of transplants and immediately water lightly to allow soil to settle around the transplant. Water each plant regularly to keep the soil from drying out.



Protecting new transplants from the sun:

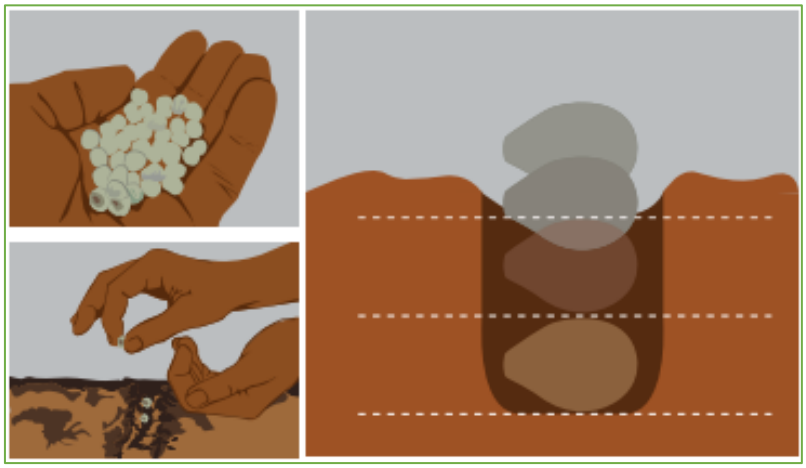
Transplants from the shade nursery are not accustomed to the full sun. To prevent new transplants from wilting and to allow them to slowly adjust to the full sun, use small branches with leaves attached to give them some shade for a few days. Even with this care, seedlings will undergo some "transplant shock."

9. Direct Seeding in the Garden Bed

Not all plants are suitable for the nursery and transplant system. Some crops, especially root crops, have much more sensitive root systems that can easily be damaged when removed from the soil. For these crops, the direct seeding method is ideal.

How to direct seed in a garden bed:

1. First, consider, "How large will the plant be when it is full grown?" The answer should help you determine plant spacing. Space the plants about one hand width apart. The foliage of a plant above ground and the roots underground both spread about the same amount.
2. Make holes or lines in the garden bed:
    a. For plants that require a wide spacing, such as cucumber, squash, watermelon, melon, okra, and bissap, make individual holes. Make a hole in the soil with a small stick or pencil, 2 –3 times the size of the seeds and at least 2 times the depth of the seeds. Place 2–3 seeds in each hole to ensure germination. Place the seeds in the hole and cover with soil. Thin to one plant per hole once the seedlings are 1 to 2 weeks old.



    b. For plants that are more closely spaced, such as carrot, turnip, radish, make shallow lines. Place 2-3 seeds at the appropriate spacing within the lines. Thin to one plant per hole once the seedlings are 1 to 2 weeks old.
3. After the bed is seeded, lightly tamp down the area planted to help the seed make good contact with the soil. Never pack the soil, especially a wet soil.
4. Water the bed regularly and reseed any areas that do not sprout.

10. Mounds & Ridges for Roots & Tubers

Cassava/sweet potato ridges: A ridge is a long, level mound of earth designed to provide an ideal planting surface for cassava or sweet potato that is being planted on steeply sloped land. Ridges help to prevent water erosion and top soil loss by capturing rainwater and organic matter on the slope.

How to make ridges:

1. Place the A-frame in your starting position. Move one of the feet up or down the slope until the twine rope rests on the level mark.
2. Mark the location of the first foot and "walk" the A-frame to the next point by swinging the first foot to the other side of the second foot until the twine rope rests against the level mark. The second foot should remain stationary. Be careful not to dig the feet into the ground while walking it or it will make your leveling inaccurate.
3. Continue to walk the A-frame across the contour until you have reached your stopping point. The ridges can be as long or as short as you want to make them.
4. Once the contour line is marked, move earth from the up-slope side onto the contour line until the dimensions of the ridge are appropriate for the crop
5. After the ridge is dug, use the A-frame to check that the height of the ridge is level and adjust any areas that need work
6. To make the second ridge, use the feet of the A-frame to measure 1m down-slope from the center of the first ridge. Repeat the instructions for the first ridge to complete the second ridge.

