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REGENERATIVE HOME GARDEN

GUIDEBOOK

March 2024

This guidebook was developed to provide additional technical support to farmers in the target areas, especially those who have attended the regenerative home garden training course and want to apply the practice in their home gardens. The regenerative home garden can provide a rich source of nutritious foods for the family particularly those with children under five years of age.

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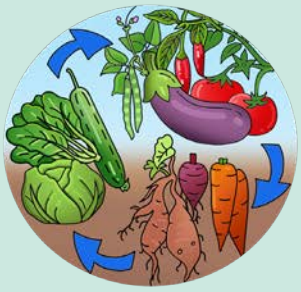
WHAT IS REGENERATIVE AGRICULTURE?

Low till or no till to minimize soil disturbance

Compost

Cover crops

Agroforestry



Crop rotation, crop diversification, or intercropping

Reduce chemical and pesticide usage

Raise animals with a clear management system, also known as 'rotational grazing'

- Regenerative agriculture is an agricultural practice that focuses on improving topsoil quality by adding more organic matter to increase soil nutrients. Such agricultural practices conserve and restore organic matter in the soil by protecting and hosting micro and macro organisms.

- Many practices are classified as "regenerative agriculture," but not all practitioners follow these techniques.

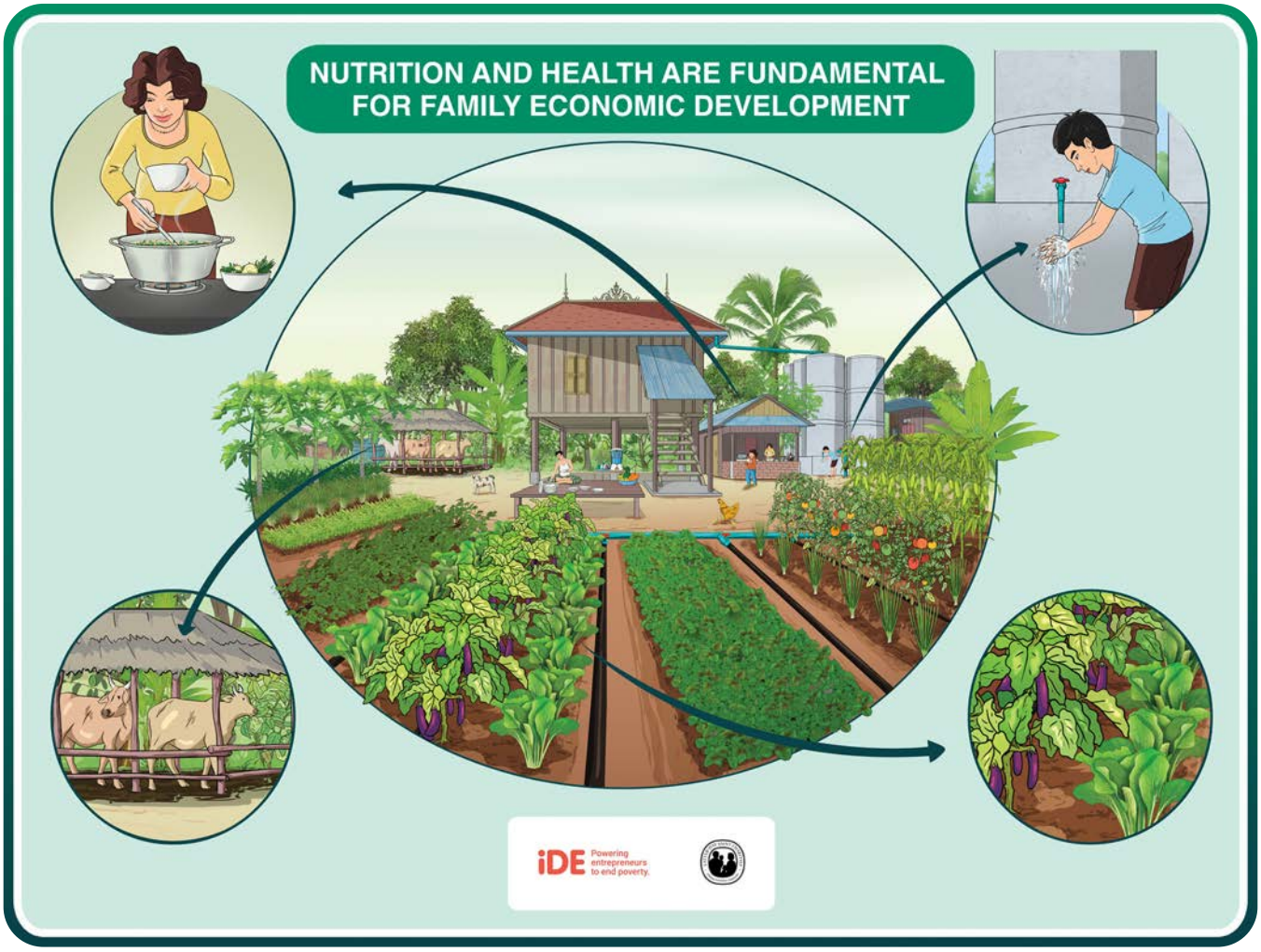
- Regenerative agriculture has the following seven basic principles.

- **Reducing tillage:** A technique that leaves the soil intact when planting to minimize disturbance to the soil by plowing.
- **Compost:** Decomposition of waste (from manure or food waste) is used as fertilizer.
- **Cover-crops:** The practice of cover-crop cultivation on land that is usually left empty without cover after harvest. By keeping the roots alive in the soil, covering the soil with crops can reduce soil erosion, increase water retention, improve soil quality, and increase biodiversity. Farmers can also practice cover-crop cultivation during harvest or between rows of perennial crops. Cover-crops can be legumes, grass for animal feeding, or sunn hemp.
- **Crop rotation, crop diversification, or intercropping:** Long-term crop rotation and increased diversity will balance soil ecosystems. It can help to control diseases and reduce pressure and destruction from pests and weeds which will help to reduce the use of agrochemicals.
- **Raising animals with a clear control system, also known as "rotational grazing":** Such practices have been implemented by indigenous people who mimicked the way large animals/ cattle move in herds across the meadow. The method of moving animals between grass patches regularly, helps to increase soil fertility and allows the grassland time to regenerate.
- **Reducing the use of chemicals and pesticides:** The practice of replenishing the topsoil and using bio-pesticides can reduce dependence on pesticides or other chemicals.
- **Adopting agro-forestry practices:** Indigenous practices mimicking the forest system include large and small trees into the crop system and animals raising.

Benefits of regenerative agriculture:

- Focuses on soil health.
- Reduces dependence on farming inputs (agro-chemicals).
- Considers the benefits of ecosystems.
- Improves soil health and fertility, which is the foundation of water health, nutrients and carbon cycles. This is demonstrated by healthy crops, increased yields, better soil test results and the viability of soil micro-organisms such as earthworms.
- Reduces soil erosion.
- Lower water pollution by using fewer chemical substances.
- Improves soil water retention capacity by using more compost fertilizer.

WHAT IS A REGENERATIVE HOME GARDEN?



The term “home garden” refers to a garden set up near the house where a variety of vegetables are grown. These include leafy vegetables, fruit vegetables, root crops mixed with herbs and spices, and short-life and long-life fruit crop. Other multi-purpose crops that can help to improve soil quality, and can be used as compost and for animal feed, are also produced. The home garden program will focus more focus more on a selection of highly nutritious vegetables such as edible amaranth, cabbage, pumpkin, sweet potato, moringa and fast-growing fruit trees such as papaya, banana, custard apple, guava, and so on. Home garden for a nutrition program provides a variety of vegetables throughout the year to complement household needs, and to also provide secondary income. Family gardening is a food production, and is practiced all over the world.