REMEMBER

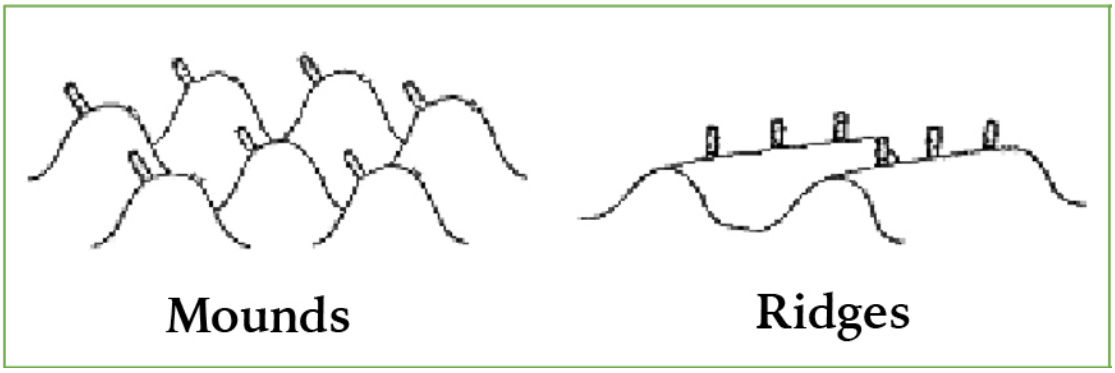
Good enough is good enough! As long as the twine rope is resting between the two outer marks, we will consider the top of the ridge to be level.

Cassava ridges:

- Dimensions—1m wide by 50cm tall
- Plant spacing—approximately 1m between ridges with some variation due to contour "snaking". 1m spacing within the ridge. Plant 25cm cuttings at a 45-degree angle to a depth of 20cm. As the roots develop, move the sides of the ridge that have settled down to the top of the ridge to cover emerging roots.

Sweet potato ridges:

- Dimensions—80cm wide by 30cm tall
- Plant Spacing—approximately 1m between ridges with some variation due to contour "snaking". 1m spacing within the ridge. Plant 30cm vines to a depth of 20cm. As the tubers develop, move the sides of the ridge that have settled down to the top of the ridge to cover emerging tubers.



Cassava/sweet potato mounds:

A mound is small, circular hill of soil that provides an ideal planting surface for cassava or sweet potato that is being planted on flat land. Mounds are much less work than ridges, but are not suitable for steep slopes as they erode quickly in heavy rainfall. Both mounds and ridges increase yields significantly, increase the ease of harvest, and reduce damage to roots and tubers at the time of harvest.

How to make mounds:

1. Use a hoe or digger to till the entire planting area as deeply as possible – 20-30cm minimum
2. Use the feet of the A-frame to walk across the planting area marking 1m by 1m spacing. A tape measure can be used as well

3. Once the planting positions are marked, move earth from all sides surrounding the planting area until the mounds meet the correct dimensions for the crop being planted

Cassava mounds:

- Dimensions—1m wide by 50cm tall
- Plant Spacing—1m by 1m between the top of each mound. Plant 25cm cuttings at a 45-degree angle to a depth of 20cm. As the roots develop, move the sides of the mound that have settled down to the top of the ridge to cover emerging roots.

Sweet potato mounds:

- Dimensions—80cm wide by 30cm tall
- Plant Spacing—1m by 1m between the top of each mound. Plant 30cm cuttings to a depth of 20cm. As the roots develop, move the sides of the mound that have settled down to the top of the ridge to cover emerging roots.

11. Integrated Pest Management (IPM)

Pests are objectionable organisms that can harm crops. As such, a pest can be a plant, an insect, a microbial or an animal. When most people think of pests they think of insects, but fungi, viruses, bacteria, weeds, rodents and other organisms can be as destructive as insects. They may all compete with us for food, inflict injury, or just be annoying. Fortunately, we can control pests or limit their impact without damaging our environment.

Insects and other creatures are an important part of a healthy ecosystem. A pest-free garden is expensive and impractical. In fact, a pest-free garden is actually undesirable. Your goal should be to keep pest populations below the level at which they cause unacceptable damage. If you allow a low level of pests to survive, some of their natural enemies will also survive. That is good!

In the community, it is usually not practical to control pests with chemical pesticides, which are often unavailable and expensive. When a pesticide is used improperly, negative effects can result: it may leave harmful pesticide residues on the food; it may make handling the plants more hazardous; and it may harm beneficial insects, earthworms, birds and even livestock.

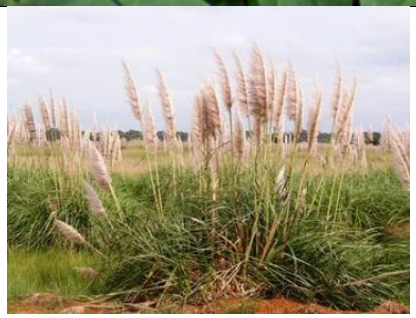
The following pages feature examples of pests and tips for how to control them.