The main features of a family garden:

- The garden should be arranged near, or next to, the house, and be easy for women to care for and harvest daily.
- It should be near a water source (pond, water stream, river) or a rainwater harvesting system as a source for irrigation and household use.
- It should be located in an area that is not flooded to support year-round cultivation.
- A variety of vegetables are grown to meet the needs of household use.
- Gardens are designed using low-cost resources.
- Vegetable gardens can be small or large depending on the size of the land that the farmer has.
- Family members should help to take care of the garden, especially young children: Youngsters who participate in gardening can reap many benefits to support their growth.

What types of vegetables or crops should farmers cultivate?

Vegetables and fruit trees are essential crops that are easy to grow and manage, and have many benefits for the health of both humans and animals. The type of vegetables and other crops chosen should have diverse harvesting times (vegetables or perennial crops or annual crops), particularly those that require less water and fertilizer, and are tolerant to pests and diseases. Farmer should choose vegetables that are high in vitamins and iron, easy to grow, high yield and popular, easy to grow, high yielding and popular. They should also be widely accessible and be able to produce seeds.

Below are the types of vegetables or crops that farmers could choose:

1 Leafy vegetables: e.g. cabbage, amaranth, morning glory, salad

2 Fruity vegetables: e.g. tomatoes, eggplant, bitter melon, luffa, papaya

3 Tuber vegetables: e.g. carrots, radish, taro, sweet potatoes

- **Herb and spices:** e.g. herbs, spring onion, lemongrass, galanga, turmeric, finger root, or ginger
- **Fast-maturity fruit trees:** e.g. banana, papaya, guava, custard apple, citrus vine or passion fruit
- **Other crops:** e.g. moringa, climbing wattle, ivy gourd, star gooseberry, agati, spinach tree or Chaya

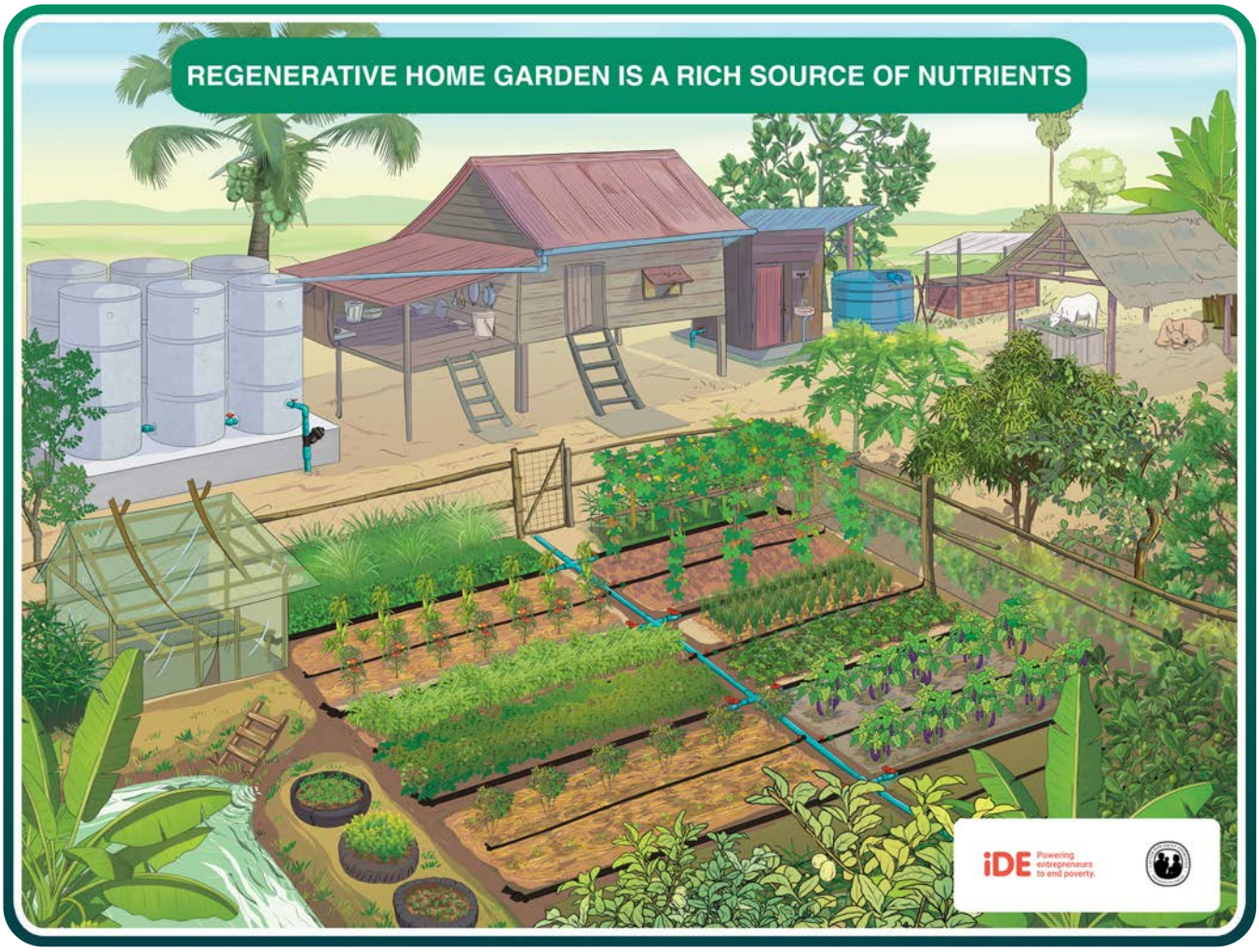
The health benefits of eating vegetables and fruits

Cambodians are among the people who consume fewer vegetables and fruits than the amount recommended by the World Health Organization. To be healthy, everyone should consume at least 400 grams of vegetables and fruits per day. Naturally grown vegetables and fruits from the family home garden are the safest and are highly nutritious especially for pregnant and lactating women, and for children under five years old. All fruits and vegetables can provide vitamins, fiber, and minerals to improve health in general and to boost the body's immune system. This can protect against various diseases. Everyone should consume a variety of vegetables and fruits regularly for general well-being, but for pregnant women, consumig the right food especially leafy green vegetables, is essential because they are rich in iron: This helps to produce red blood cells and contributes to the development of the baby. Having a family garden next to, or near to, the house will promote the regular consumption of vegetables and fruits because women, most of whom are family cooks, can easily access them without spending time and money.

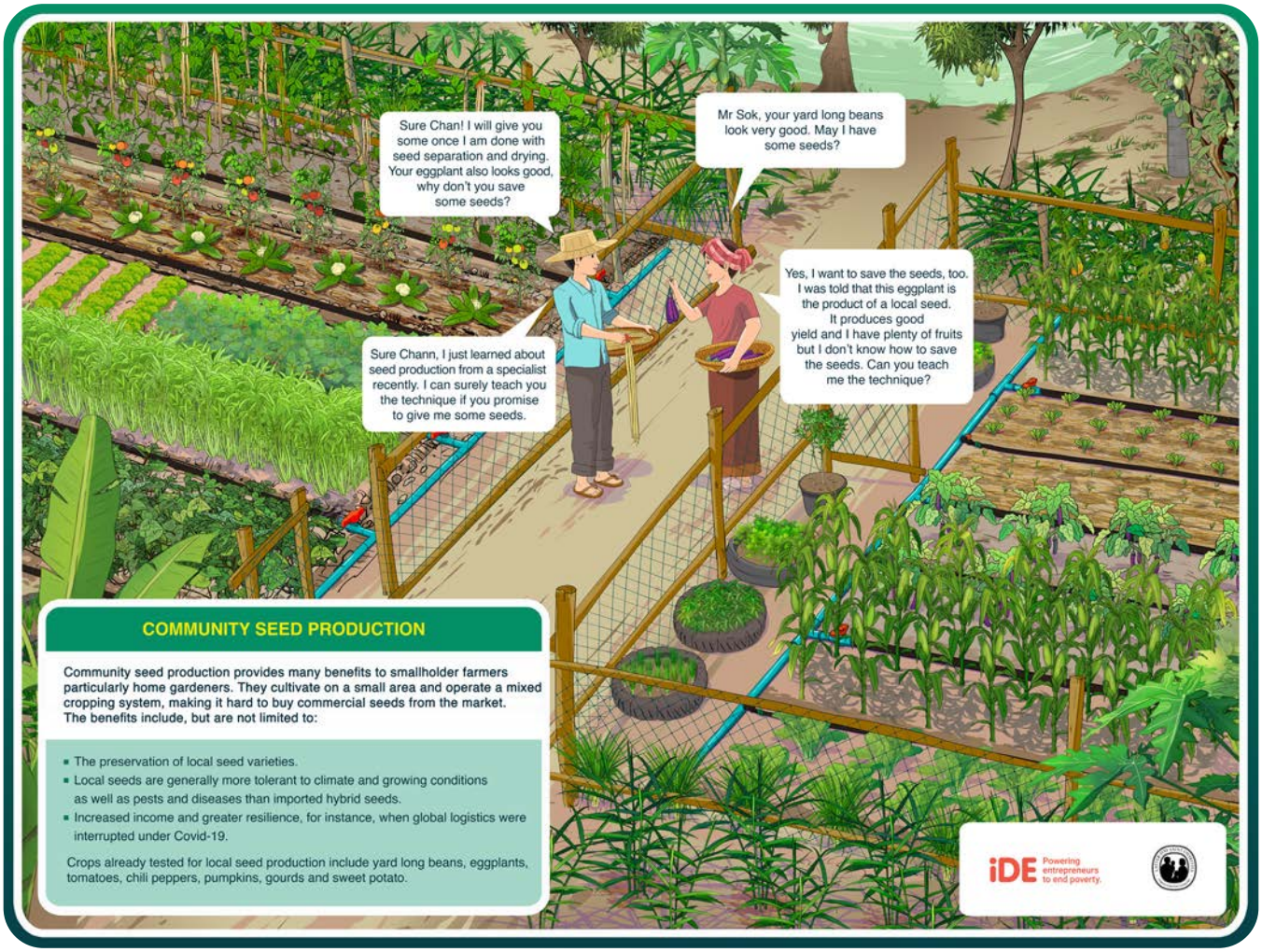
Home garden design

Before the preparation of their garden, farmers should consult their families and specialists about home garden design, and more specifically about the location. This is because, according to the principles of regenerative agriculture, the home garden should be permanently placed where there will be no need for future relocation. Attention should be paid to the:

- Total size of land approved by the family for gardening.
- Main location for the installation of the compost shelter, rainwater harvesting system, nursery for seedling production, biodigester, and so on.
- Installation of barriers and fencing to prevent livestock from destroying or disturbing crops. This is very important.
- The installation of a micro irrigation system to ease the burden on women.
- Different garden layouts should be created for the different types of crops.
- The image below is an example of an ideal regenerative home garden.



CULTURAL PRACTICE



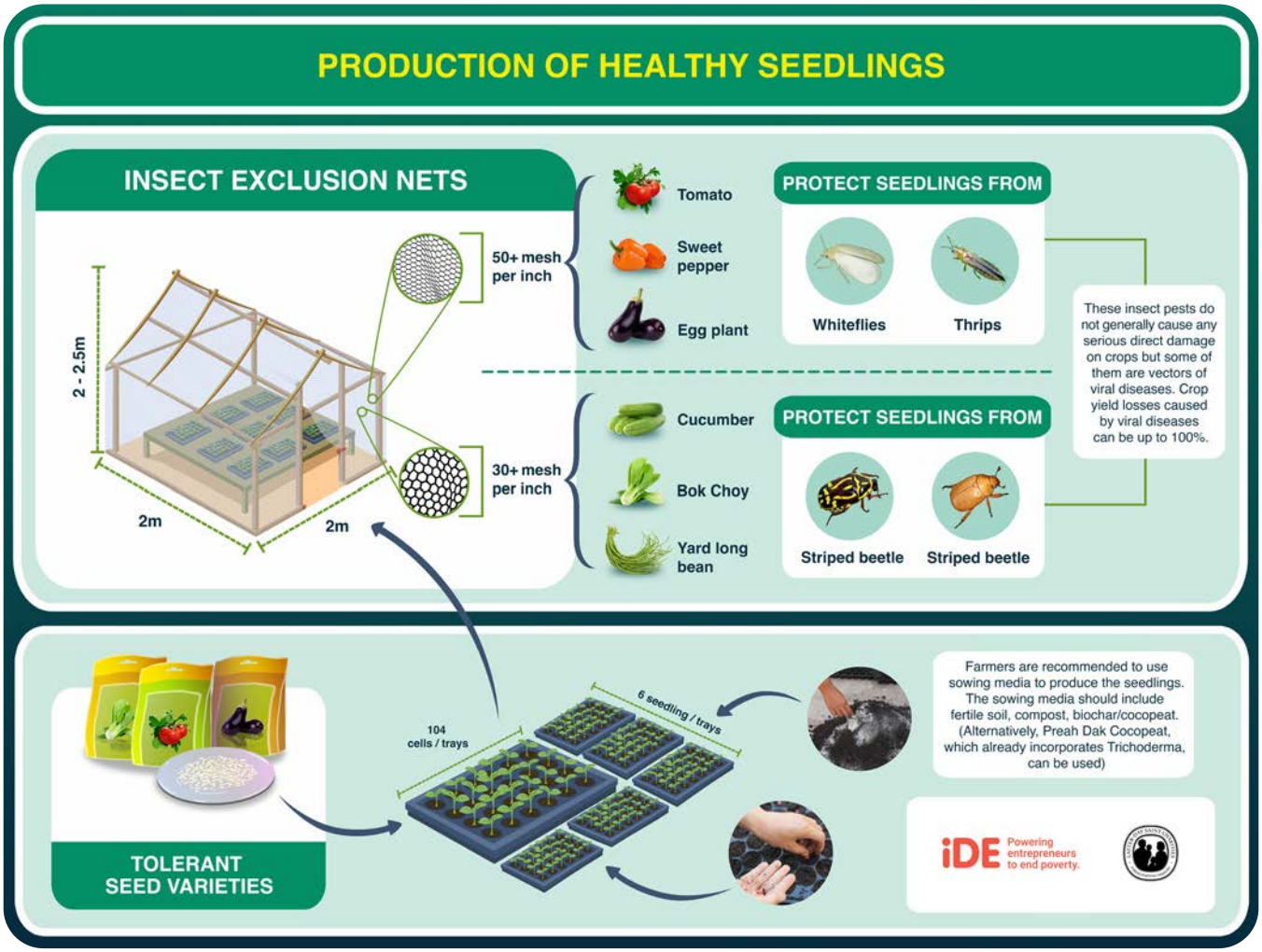
Seed selection

Select a variety of seed that is tolerant to weather, diseases and pests, high in nutrient content, and produces a high yield. Seeds can also be collected after harvesting.

Land preparation:

- Clean the soil from previously harvested crops, eliminating those that were infected, as well as weeds.
- Till the soil at least twice to clear out the weeds.
- Make new beds or renovate the old ones.
- Apply at least 1 kg of compost per 1 square meter (the more compost you can apply, the better the soil quality).
- Mix compost well in the beds.
- Install a micro irrigation system (e.g. a drip, or spray tube system).
- Apply organic mulching using straw or other leaves to prevent runoff and reduce weed growth.
- Prepare a drainage system to release water from the garden.

NURSERY



Transplanting and direct seeding

Crop density (plant and row spacing)

Guide to plant spacing and density

Crop	Bed spacing (m)	Plant spacing (m)	Row spacing (m)	Planting recommendation	Seed requirement per 100m^2	Planting method
Yard long bean and cucumber	1.50	0.3		1 row/ bed	222	Transplanting
Cabbage family and amaranth	1.50	0.1 - 0.15	0.1 - 0.15	5 to 6 rows/ bed	2,667- 4,000	Direct seeding/ transplanting
Pumpkin, bitter melon and winter melon	1.50	0.50		1 row/ bed	133	Transplanting
Eggplant, tomato and chili	1.50	0.75	0.50	2 rows/ bed	178	Transplanting

Transplanting and Direct Seeding:

- Two to three days before planting, farmers must water the prepared beds untill it is fully saturated, or for about an hour if a drip irrigation system is used.

- Make small holes in the beds, based on the recommended plant and row spacing.

- Before planting, farmers should apply beneficial fungus Trichoderma at a rate of 20 grams per 20 liters of water. The recommended application is 200 - 250ml/hole (half of a 500ml water bottle). After Trichoderma application, farmers must transplant the seedlings immediately because Trichoderma is a species of fungi that lives in the plant root ecosystems.

- Select only healthy seedlings for transplanting. Avoid shaking soil off of the seedlings, and do not bury the roots too depth that is too shallow. Transplant the seedlings in the evening when it is not too hot.

- For crops to be planted directly - such as water spinach, amaranth, bok choy, chinese curly cabbage, choy sum and so on. Farmers should use a stick to make a long hole across the bed, mixing the seeds with Trichoderma before planting (100g of water spinach seeds or one tablespoon of cabbage seeds mixed with half a teaspoon of Trichoderma). Place the seeds on the prepared hole, gently cover them with soil using a rake, or sprinkle the soil on top. Then cover with straw, and water thoroughly.

Preparation:

The advantage of trellising is that it can support plant growth, achieve better air circulation, enable access to full sunlight, and allow for quick leaf drying after rain. It can also reduce disease incidents, and support crop management and harvesting. Trellising should be conducted before transplanting to minimize disturbance to newly transplanted seedlings or destruction of the roots.

The length of the poles used for staking depends on the crop types:

- Cucumber and long bean: 2.5m.
- Tomato, sweet pepper and eggplant. Differs according to the variety: 1.5-2m.

The staking poles should be buried about 0.5 m underground.

Irrigation:

Farmers should use an irrigation system for convenience and for a reasonable price. Farmers should choose the type of irrigation system that is suitable for crop type:

1. Drip system used for fruity vegetables and fruit trees

2. Spraytube system use for leafy vegetables

Benefits of an irrigation system include:

- It saves time
- It is easy to use, especially for women
- It is economical and easy to manage according to crop needs
- It contributes to vigorous plant growth due to adequate watering

Pest management :

1. Pruning

Pruning can reduce wet canopy and lower the disease incidence. It also allows the plants to receive adequate sunlight and contributes to vigorous plant growth by ensuring that enough nutrients are available. In addition, it reduces the chance of disease transmission by removing infected leaves.

Pruning techniques:

- Crops that should be pruned include tomato, eggplant, long bean, pumpkin, luffa, winter melon, bitter melon, chili, cucumber and so on.
- Remove old infected leaves or those damaged by pests.
- Remove suckers and branches that grow from the lateral branches because these can consume nutrients from crops, and can become hosts of pests and diseases.
- All of the pruning waste can be used as compost (although it must be well decomposed). Infected plant cuttings should be burned to avoid transmitting the disease to other plants.
- Tools for pruning include knives, scissors or pruning shears. The pruning tools need to be cleaned regularly with soap and bleach solution (10% bleach).

2. Sanitation and weed management:

- Remove or collect infected plants from the garden.
- Control the weeds and remove old plants from the garden because they can be hosts to insect pests and diseases.
- Clean the garden and surrounding areas regularly.

SOIL FERTILITY IMPROVEMENT

After years of cultivation, soil becomes degraded particularly if farmers do not apply enough organic matters. Therefore, it is very important to amend and improve soil quality.

1 Application of organic matters or compost

Application of organic matter such as compost, vermicompost and bioslurry from the biodigester, can help to improve air circulation in the soil, enhance soil quality and make the conditions more favorable for soil biota. This can also contribute to a reduction in the use of chemical fertilizers which can affect soil quality, damage soil structure and make the soil more acidic. The recommended application is 1 to 5 kg/m2 per year. Organic matter, or compost, should be used regularly — the more compost used, the better the soil quality.

2 Cover crops

Cultivating cover-crops once or twice a year can contribute significantly to an improvement in soil quality. It can help to protect the topsoil from erosion, keep the soil moist, increase soil humus (that can be good source of nutrients for soil biota), improve soil structure, and enable trapped nutrients to become available to plants. Cover-crops also assist in weed management.

Cover crop types

Stylo Sun hemps Beans

3 Anaerobic soil disinfection

The method of Anaerobic Soil Disinfection (ASD) is important because, after many years of cultivation, pests and diseases will have accumulated, particularly those that are soil-borne diseases caused by bacteria and fungi. Most of these diseases can cause at least 80% of yield loss. The ASD method, using a carbon source and anaerobic soil conditions, was first implemented in Japan and the Netherlands. ASD is highly effective in controlling bacterial wilt on tomatoes, and fusarium wilt on long beans. This method has also been tested and proven effective with smallholder farmers in Cambodia. This method does not use chemicals, and farmers can choose any locally available and affordable carbon sources, such as waste from vegetables— particularly those in the cabbage family— biochar, rice bran and cover-crops.

ASD procedure:

- The process for land preparation and bedding is the same as that for general land preparation.
- Chop the sources of carbon, vegetable waste or cover-crops into small pieces.
- Apply the carbon source to the prepared beds 3 kg/m2.
- Incorporate them well with the topsoil.
- Raise the margins of the beds a little to hold the water on the bed.
- Water until the soil is saturated (until the water is seen flowing from the bed).
- Cover the bed with plastic mulch and make sure that it is airtight and that there are no holes or damage, and fully seal the margin of the plastic by burying it into the soil. If there are no tears or punctures, then close the lower sub-edge of the plastic to fully seal it.
- Leave it to ferment or decompose for at least five to six weeks. Farmers need to prevent livestock from entering the garden, especially dogs, chickens and ducks, because these animals can damage plastic mulch. This would render the process no longer effective because it would become aerobic instead of anearobic.
- Plastic mulch must be removed one week before planting.

Based on experience, this method is not only effective in controlling soil-borne pathogens, but will also help to improve soil fertility and structure.

4 Benefits of compost fertilizer

- It reduces the use of chemical fertilizers and saves costs.
- It supports an improvement in soil quality and structure.
- It helps to increase nutrient availability for crops, and improve soil aeration for better root development.
- It prevents or reduces weeds, fungal diseases, bacteria and nematodes if farmers use animal manure without going through the decomposition process of composting.
- It increases crop yields and reduces production cost.
- It enhances soil quality and sustainability in agricultural production.