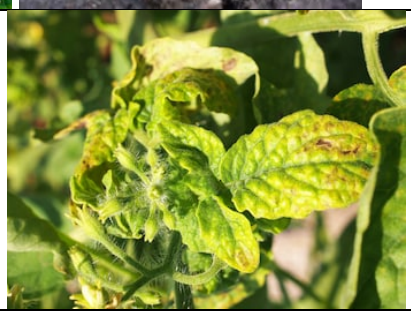
Examples of pests:

Insects: chewing and sucking insects cause injury to plants and stored products, although not all insects are pests	
<u>Chewing insects—</u>most widely recognized; chews off plant parts causing damage such as: • ragged leaves • foliage consumption • mining in leaves • stems and trunks of plants Examples: grasshopper, African maize stalk borer	 
<u>Sucking insects—</u>pierce through the epidermis and suck the sap; may serve as vectors of diseases Examples: aphids, leafhoppers, thrips, whitefly, flies, mites etc.	 

Vertebrate: eat large amounts of human food and also damage the crops; include rodents (rats), groundhog, birds, and other animals	
Examples	 

Mollusks: include slugs and land snail; decrease quality of grains and fruit	
Example: Deroceras reticulatum	 

Weeds: weeds are plants considered undesirable in a particular situation; “a plant in the wrong place”	
<u>Broadleaf weeds</u> Example: clover	
<u>Grassy weeds</u> Examples: Nutsedge, Pampas grass, Bermuda grass	 

Microbial: organisms that cause disease; include bacteria, fungi, nematodes, viruses, and mycoplasmas	
<u>Bacterial diseases</u> Examples: angular leaf spot, wilt, black rot	 
<u>Fungal diseases</u> Examples: downy mildews, damping off disease	 
<u>Viruses</u> Examples: cassava mosaic virus and tomato yellow leaf curl virus	 

Pest control:

<u>Insects:</u> Insect pests can be controlled in two ways:

1. using natural pesticides
2. using chemical pesticides

The natural methods are always less expensive and more benign. Here is a list of non-toxic methods:

- Prune out insect-infested areas of plants
- Dislodge insects gently with a stream of water or a brush
- Handpick insects from plants and drop them into a bucket of soapy water
- If cutworms shear off your transplants, gently dig in the soil to find and kill the cutworm. Then you can transplant another plant.
- Remove diseased plants and harvested plant remains

Remove Spent Plants to Reduce Disease and Insect Carryover

Remove plants in the garden when they stop producing fruits and vegetables.

For example, after harvest remove all of the cucumber and squash vines.

Compost these plants if they have not been infected by disease or insects.
If diseased, dispose of far away from the garden.

Cassava pest control:

Name & description	Photo	Control measures
<u>Whitefly:</u> one of the most challenging to control, vectors for viruses and diseases • Larvae (oval-shaped) found on the underside of young leaves • Adults scattered over the plant Damage includes: leaves wilting and falling, sooty moulds on the leaves, fruit rotting		• Cultural-field sanitation, crop rotation, intercropping, use of clean planting materials • Resistance/tolerance varieties • Chemical-Hitcel, samocholo • Biological agent • IPM

<u>Cassava Green Mite:</u> spreads quickly by wind and movement of infested planting materials, peak time is first half of the dry season Damage includes: yellow spotting of leaves, loss of chlorophyll, may show mottled symptoms, leaves may dry and fall off causing a candle stick appearance, root yield losses	 *Cassava Green Mite and its damage on leaves*	• Use of tolerant/ resistant cassava varieties • Field sanitation • Insecticides and miticides, including Dimethoate, Dicofol and Acaricide • Biological—predatory mite (Phytoseiid Typhlodromalus aripo)

Weeds: Weeds can be controlled in various ways:

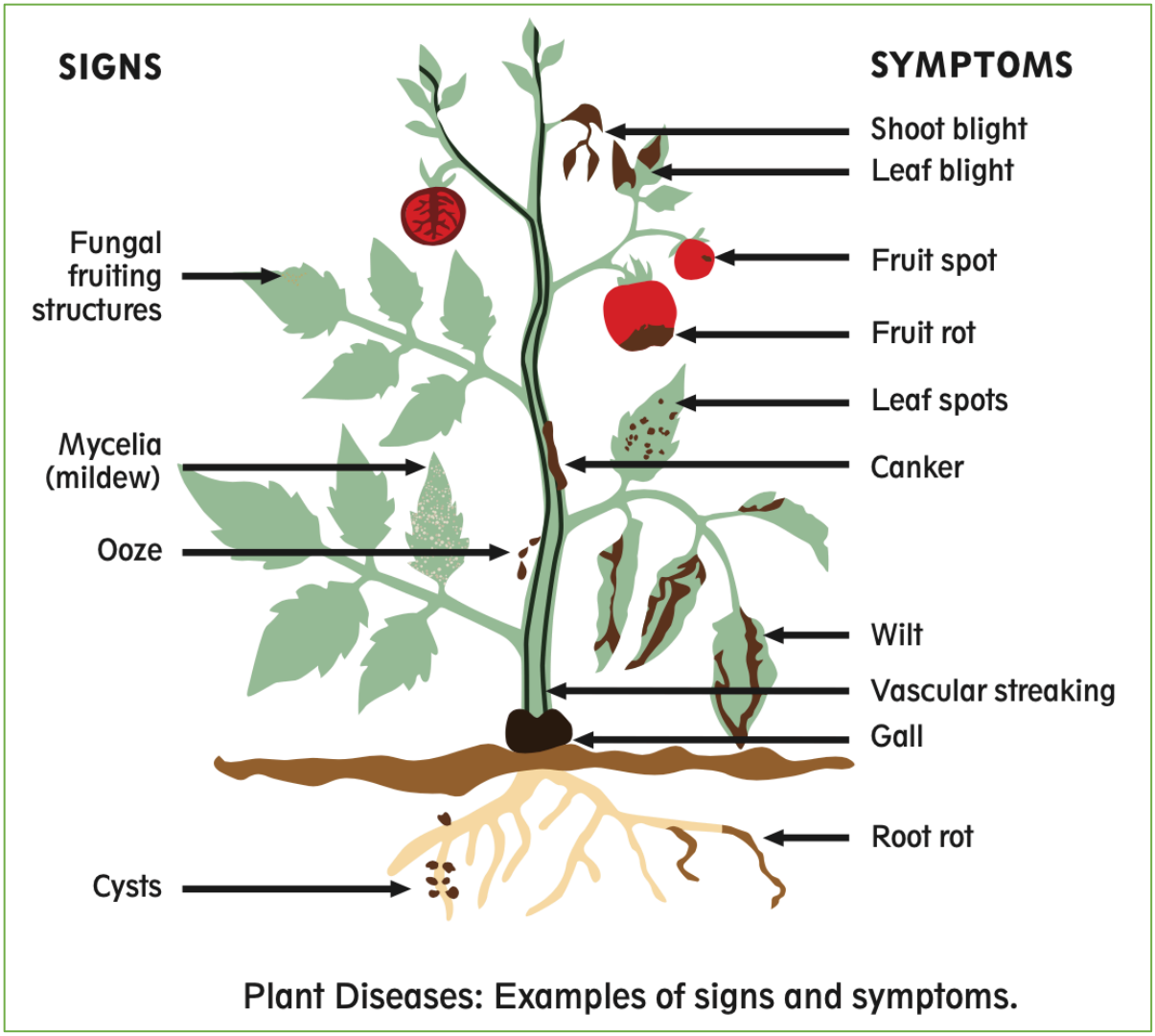
- Pull by hand
- Cultivate with a hoe where appropriate
- Use mulches generously
- Use chemical or natural herbicides

Diseases: The disturbance of the physiology, structure or function of the plant. There are two causes of plant diseases:

1. Biotic causes involve infectious pathogens that spread from plant to plant. The three most common are fungi, bacteria and viruses.
2. Abiotic causes are non-living; including such things as excess moisture, shortage of plant nutrients and heat extremes.

Plant disease signs versus symptoms:

- Symptoms—the visible effects of disease on the plant, the response of the plant to the pathogen; may be discolored, malformed or dying regions on plants
- Signs—actual, physical evidence of the pathogen



Plant Diseases: Examples of signs and symptoms.