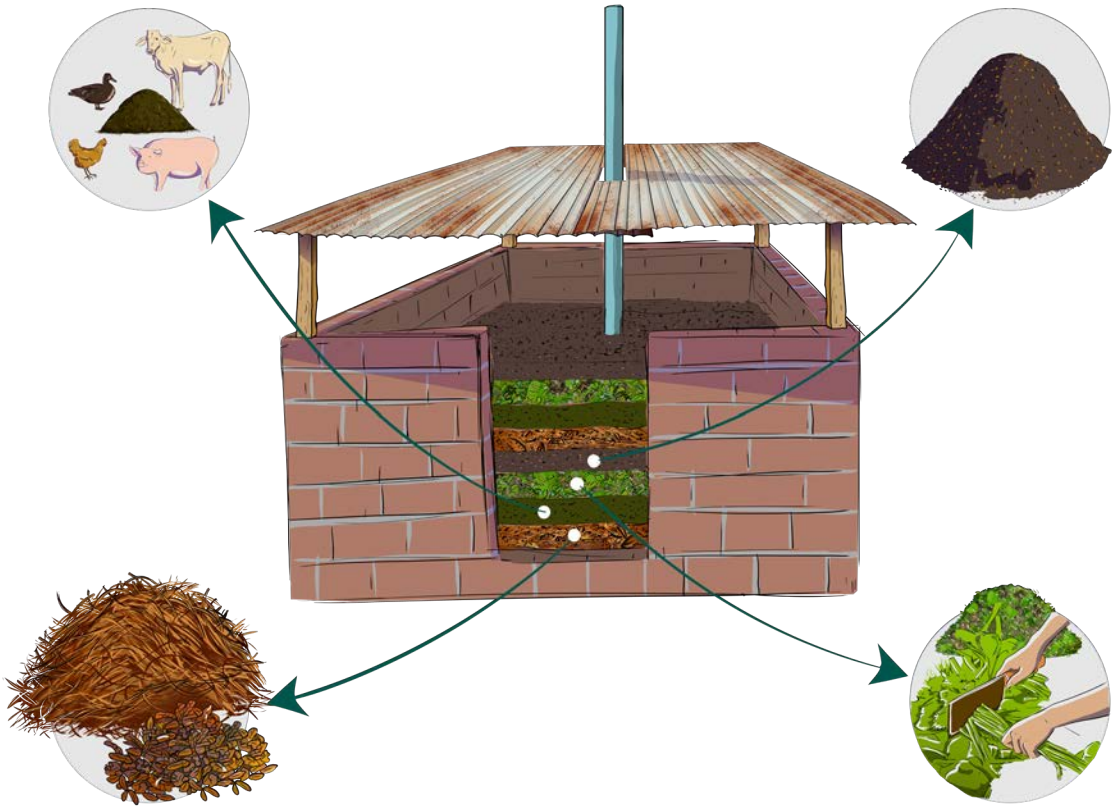
Production of Fast Compost	
Purpose	To improve soil fertility and health.
Implementation	Easy.
Production time	Before planting and continue on a regular basis.
Raw materials and equipment needed	1. Animal manure (from cows, buffalos, chicken or ducks) needs to dry in the shade and be broken into small pieces. 2. Biochar made from 95% burnt rice husk, and rinsed with water for five minutes to remove the ash and salt. 3. Agricultural lime, calcium oxide (CaO), calcium hydroxide [Ca(OH)2], or dolomite [CaMg(CO)3]. 4. Large plastic bags (weight 1kg).

Duration	21 days
Fast compost making process	**Step 1:** Take 100kg of cow manure or 13 of 20L buckets. **Step 2:** Take 50Kg or 13 of 20L buckets of biochar. **Step 3:** Take 3kg of agricultural lime. **Step 4:** Mix the three ingredients well together. **Step 5:** Water the soil about 60-80%, or four buckets, or 80 liters. **Step 6:** Pour the fertilizer mixture into a clear plastic bag then close it so that is it air-tight. **Step 7:** Place the bag under the sun for 21 days before use.

Utility	1) For seedling production, mix 40% of compost, 20% of soil and 40% of cocopeat or decomposed rice straw. 2) For basal application: use 3 to 5 kg/m^2.
Economic details: income and expense	**Income:** 1. Save money on buying chemical fertilizer. 2. When the soil is fertile, crops are healthy so the yield is in creased. 3. It reduces costs for weed management and uses less water. **Expenditure:** 1. Buy big plastic bags, agricultural lime, rice husks or biochar with an estimate cost of about 15,000 to 20,000 riels to produce about 800 kg of compost. 2. Farmers must have animal manure.
Climate, environment and sanitation	**Climate:** It helps plants to better withstand drought because, with compost, soil becomes more aerobic and retains a higher level of moisture. **Environment:** Reduces CO_2 emissions and captures carbon dioxide from the atmosphere transferring it into the soil. **Sanitation:** Keeps the environment around the house clean, free of manure and odors, as well as from pathogens that can affect human health particularly among young children under five years of age.

Production of Pile Compost	
Purpose	To improve soil fertility and health.
Implementation	Easy.
Production time	Before planting and continue on a regular basis.
Raw materials and equipment needed	1. Animal manure (from cows, buffalos, chickens or ducks) needs to dry in the shade and then broken into small pieces. 2. Dried plant leaves, dried weeds, straw and sugarcane waste (chop into small pieces). 3. Fresh green plants, vegetable waste, Siam weeds, legumes and sesbania (chop into small pieces). 4. Biochar— 95% made from burnt rice husk, then rinsed with water for five minutes to remove the ash and salt. 5. Compost tank and shelter built from cement or bamboo (depending on the availability of resources). 6. Bamboo sticks or PVC pipes must be perforated for two rows from bottom to top for ventilation.
Duration	90 to 120 days.
Pile compost making process	**Step 1:** Prepare the first layer by placing dried plants into the compost tank. Then place the perforated bamboo sticks/PVC pipes in the center. Then water and press the materials tightly to a thickness of about 25cm. **Step 2:** Prepare the second layer, add cow manure and follow the same procedure as the first layer until this layer reaches a thickness of 25cm. **Step 3:** Prepare the third layer using fresh green plant materials and follow the same procedure until this layer reaches a thickness of 25cm. **Step 4:** Prepare the fourth layer— place biochar in the same way as in the first, second and third steps until it reaches a thickness of 20cm. **Step 5:** Repeat from steps 1- 4 until the compost tank is full. **Step 6:** Then cover the compost tank with a rubber tent if there is no shelter. **Step 7:** On the 45th day, stir the compost thoroughly. After 90-120 days, the compost has already properly decomposed (the pile of compost has cooled down) and is ready to use.

7



Utility	1) For seedling production: mix 40% of compost, 20% of fertile soil and 40% cocopeat or decomposed rice straw. 2) For basal application: 3 - 5 kg/m2.
Economic details: income and expense	**Income:** 1. Save money from not needing to buy chemical fertilizers. 2. When the soil is fertile, crops are healthy so the yield is increased. 3. Maintenance costs for weed management are reduced and less water is used. **Expenditure:** 1. If the cost of building a compost tank and shelter is not included, and only large PVC pipes/ bamboo sticks size 60mm, and biochar are purchased, the total estimated cost is 10,000-15,000 riels for the production of 2,000kg of compost. 2. Farmer must have animal manure.
Climate, environment and sanitation	**Climate:** Compost helps plants to withstand drought better because it makes the soil more aerobic, and enables it to retain more moisture. **Environment:** It reduces CO_2 emissions and captures carbon dioxide from the atmosphere transferring it into the soil. **Sanitation:** Keeps the environment around the house clean, free from animal manure and odors, as well as from pathogens that can affect human health particularly among young children less than five years of age.

Production of Virmicompost	
Purpose	To improve soil fertility and health.
Implementation	Easy.
Production time	Before planting and continue on a regular basis
Raw materials and equipment needed	1) Compost or fertile soil: 3 parts 2) Fresh cow dung and food waste: 1 part 3) Fresh green plants / vegetable waste: 1 part 4) Dried leaves: 1 part 5) A plastic basket with small holes 6) Net to reduce sunlight 7) A large plastic basket with lid 8) Tool for making holes 9) Container for watering 10) A shovel or hoe
Duration	50 to 60 days
Earthworm compost making process	**Step 1:** Chop kitchen waste, fresh plant materials and dried leaves into small pieces. **Step 2:** Mix together the raw materials, compost or fertile soil with cow dung and water to make the mixture moist to about 60% to 80%. **Step 3:** Place the basket into the pit (which has already been dug to a size that can fit the basket). **Step 4:** Cover the basket with net to reduce direct sunlight. **Step 5:** Seven days later, open the net and lift the basket out of the pit. **Step 6:** Remove the soil from the basket and collect the earth-worms. **Step 7:** Good soil should have at least 110 to 278 earthworms/m2. **Step 8:** Place the earthworms in the container of mixed soil for vermicompost production, and cover the container to protect it from rainwater. Then place it in a shaded area. **Step 9:** About a month and a half after, the vermicompost can be collected and used.


1


2


3


4


5


6


7

Utility	1. For seedling production: mix 20% of the compost with 20% of fertile soil, 30% of biochar, and 30% cocopeat or decomposed rice straw. 2. Basal application: 3- 5 kg/ m2.
Economic detials: income and expense	**Income:** 1. Save money from the cost of buying chemical fertilizers. 2. When the soil is fertile, crops are healthy so yield is increased. 3. Maintenance costs for weed management are saved and from less water has been used. **Expenditure:** 1. A large plastic basket and drilling tools cost about 15,000 - 20,000 riels to produce 10kg of vermicompost once every 15 days. 2. Farmers must have dried and fresh plant waste.
Climate, environment and sanitation	**Climate:** Compost helps plants to better withstand drought because it makes the soil more aerobic and able retain a high moisture content. **Environment:** CO_2 emissions are reduced and carbon dioxide is transferred from the atmosphere into the soil. **Sanitation:** Composting keeps the environment around the house clean, free from animal manure and odors, as well as from pathogens that can affect human health particularly among young children under five years of age.

Production of Bioslurry Compost

Purpose	To improve soil fertility and health.
Implementation	Easy.
Production time	Conduct before planting and continue on a regular basis.
Raw materials and equipment needed	1) Bioslurry from the biodigester. 2) Dried plants, leaves, grasses, dry straw and sugarcane waste (must be finely chopped). 3) Fresh green plants, vegetable waste, Siam weeds and legumes (must be finely chopped). 4) A cement compost tank with a rainproof cover (if possible).
Duration	45 to 60 days
Biodigester compost making process	**Step 1:** Finely chop dried and fresh plant materials. **Step 2:** Place chopped plant materials into the storage tank until the mixture reaches a level of 60 to 70%. **Step 3:** Pour bioslurry from the biodigester onto the plant materials until the tank is full. **Step 4:** Store it for 45 - 60 days before use.

Utility	1. For seedling production: mix 20% of this compost with 20% of fertile soil, 30% of biochar and 30% cocopeat or decomposed rice straw. 2. Basal application: 1- 5 kg/m^2.
Economic detials: income and expense	**Income:** 1. Save money on the cost of buying chemical fertilizers. 2. When the soil is fertile, crops are healthy so yield is increased. 3. It reduce maintenance costs for weed management and uses less water. **Expenditure:** 1. Construction of a compost storage tank costs about 150,000 - 200,000 riels and can produce about 2,000kg of compost. 2. Farmers must have dried and fresh plant materials.
Climate, environment and sanitation	**Climate:** Helps plants to withstand drought better because the compost makes the soil more aerobic and able to retain a high moisture in the level. **Environment:** Reduces CO_2 emissions and captures carbon dioxide from the atmosphere transferring it into the soil. **Sanitation:** Keeps the environment around the house clean, free from animal manure and odors, as well as from pathogens that can affect human health particularly among young children aged under five years.

IRRIGATION SYSTEMS

Advantages of irrigation systems (drip or spray tube systems)

1 . Irrigation using a drip system requires 50% less water than is required for manual watering or the furrow irrigation method or canal.

2 . They reduce energy costs needed to pump water.

3 . They reduce labor costs.

4 . They improve the efficiency of water use because crops receive only the amount of water they need.

5 . They reduce the prevalence of disease because the underside of leaves remains dry.

6 . Water drops directly onto the right spot or the root system without being wasted on non-crop areas. Thus, there is a reduction in weed growth.

7 . Harvesting is easier and can be done even during irrigation because the area between the beds remains dry.

8 . Fertigation is easy.

9 . Compared with manual irrigation practices, drip irrigation systems cause less soil erosion and nutrient leakage.

10 . They are convenient for women due to low labor requirement.

Composition of irrigation systems

1 . Water source

2 . Water reservoir or water pump

3 . Main pipe

4 . Filter

5 . Valve

6 . 90-degree elbow water divider

7 . Sub-pipe or sub-head hose

8 . Dripline connector

9 . Dripline

10 . Spray tube

Installation of irrigation systems and usage:

1. Drip irrigation system:

Suitable for crops like cauliflower, cabbage, long beans, tomatoes, eggplant, chili, okra, corn, papaya, banana and sugarcane, etc. The installation must be prepared before planting and after bed preparation by using a drip line 2-3L/hr flowrate for sandy soil (which is common in Siem Reap). Place a dripline in the middle of the bed (the space between the rows is 1.5 meters) for crops that are planted one to two rows per bed, and install two lines for crops that plant three or more rows per bed.

2. Spray tube irrigation system:

Suitable for leafy greens and tubers such as mustard greens, curly cabbage, bok choy, choy sum, lettuce, spring onion, radish and herbs. The installation must be prepared before planting and after bed preparation, using a spray tube with three emitters per hole. Install the spray tube in one row between every two beds.

Maintenance:

- The filter is the most important part of the irrigation system, and it needs to be washed regularly to prevent clogging from mud, plant parts, sand, minerals, etc.
- Drain the sludge from the dripline or spray tube every two weeks.

COVER-CROPS

Importance of cover-crops

Cover-crops are very important for soil health because they are the foundation for crop cultivation to reduce the spread of soil-borne diseases, and they break insect and weed life cycles. Cover-crops also increase the volume of organic matters through their decomposition. The topsoil is rich in biological activity that constantly replenishes nutrients (thereby reducing losses through the ground and plants), and root systems of cover-crops connect to underground water and can absorb water from the deep layers of the soil for vegetable crops with shallow roots.

Functions and benefits of cover-crops

- Protect the topsoil and reduce soil erosion
- Keep the soil moist
- Increase bacterial production that can become feed for microorganisms in the soil
- Improve soil organic matter
- Improve soil structure
- Release some trapped nutrients and make them available for plants
- Contribute to the management of weeds, insect pests and diseases

Large-leaved sunn hemp

- Age 60 days
- Average dried biomass production is 700g/m^2
- Nitrogen production from 100g to 150g/ 10m^2
- Seed requirements 200-300g/100m^2

Small-leaved sunn hemp

- Age from 80 - 90 days
- verage fresh biomass production from 700g to 1kg, and dried biomass about 200g/m^2
- Nitrogen production from 150g/10m^2
- Seed requirement: less than 150g/100m^2

Legume (mung bean, soybean and cowpea)

- Age 60 days
- Dried biomass production 300-700g/m^2
- Nitrogen production 50-100g/10m^2
- Good to integrate with other cover crops that have different functions and benefits
- Seed requirement: 250-300g/100m^2

Stylo grass (can also be used as animal feed)

- Long life
- Dried biomass production from 300-1000g/ 1m^2
- Nitrogen production from 50-100g/10m^2
- Tolerance to sandy soil and soil with low nitrogen
- Seed requirement: less than 100g/100m^2

INTERCROPPING

Intercropping is a multi-crop cultivation practice whereby two or more crops are simultaneously grown in the same garden. This is a form of multi-purposes. The ultimate goal of this practice is to obtain greater yields on the same plot size by using resources or ecological processes that will not be used by a single crop.

Intercropping table

Crop	Integrate with
Yard long beans	Corn, Chinese radish, and leafy greens
Corn	Tomatoes, eggplant, chili, beans, rice cucumber, pumpkin and winter melon
Tomatoes	Beans, corn, crucifers and amaranth
Pumpkin	Beans, corn, crucifers and amaranth
Cabbages	Spring onion, amaranth, hairy basil and Thai basil
Cauliflower and cabbage	Spring onion, Thai basil and hairy basil

CROP ROTATION

Crop rotation is the practice of rotating different type of crops and families on the same plot of land. This practice reduces crop dependency on a specific group of nutrients, and minimizes the use of agricultural inputs including fertilizers and agrochemicals to control pests, diseases and weeds remaining in the field from the previous crops. It will increase plant resistance.

Growing the same crop on the same plot continuously for many years will gradually reduce the amount of some nutrients in the soil and build up insect pests, disease and weed population. It will also degrade soil quality and crop yields. Good crop rotation schedules can reduce the need for fertilizers, pesticides and herbicides by harnessing the ecosystem services from diverse crop production. In addition, crop rotation can improve soil structure and organic matter which reduce erosion and increases the resilience of the garden.

Crop rotation table

Crop	Crop rotation
Yard long beans	Pumpkin, luffa, winter melon, bitter melon, corn, cabbage, amaranth and morning glory
Corn	Tomatoes, eggplant, chili, long beans, cucumber, pumpkin, winter melon, luffa, cabbage and amaranth
Tomatoes	Long bean, corn, pumpkin, winter melon, luffa, cabbage, amaranth and morning glory
Pumpkin	Long bean, corn, cabbage, amaranth and morning glory
Leafy greens	Garlic, amaranth, hairy basil, holy basil, tomatoes, eggplant, peppers, long bean, cucumber, pumpkin, winter melon, luffa and morning glory
Cauliflower and cabbage	Corn, tomato, eggplant, pepper, long bean, cucumber, pumpkin, winter melon, luffa, amaranth, garlic, basil and holy basil
Morning glory	Tomatoes, eggplant, pepper, long bean, corn, cucumber, pumpkin, winter melon, luffa, amaranth, garlic, hairy basil and holy basil
Amaranth	Tomatoes, eggplant, pepper, long bean, corn, cucumber, pumpkin, winter melon, luffa, cabbage, garlic, hairy basil and holy basil

LIVE BARRIERS

Live barriers form a boundary between living plants grown on the border of the garden to protect, or to separate, nearby crops. This can reduce wind speed, sunlight, pathogens, insect infestations and diseases. The main purpose of live barriers is to protect against air-borne diseases that are transmitted through the air, and sucking insect pests: Those can transmit the disease through sucking plant nutrients because they carry the virus both internally and externally.

Types of live barriers for bordering plants:

Mango, coconut, jackfruit, sapodilla, sesbania, kassod trees, ashoka trees, moringa, and plants with large and strong stems from which rotten leaves can become fertilizer for crops.

Type of fencing plants for plot dividing:

These inlcude banana, sugarcane, neem trees, sesbania, moringa, longan, sapodilla and plants that have fewer branches.

INTEGRATED PEST MANAGEMENT

Pests:

1. Insects
2. Diseases: fungi, bacteria, and viruses

Preventive measures:

- Use seed varieties that are resistant to pests, diseases, and growing conditions
- Regularly clear-out weeds and old infected crops around the garden
- Use yellow sticky traps to monitor the cycle of insects (if farmers can afford this)
- Use pheromone or sweet traps
- Prune
- Regularly conduct garden scouting
- Use biological control agents such as Trichoderma for prevention
- Practice inter-cropping and crop rotation

Pruning:

- Pruning two to three times can help plants to be more uniform and increase in yield.
- Perform regular garden sanitation through pruning of infected crops or trim unproductive branches.

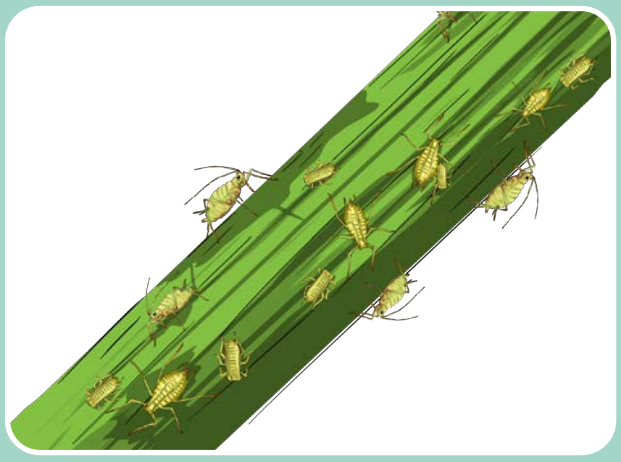
PESTS AND DISEASES

Whitefly, aphid, thrip, etc.

- Their main body can be divided into three parts
- They have six legs or three pairs
- They have two antennas
- They have two or four wings

Life cycle: eggs, nymphs, adults.

Feeding: leaves, flowers, roots, fruit, seed or by sucking.

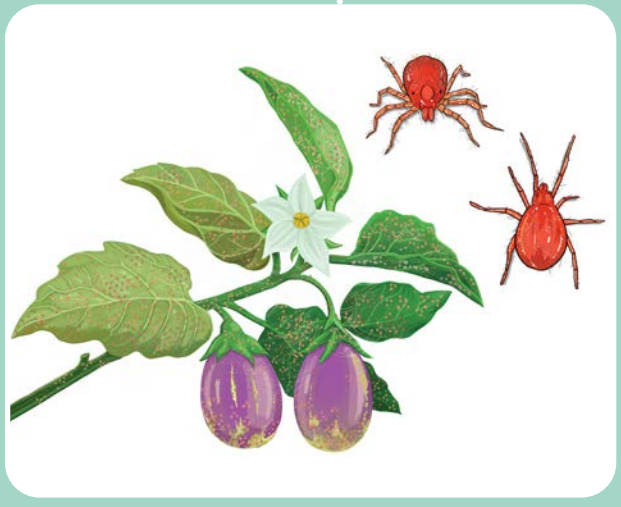


Spiders

- Their main body can be divided into two parts
- They have eight legs
- They have no antenna
- They have no wings

Life cycle: eggs, spiderlings, adults.

Feeding: sucking nectar.



Why is insect identification important?

It is important to know if an insect might adversely affect crops or is useful (pollinators, natural enemies, bio-refining insects) or a pest (worms, insect vectors), or is neutral. This is necessary to determine the control measure, know its habitat, eating habits, life cycle, and behavior etc. The more we know about the pests, the better we can prevent and control them.

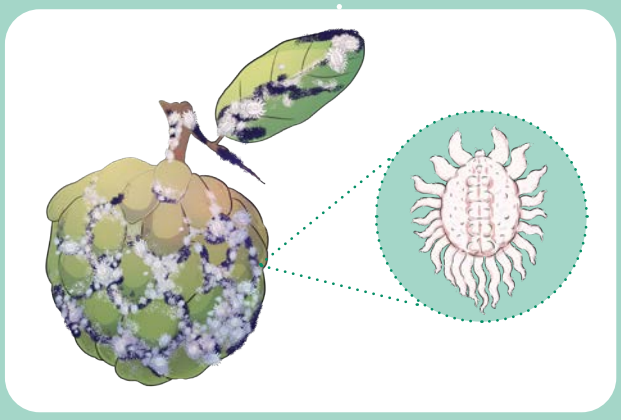
Insect pests with three stages of their life cycle

- The adults and nymphs have the same appearance, and can usually be seen living in the same place and eating the same food.
- When we use pesticide, we can control only two stages. The eggs can be safe from the pesticide because they are hidden and do not eat.
- New outbreaks depend on the amount of hidden eggs and the arrival of new populations.
- Be careful of the hosts to insect pests, especially weeds.

About 250 species of aphids are pests that transmit viral pathogens, are shaped like an avocado, and have two horns on their belly.

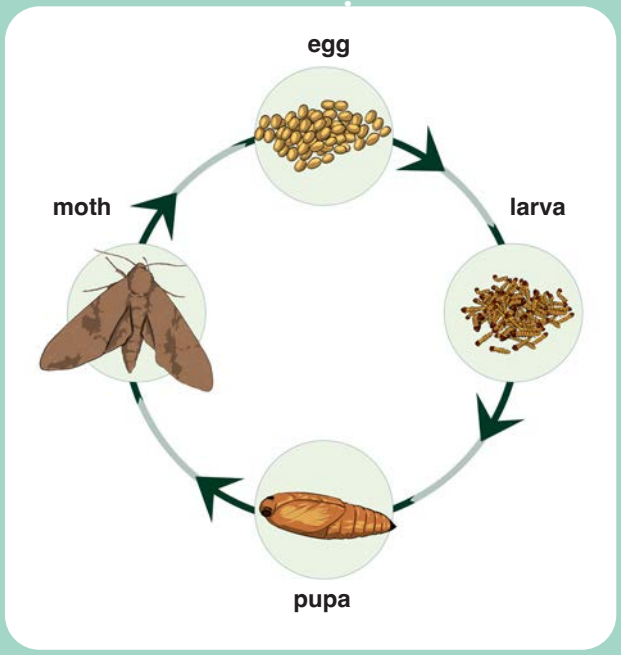
Mealybug

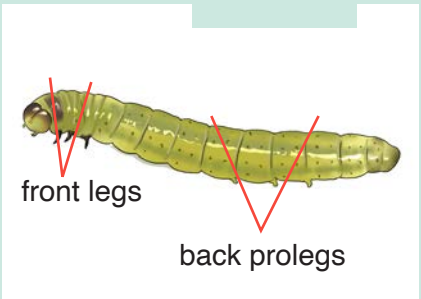
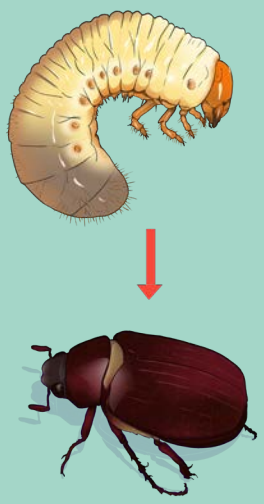
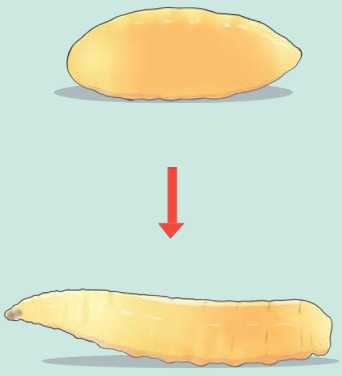
A sucking insect that moves slowly, lives in alliance with ants and directs the ants to other host plants.



Life cycle of insect pest with four stages

- The moth and newly hatched larvae are different. They do not live in the same place and also do not eat the same food.
- At the egg stage and the pupa stage they can escape from being killed or removed because they hide themselves and do not eat.
- When spraying, we kill only one stage or two stages at most: the eggs and pupa can escape safely.
- Farmers usually know only the stages that cause destruction but do not know about this life cycle.



Larvae of the moths	Larvae of the beetles	Larvae of the flies
► They have three pairs of true legs at the front ► They have four pairs of prolegs at the back ► True legs are segmented and located close to the head	► They have three pairs of true legs at the front ► No prolegs ► Visible head	► No head ► No legs
		

WHEN THERE IS NO CROP WHERE CAN THE INSECT PESTS BE FOUND?

They feed on, and reproduce in, weeds or grass.
The host plants can be in the same family, or from a different family of the crop that they destroyed.

For example: Diamondback moth destroys cabbage, mustard green, bok choy, kale and all crops in the cabbage family.

Whitefly damages tomato, long bean, cucumber and other crops.

How dangerous can the host plants be for crop cultivation?

Disease factors: Infected agents that can cause damage to plants are called pathogens.

Types of pathogens:

1. Fungi
2. Bacteria
3. Viruses

These pathogens can live in the soil, plants, water, and some insects. They are all sources of disease transmission. The fungi and bacteria can spread through:

- Air
- Rain
- Pests
- Water
- Seed
- Equipment and agricultural machinery
- Human activities (clothing, shoes...)

What farmers need to know about pests

- It is necessary to reduce the use of agricultural chemicals to keep the impact on the environment to a minimum.
- Effective crop management can produce safe vegetables for consumption and does not affect the health of family members.

Management measures:

General measures commonly used include biological, cultural, and chemical. For the home garden, farmers should focus more on biological as well as mechanical measures which mean catching the insects or removing infected plants by hand. The chemical measure should not be used.

Sampling:

Sampling is necessary to determine the presence and the prevalence of infection or contamination before the symptoms appear on plants. When the symptoms appear (especially in the case of viruses) it is already too late to get rid of them. Farmers need to know what to look for and where, and sampling needs to be conducted at least three times/week. Farmers should take notes and keep records.

Identification of pathogens (wilting)

Problem	Why has it happened?	What to observe?
Wilting Of plants	Not enough water	Moisture in the soil
		Clogging of the drip line
	Nematode	Pull the plant to inspect the root system
		Check nodules on the roots
		Nematodes that can be seen through a microscope
	Fusarium	The plant becomes yellow, and the top part of the plant is the first to wilt
		plant looks normal when the weather is cold
		The part of the plant that has been affected cannot be healed
		The inner part of the stem becomes brown
	Bacteria	The plant still looks green but many of the leaves have started to wilt
		The part of the plant that has been affected cannot be healed
		The plant looks permanently wilted even under cold weather conditions
		Inspect the ooze of bacteria by using a glass of water

Identification of pathogens (viruses)




LOCAL SEED PRODUCTION

iDE encourages farmers to produce local seeds from some selected crops that are known to be high quality as commercial seeds.

The benefits of the community seed production include:

- Preservation of local seeds.
- Local seeds are more suitable for local climates and growing conditions, and can resistant to diseases and insects better than hybrid seeds or varieties imported from outside.
- They can provide additional income, and the supply is safer compared with imported seeds. This was important when global logistics were disrupted during Covid-19. particularly when global logistic disrupted during Covid-19 pandemic.

From experience, good quality local seeds that perform similarly to imported seeds when compared according to crop resistance, market demand, color and taste, include long bean, eggplant, tomato and rice melon.

How to select local seed

- Choose healthy plants that have vigorous stems, uninfected fruit, and look healthy with no sign of any damage.
- Wrap the selected fruits with paper bags to protect them from damage (only if farmers can afford to buy the paper bags).
- Leave the selected fruits for seed production to ripen on the stem, or when the skin turns yellow or red.

For tomato, eggplant, and rice melon

- Cut the ripe fruit from the stem.
- Then cut the top and the bottom part of the fruit (about 2 cm).
- Split the seeds and squeeze by hand to separate seeds from flesh, using a fine mesh net.
- Rinse the separated seeds from the flesh with clean water multiple times.

For string beans

- Cut the ripe fruit and leave it to sun dry in the nursery for four to five days.
- Separate the seeds from the seed pods by hand if the amount is small.

For all crops

- Soak the seeds in bleached water (15%) for about 15 minutes to clean off some viruses that can stick to the outer layers of the seeds.
- Dry the seeds in the nursery for two to three more days (except from 10 am in the morning to 2-3pm in the afternoon).

How to store seeds:

- Collect well-dried seeds and mix them it with talc powder or bamboo ash
- Pack the seeds in a well-sealed paper or plastic bag and store in a sealed container
- Note the seed name and date of collection (crop name, where it come from, when the seeds were collected).
- Store the seed container in a dry place, well ventilated, cold, and not in direct sunlight.
- Seeds should be kept for at least 60 to 90 days for seed dormancy before planting in order for the seeds to grow well and for crops to be healthy.

RAINWATER STORAGE SYSTEM

From observing farmers, especially smallholders, there is a shortage of water, and no other options to expand water storage capacity in the family and farms.

iDE piloted rainwater harvesting systems for smallholder farmers especially for families with gardens located in or near the house. Thirteen prototype systems have been built using a collection of six concrete stands with a height of 2.5 meters on top of an 0.80 cm foundation. Therefore, the total height of the system is 3.30 meters (as shown in the picture below). This system has the capacity to store 11,000 liters or 11 cubic meters of rainwater. Based on the experience of farmers, the water stored in this system is enough to irrigate a garden size of 250 m2 up from eight to 11 times, and is also sufficient for household use.

Advantages of a rainwater harvesting system:

1. Stores rainwater in the dry season, or during a dry spell, for the irrigation of the home garden and daily household use.
2. It can provide clean water for household use and for livestock.
3. It can irrigate the garden using a drip system without using a motor to pump.
4. It can refill water from a well or pond during the dry season so that these sources can have time to recharge.