Cassava diseases:

Name & description	Photo	Control measures
<u>Cassava Mosaic Disease (CMD):</u> whiteflies are vectors, can cause 100% crop failure • Symptoms: variable coloring of leaves		• Phytosanitation • Disease-resistant varieties • Cultural practices • Vector control and mild-strain protection • Use of biological agents-like Serangium Parcesetosum • IPM
<u>Bacterial Blight Disease:</u> one of the most widespread diseases, transmitted by infected planting material and farm tools, can cause yield loses of up to 50% or more, can survive from one growing season to the next, uses wounds as an entry point		• Cultural: field sanitation, soaking stakes in hot water, intercropping, sterilizing tools etc. • Resistant/ tolerant varieties • Biological agents: Pseudomonas fluorescens and P. putida • Chemical: Nordox (Cuprous Oxide)

7 Steps to successful plant disease management:

1. Careful observation
2. Accurate disease diagnosis
3. Knowing the symptoms and signs of a specific disease/diseases
4. Knowing healthy plants from diseased plants
5. Types of management practices to be applied
6. Know the treatment/treatments to apply
7. Identify symptom variability

12. Chemical Pesticide Application & Safety

Pesticides: substance or mixture of substances used to prevent or destory pests; includes—insecticides, fungicides, herbicides (for weeds), nematicides, rodenticides, molluscides, bactericides

ALWAYS LOOK AT THE LABEL FOR THE ACTIVE INGREDIENT,
AND KNOW ITS FUNCTION AND DANGERS

General Precautions When Handling and Using Pesticides

- Wear protective equipment: glasses, mask, long-sleeve shirt, and rubber gloves.
- Never eat, drink, or smoke while handling pesticides.
- Wash your hands after handling pesticides.
- After using pesticides, wash well, change your clothes, and wash them separately from other laundry.

Pesticides should:

- Be handled with care (pesticides may be flammable, corrosive, poisonous and/or explosive)
- ONLY be used if there is a need and when the damage done doesn't exceed the cost of protection
- ONLY applied at the recommended rate (read the label) and NOT before rain or when it's too hot
- Be correctly chosen and used to match the appropriate pest
- Herbicides should be applied when weeds are young and actively growing
- Be properly disposed of (including their containers)

13. Chemical Fertilizer Best Practices

Major nutrients needed by plants:

- **Nitrogen (N)—**plant growth (leaves, stems, roots, etc.)
- **Phosphorus (P)—**plant health, energy transfer, assists with photosynthesis, nutrient movement
- **Potassium (K)—**flowers and fruits, fight disease, and to protect against frost and drought

Sometimes nutrients need to be added to the soil to improve plant growth and yield; these nutrients are called fertilizers.

Fertilizers: substances added to the soil to improve plant growth and yield; can be natural or synthetic/artificial

Natural—clover, compost, manure, wood ash, charcoal powder, legumes like peas and beans (plants that take nitrogen from the air and put it into the soil)

- Can be collected in the form of animal manures, wood ash, and charcoal powder, or made on the farm as compost. Natural fertilizers work best when they are worked into the soil before planting.

Chemical

- Complete fertilizer: Has all 3 primary nutrients (N:P:K)
- Incomplete fertilizer: Does not have all 3 primary nutrients
- Can be purchased as: granules (scratched into the soil), powdered (dissolved in water), and liquid (usually a concentrate that has to be mixed with water). Chemical fertilizers work best when applied in small amounts throughout the growing season.

Types of chemical fertilizers (classification):		
Incomplete: supply only one of the primary nutrients (N, P, or K) Examples—urea, ammonium sulphate, potassium chloride and potassium sulphate	Complete: Contain 2 or 3 primary plant nutrients Examples—ammonium phosphate, nitrophosphates	Mixed: physical mixtures of straight fertilizers, contain 2 or 3 primary plant nutrients

Fertilizer grade: minimum percentage of nitrogen (N), phosphorus (P) and potash/potassium (K) present in a fertilizer material

- For example—A 100kg bag of fertilizer has a grade of 15(N)-12(P)-18(K)
  - Nitrogen: 100kg x 15%=15kg
  - Phosphorus: 100kg x 12%=12kg
  - Potassium: 100kg x 18%=18kg

Applying chemical fertilizer		
Broadcasting: application of fertilizer uniformly over the entire field. Fertilizer may be applied to the soil at planting or over a standing crop as a top dressing. Generally used for large amounts of fertilizer.	Placement: fertilizer is applied to and then incorporated into the soil through plowing or injection (for liquid)	Precision or micro application: small amounts of granular or liquid fertilizer applied at the base of the plant at strategic times throughout the growing season

Applying natural fertilizer		
Broadcasting: application of compost uniformly over the entire field. Best to apply before the growing season or when the field is barren.	Placement: compost is applied to and then incorporated into the soil through plowing or hoeing	Precision or micro application: small amounts of compost added to holes where seeds or transplants will be planted, or at the base of the plant at strategic times throughout the growing season

Additional notes: